IRANIAN ECONOMIC REVIEW

Print ISSN: 1026-6542
Online ISSN: 2588-6096

University of Tehran

Iranian Economic Review (IER), Vol. 29, No. 4, 2025

University of Tehran

In The Name of God

Iranian Economic Review (IER), Vol. 29, No. 4, 2025

University of Tehran

Iranian Economic Review journal is indexed in **SCOPUS** as the largest abstract and citation database of international peer- reviewed journals.

IRANIAN ECONOMIC REVIEW

Faculty of Economics, University of Tehran

Volume 29 | 2025 | No. 4

CALL FOR PAPERS
IRANIAN ECONOMIC REVIEW

The IER (ISSN 1026-6542) editorial board welcomes papers for the upcoming volume. See Submission Guidelines on the back.

Papers should be uploaded in:

http://ier.ut.ac.ir

Chairman of the Editorial Board

Ali Taiebnia

Faculty of Economics,

University of Tehran,

P.O. Box 14155- 6445,

Tehran, Iran.

Tel, Fax: (+9821)- 88004584

E-mail: ier@ut.ac.ir

Website: http://ier.ut.ac.ir

Iranian Economic Review, 2025, 29(4),1186-1204
DOI: https://doi.org/10.22059/ier.2024.366514.1007824

RESEARCH PAPER

Examining the Impact of Income, Population Ageing, and Environmental Quality on Healthcare Expenditure in OPEC Member Countries

Hojjat Izadkhasti[*,a]

a. Department of Economics, Faculty of Economics and Political Sciences, Shahid Beheshti University, Tehran, Iran.
* Corresponding author.

Received: 12 October 2023, Revised: 01 February 2024, Accepted: 12 February 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

The rising cost of healthcare in countries poses a growing threat to the sustainability of healthcare systems and the fiscal stability of governments. As a result of economic development, increased life expectancy, population ageing, and decline in environmental quality, the geriatric population is exposed to air pollution for an extended period of time. This increases the demand for medical services and long-term care, as well as the increased expenditure on healthcare. This study investigates the effect of income, population ageing, and environmental quality on healthcare expenditure in OPEC member countries from 2000 to 2020 using the panel data method. According to the results, urbanization, life expectancy, and population ageing, as well as increased disability and underlying maladies, increase the demand for medical care and the associated costs. Also, the elasticity of healthcare expenditure based on GDP per capita is less than one. Therefore, health services are considered essential goods in OPEC member countries. In addition, the decline in environmental quality and the long-term exposure of the elderly population to air pollution have led to increased healthcare expenditure that threatens the financial and healthcare systems of the government.

Keywords: Ageing of the Population, Expenditure of Healthcare, Life Expectancy, OPEC, Quality of Environment.

JEL Classification: C23, H51, I19, Q52.

1. Introduction

Since the 1970s, healthcare expenditure has been the focus of economists, and one of the challenges in the discipline of health economics is to identify the factors that influence healthcare expenditures. These expenditures play an essential role in the health of people and the economic development of countries (Fogel, 2004). In developed and developing countries, the correlation between economic growth and healthcare expenditures is positive (Braedle and Colombier, 2016; Murthy and Okunade, 2016; Lopreite and Mauro, 2017; Lopreite and Zhu, 2020). Specifically, economic expansion and a rise in income increase the demand for medical services. In addition, increasing rates of chronic diseases (such as cardiovascular diseases, cancer, chronic kidney disease, diabetes, and their related complications) in senior age groups increase the demand for long-term healthcare services, such as costly technologies and hospitalizations that jeopardize the viability of healthcare systems (Murthy and Ukpolo, 1994; Feng et al., 2020). Also, people's life expectancy rises with economic growth, urbanization expansion, and the enhancement of medical and health services. Consequently, the increase in life expectancy as one of the indicators of health status also results in increased healthcare expenditures (Werblow et al., 2007; Harper, 2014). In contrast, increased healthcare expenditures result in greater availability of medical products and long-term health services, as well as increased life expectancy (Kunze, 2014). As the life expectancy of the elderly increases, so does the duration of infirmity and underlying disease, which increases the elderly's need for medical care and their healthcare expenses (Borrescio-Higa and Valenzuela, 2021). The level and structure of social costs are also affected by demographic patterns, and the demographic pressures of an ageing population increase the demand for medical services (Heller et al., 1986). Economic and social development, a decline in mortality rate, increased life expectancy, and a decline in fertility rate of women have resulted in structural changes in the population and compelled many nations to transition into a geriatric society (Wang et al., 2022). There is concern that the demographic pressures induced by the ageing of the population will lead to an unsustainable increase in public spending. Ageing and urbanization are global demographic patterns with significant social, economic, and political implications (Leeson, 2018). The increase in the geriatric population in various nations and their increased use of health services drives up healthcare costs (Manski et al., 2013; Choi and Shin, 2015; Uddin et al., 2016; Lopreite and Zhu, 2020). The Organization for Economic Co-operation and Development (OECD) predicts that by 2050, Europe's age-related social costs will increase from approximately 19% of GDP in 2000 to approximately 26%. More than half of this increase is attributable to pensions and costs associated with the elderly's health and long-term care (Dang et al., 2001). If population ageing coincides with deteriorating health at older ages, public expenditures will be further impacted. According to

United Nations statistics, the percentage of the world's geriatric population (those aged 65 and older) has increased by 3.16% over the past 30 years and approached 10% by 2020. In 2021, the global elderly population increased to 2.723 million persons. It is anticipated that by 2050, the global population of senior citizens will reach 1.5 billion (United Nations, 2023). Economic prosperity and urbanization expansion are linked to the degradation of the environment and the emission of pollutants. In the theoretical literature, the quality of the environment also affects healthcare expenditures, and there is consensus in this field (Narayan and Narayan, 2008; Apergis et al., 2018c; Zaidi and Saidi, 2018), whereas less literature concentrates on the opposite relationship. Sami and Chokri (2014) confirmed a stable, long-term relationship in Tunisia between healthcare expenditure per capita, population ageing, healthcare, GDP, and environmental quality. Ahmad et al. (2021b) demonstrated a bidirectional causal relationship between CO2 emissions and the increase in healthcare costs in 27 Chinese provinces.

This study examines the impact of income per capita, population ageing, and environmental quality on healthcare expenditure in OPEC member countries[1] from 2000 to 2020 using the panel data method. The novelty of this research is to examine the interactive effect of population ageing and life expectancy, the interactive effect of the urban population and life expectancy, and the interactive effect of urban population and carbon dioxide emissions on the per capita healthcare expenditure per capita.

Section 2 provides the literature review and research background. In Section 3, the model is described, and the data are reported. Section 4 presents the model estimation and analyzes the results. Finally, in section 5, the results and policy recommendations are presented.

2. Literature Review

Newhouse (1977) was the first to investigate the factors affecting the cost of healthcare in selected countries that are members of the OECD and concluded that the income of the communities is the most significant factor affecting the cost of healthcare in these countries. In this regard, numerous studies have investigated the correlation between healthcare costs and economic growth or per capita income. Gerdtham et al. (1992) demonstrated that GDP per capita significantly explained the variation in healthcare costs across 19 OECD countries. Wang (2011) analyzed the causal relationship between the increase in healthcare costs

[1]. OPEC member countries include Algeria, Iran, Iraq, Kuwait, Libya, Qatar, Saudi Arabia, United Arab Emirates, Ecuador, Angola, Venezuela, and Congo.

and economic growth using data from 31 countries from 1986 to 2007. According to the findings of Amiri and Ventelou (2012), there is a two-way Granger causality between GDP and healthcare costs in OECD nations. Braendle and Colombier (2016) demonstrated a correlation between per capita income and the growth of healthcare expenditures. Amiri and Linden (2016), using data from 22 OECD countries from 1970 to 2012, discovered that the bidirectional relationship between GDP and total healthcare costs is prevalent in the overwhelming majority of countries. Halici-Tuluce et al. (2016) found a reciprocal relationship between healthcare expenditures and economic growth for both low- and high-income economies. Chaabouni et al. (2016) detected a bidirectional relationship between healthcare expenditure and economic growth in 51 low-, middle-, and high-income countries from 1995 to 2013. Other studies in developed and developing countries have found a positive correlation of healthcare costs with economic growth and income (Lopreite and Mauro, 2017; Lopreite and Zhu, 2020).

The level and structure of social costs are also affected by demographic patterns, so that the demographic pressures of an ageing population increase the demand for medical services (Heller et al., 1986). The increase in the geriatric population in various nations and the increased utilization of health services by this group cause a rise in healthcare expenditures (Hosoya, 2014). Manski et al. (2013) indicated that the use of medical care and visits to care centers is on the rise among the elderly in the United States. Ageing is associated with a decline in physical abilities and the development of chronic and underlying diseases. If the ageing of the population coincides with a decline in health as people age, medical expenses will rise. As the life expectancy of the elderly increases, so will the duration of disability and underlying disease, increasing the elderly's need for medical care and their healthcare expenses (Borrescio-Higa and Valenzuela, 2021). Increasing the frequency and duration of health service use, as well as increasing the cost of medication, treatment, and rehabilitation for the elderly relative to other age groups, causes increased healthcare costs (Jenson, 2007). Additionally, the increase in the elderly population increases the government's healthcare expenditures and contributes to a rise in the government budget deficit (Derek and Chen, 2004; Kluge, 2013). Izadkhasti and Balaghi Inalo (2018) examine the effects of the allocation of government expenditure to the health sector and prevention of pollution in an endogenous growth model. Consequently, the increased demand for medical services and care among this age group primarily affects the government's financial instability (Lopreite and Zhu, 2020; Jia et al., 2021). Therefore, the government can allocate resources to address the negative effects of ageing by implementing appropriate policies or by predicting future population age changes (Auerbach, 2012). Murthy and Okunade (2016), using annual data from 1960 to 2012 and an autoregressive distributed lag (ARDL) approach, identified real per capita income, the proportion of the population over 65 years old, and the level of healthcare technology as the primary drivers of per capita healthcare expenditure. Izadkhasti et al. (2017) analyzed the effects of green taxes on emissions of pollution and health index in Iran, using a two-stage least squares technique and system of simultaneous equations, during the period (1989-2014). The results indicate that the green tax will reduce pollutants. Also, simultaneously reducing emissions of pollution will increase the health index. Jia et al. (2021), using gray system theory, examined the degree of correlation between healthcare expenditures, population ageing, and economic conditions from 2000 to 2018 in China. The results indicated that the government and society of China played a significant role in reducing the medical burden of residents. In addition, the recovery of the economy and the ageing of the population have increased the demand for health services. The OECD predicts that by 2050, Europe's age-related social costs will increase from approximately 19% of GDP in 2000 to approximately 26%. More than half of this increase is attributable to pensions and costs associated with the elderly's health and long-term care (Dang et al., 2001).

On the other hand, with economic, social, and urban development, life expectancy has also increased. However, with the discharge of pollutants, the quality of the environment has decreased, leading to an increased elderly population with underlying diseases. This has ultimately resulted in a rise in healthcare demand and costs. In this regard, Linden and Ray (2017) discovered a positive relationship between public healthcare expenditures (particularly private expenditures) and life expectancy for 34 OECD countries between 1970 and 2012 using the panel data method. Lopreite and Mauro (2017) applied Bayesian Vector Autoregression (B-VAR) models from 1990 to 2013 in Italy and concluded that healthcare expenditures responded more to the population ageing index than to life expectancy and economic development. Gallet and Doucouliagos (2017), using meta-regression analysis, detected evidence that the mortality rate has a greater effect on healthcare costs than life expectancy. Lopreite and Zhu (2020), using Bayesian Vector Autoregression (B-VAR) models, examined the effects of population ageing on healthcare costs and economic growth in China and the United States from 1978 to 2016. The results indicated that economic growth encourages healthcare expenditures and that increasing life expectancy contributes to a rise in the ageing index in China and the United States. Moreover, the significance of the population ageing index on healthcare expenditure and GDP is greater in China than in the United States. Linden and Ray (2017) divided 34 OECD countries into three categories based on public spending as a percentage of GDP, and discovered a positive correlation between public healthcare spending and life expectancy in countries with a larger proportion. Liu (2020) examined the relative importance of ageing in increasing healthcare costs by examining diabetes care costs in Taiwan, and found that approximately 75% of the variation in diabetes care costs was attributable to the effects of population ageing.

The decline in environmental quality and the discharge of pollutants have exposed the elderly to underlying diseases, thereby increasing the demand for healthcare and treatment. Gerdtham et al. (1992) investigated for the first time the impact of air pollution on healthcare costs in Canadian provinces. There is consensus in the theoretical literature regarding the relationship between environmental quality and healthcare expenditures (Narayan and Narayan, 2008; Apergis et al., 2018c; Zaidi and Saidi, 2018), whereas less research has been conducted on the inverse relationship. Accordingly, the long-term exposure of the elderly population to air pollution increases the cost of healthcare. In some previous studies, urban populations have been the primary focus, and the statistical power to estimate health effects in other groups is insufficient (Di et al., 2017). In Tunisia, Sami and Chokri (2014) confirmed a stable long-run relationship between healthcare expenditure per capita, population ageing, healthcare density, GDP, and environmental quality. Ahmad et al. (2021b) found a bidirectional causal relationship between CO2 emissions and the development of healthcare expenditures in 27 Chinese provinces. Apergis et al. (2018a) confirmed that consumption of renewable energy and healthcare expenditure decreased CO2 emissions in 42 sub-Saharan African nations. In addition, they proposed increased funding for renewable energy and healthcare initiatives. Wu (2019) analyzed the footprint of China’s healthcare system using the environmental extended input-output technique. The results indicated that China had a smaller carbon footprint per capita for healthcare than developed nations, but comparatively higher emissions per unit of healthcare expenditure.

The novelty of this research is to examine the interactive effect of population ageing and life expectancy, the interactive effect of the urban population and life expectancy, and the interactive effect of urban population and carbon dioxide emissions on the per capita healthcare expenditure per capita.

3. Methods and Materials

As a result of economic development, increased life expectancy, population ageing, and decline in environmental quality, the geriatric population is exposed to air pollution for an extended period of time. This increases the demand for medical services and long-term care, as well as the increased expenditure on healthcare. Therefore, following Lopreite and Mauro (2017), Lopreite and Zhu (2020), Ahmad et al. (2021b), and Wang et al. (2022), we examine the effect of population ageing and environmental quality on healthcare expenditure in OPEC member countries using the panel data method over the period of 2000 to 2020.

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} + \beta_3 LLE_{it} + \beta_4 LUB_{it} + \beta_5 LCO2_{it} + \eta_i + \varepsilon_{it} \quad (1)$$

Where LHE_{it} is the logarithm of healthcare expenditures per capita (at current prices), $LGDPP_{it}$ is the logarithm of GDP per capita (at constant 2015 prices), LAP_{it} is the logarithm of the population aged 65 and over, LLE_{it} is the logarithm of life expectancy at birth, LUB_{it} is the logarithm of the urban population (as a percentage of the total population), and $LCO2_{it}$ is the logarithm of carbon dioxide emissions per capita in i^{th} country in time period t. η_i stands for individual effects, while ε_{it} stands for the error term. In Equations 2 through 5, the interactive effect of urbanization and life expectancy, the interactive effect of urbanization and carbon dioxide emissions, the interactive effect of population ageing and carbon dioxide emissions, and the interactive effect of population ageing and life expectancy are tested on per capita healthcare expenditure, respectively:

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} + \beta_3 LUB_{it} * LLE_{it} + \beta_4 LCO2_{it} + \eta_i + \varepsilon_{it} \quad (2)$$

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} + \beta_3 LUB_{it} * LLE_{it} + \beta_4 LCO2_{it} + \eta_i + \varepsilon_{it} \quad (3)$$

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} + \beta_3 LLE_{it} + \beta_4 LUB_{it} * LCO2_{it} + \eta_i + \varepsilon_{it} \quad (4)$$

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} * LCO2_{it} + \beta_3 LLE_{it} + \beta_4 LUB_{it} + \eta_i + \varepsilon_{it} \quad (5)$$

$$LHE_{it} = \alpha_i + \beta_1 LGDPP_{it} + \beta_2 LAP_{it} * LLE_{it} + \beta_3 LUB_{it} + \beta_4 LCO2_{it} + \eta_i + \varepsilon_{it} \quad (6)$$

The data of OPEC member countries were obtained from the website of the World Bank. Libya and Venezuela have been eliminated due to the absence of data for certain variables. The estimation of the model is performed using the panel data model and STATA 17 software. The variables are described in Table 1.

Table 1. Description of Variables

Variable	Symbol	Definition	Source
Healthcare expenditure	HE	Healthcare expenditure per capita (current US$)	(WDI[1], 2022)
GDP per capita	GDPP	GDP per capita is gross domestic product divided by midyear population (constant 2015 US$)	(WDI, 2022)
Ageing population	AP	Population ages 65 and above	(WDI, 2022)
Life expectancy	LE	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	(WDI, 2022)
Urbanization	UB	Urbanization rate is the measurement index of urbanization, which generally adopts a demographic index, namely the proportion of urban population in the total population (%)	(WDI, 2022)
Carbon dioxide emissions per capita	CO2	Regional carbon dioxide emissions (metric tons per capita)	(WDI, 2022)

4. Results and Discussion

Before analyzing the relationship between the variables, the variables' stationarity ought to be examined with unit root tests. In panel data models, the Levin-Lin-Chu (LLC) test, the Im-Pesaran-Shin (IPS) test, the Breitung test, the Fisher-ADF test, and the Hadri LM test are applied. Results are reported in Table 2. The unit root tests were done with an individual intercept for each variable, and the optimal lag length was selected automatically using the Schwarz Information Criterion (SIC). According to Levin-Lin-Chu and Hadri LM test, all variables are stationary at 1 %, level. Also, Life expectancy and Urbanization, based on all unit root tests, are stationary.

1. World Bank Database

Table 2. Panel Unit-Root Tests for Variables

Variables	LLC	Breitung	IPS	Fisher- ADF	Hadri
Ln (Healthcare expenditure per capita)	-4.63	3.08	-1.68	13.80	25.16***
Ln (Ageing population)	-12.26***	6.94***	-3.05***	19.94	28.14 ***
Ln (GDP per capita)	-6.20***	5.16***	-1.61	26.44	20.77***
Ln (Life expectancy)	-7.70***	8.65***	-2.23**	43.26***	35.95***
Ln (C02 per capita)	-5.38***	2.07	-1.41	7.13	14.53***
Ln (Urbanization)	-4.66***	7.55***	-60.34***	189.8***	26.5***

Source: Research finding.

Note: The unit root tests were done with an individual intercept for each variable. The optimal lag length was selected automatically using the Schwarz Information Criterion (SIC). *, **, and *** are significant at the 10%, 5 % and 1 % level, respectively.

To avoid spurious relationships and ensure the existence of a long-term relationship between variables, panel cointegration tests provided by Pedroni (1999, 2004) are applied, where the null hypothesis indicates the absence of cointegration between model variables. This method estimates cointegration regression separately for each country. The null hypothesis is rejected at a significance level of 10% based on the rho and ADF statistics of the panel in Table 3, and there is a long-term relationship between the variables of the model.

Table 3. Pedroni Cointegration Test

Test Stats	Panel-stats	Group-stats
v-stat	0.777	-
rho-stat	1.856*	3.227*
t-stat	-0.8944	-0.3399
ADF-stat	-2.183*	-1.714*

Source: Research finding.

Note: The data has been time-consuming. All test statistics have an N(0,1) distribution under the null hypothesis of no cointegration. *, is significant at the 10%, level.

Table 4 provides descriptive statistics of research model variables, such as mean, maximum, minimum, and standard deviation for ten OPEC member nations from 2000 to 2020. The dependent variable in this study is the logarithm of healthcare expenditures per capita, while the independent variables are the logarithms of GDP per capita, the population aged 65 and over, life expectancy, carbon dioxide emissions per capita, and the percentage of urban population.

Table 4. Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
Ln Healthcare expenditure per capita	210	5.684	1.293	2.564	**7.6166**
Ln Ageing population	210	12.676	1.763	8.998	**15.640**
Ln GDP per capita	210	9.106	1.199	7.369	**11.204**
Ln Life expectancy	210	4.262	0.120	3.829	**4.394**
Ln C02 per capita	210	1.445	1.945	-3.515	**3.863**
Ln Urbanization	210	4.263	0.260	3.558	**4.605**

Source: Research finding.

Note: Mean is the average, Std is the standard deviation, Min is the minimum, and Max is the maximum.

Figure 1 depicts the trend of healthcare expenditures (%GDP), and Figure 2 shows the trend of the population aged 65 and older (%POP) in OPEC member countries during the period 2000-2020.

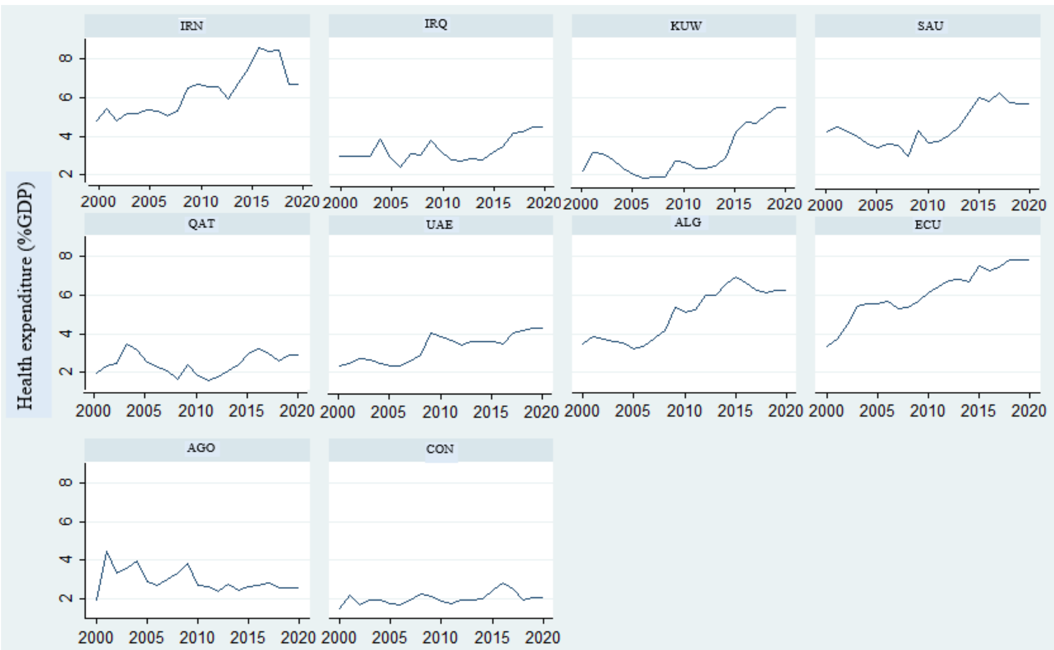


Figure 1. Healthcare Expenditure Trends (%GDP) in OPEC Member Countries between 2000 and 2020

Source: Research finding.

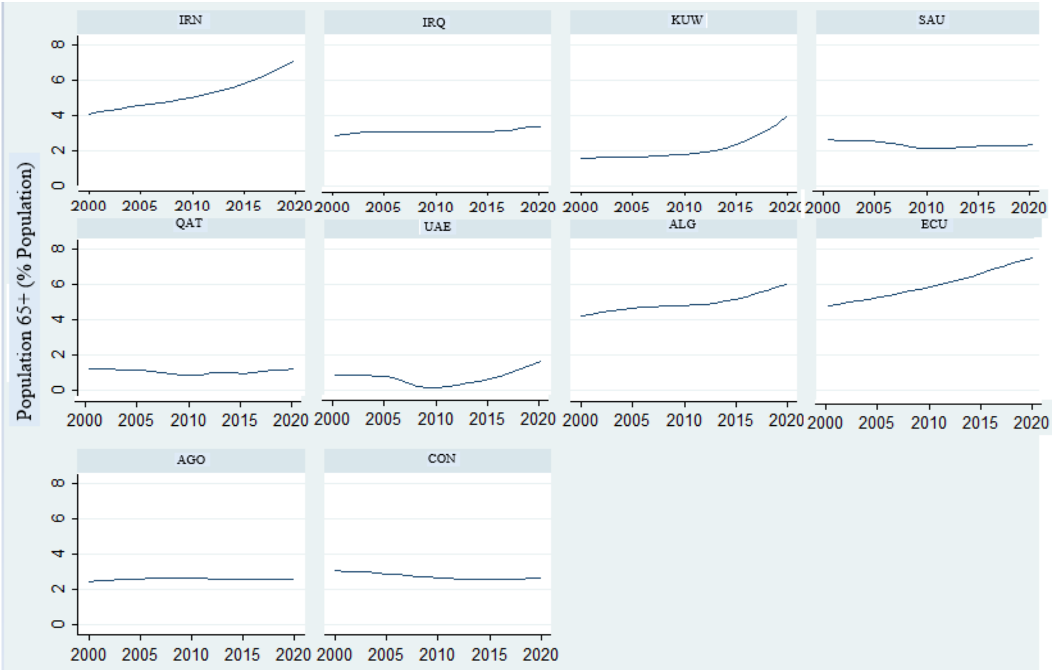


Figure 2. Population Trend of 65 Years and Older (%POP) in Selected Countries between 2000 and 2020

Source: Research finding.

The F-Limer test is utilized to distinguish between pooling and panel data. The null hypothesis is rejected at a significance level of 1% using the F-test across multiple models, and the statistical data is confirmed to be panel data, as shown in Table 5. Also, the null hypothesis is rejected at the 1% level based on the results of the Hausman test, and the estimation confirms the model of fixed effects versus random effects. According to the results obtained, the increase in GDP per capita raises the cost of healthcare expenditure per capita. In models 1 through 5, the income elasticity of healthcare expenditure was 0.611, 0.667, 0.402, 0.557, and 0.720, respectively, and all of which are less than one. Consequently, healthcare facilities are necessary goods in OPEC member countries. This result is consistent with previous research findings in this field. Amiri and Ventelou (2012) discovered a two-way Granger causality between GDP and healthcare expenditures. Braendle and Colombier (2016) demonstrated a correlation between per capita income and the growth of healthcare expenditures. Amiri and Linden (2016) exhaustively determined the bidirectional relationship between GDP and total healthcare expenditures. In the short-term, Halici-Tuluce et al. (2016) demonstrated a reciprocal relationship between healthcare expenditures and economic growth for both low-income and high-income economies in their sample. Chaabouni et al. (2016) discovered a bidirectional relationship between healthcare expenditures and economic growth in 51 low-, middle-, and high-income countries.

In models 1 to 3, a 1% increase in the population aged 65 and older has resulted in increases of 0.587%, 0.567%, and 0.593% in per capita healthcare expenditure, which are significant at the 1% level. Consequently, old age is associated with a decline in physical capabilities and chronic and underlying diseases, and as health declines with age, the treatment costs rise. These outcomes are consistent with those of Manski et al. (2013), Choi and Shin (2015), Uddin et al. (2016), Lopreite and Zhu (2020), and Borrescio-Higa and Valenzuela (2021).

In models 1, 3, and 4, an increase of 1% in life expectancy led to increases of 2.782%, 5.169%, and 10.633% in healthcare expenditure per capita, respectively. Life expectancy increases as a result of economic development and the enhancement of medical and healthcare services. These results are consistent with those of Werblow et al. (2007), Harper (2014), and Linden and Ray (2017). Considering that economic and social development and increased life expectancy result in population structure changes (Wang et al., 2022), ultimately, this will increase healthcare and medical costs. In this regard, the estimated coefficient for the interactive effects of life expectancy and population ageing with healthcare costs was calculated to be 0.139.

In models 1, 2, and 5, an increase of 1% in per capita carbon dioxide emissions led to increases of 0.905%, 0.864%, and 0.825% in per capita healthcare costs, respectively. This result is consistent with findings of Narayan and Narayan (2008), Apergis et al. (2018c), and Zaidi and Saidi (2018). Ahmad et al. (2021b) also found a two-way causal relationship between CO2 emissions and the increase in healthcare costs. With the growth of urbanization and the increase in urban population, carbon dioxide emissions also increase. On the basis of this information, the interactive effect of urbanization and carbon dioxide emission on the per capita cost of healthcare has been analyzed, and its estimated coefficient is 0.266.

In models 1, 4, and 5, a one percent increase in the urban population led to an increase in healthcare expenditure per capita of 2.168%, 4.802%, and 2.944%, respectively. Because economic, social, and urbanization development also increase life expectancy and healthcare costs, the estimated coefficient for the interactive effect of urban population and life expectancy on healthcare expenditure per capita has been calculated as 0.618.

Table 5. Results of Fixed Effects Regression Estimation

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
LnGDPP	0.641** (0.246)	0.667** (0.225)	0.402* (0.239)	0.557** (0.218)	0.720*** (0.227)
LnAP	0.587*** (0.078)	0.567*** (0.079)	0.593*** (0.076)	-	-
LnLE	2.782** (1.291)	-	5.169*** (0.689)	10.633*** (1.291)	-
LnCO2	0.905*** (0.244)	0.864*** (0.226)	-	-	0.825** (0.234)
LnUR	2.168* (1.137)	-	-	4.802*** (1.218)	2.944*** (0.694)
LnUR∗LnLE	-	0.618*** (0.082)	-	-	-
LnUR∗LCO2	-		0.266*** (0.052)	-	-
LnAP∗ LCO2	-	-	-	0.322 (0.205)	-
LnAP∗LnLE	-	-	-	-	0.139*** (0.205)
C	-30.021*** (2.705)	-20.091*** (1.932)	-29.30*** (2.583)	-66.910*** (4.911)	-22.139*** (2.968)
F test*	F(9, 195) = 10.06***	F(9, 196) = 10.48***	F(9, 196) = 14.07***	F(8, 159) = 17.85***	F(9, 196) = 10.13***
Hausman test	10.06***	29.60***	34.84***	61.30***	37.20***
Observations	210	210	210	210	210
Number of countries	10	10	10	10	10
	Within = 0.65 Between = 0.75 Overall = 0.68	Within = 0.65 Between = 0.77 Overall = 0.70	Within = 0.56 Between = 0.96 Overall = 0.88	Within = 0.65 Between = 0.87 Overall = 0.79	Within = 0.64 Between = 0.76 Overall = 0.69

Source: Research finding.

Note: The figures enclosed in parentheses beneath the regression coefficients represent standard errors. *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively. The dependent variable is the logarithm of health expenditure per capita (current US$). The ageing population, GDP per capita, life expectancy, per capita CO2 emissions, and urbanization are all expressed in natural logarithms.

5. Conclusion and Policy Recommendation

Identifying the factors that affect healthcare costs is one of the challenges of health economics. In both developed and developing countries, economic growth and income are positively correlated with healthcare costs. Additionally, the rise in income increases the demand for medical services. Increasing rates of chronic diseases (such as cardiovascular disease, cancer, chronic kidney disease, diabetes, and their related complications) and long-term exposure to air pollution increase the demand for long-term healthcare services, such as technologies, among senior age groups. Hospitalization becomes costly, putting the sustainability of healthcare systems at peril. Population ageing, increased life expectancy, the growth of urbanization, and a decline in environmental quality due to increased environmental pollutants influence the level and structure of social costs and healthcare costs. This study investigates the effects of population ageing, environmental quality, and income per capita on healthcare costs per capita in OPEC member countries from 2000 to 2020. According to the findings, the rise in income per capita increases the demand for medical services. Due to the fact that the income elasticity of healthcare expenditures is less than one, health services are necessary goods in OPEC member nations. The increase in the geriatric population has led to an increased cost of healthcare per capita. Hence, old age is linked to a decline in physical capabilities and chronic and underlying diseases. If population ageing and health decline at older ages occur simultaneously, medical expenses will rise. Increasing life expectancy, combined with infirmity and underlying disease, increases the medical care requirements of the population. Based on this, the increasing frequency and duration of the elderly's use of health services, as well as the rising costs of medication, treatment, and rehabilitation, contribute to a rise in healthcare costs. As a consequence, the interaction between an aging population and life expectancy has led to increased healthcare expenditures. In addition, urbanization and the decline in environmental quality as a consequence of the increase in carbon dioxide emissions have exposed people to air pollution for an extended period of time and increased the per capita cost of healthcare. Also, the interactive effects of the rise in urbanization and life expectancy, as well as the interactive effects of the rise in urbanization and per capita carbon dioxide emissions, have increased the per capita cost of healthcare.

Considering the economic, social, and urban development, along with the ageing of the population, the increased life expectancy, and the decline in environmental quality in various societies, there has been an increase in the demand for long-term healthcare services, as well as increased public expenditures and healthcare costs. This threatens the viability of healthcare systems and has resulted in numerous economic, social, and political consequences and difficulties. Therefore, suggested that the government's implementation of practical and comprehensive policies and programs can mitigate the challenges posed by the ageing of the population, the decline in environmental quality, and their reciprocal effects on the rise in costs.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Ahmad, M., Rehman, A., Shah, S. A. A., Solangi, Y. A., Chandio, A. A., & Jabeen, G. (2021). Stylized heterogeneous dynamic links among healthcare expenditures, land urbanization, and CO2 emissions across economic development levels. *Science of the total environment*, *753*, 142228. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0048969720357570.

Amiri, A., & Linden, M. (2016). Income and total expenditure on health in OECD countries: Evidence from panel data and Hsiao's version of Granger non-causality tests. *Economics and Business Letters*, *5*(1), 1-9. Retrieved from https://ideas.repec.org/a/ove/journl/aid10834.html.

Amiri, A., & Ventelou, B. (2012). Granger causality between total expenditure on health and GDP in OECD: Evidence from the Toda–Yamamoto approach. *Economics Letters*, *116*(3), 541-544. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0165176512001814.

Apergis, N., Gupta, R., Lau, C. K. M., & Mukherjee, Z. (2018). US state-level carbon dioxide emissions: does it affect health care expenditure?. *Renewable and Sustainable Energy Reviews*, *91*, 521-530. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1364032118301163.

Apergis, N., Jebli, M. B., & Youssef, S. B. (2018). Does renewable energy consumption and health expenditures decrease carbon dioxide emissions? Evidence for sub-Saharan African countries. *Renewable Energy*, *127*, 1011-1016. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0960148118305640.

Auerbach, A. J. (2012). Societal aging: Implications for fiscal policy. *Institute for Monetary and Economic Studies, Bank of Japan, Working Paper, 12-E-12*, Retrieved from https://www.imes.boj.or.jp/research/papers/english/12-E-12.pdf.

Borrescio-Higa, F., & Valenzuela, P. (2021). Does education mitigate the effect of population aging on health expenditure? A panel data study of Latin American Countries. *Journal of Aging and Health, 33*(7-8), 585-595. Retrieved from https://pubmed.ncbi.nlm.nih.gov/33913783/.

Braendle, T., & Colombier, C. (2016). What drives public health care expenditure growth? Evidence from Swiss cantons, 1970–2012. *Health Policy*, *120*(9), 1051-1060. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0168851016301816.

Chaabouni, S., & Abednnadher, C. (2014). The determinants of health expenditures in Tunisia: An ARDL bounds testing approach. *International Journal of Information Systems in the Service Sector (IJISSS)*, *6*(4), 60-72. Retrieved from https://www.igi-global.com/article/the-determinants-of-health-expenditures-in-tunisia/120592.

Chaabouni, S., Zghidi, N., & Mbarek, M. B. (2016). On the causal dynamics between CO2 emissions, health expenditures and economic growth. *Sustainable cities and society*, *22*, 184-191. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S2210670716300142.

Charfeddine, L., & Mrabet, Z. (2017). The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries. *Renewable and sustainable energy reviews*, *76*, 138-154. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1364032117303520.

Chen, D. H. C. (2004). *Population age structure and the budget deficit* (Vol. 3435). World Bank Publications. Retrieved from https://openknowledge.worldbank.org/entities/publication/9733e02d-1544-5c0e-a9e2-c1cefe6e72e3.

Choi, K. H., & Shin, S. (2015). Population aging, economic growth, and the social transmission of human capital: An analysis with an overlapping generations model. *Economic modelling*, *50*, 138-147. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0264999315001510.

Dang, T. T., Antolin, P., & Oxley, H. (2001). Fiscal implication of ageing: projections of age-related spending. *SSRN*, *607122,* Retrieved from https://ideas.repec.org/p/oec/ecoaaa/305-en.html.

Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., Dominici, F., & Schwartz, J. D. (2017). Air pollution and mortality in the Medicare population. *New England Journal of Medicine*, *376*(26), 2513-2522. Retrieved from https://www.nejm.org/doi/full/10.1056/NEJMoa1702747.

Farhadian, Z., Nivollet, M. B., Feldman, M. R. A., Heller, M. P. S., Hemming, M. R., Katz, M. M., Mansur, A., Donogh, M. D., Roggiero, E., & Kohnert, M. P. (1986). *Aging and social expenditure in the major industrial countries, 1980-2025*. Retrieved from International Monetary Fund.

Feng, J., Wang, Z., & Yu, Y. (2020). Does long-term care insurance reduce hospital utilization and medical expenditures? Evidence from China. *Social Science & Medicine*, *258*, 113081. Retrieved from https://pubmed.ncbi.nlm.nih.gov/32540515/.

Fogel, R.W. (2004). Health, nutrition and economic growth. *Economic Development* and Cultural *Change*, 52, 643–658. ABI/INFORM. Retrieved from https://ideas.repec.org/a/ucp/ecdecc/y2004v52i3p643-58.html.

Gallet, C. A., & Doucouliagos, H. (2017). The impact of healthcare spending on health outcomes: A meta-regression analysis. *Social Science & Medicine*, *179*, 9-17. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0277953617301132.

Gerdtham, U. G., Søgaard, J., Andersson, F., & Jönsson, B. (1992). An econometric analysis of health care expenditure: A cross-section study of the OECD countries. *Journal of Health Economics*, *11*(1), 63-84. Retrieved from https://pubmed.ncbi.nlm.nih.gov/10119757.

Halıcı-Tülüce, N. S., Doğan, İ., & Dumrul, C. (2016). Is income relevant for health expenditure and economic growth nexus?. *International Journal of Health Economics and Management*, *16*(1), 23-49. Retrieved from https://www.researchgate.net/publication/351249412_Is_income_relevant_for_health_expenditure_and_economic_growth_nexus.

Hosoya, K. (2014). Determinants of health expenditures: Stylized facts and a new signal. *Modern Economy*, *5*(13), 1171-1180. Retrieved from https://www.scirp.org/journal/paperinformation?paperid=52068.

Izadkhasti, H., Arabmazar, A. A., & Khoshnamvand, M. (2017). Analyzing the impact of green tax on emission of pollution and health index in Iran: A simultaneous equations model. *Journal of Economics and Modelling*, *8*(29), 89-117. Retrieved from https://ecoj.sbu.ac.ir/article_49615.html?lang=en.

Izadkhasti, H., & Balaghi Inalo, Y. (2018). Analyzing the effects of allocation of government expenditure in health sector and prevention of pollution on economic growth: endogenous growth approach. *The Economic Research*, *17*(4), 21-43. Retrieved from https://ecor.modares.ac.ir/article_13379.html?lang=en.

Jenson, J. (2007). Health Care spending and the aging of the population. Retrieved from https://ecommons.cornell.edu/bitstream/1813/76246/1/RS22619Health_Care_Spending.pdf.

Jia, H., Jiang, H., Yu, J., Zhang, J., Cao, P., & Yu, X. (2021, February). Total health expenditure and its driving factors in China: a gray theory analysis. *Healthcare*, *9*(2), 207. Retrieved from https://pubmed.ncbi.nlm.nih.gov/33673001/.

Kluge, F. A. (2013). The fiscal impact of population aging in Germany. *Public Finance Review*, *41*(1), 37-63. Retrieved from https://www.researchgate.net/publication/258175283_The_Fiscal_Impact_of_Population_Aging_in_Germany.

Kunze, L. (2014). Life expectancy and economic growth. *Journal of Macroeconomics*, *39*, 54-65. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0164070414000032.

Leeson, G. W. (2018). The growth, ageing and urbanisation of our world. *Journal of Population Ageing*, *11*(2), 107-115. Retrieved from https://link.springer.com/article/10.1007/s12062-018-9225-7.

Linden, M., & Ray, D. (2017). Life expectancy effects of public and private health expenditures in OECD countries 1970–2012: Panel time series approach. *Economic Analysis and Policy*, *56*, 101-113. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0313592616300583.

Liu, Y. M. (2020). Population aging, technological innovation, and the growth of health expenditure: Evidence from patients with Type 2 diabetes in Taiwan. *Value in Health Regional Issues*, *21*, 120-126. Retrieved from https://www.sciencedirect.com/science/article/pii/S2212109919305771.

Lopreite, M., & Mauro, M. (2017). The effects of population ageing on health care expenditure: a Bayesian VAR analysis using data from Italy. *Health policy*, *121*(6), 663-674. Retrieved from https://pubmed.ncbi.nlm.nih.gov/28392027/.

Lopreite, M., & Zhu, Z. (2020). The effects of ageing population on health expenditure and economic growth in China: a Bayesian-VAR approach. *Social science & medicine*, *265*, 113513. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0277953620307322.

Manski, R. J., Moeller, J. F., Chen, H., Schimmel, J., Clair, P. A. S., & Pepper, J. V. (2013). Patterns of older Americans' health care utilization over time. *American journal of public health*, *103*(7), 1314-1324. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC3676460/.

Murthy, N. V., & Ukpolo, V. (1994). Aggregate health care expenditure in the United States: evidence from cointegration tests. *Applied Economics*, *26*(8), 797-802. Retrieved from https://scite.ai/reports/aggregate-health-care-expenditure-in-9kPERk.

Murthy, V. N., & Okunade, A. A. (2016). Determinants of US health expenditure: Evidence from autoregressive distributed lag (ARDL) approach to cointegration. *Economic Modelling*, *59*, 67-73. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0264999316301845.

Narayan, P. K., & Narayan, S. (2008). Does environmental quality influence health expenditures? Empirical evidence from a panel of selected OECD countries. *Ecological economics*, *65*(2), 367-374. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921800907003941.

Wang, K. M. (2011). Health care expenditure and economic growth: Quantile panel-type analysis. *Economic modelling*, *28*(4), 1536-1549. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0264999311000265.

Wang, Q., Li, L., & Li, R. (2023). Uncovering the impact of income inequality and population aging on carbon emission efficiency: an empirical analysis of 139 countries. *Science of The Total Environment*, *857*, 159508. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0048969722066074.

Wang, Q., Wang, X., & Li, R. (2022). Does population aging reduce environmental pressures from urbanization in 156 countries?. *Science of the Total Environment*, *848*, 157330. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S004896972204428X.

Werblow, A., Felder, S., & Zweifel, P. (2007). Population ageing and health care expenditure: a school of ‘red herrings’? *Health Economics*, *16*(10), 1109-1126. Retrieved from https://pubmed.ncbi.nlm.nih.gov/17311357/.

Wu, R. (2019). The carbon footprint of the Chinese health-care system: an environmentally extended input–output and structural path analysis study. *The Lancet Planetary Health*, *3*(10), e413-e419. Retrieved from https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(19)30192-5/fulltext.

Zaidi, S., & Saidi, K. (2018). Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. *Sustainable cities and society*, *41*, 833-840. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S2210670717308466.

Cite this article: Izadkhasti, H. (2025). Examining the Impact of Income, Population Ageing and Environmental Quality on Healthcare Expenditure in OPEC Member Countries. *Iranian Economic Review*, *29*(4), 1186-1204.

Iranian Economic Review, 29(4), 1205-1233
DOI: https://doi.org/10.22059/ier.2024.367749.1007841

RESEARCH PAPER

Dynamic Conditional Correlation Analysis of Investor Herding: Evidence from the Indonesian and Malaysian Capital Markets

Suhendro Suhendro[*,a], Apriani Dorkas Rambu Atahau[b], Robiyanto Robiyanto[b], Harijono Harijono[b]

a. Department of Accounting, Faculty of Economics, Batik Islamic University, Surakarta, Indonesia.
b. Department of Management, Faculty of Economics and Business, Satya Wacana Christian University, Salatiga, Indonesia.
* Corresponding author

Received: 06 November 2023, Revised: 24 January 2024, Accepted: 17 February 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

This paper applies the Dynamic Conditional Correlation (DCC) multivariate GARCH model by including a volatility index to examine herding behavior. We analyzed whether stock return dispersion to the market return has a time-varying conditional correlation in the Indonesian and Malaysian capital markets. We used daily returns data of blue-chip stock and LQ45 & KLCI index for the period January 2015 – December 2022 to capture herding effects among the investors of both capital markets. The main findings demonstrate herding behavior in bullish markets before the pandemic, but only for the LQ45 and not for the KLCI. Herding will result in lower market returns. We further establish that the volatility index exhibits significant positive changes in a bearish condition amidst the epidemic in both indexes. These findings suggest that while institutional and long-term investors dominate the market for blue-chip companies, they nonetheless make investment decisions based on the majority under specific circumstances. The partial presence of herding behavior and anxiety indices in the market provides support for the behavioral finance theory, which suggests that individuals may exhibit irrational behavior.

Keywords: Dispersion, DCC GARCH, Multivariate, Volatility.
JEL Classification: C22, C58, G41.

1. Introduction

Herding is a part of human instinct widely discussed in behavioral research. Herding is a phenomenon characterized by individuals observing others' behavior and subsequently conforming to the majority (Botsvadze, 2013). As a manifestation of collective behavior, herding is influenced by the psychological comfort derived from imitating others (Haghani and Sarvi, 2019). Concerns about appearing "different" from others in the market indicate a facet of social conformity (Baddeley, 2015). This behavior has been identified and labeled as convergence behavior by Hirshleifer and Teoh (2003). In financial markets, herding refers to investors who conform to prevailing market patterns, often disregarding their information analysis (Bikhchandani and Sharma, 2001). It can be caused by information asymmetries, where not all investors can access available information. Herding manifests when the market experiences stress or crises. Excessive market volatility and asset price deviations from their fundamental values are adverse effects of herding (Alber and Ezzat, 2021).

Although numerous studies investigate the impact of herding, relatively few analyze the specific attributes of the resulting financial data volatility. The phenomenon of volatility clustering and time-varying characteristics in financial data is known as herding (Chen et al., 2021). The clustering of high and low volatility in asset prices and returns is referred to as volatility clustering in time series data. The assumption of constant error variance is frequently violated, and heteroscedasticity may manifest (Ogata, 2012; Stojanovski, 2015; Rice et al., 2020). Heteroscedasticity can introduce bias or spuriousness into parameter estimates in statistical models (e.g., regression coefficients), which may lead to misleading conclusions (Gujarati and Porter, 2009; Lauridsena and Kosfeld, 2011; Farbmacher and Kögel, 2017). The model must be efficient (Shahraki et al., 2021). This issue is a frequent practice that is often overlooked.

Hence, the Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity or DCC-GARCH (Engle, 2002) is an alternative solution to address the presence of heteroscedasticity or leptokurtic error data distribution. The DCC-GARCH model can estimate the time-varying relationship between variables. This model posits that the residual's square and the previous residuals' variance affect the current residual variance. The DCC-GARCH model arguably offers several advantages, but its application in herding analysis remains constrained. Hence, this study employs the DCC-GARCH with Normal and Student’s-t distribution to identify herding behavior within a specific temporal interval.

Time-varying characteristics refer to bullish/bearish market periods as part of investors' demand/supply dynamics. Bullish conditions represent investors' optimism to buy shares that increase prices, while bearish conditions indicate investors' pessimism, leading to price decline (Rout et al., 2017). However, the COVID-19 pandemic has greatly impacted countries, including global financial markets and developed countries (Contessi and Pace, 2021). Hence, it is imperative to investigate herding in Indonesia and Malaysia, considering their status as growing economies within the ASEAN Economic Community. This research exerts significant importance within the economic and financial landscape. Both capital markets exhibit a high degree of openness towards foreign investors and have a notable expansion rate. This argument is supported by adopting regulatory measures to improve transparency, liquidity, and accessibility in financial markets. The Financial Services Authority reported that the Indonesia Stock Exchange/IDX experiences a significant daily value of share trading, surpassing 14.000 IDR billion. This trading activity is mostly driven by domestic investors, with retail investors being the majority, accounting for 72% of the total (OJK, 2022). Meanwhile, according to the Malaysian Stock Exchange Authority (2023), a notable presence of local investors accounts for over 86% of the total investors. This majority comprises retail investors, government institutions, and nominees. Retail investors exhibit traits such as uninformed trading (Baig et al., 2022), where they make investment decisions primarily influenced by market movements or the prevailing consensus.

Prior herding studies document inconsistent results from varying analysis methods in both markets. Rizal and Damayanti (2019) observe herding behavior in the bearish market of the Jakarta Islamic Index using GARCH analysis. Further, Putra et al. (2017) utilize the CSAD-OLS analysis and reveal that Indonesian investors exhibit stronger herding behavior than Singaporean investors. In contrast, Fransiska et al. (2018) cannot document herding behavior on the IDX using stock return data in LQ45. Rahman and Ermawati (2020) analyze herding behavior in the ASEAN (Indonesia, Singapore, Malaysia, Philippines, and Thailand) and the U.S. stock market. They utilize the Newey-West estimator and demonstrate that only market crashes display herding tendencies. Meanwhile, Ah Mand and Sifat (2021) report inconclusive findings of the CSSD and CSAD models when employing OLS. On the other hand, a dynamic methodology with a two-state Markov Switching model demonstrates that herding is strongly regime-dependent and non-linear.

Previously, the literature on herding tests utilizing the DCC GARCH model was comparatively scarce, particularly concerning pandemic phenomena with complex global impacts. This study compares the effectiveness of the DCC-GARCH analysis model and the ordinary least squares (OLS) method in accurately capturing the optimal model during dynamic periods. We evaluate herding behavior, namely the volatility index (VIX), using a dynamic correlation analysis and a time-varying analysis. The VIX, also known as the Chicago Board Options Exchange Volatility Index (Brenner and Galai, 1989), measures global market uncertainty. Braiek and Jeribi (2022) indicate that higher levels of uncertainty, as measured by increased VIX ratios, lead to a stronger correlation between assets in different sectors. Essa and Giouvris (2023) examine the influence of VIX and discover that herding increases in response to heightened levels of investor uncertainty and fear. To the best of our knowledge, there is a scarcity of literature that examines the evolution of herding within both market settings. The DCC-GARCH approach exhibits the distinctive feature of uncovering the conditional correlation between beta and herding. This study contributes to the behavioral finance literature by demonstrating the comparative superiority of dynamic models in explaining the herding phenomenon.

This paper is organized as follows: Section 2 of this study presents a comprehensive literature review and formulates hypotheses. Section 3 discusses the data collection and methodology employed in the study. Section 4 entails the presentation and interpretation of empirical data, while Section 5 concludes.

2. Literature Review

2.1 The Herding Concept

The efficient market hypothesis posits that the price of a financial asset reflects all pertinent information (Fama, 1970). There exists a strong correlation between the level of market efficiency and the availability of this particular information, consisting of historical and public information (weak-form efficiency), historical, public, and insider information (semi-strong-form efficiency), or all private and public information (strong-form efficiency). However, not all investors possess the same level of information as presumed by the efficient market hypothesis. Investors in efficient markets cannot generate abnormal returns by exerting control over the market (Malkiel, 2003). Conversely, psychological factors may affect investors' irrational behavior in making decisions. Although price formation is not the primary concern of efficient market theory, behavioral finance has emerged, which encompasses the study of herding behavior.

Herding refers to the phenomenon in which investors imitate the activities of the majority or other market participants without critically evaluating available information (Kumar et al., 2021). Market information asymmetry motivates several individuals to conform to the majority, which is presumed to possess more information (Scharfstein and Stein, 1990). Herding is a behavioral tendency to imitate others' actions rather than one's own information beliefs, regardless of how those actions are perceived (Christie and Huang, 1995). If investors follow the majority, the distribution of returns will be nonexistent (homogeneous). Thus, investors feel secure, particularly when they are hesitant to act independently. Also contributing to concerns is the fear of missing out (FOMO) associated with missing trends or opportunities [see (Gupta and Shrivastava, 2022) and (Bo, 2023)].

Herding illustrates the correlation that exists between shareholder interactions. Chang et al. (2000) empirically demonstrate herding behavior in the South Korean and Taiwan markets, and to some extent, the Japanese market. On the one hand, herding behavior increases market volatility because numerous investors sell or buy large amounts of assets simultaneously. This phenomenon affects financial asset valuation, leading to mispriced assets. On the other hand, volatility arguably elicits investors' emotional responses, including anxiety and uncertainty. Greater market volatility is associated with higher systemic risk. Hence, investors commonly seek market signals or rely on collective behavior to navigate through uncertain periods. This phenomenon might elicit herding behavior among investors, wherein they collectively engage in actions to mitigate risk or capitalize on opportunities.

Arjoon et al. (2020) observe that the time-varying herding in most size-based portfolios typically exhibits similar behavior to the overall market. Intentional herding is observed in the overall market and is particularly prevalent during bullish markets. However, Bohl et al. (2017) re-examine the herding measure proposed by Chang et al. (2000) for the S&P 500 and the EuroStoxx50. Their findings confirm that the CSAD measure has misleading consequences: the true coefficient is positive under the null hypothesis of no herding. A supplementary analysis investigates the impact of global market volatility on herding. Andrikopoulos et al. (2017) discovered that cross-border transactions on the Euronext exhibit varied herding dynamics. They observe significant intraday herding before and after the 2007-2009 financial crisis, with the highest occurrence during the market crisis. Kumar et al. (2021) document the occurrence of herding behavior in commodities markets across the Asia-Pacific region, encompassing China, India, Japan, Malaysia, Singapore, Taiwan, and Thailand, particularly during periods of heightened market volatility. According to Asadi et al. (2022), herding on the Tehran Stock Exchange is statistically significant at the 1% level but insignificant when considering the overall market. Herding is particularly evident amid major fluctuations in other commodities such as gold and currency prices.

Investors may experience emotional responses, including anxiety and uncertainty, in response to volatility. Systemic risk may increase when excessive volatility is prevalent across financial markets. Investors typically seek out other investors' signals and actions to help them mitigate uncertainty during periods of high volatility. Herding behavior may ensue, whereby investors imitate the actions of their peers to evade risks or seize opportunities. Herding behavior may occasionally catalyze heightened volatility. When numerous investors collectively engage in comparable activities, such as selling substantial assets, the market may experience heightened volatility due to intense selling pressure.

Beta can be used to measure the volatility of a financial asset or market. Non-volatile stocks or markets are characterized by a small beta (<1) and vice versa. In the CAPM context (Sharpe, 1964), beta is assumed to be constant over time and is estimated via ordinary least squares (OLS). However, there is widespread evidence in the market that beta risk fluctuates over time [Nieto et al. (2014); Brooks et al. (1998); Fabozzi and Francis (1979)]. Based on this evidence, defining beta as a series of conditional time changes is appropriate. Recent literature has applied several econometric methods to estimate time-varying betas across countries (McKenzie et al., 2001). Extensive studies have used the GARCH model for beta volatility (Chen et al., 2021). Due to multiple return dispersion-measuring variables, the one-dimensional GARCH model is not an optimal analysis method. This study's beta estimation method for multiple variables is dynamic conditional correlation (DCC), implemented within the multidimensional GARCH model.

Engle (2002) developed dynamic conditional correlation (DCC) by modelling variance and conditional correlation on time variables, which enables the mitigation of asymmetric volatility dynamics. Park and Kim (2017) and Tsionas et al. (2022) have employed dynamic measurement models to investigate herding behavior within the U.S. capital market. Ferreruela et al. (2022) investigate herding in the context of ten Asia-Pacific markets from February 1995 to March 2022. Samitas et al. (2022) empirically investigate the impact of the pandemic on stock markets using the DCC model to test correlations (bonds, stock indices, and credit default swaps) between countries (emerging and developed markets).

2.2 Herding Measurement

In the herding context, the use of return dispersion pertains to quantifying the variability of the returns of different assets comprising a given portfolio. Investor behavior can be statistically measured by calculating the similarity or divergence of the dispersion. Herding behavior is indicated by the low level of return dispersion, which occurs when investors make relatively similar investment decisions, resulting in nearly identical increases or decreases in investment returns. Conversely, higher dispersion rates of returns signify substantial variation in investment returns or investors making various decisions to avoid conforming to the majority. Rational investors (Fama, 1970) use CAPM (Sharpe, 1964) to guide decision-making concerning the balance of returns and risks. Nevertheless, Hirshleifer and Teoh (2003) caution against the possibility of investor bias arising from investors' imperfect cognitive abilities and social dynamics such as herding. One can assess a market's efficiency or irrationality (herding) by examining its return dispersion.

Christie and Huang (1995) employ the dispersion of individual stock returns during significant cross-sectional price changes (CSSD) to quantify herding. Hwang and Salmon (2004) developed this model by using the standardized standard deviation of factor loadings to measure the degree of herding. They observe herding during periods of market calmness as opposed to periods of depressed markets in the U.S. and South Korea. Herding occurs when investors adhere more closely to the overall market performance. Investors purchase assets with a beta value below one on the assumption that they are relatively inexpensive, while selling assets with a beta value above one because they are already costly in comparison to the market. In their study, Chang et al. (2000) employ cross-sectional absolute deviation (CSAD) to quantify the non-linear nature of return dispersion. Chiang and Zheng (2010) expand CSAD in various markets (bullish and bearish).

Previous research documenting herding behavior enables us to hypothesize herding behavior in the Indonesian and Malaysian capital markets before and during the pandemic. The financial crisis caused by the COVID-19 pandemic will likely affect herding behavior. This research considers the periods to differentiate the herding phenomenon in normal market conditions in the long term and crisis conditions in the short term. Therefore, this study uses a recent daily data set spanning eight years to test this hypothesis. We also hypothesize that herding occurs in different market conditions (bullish and bearish) over that period. We also predict that the volatility index will influence investor herding, as indicated by the high Volatility Index as a reflection of investors' anxious reactions in the wake of the pandemic.

3. Methods and Materials

3.1 Data

This study generated the stock data from www.idx.co.id and www.bursamalaysia.com, while the daily closing price data of stocks, stock indices, and volatility indices were obtained from www.yahoofinance.com and www.investing.com. Our population is firms listed in the LQ45 (Indonesia Stock Exchange) and FTSE KLCI (Bursa Malaysia) indices, representing a group of stocks with high capitalization, large transaction values, and excellent financial performance. We utilized the purposive *sampling* techniques based on the criteria of stocks continuously listed from 2015 to 2022.

3.2 Herding Models

Our herding measurement uses the dispersion of stock returns on portfolio/market returns. Stock returns (R_{it}) are calculated by dividing the price of stock *i* in period *t* by its price at the previous period (*t-1*), as illustrated by the following formula:

$$R_{it} = \frac{P_{it} - P_{i\,(t-1)}}{P_{i\,(t-1)}} \qquad (1)$$

where P_{it} and $P_{i\,(t-1)}$ are the closing price of individual stocks of LQ45 or FTSE KLCI firm at time *t* and $t-1$. The calculation of market returns (R_{mt}) in period *t* is:

$$R_{mt} = \frac{P_{mt} - P_{m\,(t-1)}}{P_{m\,(t-1)}} \qquad (2)$$

where, P_{mt} and $P_{m\,(t-1)}$ are the closing index of LQ45 or FTSE KLCI on period *t* and $t-1$.

Return dispersion of the cross-sectional standard deviation (CSSD) can be utilized to detect herding (e.g., Christie and Huang 1995). The relationship between the CSSD of dispersion of individual stock returns and market return is linear. The estimation indicates that rational asset pricing models and herding will produce opposite consequences. Herding is (not) observed when the correlation value of the dispersion is low (high). Despite being an intuitive measure, this model is significantly impacted by outliers in the linear correlation of the data. Subsequently, Chang et al. (2000) propose a more suitable metric, the cross-sectional absolute deviation (CSAD) of stock requationlative to the market portfolio returns. The CSAD is calculated as follows:

$$CSAD_t = \Sigma_{i=1}^{N} \frac{|R_{it} - R_{mt}|}{N} \qquad (3)$$

where N is the number of shares in the portfolio.

The relationship $CSAD_t$ and R_{mt} is a form of non-linear regression expressed below.

$$CSAD_t = \alpha + \gamma_1 R_{mt} + \gamma_2 R_{mt}^2 + \varepsilon_t \qquad (4)$$

Herding is present if the negative coefficient γ_2 is significant, and conversely, herding is not present when the positive coefficient γ_2 is significant. The quadratic relation suggests that $\mathrm{CSAD_t}$ reaches its maximum value when $\mathrm{R_{mt}} = -(\gamma_1/2\gamma_2)$. That is, as $\mathrm{R_{mt}}$ increases, over the range where realized average daily returns are less (greater) than $\mathrm{R_{mt}}$, $\mathrm{CSAD_t}$ is trending bull/bear (Chang et al., 2000).

Chiang and Zheng (2010) add a formula with the asymmetric conditions of a bull market ($\mathrm{R_{mt}}$>0) and a bear market ($\mathrm{R_{mt}}$<0). Another important problem is whether herding has a relation with the volatility index. If so, the implication is that herding exists more when the market is overwhelmed by investors' anxiety. We use the CBOE Volatility Index (VIX) variable within equation 5 as follows:

$$\mathrm{CSAD_t} = \alpha + \gamma_1 \mathrm{R_{mt}} + \gamma_2 |\mathrm{R_{mt}}| + \gamma_3 \mathrm{R_{mt}^2} + \beta Vix + \sigma_t^2 + \varepsilon_t \tag{5}$$

$$\mathrm{CSAD_t^{Bull}} = \alpha + \gamma_1 \mathrm{R_{mt}} + \gamma_2 \left|\mathrm{R_{mt}^{Bull}}\right| + \gamma_3 (\mathrm{R_{mt}^{Bull}})^2 + \beta \mathrm{V}ix + \sigma_t^2 + \varepsilon_t \quad \text{if } \mathrm{R_{mt}} > \text{median} \tag{6}$$

$$\mathrm{CSAD_t^{Bear}} = \alpha + \gamma_1 \mathrm{R_{mt}} + \gamma_2 \left|\mathrm{R_{mt}^{Bear}}\right| + \gamma_3 (\mathrm{R_{mt}^{Bear}})^2 + \beta \mathrm{V}ix + \sigma_t^2 + \varepsilon_t \quad \text{if } \mathrm{R_{mt}} < \text{median} \tag{7}$$

where $\mathrm{R_{mt}^{Bear}}$ is the bearish market return at time *t*, and $\mathrm{R_{mt}^{Bear}}^2$ denotes the square value of the market return as a non-linear relationship during bearish market periods. $\mathrm{R_{mt}^{Bull}}$ represents the bullish market return at time *t*, and $\mathrm{R_{mt}^{Bull}}^2$ denotes the square value of the market return as a non-linear relation of periods of a bull market. $\mathrm{CSAD_t^{Bear}}$ is the dispersion of stock returns at time *t* during bearish market conditions, and $\mathrm{CSAD_t^{Bear}}$ refers to the dispersion of stock returns at time *t* during bearish market conditions. Vix is the value of the volatility index on day *t*. A significant and negative Vix would imply that a rise in market stress and fear regarding economic conditions would make investors follow the market consensus, contributing to a hike in herding behavior and vice versa.

Before measuring herding, it is necessary to assess the stationarity of the data using the unit root test. The test is capable of determining whether or not a time series contains a unit root. A unit root occurs when the root of a time series is approximately equal to one (1), signifying that the series is non-stationary with respect to its mean. The model for unit root testing is as follows:

$$\Delta Y_t = \alpha_1 + \gamma_1 + \beta_1 Y_{t-1} + \sum_{i=1} \delta_t \Delta Y_{t-1} + \varepsilon_t \tag{8}$$

The following hypothesis is compiled based on the Augmented Dickey-Fuller (ADF) value results.

$\mathrm{H_0}$: $\delta = 0$: Time series data has a unit root, indicating non-stationarity.

$\mathrm{H_1}$: $\delta \neq 0$: Time series data does have a unit root, indicating stationarity.

The interpretation of the ADF test results is as follows: $\mathrm{H_0}$ is not rejected when the ADF test statistic exceeds the critical value, but is accepted when the statistic is

less than the critical value (<0.05). The ARCH (Autoregressive Conditional Heteroskedasticity) test is continued to ascertain the subsequent mode of analysis once the data has become stationary. In time series data, the ARCH test is utilized to identify and model conditional heteroskedasticity. The following hypothesis was constructed using the ARCH-LM (Lagrange Multiplier) test results.
H_0 : The squared residuals exhibit no residual autocorrelation.
H_1 : The squared residuals exhibit residual autocorrelation.
The results of the ARCH-LM test can be interpreted as follows: H_0 is rejected (supported) if the test statistic is greater (lower) than the critical value.

3.3 Dynamic Conditional Correlation GARCH

Engle (1982) introduces ARCH to overcome non-constant error variance in financial time series data where the error variance (σ_t^2) is strongly influenced by errors in the previous period (e_{t-1}^2). Bollerslev (1986) extends ARCH into Generalized Autoregressive Conditional Heteroskedasticity (GARCH), where error variance (σ_t^2) depends not only on errors in the previous period (e_{t-1}^2) but also error variance in the previous period (σ_{t-1}^2). GARCH is developed by including quadratic error elements and period errors variance into the ARCH model to avoid excessive lag. The GARCH model specification is:

$$\sigma_t^2 = a_o + a_1 e_{t-1}^2 + \cdots + a_1 e_{t-p}^2 + \lambda_1 \sigma_{t-1}^2 + \cdots + \lambda_p \sigma_{t-q}^2$$
$$\text{with } e_t = \sigma_t\, x_t, x_t \sim i.i.d\ N\ (\mu, \sigma^2), a_o > 0 \text{ and } a_t \geq 0 \text{ for } i = 0 \tag{9}$$

Furthermore, Engle (2002) modifies GARCH by modifying the Dynamic Conditional Correlation (DCC) GARCH framework that combines each asset's volatility measurement components and a dynamic correlation model to measure the relationships between those assets. DCC-GARCH offers the advantage of handling dynamic rather than static correlation and can accommodate non-normally distributed data (Robiyanto, 2018).

The model suggests that the covariance matrix (H_t) can be composed into a conditional standard deviation (D_t) and a correlation matrix (R_t). Both models (D_t and R_t) are designed to be time-varying. The following is the DCC GARCH equation:

$$r_t = \mu_t + a_t$$
$$a_t = H_t^{1/2} a_t\, z_t \tag{10}$$
$$H_t = D_t R_t D_t$$

where

r_t : $n\ x$ 1 vector of log returns of *n* assets at time *t.*
a_t : $n\ x$ 1 vector of mean-corrected returns of *n* assets at time *t*, i.e. $\mathrm{E}[a_t] = 0$. $\mathrm{Cov}[a_t] = H_t$.
μ_t : $n\ x$ 1 vector of the expected value of the conditional r_t.
H_t : $n\ x\ n$ matrix of conditional variances at a_t time *t.*

$H_t^{1/2}$: $n\ x\ n$ matrix at time *t*. such that H_t is the conditional variance matrix of a_t. $H_t^{1/2}$ may be obtained by a Cholesky factorization of H_t.

D_t : $n\ x\ n$ as the diagonal matrix of conditional standardized deviation of a_t in time *t*.

R_t :$n\ x\ n$ as a conditional matrix of a_t in period *t*.

z_t : $n\ x\ 1$ vector of iid errors such that $\mathrm{E}[z_t] = 0$ and $\mathrm{E}[z_t z_t^T] = 1$.

The elements in the diagonal matrix (D_t) represent the standard deviations of the univariate GARCH model.

$$D_t = \begin{bmatrix} \sqrt{h_{1t}} & 0 & \cdots & 0 \\ 0 & \sqrt{h_{2t}} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sqrt{h_{nt}} \end{bmatrix} \tag{11}$$

where $h_{i,t} = \ a_{i0} \ + \ \sum_{q=1}^{Q_1} \alpha_{iq} \ \alpha_{i,t-q}^2 + \sum_{p=1}^{P_1} \beta_{iq} \ h_{i,t-q}^2$, R_t is a correlation matrix. R_t is the conditional correlation matrix of the standardized residuals ε_t, i.e.:
$\varepsilon_t = D_t^{-1} a_t \sim N(0, R_t)$.

Since R_t is a correlation matrix, it is symmetric.

$$R_t = \begin{bmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \cdots & \rho_{1n,t} \\ \rho_{12,t} & 1 & \rho_{23,t} & \cdots & \vdots \\ \rho_{13,t} & \rho_{23,t} & 1 & \ddots & \vdots \\ \vdots & \vdots & \ddots & \ddots & \rho_{n-1,n,t} \\ \rho_{1n,t} & \rho_{2n,t} & \cdots & 0 & 1 \end{bmatrix} \tag{12}$$

The elements of $H_t = D_t R_t D_t$ are:

$$[H_t]_{ij} = \sqrt{h_{it} h_{jt\rho_{ij}}}$$

where $\rho_{ii} = 1$. To ensure both of these requirements in the DCC-GARCH model, R_t is decomposed into (Jabalameli et al., 2020):
$R_t = Q_t^{*-1} Q_t Q_t^{*-1}$and $Q_t = (1 - \alpha - \beta)\overline{Q} + \alpha \varepsilon_{t-1} \varepsilon_{t-1}' + \beta Q_{t-1}$
where Q_t^* is a diagonal matrix consisting of the square roots of the diagonal elements of the matrix Q_t, thus $Q_t^* = Diag(Q_t)^{1/2}$.

4. Results

4.1 Descriptive Statistics

The descriptive statistics for the entire dataset are presented in Table 1. These statistics include observation numbers (N), the average returns dispersion (CSAD), average stock returns ($\mathrm{R_i}$), and average market returns ($\mathrm{R_{mt}}$) of FTSE KLCI, which are 1951 days, -0.01 percent, -0.53 percent, and 0.02 percent, respectively, with standard deviations of 0.72 percent, 0.85 percent, and 0.73 percent.

Meanwhile, observation numbers (N), the average returns dispersion ($\mathrm{CSAD_t}$), average stock returns ($\mathrm{R_i}$), and average market returns ($\mathrm{R_{mt}}$) of LQ45 are 1968 days, 1.01 percent, 0.03 percent, and -0.02 percent, respectively, with standard deviations of 1.15 percent, 1.17 percent, and 1.32 percent. The overall average values data of the volatility index (Vix) is 18.68 with a standard deviation of 7.91. Under all data conditions, the excess kurtosis value (>3) is leptokurtic (abnormal curve). A leptokurtic distribution can be visualized as a thin 'bell' with a high peak (Kalner, 2018), as the GARCH models require.

Table 1. Descriptive Statistics

Index	Var	N	Mean	Median	Max.	Min.	Std Dev.	Kurtosis
KLCI	$\mathrm{CSAD_t}$	1951	0.0053	0.0027	0.0655	0.0001	0.0072	16.73
	$\mathrm{R_i}$		0.0002	0.0002	0.0627	-0.0871	0.0089	14.64
	$\mathrm{R_{mt}}$		-0.0001	-0.0001	0.0685	-0.0526	0.0073	11.27
LQ45	$\mathrm{CSAD_t}$	1968	0.0101	0.0065	0.1489	0.0001	0.0115	24.64
	$\mathrm{R_i}$		0.0003	0.0008	0.0947	-0.0836	0.0117	10.08
	$\mathrm{R_{mt}}$		-0.0002	0.0001	0.1492	-0.0826	0.0132	14.90
CBOE	Vix		18.68	16.54	82.69	9.14	7.91	14.21

a. Test distribution is not Normal.
b. Calculated from data

Source: Research finding.

Figure 1 shows the volatility graph of the daily returns of both indices. The residuals of both indices fluctuate and deviate from their means. In that case, analyzing the conditional variance of returns is necessary. Thus, heteroscedasticity needs to be tested for the returns of both indexes (ARCH test).

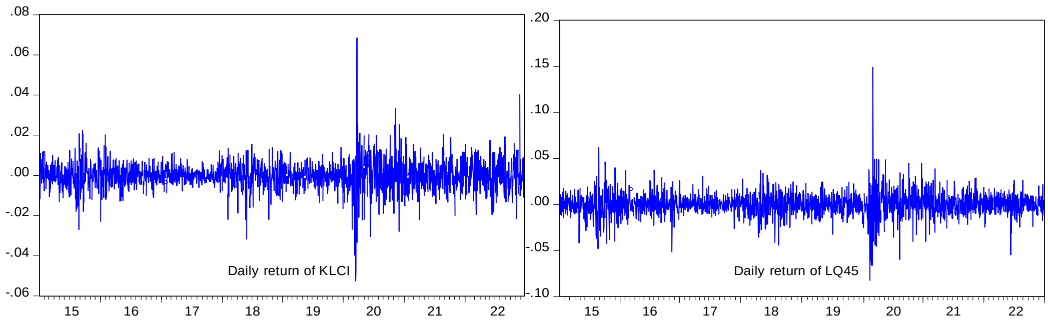


Figure 1. Daily Returns of the Indices for 8 Years.
Source: Research finding.

4.2 Stationarity Test

The null hypothesis of the stationarity test based on the Augmented Dickey-Fuller (ADF) value results that the data have a unit root, indicating non-stationarity (Eq. 7). Table 2 shows that all data for measuring research variables have significant *p*-values (<0.05). Therefore, all data in this study are stationary (H_0 is rejected) and do not have a unit root at the level.

Table 2. Unit Root Test

		ADF Test	Prob.
KLCI	$CSAD_t$	-6.9110	0.0000
	R_i	-49.7903	0.0001
	R_{mt}	-10.8249	0.0000
LQ45	$CSAD_t$	-7.8214	0.0000
	R_i	-8.9377	0.0000
	R_{mt}	-42.5447	0.0000
CBOE	Vix	-4.8023	0.0001

Source: Research finding.

4.3 ARCH-LM Test

The ARCH-LM test results (Table 3) suggest that the p-values of these statistics imply that the correlation between residuals is insignificant in all lags (<0.05) or H_0 is rejected. The ARCH-LM test implies the presence of a conditional heteroscedasticity problem in all time series. Therefore, in order to model the conditional variances of the aforementioned models, the following DCC GARCH (1,1) model will be used.

Table 3 Heteroscedasticity Test

KLCI	F-statistic	7.7029	Prob. F (1.1756)	0.0000
	Obs.*R-squared	1.4330	Prob. Chi-Square (1)	0.0000
LQ45	F-statistic	14.8981	Prob. F (1.1756)	0.0001
	Obs.*R-squared	14.8023	Prob. Chi-Square(1)	0.0001

Source: Research finding.

Note: The heteroscedasticity test is conducted using the ARCH-LM method. A test statistic lower (higher) than the critical value indicates the presence (absence) of heteroscedasticity in the data.

4.4 DCC GARCH Model

Table 4 presents the estimation results for DCC-GARCH (1,1) with Student's t distributions have a smaller AIC than the normal distribution, are free from heteroscedasticity problems (ARCH>0.05), and have a significant variance equation (<0.05). The analysis reveals that the value of γ_3 is insignificantly negative (>0.05), indicating that the KLCI investors did not exhibit herding behavior in the overall data (2015-2022 periods). Likewise, OLS analysis produces insignificantly negative values of γ_3 (>0.05), but the data exhibits heteroscedasticity problems (ARCH<0.05). The findings indicate that investors tend to exhibit herding behavior in the overall market, and this tendency shows a nonlinear relationship with the market return. Nevertheless, this relationship lacks significance. The results are consistent with Ah Mand and Sifat (2021) for Malaysian conventional stocks for the overall market.

Meanwhile, the value of γ_3 in LQ45 is significantly positive (<0.05), implying that LQ45 investors did not exhibit herding behavior in the overall data. The OLS analysis produces significantly positive values of γ_3 (<0.05), but the data have heteroscedasticity problems (ARCH<0.05). In other words, there is no evidence of investors' herding behavior with a positive relationship, whether linear or nonlinear, across the entire market. The findings are consistent with Fransiska et al. (2018), who cannot document herding on LQ45 stocks.

Table 4. Herding Analysis Using DCC-GARCH (1,1) and OLS Models

		DCC-GARCH				**OLS**	**ρ-value**
		Normal	**ρ-value**	**Student's-t**	**ρ-value**		
KLCI	α	-0.0020	0.3086	0.0011	0.0000	0.0014	0.0009
	γ_2	0.1406	0.0276	0.0932	0.0000	0.4573	0.0000
	γ_3	3.6646	0.1792	-0.5259	0.5085	-2.6025	0.0958
	Vix	0.0002	0.0614	0.0001	0.2220	0.0001	0.0000
	Log-like.	7.5638		8.0911		6.9833	
	AIC	-7.7496		-8.2894		-7.1546	
	ARCH		0.7136		0.8056		0.0000
	μ_t	0.0001	0.3220	0.0001	0.0037		
	a_t	0.0940	0.0019	0.5578	0.0006		
	t-dist.	0.9297	0.0000	0.7508	0.0000		
LQ45	α	0.0073	0.0000	0.0062	0.0000	0.0031	0.0000
	γ_2	0.2589	0.0000	0.1578	0.0000	0.4557	0.0000
	γ_3	4.5869	0.0080	1.0310	0.0000	3.9490	0.0000
	Vix	-0.0002	0.0000	-0.0001	0.0000	0.0001	0.0000
	Log-like.	6.7912		6.8685		6.4444	
	AIC	-6.8945		-6.9720		-6.5451	
	ARCH		0.1405		0.1629		0.0000
	μ_t	0.0815	0.0000	0.0720	0.0000		
	a_t	0.9185	0.0000	0.9230	0.0000		
	t-dist.			3.6470	0.0000		

Source: Research finding.

Note: γ_2 represents the coefficient for the absolute market returns, γ_3 represents the coefficient for the non-linear square market returns (Eq. 5), μ_t and a_t are equation variances (Eq. 10). The best model for the Indonesian LQ45 market and the Malaysian KLCI market is the DCC GARCH (1,1) model with a Student's-t distribution.

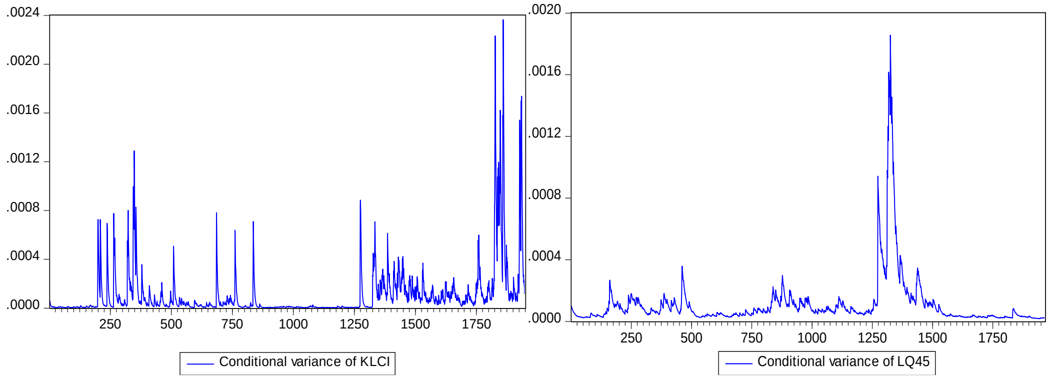


Figure 2. Graph of Conditional Variance in Overall Data
Source: Research finding.

The effect of the VIX is significantly negative in LQ45 but insignificant in KLCI, suggesting the effect of anxiety in the decision-making of LQ45 stock investors in overall observations. As previously suggested, anxious investors may make irrational decisions significantly associated with VIX and the return dispersions in the overall market. An increase in VIX is associated with lower return dispersions, implying that each investor's response tends to vary. Changes in VIX will impact investors' risk appetite for capital markets. An increase in VIX typically arises amidst a market crisis when investors sell their financial assets (Giot and Laurent, 2003). Large volatility serves as a signal for long-term investors to make buying or selling decisions.

Table 5. DCC-GARCH (1,1) and OLS in Bullish Market

		DCC-GARCH				**OLS**	**ρ-value**
		Normal	**ρ-value**	**Student's-t**	**ρ-value**		
KLCI	α	0.0019	0.0002	0.0010	0.0000	0.0017	0.0000
	γ_2	0.0766	0.0237	0.0299	0.0003	0.0672	0.0731
	γ_3	0.9181	0.0000	0.9631	0.0000	0.9271	0.0000
	Vix	-0.0001	0.7554	0.0001	0.1393	0.0001	0.3034
	Log-like.	3.9352		4.7636		3.7168	
	AIC	-8.1477		-9.8638		-7.6950	
	ARCH		0.4365		0.0318		0.0000
	μ_t	0.0001	0.1383	0.0001	0.9669		
	a_t	0.0750	0.0274	1.8851	0.9668		
	t-dist.	0.8599	0.0000	0.8207	0.0000		
LQ45	α	0.0066	0.0000	0.0054	0.0000	0.0031	0.0000
	γ_2	0.3691	0.0001	0.3129	0.0000	0.4557	0.0000
	γ_3	3.1584	0.0055	4.5578	0.0000	3.9490	0.0000
	Vix	-0.0001	0.0012	-0.0001	0.0004	0.0001	0.0000
	Log-like.	3.5135		3.5819		6.4444	
	AIC	-6.8420		-6.9736		-6.5451	

ARCH		0.2398		0.6981		0.0000
μ_t	0.0911	0.0000	0.1284	0.0002	0.0911	0.0000
a_t	0.9011	0.0000	0.8618	0.0000	0.9011	0.0000
t-dist.			3.4156	0.0000		

Source: Research finding

Note: The best model of both markets in bullish conditions is DCC GARCH (1,1) with a Student's-t distribution.

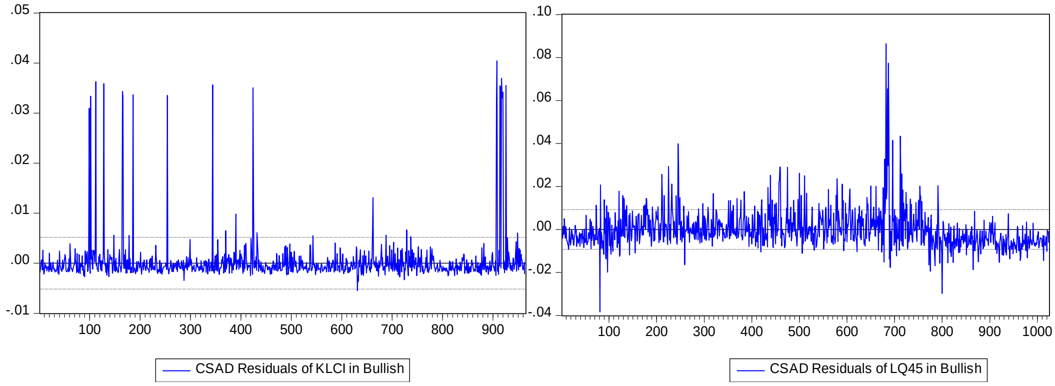


Figure 3. Graph of CSAD Residuals in Bullish Markets
Source: Research finding

Next, we investigate the level of herding behavior on days with positive market returns (bullish) using equation 6 (also available in Table 5). In both markets, in contrast to OLS, which exhibits heteroscedasticity (ARCH < 0.05), the ARCH value of GARCH (1,1) for the bullish market for overall data is greater than 0.05, indicating the absence of heteroscedasticity. The AIC value implies that the GARCH (1,1) Student's-t distribution has the smallest value and a significantly positive value of square market returns ($\gamma_3 > 0$), indicating no herding on both markets in bullish conditions. Return dispersions of CSAD do not significantly decrease during bullish market movements, indicating that herding behavior is generally unobservable among stock investors when the market prices increase. The results are consistent with Ah Mand and Sifat (2021) for Malaysian conventional stocks, demonstrating both positive linear and nonlinear relationships of the dispersion returns during bullish markets. The effect of VIX is statistically insignificant in KLCI but significantly negative in LQ45 (<0.05) in bullish conditions. The anxiety index and return dispersion exhibit a significantly negative relationship. Nevertheless, investor anxiety does not promote herding behavior at LQ45. Herding behavior is absent when investors' fear diminishes.

The GARCH (1,1) Student's-t model is utilized to analyze data from a shorter period (Table 6) in the bullish market conditions before the pandemic (2015-2019) and during the epidemic (2020-2022). According to Zhang and Giouvris (2022), herding behavior is one of the short-lived phenomena within large stock price fluctuations.

Previous research indicates that herding behavior is relatively uncommon in bullish market conditions. Table 6 displays a stable model with a positive γ_3 value in bullish markets before and during the pandemic in KLCI. Although the γ_3 value of LQ45 is negative; it is insignificant. Thus, investors in both market groups in different conditions confirm previous findings that herding does not occur over shorter periods. The effect of VIX on the dispersion of stock returns in the bullish before or during the pandemic is insignificant (>0.05).

Table 7 presents the GARCH (1,1) analysis results and compares them with the OLS models in the bearish markets of 2015-2022 using equation 7. Previous studies have demonstrated herding behavior during significant market movements or crises in the U.S. (BenSaïda, 2017).

In contrast to OLS, which exhibits heteroscedasticity (ARCH < 0.05), the model specification of GARCH (1,1) demonstrates heteroscedasticity-free results. The AIC value implies that GARCH (1,1) Student's-t has the smallest value. The GARCH (1,1) Student's-t model shows that both the absolute and square market returns ($\gamma_2, \gamma_3 > 0$) have significantly positive values, indicating no herding behavior in both markets during bearish conditions. Thus, investor herding behavior does not exhibit a linear or nonlinear relationship during bearish market conditions in LQ45 or KLCI. The impact of VIX on the dispersion of stock returns in bearish markets is insignificant (p-value > 0.05).

The GARCH (1,1) with Student's-t is applied to data with a shorter period (Table 8) in the bearish before the pandemic (2015-2019) and during the pandemic (2020-2022). Herding, an imitative behavior accompanied by ignoring one's beliefs, can be considered a short-term tendency. As Zhang and Giouvris (2022) suggest, herding behavior is one of the short-lived phenomena in large stock price fluctuations.

Table 6. DCC-GARCH (1,1) in Bullish Before and During the Pandemic

		Before				**During**			
	Indicator	**DCC-GARCH**	**ρ-value**	**OLS**	**ρ-value**	**DCC-GARCH**	**ρ-value**	**OLS**	**ρ-value**
KLCI	α	0.0008	0.0000	0.0013	0.0621	0.0008	0.0000	0.0016	0.0864
	γ_2	0.0298	0.0280	0.0326	0.5647	0.0547	0.0320	0.2076	0.0160
	γ_3	0.9632	0.0000	0.9615	0.0000	0.0956	0.9143	-2.6290	0.1794
	Vix	0.0001	0.0879	0.0001	0.2090	0.0001	0.2050	0.0001	0.9021
	Log-like	3.0463		2.4054		1.7217		1.3261	
	AIC	-9.9910		-7.8863		-9.6489		-7.4274	
	ARCH		0.1724		0.0286		0.4894		0.0000
	μ_t	0.0328	0.5442			8.3208	0.9998		
	a_t	0.9241	0.0000			0.5489	0.0000		
	t-dist.	2.0306	0.0000			2.0001	0.0000		
LQ45	α	0.0023	0.0358	0.0029	0.0134	0.0012	0.2732	0.0029	0.0134
	γ_2	0.8103	0.0000	0.7724	0.0000	0.0972	0.0228	0.7724	0.0000
	γ_3	-6.4531	0.1713	-5.9692	0.0177	6.0559	0.0000	-5.9692	0.0177
	Vix	0.0001	0.1327	0.0001	0.2295	0.0001	0.0692	0.0001	0.2295
	Log-like	2.2546		2.2421		1.3727		2.2426	
	AIC	-6.9586		-6.9289		-7.2014		-6.9290	
	ARCH		0.5028		0.0000	0.1457	0.0039		0.0000
	μ_t	0.1165	0.0035			0.8469	0.0000		
	a_t	0.3813	0.2770			3.8988	0.0000		
	t-dist.					0.1457	0.0039		

Source: Research finding.

Note: The table illustrates GARCH (1,1) Student's-t distribution to detect herding in bullish markets before and during the pandemic. Herding is indicated by a significantly negative value of γ_3 .

Table 7 Herding Analysis Using DCC-GARCH (1,1) and OLS in Bearish Markets

		DCC-GARCH				OLS	ρ-value
		Normal	**ρ-value**	**Student's-t**	**ρ-value**		
KLCI	α	0.0007	0.2889	0.0006	0.0001	0.0001	0.8256
	γ_2	0.9964	0.0000	0.2843	0.0000	0.9603	0.0000
	γ_3	0.0021	0.3832	0.3565	0.0000	0.0222	0.0000
	Vix	-0.0002	0.0000	-0.0001	0.0536	-0.0001	0.0000
	Log-like.	3.7455		4.6446		3.6101	
	AIC	-7.5888		-9.4123		-7.3147	
	ARCH		0.0256		0.9427		0.0000
	μ_t	0.0001	0.3920	0.0001	0.6712	0.0001	
	a_t	0.0706	0.0013	1.3886	0.6737	0.0706	
	t-dist.	0.9327	0.0000	-0.0004	0.0072	0.9327	
LQ45	α	0.0080	0.0000	0.0056	0.0000	0.0050	0.0000
	γ_2	0.1675	0.0956	0.0587	0.2336	0.2558	0.0002
	γ_3	6.1536	0.0405	1.0672	0.0000	8.4011	0.0000
	Vix	-0.0002	0.0007	-0.0001	0.0929	0.0001	0.1012
	Log-like.	3.2509		3.3043		3.1035	
	AIC	-6.8851		-6.9964		-6.5736	
	ARCH		0.4977		0.8637		0.6689
	μ_t	0.1207	0.0002	0.1117	0.0011		
	a_t	0.8820	0.0000	0.8865	0.0000		
	t-dist.			3.1622	0.0000		

Source: Research finding.

Note: A significantly negative value of γ_3 indicates herding. The best model of both markets in bearish is DCC-GARCH (1,1) Student's-t distribution.

Table 8. DCC-GARCH (1,1) in Bearish Market Before and During the Pandemic

		Before				During			
	Indicator	**DCC-GARCH**	**ρ-value**	**OLS**	**ρ-value**	**DCC-GARCH**	**ρ-value**	**OLS**	**ρ-value**
KLCI	α	0.0011	0.0000	-0.0001	0.8947	0.0006	0.0087	0.0021	0.0294
	γ_2	0.0442	0.0005	0.9834	0.0000	0.0131	0.5877	-0.2780	0.0019
	γ_3	0.4762	0.0000	0.0094	0.0439	0.0602	0.9483	1.6376	0.0000
	Vix	0.0001	0.6491	-0.0001	0.0253	0.0001	0.0001	0.0001	0.2252
	Log-like	3.0230		2.3277		1.8244		1.4214	
	AIC	-9.8496		-7.5814		-9.7601		-7.6002	
	ARCH		0.9331		0.0000		0.9462		0.0000
	μ_t	0.0501	0.9961			7.2468	0.9998		
	a_t	-0.3308	0.9202			0.3550	0.0087		
	t-dist.	2.0002	0.0000			2.0001	0.0000		
LQ45	α	0.0041	0.0010	0.0055	0.0000	0.0021	0.0722	0.0009	0.5906
	γ_2	0.6467	0.0000	0.5714	0.0000	-0.2457	0.0000	0.1212	0.2922
	γ_3	-9.4743	0.0000	-1.7036	0.5571	1.4595	0.0000	1.1076	0.0000
	Vix	-0.0001	0.9151	-0.0001	0.8485	0.0001	0.0430	0.0002	0.0005
	Log-like	2.0605		2.0092		1.3036		1.1222	
	AIC	-6.9778		-6.8088		-7.3351		-6.3177	
	ARCH		0.7359		0.0000		0.8350		0.7681
	μ_t	0.0640	0.0727			0.0001	0.1029		
	a_t	0.8460	0.0000			0.1464	0.0065		
	t-dist.	3.4631	0.0000			0.8554	.0000		

Source: Research finding.
Note: In the bearish market before and during the pandemic, the best model of FTSE KLCI or LQ45 is DCC GARCH (1,1) with a Student's-t distribution.

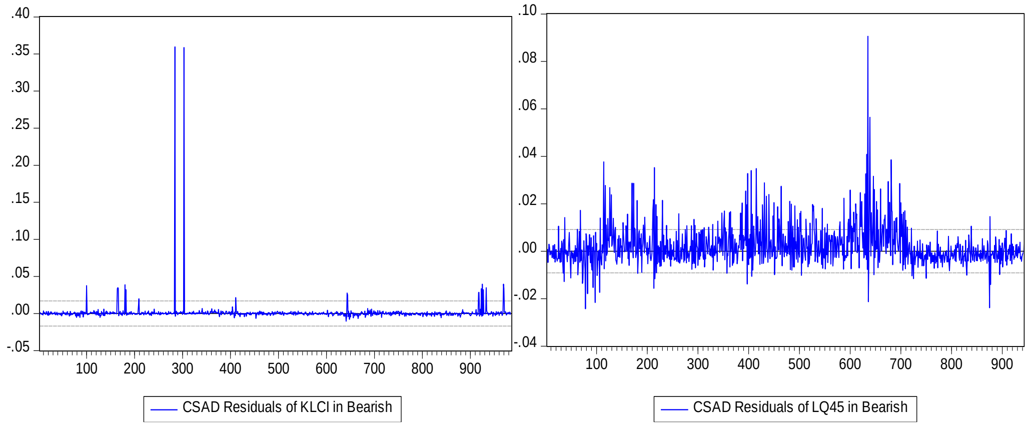


Figure 4. Graph of CSAD Residuals in Bearish Markets
Source: Research finding.

The model indicates that KLCI investors generally do not exhibit herding behavior. However, LQ45 investors indicate herding behavior before the pandemic in bearish market conditions in 2015-2019, with a significant nonlinear relationship with market returns. These results are in line with Ah Mand and Sifat (2021), who document a linear relationship between Malaysian conventional investors' herding behavior with market returns in bearish markets. The effect of VIX on bearish conditions before the pandemic is insignificant (>0.05) but significantly positive in bearish conditions during the pandemic on both indexes. Herding is a period and market variant that is not associated with market crises. Similarly, Zhang and Giouvris (2022) indicate a reciprocal relationship between the volatility index and herding unrelated to market crises due to the pandemic. The impact of the volatility index on herding is limited and transient. Furthermore, Essa and Giouvris (2023) reveal that volatility increases as investors' anxiety and uncertainty regarding the future of the economy intensify.

5. Conclusion

Our financial data exhibit heteroscedasticity-related data abnormalities. According to the kurtosis value (>3), the distributed data is leptokurtic (Kalner, 2018). As previous studies show, changes in prices and returns on securities in financial markets are not normally distributed (Chae and Lee, 2018). Statistically, the excess kurtosis should be zero for a normal distribution. OLS analysis of non-normal data will produce spurious regressions and erroneous conclusions (Gujarati and Porter, 2009). The utilization of DCC GARCH over OLS when dealing with non-normal data is crucial due to its capacity to capture time-varying volatility and correlation dynamics. Moreover, Feng and Shi (2017) contend that the Student's t distribution should be utilized instead of the normal distribution to account for the leptokurtic distribution through its specification. The DCC GARCH Student-t findings observe herding behavior in the pre-pandemic bull markets, but only for the LQ45 and not the FTSE KLCI. Thus, herding will result in lower market returns and vice versa.

Bullish markets can be defined as an optimistic anticipation concerning the future trajectory of asset prices, as evidenced by the surge in stock prices. When the outlook for a market is widely positive, individuals often tend to conform their behavior to the majority's sentiments for a sense of safety. Potential profits may induce "fear of missing out" (FOMO) among LQ45 investors. As suggested by Gupta and Shrivastava (2022), FOMO can motivate investors to "follow market consensus" and purchase assets without performing a fundamental information analysis. Herding under specific circumstances (bullish) supports the behavioral finance theory concerning irrational market behavior and should not be disregarded. Nevertheless, the impact of herding on the overall market behavior (overall/ bearish) is insignificant, suggesting that the market is efficient.

Each index comprises a collection of blue-chip stocks with solid fundamentals and performance. They are typically owned by institutional and long-term investors who engage in information-driven transactions (known as "informed trading"). Each investor has sufficient time to gather information and move independently from the others.

It is secure for investors to place their trust in blue-chip stocks with large market capitalizations, as no individual investor can influence the market consensus. Each investor behaves independently. The uneven dispersions of stock returns relative to market returns indicate the degree of independence in investment decisions. As predicted by the CAPM, the dispersions of individual market returns will diminish as the average share price movement increases (Mertzanis and Allam, 2018).

The VIX index had no significant effect on the dispersion of bullish or bearish markets before the pandemic. Nonetheless, the VIX significantly affects the bearish market during the pandemic in both indexes. The VIX coefficient exhibits a positive value during pandemic-driven extreme market conditions. A rise in the VIX is associated with an increase in the dispersion of returns (CSAD). Hence, each investor's response increases as the VIX index increases. Changes in the VIX will affect investors' risk appetite for the stock market. VIX frequently increases during financial crises as investors overreact by selling their financial assets to limit losses (Giot and Laurent, 2003).

This paper empirically examines time-varying herding through the DCC-GARCH model and tests daily herding by including a volatility index variable before and during the pandemic. This model has reliable forecasting capabilities, especially from multi-frequency data sets. This paper offers a potential contribution by further elucidating the relationship between beta and volatility in the context of herding behavior. In this respect, herding is a fluid phenomenon that fluctuates over time. The results differ from Hsieh (2013), who documents that small-share investor groups employing a feedback strategy are more prevalent in markets with greater pressure. Beta herding becomes a factor when portfolio movements are extreme or markets are volatile.

Our research results are important for investors. For example, the size of beta herding for systematic risk factors can be adjusted regarding portfolio allocation. Blue-chip portfolio policies are also important to reduce losses due to investor herding. Future research could expand the model to clustering volatility or leverage effects. It might be better to use other models, such as the EGARCH, QGARCH, and GJR GARCH, that capture the asymmetry in the conditional variances. In addition, macroeconomic and fundamental factors dynamics can be used as a proxy for time-varying beta.

Statements and Declarations

- Acknowledgment: The author would like to thank the Ministry of Education and Culture of the Republic of Indonesia for financial support through the National Competitive Research Grant-Doctoral Dissertation Research (SK. No. 033/E5/PG.02.00/2022, dated April 27, 2022, with Derivative Contract No.: 001/LL6/PB /AK.04/2022 dated on May 11, 2022).

- Conflicts of Interest Statement: The authors have no conflicts of interest to declare.

References

Ah Mand, A., & Sifat, I. (2021). Static and regime-dependent herding behavior: An emerging market case study. *Journal of Behavioral and Experimental Finance*, *29*, 100466. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S2214635021000101?via%3Dihub.

Alber, N., & Ezzat, E. (2021). The Impact of Herding Behavior on Stock Mispricing: The Case of Listed Companies at the Egyptian Exchange. *European Journal of Business and Management Research*, *6*(4), 7–10. Retrieved from https://www.ejbmr.org/index.php/ejbmr/article/view/917/500.

Andrikopoulos, P., Kallinterakis, V., Leite Ferreira, M. P., & Verousis, T. (2017). Intraday herding on a cross-border exchange. *International Review of Financial Analysis*, *53*, 25–36. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1057521917301023?via%3Dihub.

Arjoon, V., Bhatnagar, C. S., & Ramlakhan, P. (2020). Herding in the Singapore Stock Exchange. *Journal of Economics and Business*, *109*, 105889. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0148619519300712?via%3Dihub.

Asadi, G. H., Tabrizi, H. A., & Farazmand, S. (2022). Exchange Rates, Gold Coin Prices, and Herding in the Stock Market. *Iranian Economic Review*, *26*(2), 389–406. Retrieved from https://ier.ut.ac.ir/article_88170_a1fe7ac96dc71c8113b5a15fe155cd53.pdf.

Baddeley, M. (2015). Herding, Social Influences and Behavioural Bias in Scientific Research. *EMBO Reports*, *16*(8), 902–905. Retrieved from https://www.embopress.org/doi/full/10.15252/embr.201540637.

Baig, A. S., Blau, B. M., Butt, H. A., & Yasin, A. (2022). Do Retail Traders Destabilize Financial Markets ? An Investigation Surrounding the COVID-19 Pandemic. *Journal of Banking and Finance*, *2022*(November), 1–18. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC9355410/.

BenSaïda, A. (2017). Herding Effect on Idiosyncratic Volatility in U.S. Industries. *Finance Research Letters*, *23*, 121–132. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1544612317300442?via%3Dihub.

Bikhchandani, S., & Sharma, S. (2001). Herd Behavior in Financial Markets. *IMF Staff Papers*, *47*(3). Retrieved from https://www.imf.org/external/pubs/ft/staffp/2001/01/pdf/bikhchan.pdf.

Bo, C. C. (2023). A critical review of FOMO behaviour among young investors. *Issues and Perspectives in Business and Social Sciences*, *3*(1), 14–18. Retrieved from https://journals.mmupress.com/index.php/ipbss/article/view/vol3iss1bo/vol3iss1bo.

Bohl, M. T., Branger, N., & Trede, M. (2017). The Case for Herding is Stronger than You Think. *Journal of Banking and Finance*, *85*, 30–40. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0378426617301930.

Bollerslev, T. (1986). Generalized Autoregressive Conditional Heteroskedasticity. *Journal of Econometrics*, *31*, 307–327. Retrieved from https://public.econ.duke.edu/~boller/Published_Papers/joe_86.pdf.

Botsvadze, I. (2013). Herd Behavior in Equity Markets - The International Evidence. *Journal of Business*, *2*(2), 41–46. Retrieved from https://jb.ibsu.edu.ge/jms/index.php/jb/article/view/61.

Braiek, S., & Jeribi, A. (2022). Cryptocurrencies' Time to Shine in the World. *Iranian Economic Review*, *27*(4), 1154-1198. Retrieved from https://ier.ut.ac.ir/article_94930_236956ca52f2196f2f9a42451d862311.pdf.

Brenner, M., & Galai, D. (1989). New Financial Instruments for Hedging Changes in Volatility. *Financial Analysis Journal*, *45*(4), 61–65. Retrieved from https://pages.stern.nyu.edu/~mbrenner/research/FAJ_articleon_Volatility_Der.pdf.

Brooks, R. D., Faff, R. W., & McKenzie, M. D. (1998). Time-varying beta risk of Australian industry portfolios: A comparison of modelling techniques. *Australian Journal of Management*, *23*(1), 1–22. Retrieved from https://journals.sagepub.com/doi/epdf/10.1177/031289629802300101.

Calzolari, G., Halbleib, R., & Parrini, A. (2014). Estimating GARCH-Type Models with Symmetric Stable Innovations: Indirect Inference versus Maximum Likelihood. *Computational Statistics and Data Analysis*, *76*, 158–171. Retrieved from https://d-nb.info/1163950564/34.

Chae, J., & Lee, E. J. (2018). Distribution uncertainty and expected stock returns. *Finance Research Letters*, *25*, 55–61. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1544612317303574.

Chang, E. C., Cheng, J. W., & Khorana, A. (2000). An Examination of Herd Behavior in Equity Markets: An International Perspective. *Journal of Banking and Finance*, *24*(10), 1651–1679. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0378426699000965.

Chen, Y. C., Wu, H. C., Zhang, Y., & Kuo, S. M. (2021). A transmission of beta herding during the subprime crisis in Taiwan's market: DCC-MIDAS approach. *International Journal of Financial Studies*, *9*(70), 1–16. Retrieved from https://www.mdpi.com/2227-7072/9/4/70.

Chiang, T. C., & Zheng, D. (2010). An Empirical Analysis of Herd Behavior in Global Stock Markets. *Journal of Banking and Finance*, *34*(8), 1911–1921. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0378426609003409.

Christie, W. G., & Huang, R. D. (1995). Following the Pied Piper: Do Individual Returns Herd around the Market? *Financial Analysts Journal*, *51*(4), 31–37. Retrieved from https://www.tandfonline.com/doi/abs/10.2469/faj.v51.n4.1918.

Contessi, S., & Pace, P. De. (2021). The International Spread of COVID-19 Stock Market Collapses. *Finance Research Letters*, *42*(C), 1–11. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC8450777/.

Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business and Economic Statistics*, *20*(3), 339–350. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=236998.

Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, *50*(4), 987–1008. Retrieved from http://www.econ.uiuc.edu/~econ536/Papers/engle82.pdf.

Essa, M. S., & Giouvris, E. (2023). What is the Effect of VIX and (un)Expected Illiquidity on Sectoral Herding in US REITs during (Non)Crises? Evidence from a Markov Switching Model (2014–2022). *Journal of Behavioral Finance*, *0*(0), 1–23. Retrieved from https://www.tandfonline.com/doi/full/10.1080/15427560.2023.2249155#d1e115.

Fabozzi, F. J., & Francis, J. C. (1979). Mutual Fund Systematic Risk for Bull and Bear Markets: An Empirical Examination. *The Journal of Finance*, *34*(5), 1243–1250. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2586506.

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, *25*(2), 383. Retrieved from https://people.hec.edu/rosu/wp-content/uploads/sites/43/2023/09/Fama-Efficient-capital-markets-1970.pdf.

Farbmacher, H., & Kögel, H. (2017). Testing Under a Special Form of Heteroscedasticity. *Applied Economics Letters*, *24*(4), 264–268. Retrieved from https://www.tandfonline.com/doi/full/10.1080/13504851.2016.1181827.

Feng, L., & Shi, Y. (2017). A Simulation Study on the Distributions of Disturbances in the GARCH Model. *Cogent Economics and Finance*, *5*(1), 1–19. Retrieved from https://www.tandfonline.com/doi/full/10.1080/23322039.2017.1355503#abstract.

Ferreruela, S., Kallinterakis, V., & Mallor, T. (2022). Cross-Market Herding: Do 'Herds' Herd with Each Other? *Journal of Behavioral Finance*, 1–45. Retrieved from https://zaguan.unizar.es/record/119011/files/texto_completo.pdf.

Financial Services Authority (OJK). (2022). Capital Market Fact Book 2022. Retrieved from https://ojk.go.id/en/Statistik/Pasar-Modal/Laporan-Tahunan/Pages/Capital-Market-Fact-Book-2022.aspx.

Giot, P., & Laurent, S. (2003). Value-at-Risk for Long and Short Trading Positions. *Journal of Applied Econometrics*, *18*(6), 641–663. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/jae.710.

Gujarati, D. N., & Porter, D. C. (2009). *Basic Econometrics; The McGraw-Hill Series Economics* (5th Ed.). New York: McGraw-Hill.

Gupta, S., & Shrivastava, M. (2022). Herding and Loss Aversion in Stock Markets: Mediating Role of Fear of Missing Out (FOMO) in Retail Investors. *International Journal of Emerging Markets*, *17*(7), 1720–1737. Retrieved from https://www.emerald.com/ijoem/article-abstract/17/7/1720/146285/Herding-and-loss-aversion-in-stock-markets?redirectedFrom=fulltext.

Haghani, M., & Sarvi, M. (2019). 'Herding' in direction choice-making during collective escape of crowds: How likely is it and what moderates it? *Safety Science, 115*(February), 362–375. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0925753518309287.

Hirshleifer, D., & Hong Teoh, S. (2003). Herd Behaviour and Cascading in Capital Markets: A Review and Synthesis. *European Financial Management*, *9*(1), 25–66. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=296081.

Hsieh, S. F. (2013). Individual and Institutional Herding and the Impact on Stock Returns: Evidence from Taiwan Stock Market. *International Review of Financial Analysis*, *29*(C), 175–188. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1057521913000045.

Hwang, S., & Salmon, M. (2004). Market Stress and Herding. *Journal of Empirical Finance*, *11*(4), 585–616. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0927539804000507.

Jabalameli, F., Ghorbani, P., & Ahmadian, M. (2020). Risk Management in Oil Market: A Comparison between Multivariate GARCH Models and Copula-Based Models. *Iranian Economic Review*, *24*(2), 489–513. Retrieved from https://ier.ut.ac.ir/article_76015_c38140a75f74c942b20db4a48c6bd01d.pdf.

Kumar, A., Badhani, K. N., Bouri, E., & Saeed, T. (2021). Herding behavior in the commodity markets of the Asia-Pacific region. *Finance Research Letters*, *41*(C), 101813. Retrieved from https://www.researchgate.net/publication/346358389_Herding_behavior_in_the_commodity_markets_of_the_Asia-Pacific_region.

Lauridsena, J., & Kosfeld, R. (2011). Spurious Spatial Regression and Heteroscedasticity. *Journal of Spatial Science*, *56*(1), 59–72. Retrieved from https://doi.org/10.1080/14498596.2011.567411.

Malkiel, B. G. (2003). The Efficient Market Hypothesis and Its Critics. *Journal of Economic Perspectives*, *17*(1), 59–82. Retrieved from https://eml.berkeley.edu/~craine/EconH195/Fall_14/webpage/Malkiel_Efficient%20Mkts.pdf.

McKenzie, M. D., Mitchell, H., Brooks, R. D., & Faff, R. W. (2001). Power arch modelling of commodity futures data on the London Metal Exchange. *International Journal of Phytoremediation*, *21*(1), 22–38. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/13518470123011.

Mertzanis, C., & Allam, N. (2018). Political Instability and Herding Behaviour: Evidence from Egypt's Stock Market. *Journal of Emerging Market Finance*, Retrieved from *17*(1), 29–59. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0972652717748087.

Nieto, B., Orbe, S., & Zarraga, A. (2014). Time-varying market beta: Does the estimation methodology matter? *Sort*, *38*(1), 13–42. Retrieved from https://www.raco.cat/index.php/SORT/article/download/277216/365148.

Ogata, H. (2012). Optimal Portfolio Estimation for Dependent Financial Returns with Generalized Empirical Likelihood. *Advances in Decision Sciences*, *2012*, 1–8. Retrieved from https://www.emis.de/journals/HOA/ADS/Volume2012/973173.pdf.

Park, B. -J., & Kim, M. -J. (2017). A Dynamic Measure of Intentional Herd Behavior in Financial Markets. *MPRA Paper, 82025*(October). Retrieved from https://mpra.ub.uni-muenchen.de/82025/1/MPRA_paper_82025.pdf.

Putra, A. A., Rizkianto, E., & Chalid, D. A. (2017). The Analysis of Herding Behavior in Indonesia and Singapore Stock Markets. *11th International Conference on Business and Management Research (ICBMR 2017)*, *36*(November), 197–206. Retrieved from https://www.atlantis-press.com/proceedings/icbmr-17/25887772.

Rahman, E., & Ermawati. (2020). Analysis of Herding Behavior in the Stock Market: A Case Study of the ASEAN-5 and the U.S. *Bulletin of Monetary Economics and Banking*, *23*(3), 297–318. Retrieved from https://bulletin.bmeb-bi.org/cgi/viewcontent.cgi?article=1044&context=bmeb.

Rice, G., Wirjanto, T., & Zhao, Y. (2020). Tests for Conditional Heteroscedasticity of Functional Data. *Journal of Time Series Analysis*, *41*(6), 733–758. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/jtsa.12532.

Rizal, N. A., & Damayanti, M. K. (2019). Herding Behavior in the Indonesian Islamic Stock Market. *Journal of Islamic Monetary Economics and Finance*, *5*(3), 673–690. Retrieved from https://www.jimf-bi.org/JIMF/article/view/1079/781.

Robiyanto, R. (2018). DCC-GARCH Application in Formulating a Dynamic Portfolio between Stocks in the Indonesia Stock Exchange with Gold. *Indonesian Capital Market Review*, *10*(1). Retrieved from https://scholarhub.ui.ac.id/icmr/vol10/iss1/3/.

Rout, B., Mohanty, A., & Kacharia, A. K. (2017). Bull Vs Bear Market- an Investment Game Analysis Using Moving Average Method. *International Journal of Research-Granthaalayah*, *5*(11), 425–443. Retrieved from https://www.granthaalayahpublication.org/journals/granthaalayah/article/view/IJRG17_A12_834/2259.

Samitas, A., Kampouris, E., & Polyzos, S. (2022). COVID-19 Pandemic and Spillover Effects in Stock Markets: A Financial Network Approach. *International Review of Financial Analysis*, *80*(C), 102005. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC8694798/.

Scharfstein, D. S., & Stein, J. C. (1990). Herd Behavior and Investment. *American Economic Review*, *80*(3), 465–479. Retrieved from https://stein.scholars.harvard.edu/sites/g/files/omnuum5951/files/stein/files/aer1990_0.pdf.

Shahraki, J., Shahraki, A. S., Ahmadi, N. A., & Radmehr, Z. (2021). The Economic Assessment of the Production and Technical Efficiency of Bakeries (Focus on Social Factor Using Stochastic Frontier Analysis). *Iranian Economic Review*, *25*(3), 383–395. Retrieved from https://ier.ut.ac.ir/article_84135_527189c8f186ea30543e74d2d4397680.pdf.

Sharpe, W. F. (1964). Capital Asset Price: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, *19*(3), 425–442. Retrieved from https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1540-6261.1964.tb02865.x.

Stojanovski, T. (2015). Volatility and Kurtosis of Daily Stock Returns at MSE. *UTMS Journal of Economics*, *6*(2), 209–221. Retrieved from https://www.utmsjoe.mk/files/Vol.%206%20No.%202/UTMSJOE-2015-0602-003-Ivanovski-Stojanovski-Narasanov.pdf.

Tsionas, M. G., Philippas, D., & Philippas, N. (2022). Multivariate stochastic volatility for herding detection: Evidence from the energy sector. *Energy Economics*, *109*(C), 105964. Retrieved from https://www.gfli.gr/wp-content/uploads/2022/07/Multivariate-stochastic-volatility-for-herding-detection-Evidence-from-the-energy-sector-2022.pdf.

Zhang, H., & Giouvris, E. (2022). Measures of Volatility, Crises, Sentiment, and the Role of U.S. 'Fear' Index (VIX) on Herding in BRICS (2007–2021). *Journal of Risk and Financial Management*, *15*(3), 134. Retrieved from https://www.mdpi.com/1911-8074/15/3/134.

Cite this article: Suhendro, S., Atahau, A. D. R., Robiyanto, R., Harijono, H. (2025). Dynamic Conditional Correlation Analysis of Investor Herding: Evidence from the Indonesian and Malaysian Capital Markets. *Iranian Economic Review, 29*(4), 1205-1233.

Iranian Economic Review, 29(4), 1234-1255
DOI: https://doi.org/10.22059/ier.2024.366270.1007822

RESEARCH PAPER

The Impact of Tweet Risks on Global Financial Markets Using the Quantile VAR Model

Naeim Shokri[*,a], Samad Gholami[b]

a. Department of Health Economics, Faculty of Health, Baqiyatallah University of Medical Sciences, Tehran, Iran.
b. Department of Economics, Faculty of Management & Economics, Tarbiat Modares University, Tehran, Iran.
* Corresponding author

Received: 08 October 2023, Revised: 26 December 2023, Accepted: 05 January 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
This study examines how tweets influence the emotions of investors and how these emotions impact global financial markets. The study applies the Quantile VAR model, a method that captures the dynamics of different quantiles of the conditional distribution, to analyze the data of weekly returns for five financial variables: the U.S. dollar, gold, oil, NASDAQ index, and S&P index, from 2019 to 2023. The study also constructs weighted indices of emotions based on tweets from the US and England, using a sentiment analysis tool. The results reveal a high correlation (95%) between the emotions and the average conditional distribution, indicating that emotions have a significant effect on financial markets. The study also finds that gold and the U.S. dollar are the most vulnerable to emotional shocks, especially during the peak of the COVID-19 pandemic, when fear and uncertainty were widespread. The study emphasizes the importance of addressing the direct impact of emotions on financial markets and urges policymakers and legislators to implement regulations that can protect investors and ensure market stability.
Keywords: Financial Markets, Investor Emotions, Quantile VAR, Risks, Tweets.
JEL Classification: G01, G14, G15, G17, G18.

1. Introduction
Twitter is a valuable source of information for predicting and detecting stock market events and news. However, extracting useful insights from Twitter data is not a trivial task. It requires sophisticated econometric and machine-learning methods that can create Twitter networks that accurately anticipate market movements (Bouri et al., 2021). Moreover, it involves social media analysis that can track key events in the stock market, such as “COVID-19” or “mergers” by

using keywords as indicators. For example, a surge in merger-related keywords may signal an impending merger (Karampatsas et al., 2023). Additionally, it entails transactional analysis that can monitor corporate news and rumors, and Twitter and stock market APIs that can provide real-time market updates. With market alerts, managers can keep up with vital market conditions (Reboredo and Ugolini, 2018). The main challenge of Twitter and social media analysis is the quality and reliability of the data. Many tweets are irrelevant, and fake accounts can disseminate false information, affecting investors' behavior (Sul et al., 2017; Teti et al., 2019). Furthermore, stock prices are influenced by social networks. Twitter user sentiments can sway public opinion and financial responses, and user content can support market surveillance and decision-making (Guo et al., 2025). News and tweets from CEOs, policymakers, journalists, and analysts have a significant impact on stock prices. Network and statistical analysis can identify news or rumors that affect stock prices. An alert system can give specific users immediate access to trustworthy information (Zeitun et al., 2023).

This research aims to develop a comprehensive framework for analyzing Twitter and social media data for stock market prediction and detection. The objectives of this research are:

- To review the existing literature on Twitter and social media analysis for stock market prediction and detection.

- To propose a novel methodology for creating Twitter networks that can precisely forecast market events using econometric and machine-learning methods.

- To design and implement algorithms for assessing key stock market events using keywords as indicators.

- To evaluate the performance and accuracy of the proposed methodology and algorithms using real-world data.

- To develop an alert system that can provide specific users with instant access to reliable information based on network and statistical analysis.

So the main problem of this research is how Twitter risks affect global financial markets, and the research questions of this paper are as follows:

How do tweets influence the emotions of investors in the context of global financial markets?

What is the impact of investor emotions, influenced by tweets, on global financial markets?

To what extent do emotions, as captured by weighted sentiment indices derived from tweets, affect the dynamics of financial variables, including the U.S.

dollar, gold, oil, NASDAQ index, and S&P index?

Which financial variables exhibit the highest vulnerability to emotional shocks, particularly during periods of heightened fear and uncertainty, such as the peak of the COVID-19 pandemic?

2. Literature Review

In 1936, John Maynard Keynes used the term “Animal spirits” in his book for the first time in the economic context. Since that time, researchers and economists have been searching for the determinants of the wild price movements and volatility on the stock market that cannot be explained by the fundamentals of the companies.

Over the last 10 years, a new type of media has become the most important source of data for investors and businesses: social media (Fan and Gordon, 2014). This development has led to a lot of new studies regarding the effect of social media on the stock market. The most interesting social media platform for researchers is Twitter, due to its fast growth and real-time nature. Social media is similar to other news outlets in the sense that it can also help with the information asymmetry of investors. Blankespoor et al. (2014) show that firms that use Twitter can decrease the information asymmetry and lead to an increase in liquidity, if the firms are not covered much in the other news outlets. Mao et al. (2012) investigated the effect of the daily number of tweets mentioning the S&P 500 on the stock indicators of the S&P 500. The authors find evidence that the Twitter data is correlated with the stock indicators for the S&P 500. Also, they found a predictive nature in the Twitter data, since the Twitter data could help predict whether the closing price would go up or down. Another interesting subject in the previous literature is the effect of the sentiment of the tweets, since Tetlock (2008) already showed that negative words in firm-specific news stories can forecast low firm earnings and returns.

William et al. (2023) argue that despite the utility of stock market social network analysis, it should not be solely relied upon without survey data. Their research focuses on the impact of social media news on stock prices. Twitter content analysis reveals user behavior and collective insights despite irrelevant posts. Companies like Bloomberg use Twitter sentiment analysis for predicting stock returns, although its use in investment systems is debated (Groß-Klußmann et al., 2019). Checkley et al. (2017) discovered that Twitter sentiment-based investment strategies are efficient yet ephemeral due to rapid information spread and decay. Garcia (2013) asserts that these indicators predict stock prices in recessions. Negative market views favor short positions. Ranco et al. (2015) found significant yearly Twitter data for major stock indices despite low individual stock tweets. Capital market analysis uses machine learning and game theory, leading to the development of behavioral finance, which blends behavioral economics and game theory. Twitter's extensive archives and diverse views are valuable for assessing tweet risks. In 2021, Twitter allowed academics to access its archive for risk studies (William et al., 2023).

Timmermann (2008) discovered that Twitter sentiment can forecast stock returns. Atkins et al. (2018) noted that few studies used these signals for equity index performance in trend-following strategies. Neri et al. (2012) found that financial decisions and global markets are swayed by social media sentiment, which is crucial for forecasting market trends, particularly in cryptocurrency. Shokri et al. (2021) investigated volatility spillovers from Bitcoin to other digital currencies using multivariate GARCH, noting significant impacts on Dogecoin and Dash that contribute to market irrationality, which can be amplified by tweet-driven sentiments influencing crypto prices. Similarly, Hajilo Moghadam et al. (2023) analyzed spillover effects of digital currencies on gold via wavelet coherence, identifying Bitcoin's strong influence on Litecoin, Ethereum, and Dash while affirming gold's safe-haven role, potentially exacerbated by social media volatility during crises like COVID-19. Shokri and Roshanfekr (2023) explored Bitcoin's fluctuation spillovers to other cryptocurrencies, highlighting interconnected risks that tweets from influential figures can intensify, as seen in market swings from high-profile endorsements. Complementing this, Dorouzi and Shokri (2020) examined Bitcoin's effects on international law, underscoring legal challenges from its volatility, which social media discussions and rumors can further propagate across global financial markets. Garcia and Schweitzer (2015) explored the correlation between social signals and Bitcoin algorithmic trading, showing social media's impact on Bitcoin trading.

There is a close relationship between financial markets, risk, and the performance of individual financial assets. Financial markets are inherently susceptible to various risks arising from economic, political, social, and technological factors. When uncertainties or unforeseen events materialize, they can significantly impact market sentiment and volatility. Prior research has shown that periods of heightened risk and uncertainty, such as economic downturns and financial crises, tend to negatively affect the prices and returns of various asset classes. Assets like stocks, currencies, commodities, and cryptocurrencies exhibit different levels of vulnerability to market fluctuations and risks. For example, gold has traditionally served as a safe-haven asset during times of market turmoil. The literature also indicates that non-fundamental factors like social media sentiment can influence the risk profiles of individual assets. By examining how tweet sentiment shapes investor emotions, which then feed back into market dynamics, this study aims to provide a more nuanced understanding of the relationship between overall market conditions. Such insights are crucial for improving risk management strategies and investment decisions. Also, no studies have used sentiment and volatility measures from quantile analysis to predict returns.

Twitter signals are a rich but untapped source of information for understanding the interplay between emotions and financial markets. This research explores this novel and timely topic using cutting-edge methods. The study measures how Twitter influences financial markets across different countries and sectors using market spillovers and Quantile VAR models. The study also uses tweets as sentiment indicators to capture the emotional states of investors and their impact on market outcomes.

3. Methods and Materials

This study uses the variance decomposition approach proposed by Diebold and Yilmaz (2012). This approach is based on the forward stepwise decomposition of the variance of the prediction errors for each variable in an N-variable vector autoregression. Using this approach, a portion of the variance in the prediction error of variable i, which can be attributed to shocks from variable j, was examined. The spillover index was calculated by adding the effects.

3.1 Quantile VAR Model

A quantile estimation of the conditional measurement of y_t on x_t is performed for each quantile τ of the conditional dependency of y_t/x_t as follows:

$$Q_\tau\left(y_t \,|x_t\right) = x_t\beta(\tau) \tag{1}$$

where Q_τ represents the τth conditional quantile function of y_t and τ is a number between zero and one. x_t is the vector of variables and β(τ) is the determinant of the mutual dependency between x_t and the conditional quantiles of y_t. Coefficient β(τ) represents the τth conditional quantile as follows:

$$\hat{\beta}(\tau) = \frac{a}{\beta(\tau)}\sum_{i=1}^{T}(\tau - 1_{\{y_t<x_t\beta(\tau)\}})\,|y_t - x_t\beta(\tau)| \tag{2}$$

The multivariate quantile VAR with p lags is defined as follows:

$$y_t = c(\tau) + \sum_{i=1}^{p} \beta(\tau) y_{t-i} + e_t(\tau)\,, t = 1, \ldots, T \tag{3}$$

In this equation, y_t represents the vector of dependent variables, $c(\tau)$ and $e_t(\tau)$ represent the model constant and residual, respectively, and $\beta(\tau)$ represents the coefficient matrix of dependence in the τ-th quantile.

Assuming $i=1,\ldots,p$, the values of $\hat{\beta}(\tau)$ and $\hat{c}(\tau)$ are estimated under the assumption that the residuals are independent of the lagged dependent variables, that is,

$$Q_t(e_t(\tau) \big| y_{t-1}, \ldots, y_{t-p}) = 0 \tag{4}$$

The estimation of conditional quantile y is given by the following equation, through which each quantile τ can be estimated:

$$Q_t(y_t \big| y_{t-1}, \ldots, y_{t-p}) = c(\tau) + \sum_{i=1}^{p} \hat{\beta}(\tau)\, y_{t-i} \tag{5}$$

In this section, we present a method based on multivariate dependencies. This method, proposed by Ando et al. (2022), uses a Quantile Connectedness framework based on the Diebold-Yilmaz model. Initially, Eq. (3) can be written as a moving average process.

$$y_t = \mu(\tau) + \sum_{s=0}^{\infty} A_s(\tau) e_{t-s}(\tau)\,, t = 1, \ldots, T \tag{6}$$

Furthermore, $\mu(\tau)$ represents

$$\mu(\tau) = \left(I_n - B_1(\tau) - \cdots - B_p(\tau)\right)^{-1} c(\tau) \text{ و } A_s(\tau) = \begin{cases} 0. s < 0; I_n\,, s = 0 \\ B_1(\tau) A_{s-1}(\tau) + \cdots B_p(\tau) A_{s-p}(\tau), s > 0 \end{cases} \tag{7}$$

Variable yt was obtained using the sum of residuals. In addition, generalized forecast error variance decomposition (GFEVD) is used to measure the shock structure of different variables, which provides an advantage over the simple Diebold-Yilmaz model (which uses the VAR structure). The GFEVD structure for H-step-ahead decomposition is defined as follows:

$$\theta_{ij}^{g}(H) = \frac{\sigma_{ij}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_s \sum e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_s \sum e_j\right)} \tag{8}$$

where $\theta_{ij}^{g}(H)$ represents the jth variable's gth forecast error for the ith variable at the H-steps ahead, $\sum$ is the variance matrix of the error vector, σjj is the jth diagonal element of the $\sum$ matrix, and e_i is a vector with values of one for the ith variable and zero for other values. The variance decomposition matrix was normalized as follows:

$$\tilde{\theta}_{ij}^{g} = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)} \tag{9}$$

Finally, four measures were calculated for each variable using the GFEVD structure. These, in order, are:

1. Total Connectedness Index (TCI): This represents a measure of market risk. For example, a higher TCI indicated a higher degree of overall network connectivity. This was calculated as follows:

$$TCI(\tau) = \frac{\sum_{i=1}^{N}\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ij}^{g}(\tau)}{\sum_{i=1}^{N}\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(\tau)} \tag{10}$$

2. Total overflow index from variable i to variable j (TO[1]): This calculates the overall impact of variable i on all other variables j, providing information on the general influence of variable i. This was calculated as follows:

$$TO = SI_{i\to j}(\tau) = \frac{\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ij}^{g}(\tau)}{\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(\tau)} \tag{11}$$

3. Total Inflow Index of Variable j to Variable i (FROM[2]): This evaluates the overall impact of shocks from all other variables j on Variable i in a directional manner, capturing the direction of influence.

$$FROM = SI_{i\leftarrow j}(\tau) = \frac{\sum_{j=1,i\neq j}^{N} \tilde{\theta}_{ij}^{g}(\tau)}{\sum_{j=1}^{N} \tilde{\theta}_{ij}^{g}(\tau)} \tag{12}$$

4. The difference between the total outflow (TO) and total inflow (FROM) and other variables results in net directional connectivity (NET[3]).

$$NET_i(\tau) = SI_{i\to j}(\tau) - SI_{i\to j}(\tau) \tag{13}$$

We used weekly financial market data for the variables described in Table1 for the period 2019 to 2023. Additionally, we used data related to various tweets that indicate sentiments in financial markets. Twitter data provides some attractive features for studying the effects of sentiments. The volume of available tweets is very high, with 0.22 of adults in the United States using Twitter, and approximately 500 million messages sent on this platform daily. Twitter enables the depiction of beliefs and opinions on various social media platforms. Tweets have precise timestamps that allow the exact publication time for each tweet to be known. The impact or correlation of each tweet is obtained from the number of retweets received. In January 2021, Twitter opened archives for academic researchers. To

[1]. Total directional connectedness to others
[2]. Total directional spillover index FROM indices j to index i
[3]. The net total directional spillover

extract all tweets published about financial markets, a data extraction algorithm containing keywords such as "uncertain", "ambiguous", "uncertainties", and "uncertainty" has been applied to each tweet. The Economic Uncertainty (TEU) indices are based on Twitter and span the period from June 2015 to the present. The TEU indices were developed by Thomas Renault (University of Paris 1 Panthéon-Sorbonne) in collaboration with Scott R. Baker (Northwestern), Nicholas Bloom (Stanford), and Steve Davis (University of Chicago). The text explains how the researchers extracted all the tweets that contained keywords related to uncertainty and the economy since June 2015. The uncertainty terms are ‘uncertain’, ‘uncertainly’, ‘uncertainties’, and ‘uncertainty’. The economic terms are ‘economic’, ‘economical’, ‘economically’, ‘economics’, ‘economies’, ‘economist’, ‘economists’, and ‘economy’. Using this database of tweets, they constructed four TEU indices. The first one, TEU-ENG, consists of the total number of daily English-language tweets that contain both uncertainty and economic terms. The second one, TEU-USA, isolates the number of these tweets that originate from users in the United States using a geo-tag-based classifier. US users make up about 50 percent of the English-language Twitter population in this sample. The financial data in this paper were collected from Investing.com[1].

Table 1. An Introduction to Research Variables

Variables	Descriptions
Item1	End-of-day price of gold
Gold	End-of-day price of oil
Oil	Weekly S&P Index
S&P Index	Weekly Nasdaq Index
Nasdaq Index	End-of-day price of Bitcoin
Bitcoin	Weekly Dollar Index
Dollar Index	The total number of daily tweets in English
TEU.ENG	The total number of tweets by Americans
TEU.USA	Weighted variable where retweets are given weight
TEU.WGT	Individuals residing in the United States of America
TEU.SCA	End-of-day price of gold

Source: Research finding.

In this model, the performance of the indices is first calculated using (14), and then the model is applied. The variables are generally calculated as follows: P_t represents the closing price and R_t represents the returns of the indices. These

[1]. Investing.com - Stock Market Quotes & Financial News https://www.investing.com/

variables have been applied to financial indicators such as gold, oil, S&Pthe index,the NASDAQ index, the dollar index, and Bitcoin.

$$R_t = Ln(\frac{P_t}{P_{t-1}}) \times 100 \tag{14}$$

4. Results

The descriptive statistics and data returns are shown in Table 2.

Table 2. Descriptive Statistics of Research Variables

	Gold	Oil	S&P	Nasdaq	DJI	USD	TEU.ENG	TEU.USA	TEU.WGT	TEU.SCA
Mean	22.04	2.387	49.942	183.624	414.121	0.7	22.508	24.141	26.051	18.461
Variance	449.356	6.1	3288.202	45081.26	206905.629	0.405	1283.711	1527.192	1803.457	1328.177
Skewness	2.302***	2.912***	2.563***	2.308***	2.953***	2.079***	6.664***	5.944***	6.186***	8.808***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ex. Kurtosis	8.784***	12.919***	8.687***	7.184***	13.368***	7.235***	62.592***	46.137***	50.059***	99.127***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
JB	1729.596***	3530.960***	1788.883***	1282.152***	3755.475***	1224.422***	72011.372***	39913.321***	46753.301***	178231.922***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ERS	-7.349***	-3.862***	-3.441***	-2.458**	-4.617***	-4.687***	-6.226***	-7.170***	-7.253***	-6.548***
	(0.000)	(0.000)	(0.001)	(0.014)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Q(10)	30.354***	150.612***	179.023***	236.540***	143.141***	18.229***	114.188***	143.257***	140.408***	189.772***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Q2(10)	66.341***	135.514***	94.095***	111.766***	119.149***	14.864***	86.074***	53.109***	57.624***	108.864***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)

Source: Research finding.

Note: The sign *** shows a statistical significance level of 0.99.

Table 3. Results of 0.95 Quantile level

Q=0.95	Gold	Oil	S&P	Nasdaq	DJI	USD	TEU-ENG	TEU-USA	TEU-WGT	TEU-SCA	FROM
Gold	7.02	9.36	10.74	9.33	9.95	9.32	10.61	10.80	11.43	11.45	92.98
Oil	6.90	9.98	9.60	9.16	10.17	10.02	9.65	11.55	11.93	11.05	90.02
S&P	6.61	9.41	9.83	9.02	9.79	8.99	10.39	11.93	12.18	11.85	90.17
Nasdaq	6.41	9.00	10.35	9.19	9.54	9.24	10.48	11.49	12.07	12.23	90.81
DJI	6.32	9.33	10.31	8.57	10.17	9.42	10.16	11.71	12.14	11.88	89.83
USD	6.27	9.38	10.07	8.67	9.83	9.71	10.26	11.69	11.90	12.22	90.29
TEU-ENG	6.32	9.44	9.38	8.55	9.65	9.16	10.41	12.17	12.34	12.58	89.59
TEU-USA	6.06	9.31	8.80	8.76	9.83	9.01	10.63	12.62	12.59	12.41	87.38
TEU-WGT	6.07	9.61	8.95	9.06	10.14	8.94	10.33	12.50	12.34	12.06	87.66
TEU-SCA	6.09	9.35	9.04	8.63	9.71	8.90	10.64	12.38	12.39	12.86	87.14
TO	57.04	84.19	87.25	79.76	88.60	82.99	93.16	106.20	108.97	107.72	895.88
NET	-35.94	-5.83	-2.92	-11.06	-1.23	-7.30	3.56	18.82	21.31	20.58	TCI=89.59

Source: Research finding.

Table 4. Results of 0.05 Quantile level

Q=0.05	Gold	Oil	S&P	Nasdaq	DJI	USD	TEU-ENG	TEU-USA	TEU-WGT	TEU-SCA	FROM
Gold	27.21	8.66	7.15	7.47	8.50	11.96	7.64	7.34	7.39	6.70	72.79
Oil	7.25	25.49	11.68	10.87	11.59	8.49	6.58	6.13	6.01	5.92	74.51
S&P	5.04	10.12	20.85	17.50	18.52	6.80	5.39	5.45	5.38	4.95	79.15
Nasdaq	6.35	10.11	18.28	22.05	16.04	8.08	5.18	4.81	4.81	4.30	77.95
DJI	5.64	9.81	18.10	15.05	21.09	7.45	5.82	5.94	5.76	5.33	78.91
USD	10.99	8.58	8.26	8.52	9.21	26.51	7.80	6.86	6.94	6.33	73.49
TEU-ENG	4.92	5.29	4.59	4.03	5.62	6.04	20.74	16.59	16.24	15.95	79.26
TEU-USA	4.49	4.64	4.36	3.60	5.55	5.12	15.74	19.73	19.03	17.73	80.27
TEU-WGT	4.54	4.67	4.31	3.59	5.45	5.19	15.58	19.22	19.99	17.47	80.01
TEU-SCA	4.17	4.68	4.24	3.33	5.26	4.87	15.94	18.63	18.22	20.64	79.36
TO	53.39	66.54	80.98	73.96	85.74	63.99	85.68	90.97	89.79	84.68	775.72
NET	-19.40	-7.98	1.83	-3.99	6.83	-9.50	6.41	10.70	9.77	5.32	TCI=77.57

Source: Research finding.

Table 5. Results of 0.5 Quantile level

Q=0.5	Gold	Oil	S&P	Nasdaq	DJI	USD	TEU-ENG	TEU-USA	TEU-WGT	TEU-SCA	FROM
Gold	48.82	3.64	4.24	2.49	5.75	8.99	6.41	6.66	7.78	5.21	51.18
Oil	1.87	47.99	10.35	8.24	9.25	2.94	4.73	5.26	5.24	4.11	52.01
S&P	0.72	5.88	29.49	22.25	25.55	2.35	3.39	3.81	3.53	3.03	70.51
Nasdaq	0.89	5.33	26.65	36.65	21.05	2.35	1.78	1.90	1.95	1.44	63.35
DJI	1.06	5.83	24.71	17.23	29.84	3.23	4.16	5.06	4.84	4.04	70.16
USD	6.55	3.39	4.19	3.33	5.42	52.24	6.31	6.92	7.15	4.51	47.76
TEU-ENG	1.57	2.64	3.18	1.05	4.47	3.29	27.31	19.57	19.09	17.83	72.69
TEU-USA	1.11	2.45	3.14	1.15	4.43	2.71	17.17	24.13	22.83	20.87	75.87
TEU-WGT	1.33	2.28	2.85	0.93	4.20	3.00	17.06	23.31	24.66	20.37	75.34
TEU-SCA	0.90	2.40	2.67	0.75	3.85	1.93	16.92	22.70	21.95	25.93	74.07
TO	16.01	33.85	81.98	57.43	83.97	30.79	77.92	95.19	94.37	81.41	652.94
NET	-35.17	-18.16	11.47	-5.92	13.82	-16.97	5.23	19.32	19.04	7.33	TCI=65.29

Source: Research finding.

Based on the descriptive statistics of the research variables in Table 2, the time series of the index returns exhibits higher kurtosis than that of a normal distribution (kurtosis statistic > 3). Additionally, the Jarque-Bera test rejects the assumption of normality for the return time series. Furthermore, the skewness statistic is positive, indicating that the return time series has a longer right tail than the left tail. ERS[1] was used to examine and confirm the validity of the data. Continuing the analysis, we present measures of the average correlation of the research findings (the transmission of sentiment). The results presented in Table 2 show the average values for the entire study period. To this end, we consider the results obtained from the three quantiles (0.05, 0.5, and 0.95) to determine whether severe shocks resulting from sentiment play a prominent role in the relationship between the network variables. Note that all numbers in Table 2 are presented as percentages and correspond to the average connectivity values. In addition, please note that the magnitude of the shock received (FROM) and the magnitude of the shock transmitted by others (TO) are indicated. To indicate the sender variable in the network, if a variable is a shock sender, it is denoted by a (+) sign; if it is a shock receiver, it is denoted by a (-) sign. The overall correlation index (TCI) was used to determine the relationships between variables.

Based on the results obtained from Table 3 at the 0.95 quantile level, the number of English retweets discussing market uncertainty, tweets from US residents, and the total number of tweets from individuals of American nationality had the highest impact and spillover shocks on the markets. Additionally, the TCI statistic indicated the connectivity and correlation of the data with a value of 89.59, suggesting a strong relationship between the available data.

Figure 1 shows the overall correlation index (TCI), an overflow market indicator used to measure market risk. This indicates the level of correlation between the returns of each index and the overall returns of the variables.

[1]. Elliott, Rothenberg and Stock Unit Root Test

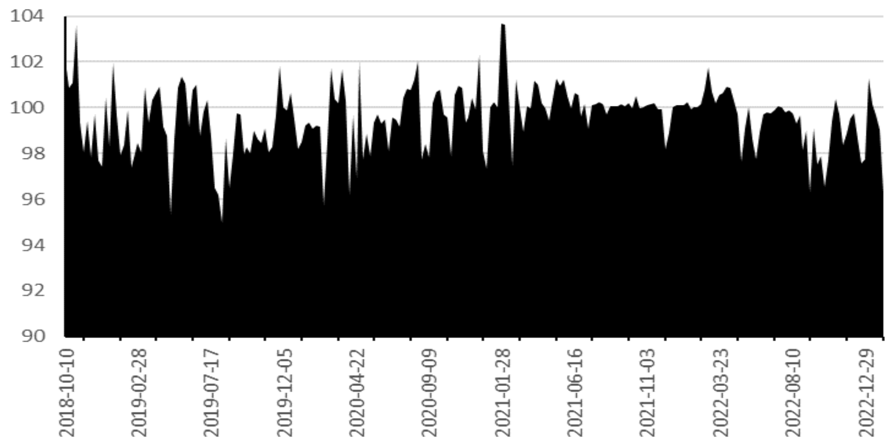


Figure 1. Overall Correlation Index
Source: Research finding.

Furthermore, considering the connectivity network shown in Figure 2, the gold market and dollar index had the highest receiver effects. Generally, the higher the TCI, the greater the coordination and correlation among the indices.

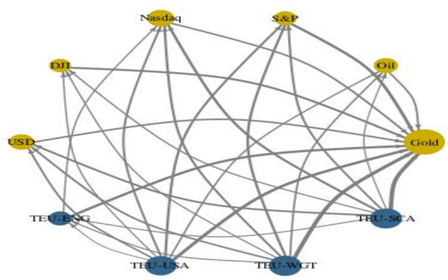


Figure 1. Network Analysis between Variables at the 0.95 quantile level
Source: Research finding.

TCI is a useful tool for analyzing index relationships. Trends and directions should be examined to interpret the TCI chart. If the TCI rises, it may mean that the market is more interconnected and sentiment spillover effects are more likely. A decreasing TCI may indicate less interrelatedness and lower sentiment spillover. Figure 1 shows periods of higher correlation, such as the COVID-19 pandemic in 2019 and the Ukraine-Russia war in 2022. Table 4 shows that at a 0.05 significance level, the most influential tweets were total tweets by Americans, retweets in

English about market uncertainty, and English tweets. The TCI statistic (77.57) showed a strong connection between the data. NET statistics revealed that English retweets discussing market uncertainty, American tweets, and English tweets had the most influence on emotional shock transmission.

Figure 3 illustrates the correlation between the indices, which showed a sudden increase after the onset of the COVID-19 pandemic in December 2019.

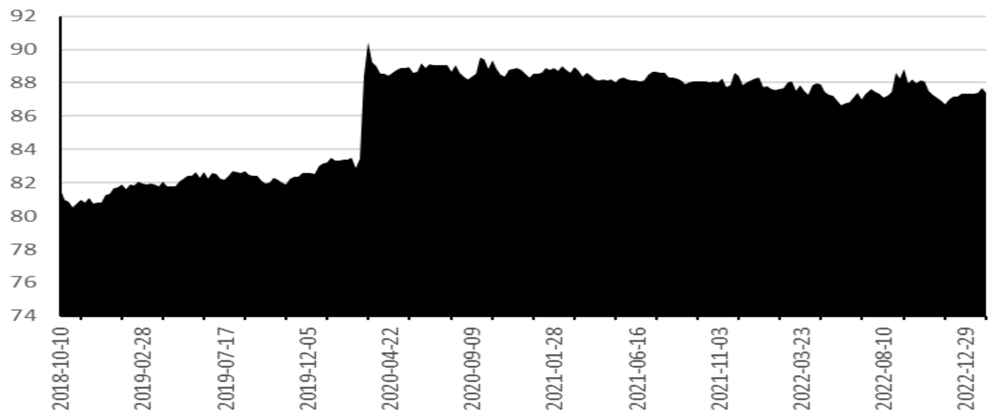


Figure 3. Overall Correlation Index
Source: Research finding.

According to the connectivity network shown in Figure 4, the gold market and dollar index were the most influential receivers of impact, similar to the 95th percentile level. Furthermore, considering the connectivity network shown in Figure 4, the gold market and dollar index are the most influential factors, similar to the 0.95 quantile level.

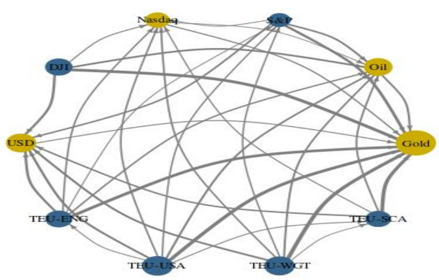


Figure 2. Network Analysis between Variables at the 0.05 Quantile Level
Source: Research finding.

Based on the NET statistics among the available data in Table 5, at the 0.5th percentile level, the total number of tweets by individuals of American nationality and English retweets discussing market uncertainty had the highest impact on transmitting emotional shocks among other tweets. Additionally, the TCI statistic indicated the connection and correlation of the data with a value of 65.29, suggesting a strong relationship between the available data.

In Figure 5, an important factor to consider when analyzing the TCI index is the trend and direction of the index over time. If the TCI increases over time, this may indicate that the market is becoming more interconnected, posing a greater risk of spillover effects among companies. For example, if a company experiences a significant event, such as bankruptcy or a major product recall, it may have ripple effects on other companies in the market that are connected to it through supply chains or business partnerships. Figure 5 shows an upward jump corresponding to the COVID-19 pandemic of December 2019. From that date onwards, the index shows an upward trend, indicating the impact of the pandemic on the correlation and connectivity among these markets. This could be due to various factors, such as changes in industry structure, consumer preferences, or regulatory changes that affect certain companies more than others.

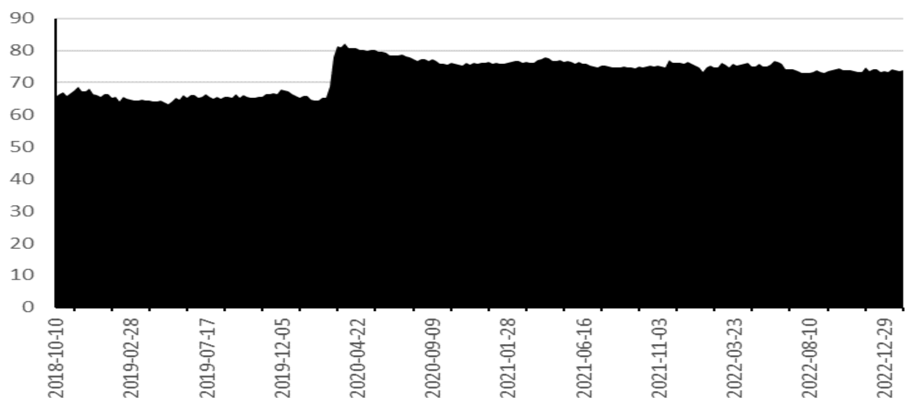


Figure 5. Overall Correlation Index
Source: Research finding.

Furthermore, considering the network connectivity shown in Figure 6, the gold market and dollar index are the major recipients of impacts, similar to the 0.95th percentile level.

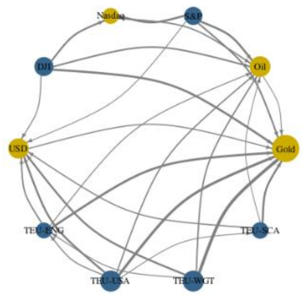


Figure 3. Network Analysis between Variables at the 0.5 Quantile Level
Source: Research finding.

TCI is only one measure of market interconnectivity and should be considered with other metrics and external factors. Global economics, politics, and technology can affect market connectivity and TCI. Results show that tweets about market fluctuations have short- and long-term effects on these markets. The dollar index and gold are most impacted by emotional waves. Other variables affect market fluctuations, but emotion in virtual spaces such as Twitter is a major factor. Research models show that tweet indices influence other markets, with gold and the dollar index having the greatest impact. In summary, tweets from American citizens or residents are the main drivers of emotions in markets. When an influential investor or analyst tweets about market movements or worries about an asset or market, it can influence other market participants, especially if the tweet is widely seen. The effect of tweets depends on many factors, such as the source's credibility, the timing of the tweet, and the emotions expressed. A tweet from a reliable, knowledgeable person with many followers can significantly influence market sentiment and cause selling. If a tweet is released during a period of market instability, it can amplify investor fear and cause sales.

Tweets can become viral and widely shared, amplifying their effect. This can cause market fluctuations or harm vulnerable assets, especially if the tweet is seen as reliable and from a reliable source. For instance, a tweet expressing optimism about an asset or market can boost investor confidence and increase buying. Pessimistic tweets can damage investor confidence, leading to more selling. Tweets may not be the only cause of market movements, but they can affect market sentiment and short-term trends. Twitter has become a popular platform for investors to share news and opinions on financial markets. Twitter emotions can influence stock prices and other financial metrics. Corea (2016) explores whether Twitter can serve as a proxy for investors' sentiment in stock market predictions within the technology sector, focusing on Apple, Facebook, and Google over two months in 2014. The researchers collected English tweets and stock data, applying sentiment scoring and volume metrics to build OLS and logistic probability models for price and trend forecasting on a minute-by-minute basis. The results indicate that Twitter posting volume enhances the model's explanatory power more than average tweet sentiment, suggesting social media's potential in financial forecasting. Bollen et al. (2011) found that Twitter emotions accurately predicted Dow Jones changes.

Although social media sentiment and financial market movements appear to be linked, caution is necessary when interpreting these results. Correlation does not always imply causation; other factors may also influence market movement. The relationship between social media sentiment and financial market movements is complex, and it is unclear if emotions are the primary drivers or just a reflection of economic conditions. Government policies, geopolitical events, and interest rate changes can also affect financial markets; therefore, attributing causality to the relationship between social media sentiment and market movement should be done with caution. This study found that emotions from tweets on Twitter significantly influence financial markets and market performance. Alomari et al. (2021) also showed this effect. It confirms Kranefuss and Johnson's (2021) and Al-Nasseri et al. (2021) findings in Twitter emotions effect on Dow Jones and S&P market fluctuations. Also, this research agrees with Ranco et al. (2015) and Sprenger et al. (2014)'s research on tweets' stock market influence, as these markets are more affected by emotions and negative news on virtual platforms like Twitter.

5. Conclusion

This study investigates how emotions expressed on Twitter, a major social network, influence financial market movements. Emotions and behaviors of humans have always played a significant role in their decisions and actions, especially in economic and investment domains. With the advent of social media platforms such as Twitter, emotions and behaviors can spread rapidly and widely, affecting investor behavior and market fluctuations. This study aims to measure the impact of Twitter emotions on different financial markets and assets, using the Twitter Connectivity Index (TCI) as a proxy for market interconnectivity. The study hypothesizes that Twitter emotions have a positive correlation with market movements, and that English and American tweets have a stronger effect than other languages or regions. The study analyzes the data from summary tables and uses machine learning models to test the hypotheses. The results confirm the hypotheses and show that Twitter emotions have a substantial effect on financial market emotions, particularly in the oil, gold, NASDAQ, and S&P markets. The results also suggest that Twitter emotions can cause market fluctuations, high returns, and small-scale investors. The study contributes to the literature on social media sentiment and financial market movements by using a novel measure of market interconnectivity, TCI, and by examining the effects of tweets on different markets and assets. The study also has practical implications for investors, policymakers, and researchers who want to understand and predict the behavior of financial markets. The study recommends using machine learning models to anticipate tweet effects, helping investors adjust portfolios and governments prepare for crises. The study also suggests using data science and platforms like Facebook to create indices like Twitter indices for future studies. This approach offers a more precise view of the effects of these platforms as financial indicators.

In conclusion, this paper shows that Twitter emotions have a significant impact on financial market movements and that TCI is a useful measure of market interconnectivity. Our paper adds to the growing body of literature on social media sentiment and financial market movements and offers practical implications for investors, policymakers, and researchers. Our paper also points out some limitations and suggests some avenues for future research. We hope that our research will stimulate further research on this topic and advance our understanding of the role of social media in financial markets.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Al-Nasseri, A., Ali, F. M., & Tucker, A. (2021). Investor sentiment and the dispersion of stock returns: Evidence based on the social network of investors. *International Review of Financial Analysis, 78*, 1-25. Retrieved from https://www.sciencedirect.com/science/article/pii/S1057521921002362.

Alomari, M., Al Rababa'a, A. R., El-Nader, G., Alkhataybeh, A., & Rehman, M. U. (2021). Examining the effects of news and media sentiments on volatility and correlation: Evidence from the UK. *The Quarterly Review of Economics and Finance, 82*, 280-297. Retrieved from https://www.sciencedirect.com/science/article/pii/S1062976921001599.

Ando, T., Greenwood-Nimmo, M., & Shin, Y. (2022). Quantile connectedness: modeling tail behavior in the topology of financial networks. *Management Science, 68*(4), 2401-2431. Retrieved from https://pubsonline.informs.org/doi/abs/10.1287/mnsc.2021.3984.

Atkins, A., Niranjan, M., & Gerding, E. (2018). Financial news predicts stock market volatility better than the closing price. The Journal of Finance and Data Science, 4(2), 120-137. Retrieved from https://www.sciencedirect.com/science/article/pii/S240591881730048X.

Blankespoor, E., Miller, G. S., & White, H. D. (2014). The role of dissemination in market liquidity: Evidence from firms' use of Twitter™. *The Accounting Review*, *89*(1), 79-112. Retrieved from https://publications.aaahq.org/accounting-review/article-abstract/89/1/79/3645.

Bollen, J., Mao, H., & Zeng, X. (2011). Twitter mood predicts the stock market. *Journal of Computational Science, 2*(1), 1-8. Retrieved from https://www.sciencedirect.com/science/article/pii/S187775031100007X.

Bouri, E., Saeed, T., Vo, X. V., & Roubaud, D. (2021). Quantile connectedness in the cryptocurrency market. *Journal of International Financial Markets, Institutions and Money, 71*, 42-65. Retrieved from https://www.sciencedirect.com/science/article/pii/S1042443121000214.

Checkley, M. S., Higón, D. A., & Alles, H. (2017). The hasty wisdom of the mob: How market sentiment predicts stock market behavior. *Expert Systems with Applications*, *77*, 256-263. Retrieved from https://www.sciencedirect.com/science/article/pii/S0957417417300398

Corea, F. (2016). Can Twitter proxy the investors' sentiment? The case for the technology sector. *Big Data Research, 4*, 70-74. Retrieved from https://www.sciencedirect.com/science/article/pii/S2214579615300174.

Diebold, F. X., & Yilmaz, K. (2012). Better to give than to receive: Predictive directional measurement of volatility spillovers. *International Journal of Forecasting*, *28*(1), 57-66. Retrieved from https://www.sciencedirect.com/science/article/pii/S016920701100032X.

Dorouzi, E., & Shokri, N. (2020). Effect of Bitcoin on the Discipline of International Law. *The International Conference on Humanities and Law,* Retrieved from https://civilica.com/doc/718340/.

Fan, W., & Gordon, M. D. (2014). The power of social media analytics. *Communications of the ACM, 57*(6), 74-81. Retrieved from https://dl.acm.org/doi/fullHtml/10.1145/2602574.

García, D. (2013). Sentiment during recessions. *The Journal of Finance, 68*(3), 1267-1300. Retrieved from https://onlinelibrary.wiley.com/share/JYBX79QQW6DE9YKJNJNI?target=10.1111/jofi.12027.

Garcia, D., & Schweitzer, F. (2015). Social signals and algorithmic trading of Bitcoin. *Royal Society Open Science, 2*(9), 20-46. Retrieved from https://royalsocietypublishing.org/doi/abs/10.1098/rsos.150288.

Groß-Klußmann, A., König, S., & Ebner, M. (2019). Buzzwords build momentum: Global financial Twitter sentiment and the aggregate stock market. *Expert Systems with Applications*, *136*, 171-186. Retrieved from https://www.sciencedirect.com/science/article/pii/S0957417419304270.

Guo, F., Lyu, B., Lyu, X., & Zheng, J. (2025). Social Media Networks and Stock Price Synchronicity: Evidence from a Chinese Stock Forum. *Abacus*, *61*(2), 419-461. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/abac.12341.

Hajilo Moghadam, A., Shokri, N., & Zisti, S. (2023). Investigating the Spillover Effects of Selected Digital Currencies with an Emphasis on Their Impact on Gold in the Era Before and After the Covid-19 Pandemic and the Role of the Government (Applying the Wavelet Coherence Approach). *Public Sector Economics Studies*, *2*(2), 115-134. Retrieved from https://pse.razi.ac.ir/article_2675.html?lang=en.

Karampatsas, N., Malekpour, S., Mason, A., & Mavis, C. P. (2023). Twitter investor sentiment and corporate earnings announcements. *European Financial Management, 29*(3), 953-986. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/eufm.12384.

Kranefuss, E., & Johnson, D. K. (2021). Does Twitter Strengthen Volatility Forecasts? Evidence from the S&P 500, DJIA, and Twitter Sentiment Analysis. *Social Science Research Network (SSRN), Colorado College Working Paper*, *2021-01*, 1-30. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3786251.

Mao, Y., Wei, W., Wang, B., & Liu, B. (2012). Correlating S&P 500 stocks with Twitter data. In *Proceedings of the first ACM international workshop on hot topics on interdisciplinary social networks research*, 69-72. Retrieved from https://dl.acm.org/doi/abs/10.1145/2392622.2392634.

Neri, F., Aliprandi, C., Capeci, F., & Cuadros, M. (2012). Sentiment analysis on social media. *IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining* (919-926). Retrieved from https://ieeexplore.ieee.org/abstract/document/6425642/.

Ranco, G., Aleksovski, D., Caldarelli, G., Grčar, M., & Mozetič, I. (2015). The effects of Twitter sentiment on stock price returns. *PloS one, 10*(9), 1-21. Retrieved from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0138441.

Reboredo, J. C., & Ugolini, A. (2018). The impact of Twitter sentiment on renewable energy stocks. *Energy Economics*, *76*(C), 153-169. Retrieved from https://www.sciencedirect.com/science/article/pii/S014098831830416X.

Shokri, N., Sahab Khodamoradi, M., and Hajiloo Moghadam, A. H. (2021). Investigating the effects of financial volatility spillover between digital currencies (application of multivariate GARCH approach). *Financial Management Perspective, 11*(35), 143-172. Retrieved from https://jfmp.sbu.ac.ir/article_102259.html?lang=en.

Shokri, N., & Roshanfekr, A. (2023). Investigating the spillover effects of Bitcoin's financial fluctuations on other digital currencies. *International Journal of Blockchains and Cryptocurrencies*, *4*(1), 65-79. Retrieved from https://www.inderscienceonline.com/doi/abs/10.1504/IJBC.2023.131643.

Sprenger, T. O., Tumasjan, A., Sandner, P. G., & Welpe, I. M. (2014). Tweets and trades: The information content of stock microblogs. *European Financial Management, 20*(5), 926-957. Retrieved from https://onlinelibrary.wiley.com/share/UUGNC78G44MHXBFZQ3RI?target=10.1111/j.1468-036X.2013.12007.x.

Sul, H. K., Dennis, A. R., & Yuan, L. (2017). Trading on Twitter: Using social media sentiment to predict stock returns. *Decision Sciences, 48*(3), 454-488. Retrieved from https://onlinelibrary.wiley.com/share/SVAHWSE6PIGINNVGXAER?target=10.1111/deci.12229.

Tetlock, P. C., Saar-Tsechansky, M., & Macskassy, S. (2008). More than words: Quantifying language to measure firms' fundamentals. *The Journal of Finance, 63*(3), 1437-1467. Retrieved from https://onlinelibrary.wiley.com/share/8YVNP3IEGRQ6KZTU7IPT?target=10.1111/j.1540-6261.2008.01362.x.

Timmermann, A. (2008). Elusive return predictability. *International Journal of Forecasting*, *24*(1), 1-18. Retrieved from https://www.sciencedirect.com/science/article/pii/S0169207007000969.

William, P., Shrivastava, A., Chauhan, P. S., Raja, M., Ojha, S. B., & Kumar, K. (2023). Natural Language processing implementation for sentiment analysis on tweets. *Mobile Radio Communications and 5G Networks: Proceedings of Third MRCN 2022* (317-327). Singapore: Springer Nature Singapore. Retrieved from https://link.springer.com/chapter/10.1007/978-981-19-7982-8_26.

Zeitun, R., Rehman, M. U., Ahmad, N., & Vo, X. V. (2023). The impact of Twitter-based sentiment on US sectoral returns. *The North American Journal of Economics and Finance, 64*, 1-16. Retrieved from https://www.sciencedirect.com/science/article/pii/S1062940822001826.

Cite this article: Shokri, N., & Gholami, S. (2025).Impact of Tweet Risks on Global Financial Markets Using the Quantile VAR Model. *Iranian Economic Review, 29*(4), 1234-1255.

Iranian Economic Review, 29(4), 1256-1288
DOI: https://doi.org/10.22059/ier.2023.360860.1007746

RESEARCH PAPER

Impact Evaluation of Instability of Financial Resources in Health System Transformation Plan on Achieving Financial Protection in Universal Health Coverage

Farzaneh Ghaemi[a], **Abbas Assari Arani**[*,a]

a. Department of Health Economics, Faculty of Management and Economics, Tarbiat Modares University, Tehran, Iran.
* Corresponding author.

Received: 15 June 2023, Revised: 28 September 2023, Accepted: 17 October 2023, Published: 15 December 2025
Publisher: University of Tehran

Abstract
Universal health coverage is defined as the reception of health services by all individuals without fear of financial hardship. The goal of financial protection in universal health coverage is to ensure that direct payments for health by households (out-of-pocket expenses) are not catastrophic or impoverishing. The Health System Transformation Plan was implemented in Iran in 2014, fully aligned with the goal of financial protection in universal health coverage. However, the financing resources of this plan were not fully allocated in 2017, and the financial support to households decreased. This increased direct payments by households and the incidence of catastrophic health expenditure and impoverishing health expenditure for them in the coming years. This study examined the level of vulnerability of different groups of households with different socioeconomic characteristics due to the reduced support of this plan. The research method was the econometric strategy of policy impact evaluation by propensity score matching. The data used involved a household income and expenditure survey. Direct payments for health by households increased, especially in 2019, due to the decrease in financial support of this plan in 2017. Catastrophic health expenditure occurred mainly in low-income deciles in urban areas and middle-income deciles in rural areas. Besides, impoverishing health expenditure occurred more frequently among unemployed urban household heads, urban heads under 15 and over 64 years old, and rural female heads. Therefore, more vulnerable groups should be covered more by insurance in future health system policies.
Keywords: Catastrophic Health Expenditure, Impoverishing Health Expenditure, Iran, Out-of-Pocket Expenses, Propensity Score Matching.
JEL Classification: C40, D10, G52, I13, I18, R28.

1. Introduction
1.1 Universal Health Coverage
Universal health coverage (UHC) (a goal of sustainable development) is defined as the reception of health services by all individuals and all countries without fear

of financial hardship. UHC has two goals of increasing "financial protection" and increasing "access to quality health services" (World Health Organization, 2023b). In this research, only the goal of financial protection is considered. Out-of-pocket (OOP) expenses are expenses paid directly by households to providers of health goods and services. The goal of financial protection in UHC is that OOP expenses do not expose people to economic pressure and do not threaten living standards (World Health Organization, 2023a). The indicators used to measure the level of financial protection in UHC are defined on two bases:

A. The incidence of catastrophic health expenditure (CHE)

OOP expenses are considered CHE when they exceed a certain percentage of household consumption expenditures. The indicators defined based on the incidence of CHE include (World Health Organization, 2021a):

- $CHE_{\%10}$ and $CHE_{\%25}$: The proportion of the population with OOP expenses of more than 10% and 25% of the total household consumption expenditures, respectively (World Health Organization, 2021a).
- $CHE_{\%40}$: The proportion of the population with OOP expenses more than 40% of the total household non-food consumption expenditures (World Health Organization, 2021a).

B. The incidence of impoverishing health expenditure (IHE)

OOP expenses can either push households into poverty or aggravate their sub-poverty situation. The degree of impoverishment caused by OOP expenses can be measured by the proportion of the population whose total consumption expenditures are above the poverty line, but due to OOP expenses, they have gone below the poverty line (Hsu et al., 2020). The indicators defined based on the incidence of IHE include:

- $IHE_{\$1.9}$ and $IHE_{\$3.2}$: The proportion of the population with total consumption expenditures minus OOP expenses below the poverty line of 1.9 and 3.2 US dollars per person per day, respectively, based on purchasing power parity (PPP) in 2011 (World Health Organization, 2021a).

In fact, these indicators measure the vulnerability of households to OOP expenses.

1.2 Health System Transformation Plan

The Health System Transformation Plan (HTP) was implemented in Iran in 2014. One of the goals of HTP in terms of financial protection has been to reduce OOP expenses and the probability of CHE and IHE incidence for the household. In this regard, under HTP, a large number of people without health insurance were covered by public health insurance provided by the Iran Health Insurance Organization (IHIO) (Iranian Ministry of Health and Medical Education, 2014). In fact, the goal of financial protection in HTP has been consistent with the goal of financial protection in UHC.

According to the law, HTP financing sources include a share of the government budget, 1% of value-added tax, 10% of sources of targeted subsidies, duties on the production, import, and supply of harmful goods and services, duties on tobacco and sugar products, and 10% of the third party insurance premium (Islamic Consultative Assembly of Iran, 2014). The most important challenge of HTP is the instability of its financing sources.

Table 1 shows the financial resources of HTP in 2014-2020. A high budget should have been allocated to HTP in 2017 according to the law, but the budget was drastically reduced in practice. This reduction was more intense in 2018. No information is available about the budget allocated to HTP in 2019 and 2020. Only a performance estimate is provided to evaluate these years. However, more detailed documentation is needed. Evidence suggests that HTP's financial resources have become unstable since 2017 (Plan and Budget Organization of Iran, 2021).

Table 1. Health System Transformation Plan Financing Sources

(billion Rials)	2014		2015		2016		2017		2018		2019		2020	
	Law	In practice	Law	In practice	Law	In practice	Law	In practice	Law	In practice	Law	Performance estimation	Law	Performance estimation
HTP	48000	43900	48000	36781	40000	40000	40000	25860	37000	17500	49000	47530	52000	52000

Source: Plan and Budget Organization of Iran, 2021.

Table 2. The Population Covered by the Iran Health Insurance Organization and its Share of the Total Health Expenditures

Year	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Population covered by IHIO* (million people)	33.8	39.6	38.4	38.4	41.2	41.3	42.1
IHIO payment of the total health expenditures ** (million Rials)	46027027	87114821	124045286	154693248	162986540	151840558	169437155
Total health expenditures** (million Rials)	656537807	909396935	1080717180	1209966019	1372165220	1544179019	1919514466
IHIO's share of total health expenditures *** (%)	7	9.5	11.4	12.7	11.8	9.8	8.8

Source: *Iran Health Insurance Organization, 2019, ** Statistical Center of Iran, 2013-2019, *** Research finding.

Table 2 shows the population covered by IHIO and the share paid by this organization from the total health expenditures in 2013-2019 (Iran Health Insurance Organization, 2019, and Statistical Center of Iran, 2013-2019). The size of the population covered by the IHIO was almost on the rise until 2019 (Iran Health Insurance Organization, 2019). Note that the share paid by IHIO of the total health expenditures increased during 2013-2016, but this share decreased in 2017 due to the instability of resources this year, and this downward trend has continued (Statistical Center of Iran, 2013-2019). Most health expenditures will have to be paid by the households themselves (in the form of OOP expenses) when health insurance coverage is reduced. This may put them in contact with CHE or IHE.

A revision of previous health system programs, such as HTP, will be the basis for designing new health system programs. The participation of households in the health system should be fair. This means that the participation of each household should be designed based on the "ability to pay" of the household. The most important contribution of households in the health system is OOP expenses (Hsu et al., 2020). To design a new system of financial protection for households in the health system based on the household's ability to pay, it is necessary to monitor the HTP to identify the vulnerable groups of society when the financial resources of this plan are reduced. Therefore, this study investigates the level of exposure of households to CHE and IHE in 2018-2019 due to the reduction of the HTP budget in 2017 and the increase in OOP expenses of households[1].

Moreover, considering that the socioeconomic status of households affects the probability of facing CHE and IHE, the effect of the instability of financial resources of the HTP on the incidence of CHE and IHE are examined separately in households with different income deciles, different places of residence, and different characteristics of the heads of households. The purpose of this analysis is to examine the differences in the level of vulnerability of households with different socioeconomic statuses, in relation to the instability of the resources of the HTP. This study makes it possible to design financial support in the future plans of the health system in such a way that more financial support is provided for more vulnerable groups and less financial support for less vulnerable groups. This will lead to a more optimal allocation of financial resources for health system plans and will make it possible to provide the necessary budget.

[1]. Note that only these two years can be analyzed due to data availability. Because national health accounts are provided only until 2019.

2. Literature Review

2.1 Theoretical Background

This study performed an economic analysis of health system plans (microeconomics of health).

As explained in the previous section, the instability of HTP's financial resources in 2017 reduced public health insurance coverage provided to households under HTP. The demand for health insurance is the demand to cover the financial risk caused by the occurrence of chronic diseases or health shocks, and actually prevent CHE and IHE for the family.

Souri (2022) presented the model of the demand for health insurance. Health insurance coverage is one of the main bases of the insurance contract between the insurance organization and the insured, according to which the health insurance organization undertakes to compensate the health expenses incurred by the insured. The health insurance organization provides health insurance coverage by receiving insurance premiums. In general, insurance coverage can be full or partial. In full coverage, all costs are paid by the insurance organization. In partial coverage, part of the costs will be compensated by the insurance organization, and the other part will be paid by the insured. Health insurance coverage is a type of partial coverage. The reason for providing partial health insurance is that people have the motivation to prevent diseases. Partial health insurance is known as coinsurance. In coinsurance, a fixed proportion of health expenses is paid by the health insurance organization. In this type of insurance, if X is the total health expenditures, the insurance organization always covers a fixed proportion λ of the total health expenditures (Equation 1).

$$C(X) = \lambda X \qquad 0 < \lambda < 1 \tag{1}$$

where $C(.)$ is the amount of insurance coverage by the health insurance organization. In this equation, $\lambda = 0$ means no insurance coverage and $\lambda = 1$ means full insurance coverage. In fact, coinsurance is a type of partial insurance coverage that divides the total health expenditures relatively between the health insurance organization and individuals. According to Equation 1, if the health insurance organization covers a higher proportion of the total health expenditures, the OOP expenses of the household will decrease.

It is worth mentioning that some people don't face only one risk or disease. It is possible for a person to have several diseases at the same time. For this reason, the health insurance organization defines X as a random variable that can be placed in the range of 0 to X_m ($X \in [0, X_m]$). In fact, X_m shows the maximum health expenditures. $F(X)$ is the probability distribution function, and Equation 2 shows the probability density function of X.

$$f(X) = \frac{dF}{dX} \tag{2}$$

In this case, the insurance organization should estimate the amount of expected health expenditures ($E(X)$) (Equation 3).

$$E(X) = \int_0^{X_m} Xf(X)dX \tag{3}$$

The economic theory of Sun and Lyu (2020) defines the type of health insurance coverage, the socioeconomic conditions of households, and the level of household health as a basis for changes in OOP expenses and the occurrence of CHE and IHE for households (Equation 4).

$$\log(P_{it}) = \beta_0 + \beta_1 * I_{it} + \beta_2 * D_{it} + \beta_3 * H_{it} + \varepsilon_{it} \tag{4}$$

where P_{it} is the probability of the incidence of CHE or IHE for household i at time t, I_{it} is the type of health insurance of household i and its coverage at time t, D_{it} is the vector of demographic indicators and the socioeconomic status of household i at time t, and H_{it} shows the level of health (presence or absence of a patient with a chronic disease in the family) for household i at time t.

Woldemichael et al. (2021) calculated $CHE_{\%40}$. To calculate $CHE_{\%40}$, it is necessary to calculate household capacity to pay (CTP) first. CTP is equal to the total household consumption expenditure minus household food expenditure. In other words, CTP is equal to household non-food expenses (Equation 5).

$$CTP_h = T_h - F_h \tag{5}$$

where, CTP_h, T_h and F_h are the payment capacity of household h, total consumption expenditure of household h, and food expenditures of household h, respectively.

Household food expenditures are defined as household subsistence expenditures; therefore:

$$CTP_h = T_h - S_h \tag{6}$$

where S_h is the subsistence expenditure of household h.

Based on this, $\text{CHE}_{\%40}$ is defined as follows:

$$\text{CHE}_{\%40} = \frac{OOP_h}{CTP_h} \geq 0.4 \tag{7}$$

where OOP_h is the OOP health expenditure of household h.

Based on Equation 7, if the ratio of the OOP of household h to the CTP of household h is more than 40%, then household h has faced CHE.

In addition, the economic theory of Sirag and Nor (2021) shows the relationship between health OOP expenses and the incidence of poverty. OOP expenses for health care can increase the financial risk and, consequently, the possibility of poverty. Equation 8 expresses the relationship between OOP expenses and poverty at the household level.

$$pov_{ht} = \beta(oop_{ht}) + \pi(Z_{ht}) + \varepsilon_{ht} \tag{8}$$

where pov_{ht} is the probability of poverty in household h at time t, oop_{ht} is OOP expenses of household h at time t, Z_{ht} is the vector of control variables of household h at time t (including the socioeconomic characteristics of the household), and ε_{ht} is the error term.

For a more detailed examination, a threshold level can be considered for OOP expenses. In this case, the probability of poverty can be calculated separately for different levels of OOP expenses (less or more than the threshold level) (Equation 9).

$$pov_{ht} = \beta_1(oop_{ht}I(oop_{ht} \leq \gamma)) + \beta_2(oop_{ht}I(oop_{ht} > \gamma)) + \pi(Z_{ht}) + \varepsilon_{ht} \tag{9}$$

where γ indicates the threshold level. Based on Equation 9, the probability of poverty in the household depends on whether the OOP expenses of the household are higher or lower than the threshold level.

2.2 Empirical Background

Some studies investigated the effects of HTP implementation on the OOP expenses of households, in a specific province or a treatment center before 2017. Some of them are reviewed below.

Alipour et al. (2021) conducted an analytical-descriptive study of cardiovascular patients hospitalized in Ardabil hospitals (Iran) in 2016 (two years after the implementation of the HTP) compared to 2013 (before the implementation of the HTP). They concluded that the OOP expenses have decreased from 54.2% to 36.7% during the mentioned years.

Ahmadi et al. (2021) conducted a meta-analysis of studies analyzing HTP during the years 2014 to 2017 and showed that this plan had almost achieved its financial goals until 2017.

Abdi et al. (2020) compared the per capita indicator of OOP expenses, the percentage of people who faced CHE, and the percentage of people who faced IHE, in 2014 (the year of HTP implementation) and 2015 (one year after HTP implementation) by analyzing the household income and expenditure survey (HIES) data. During the mentioned period, the first index decreased by 2.5%, the second index decreased by 0.8%, and the third index increased by 0.3%. In other words, this plan has been effective in improving the financial support of individuals against health expenses, but it has not had such effects on the poor.

Bayati et al. (2020) presented a time-series analysis of the effects of two fundamental reforms in the health system of Iran, including the implementation of the HTP and the Family Doctor Plan from 2009 to 2016, on the use of health services and health costs in Fars Province. The results showed that the Family Doctor Plan prevented the use of many unnecessary health services and additional health costs by correctly visiting patients. Nevertheless, the HTP increased the use of health services and, subsequently, the health costs in the Fars Province by increasing access to health services.

Haririchi et al. (2020) analyzed the goals, interventions, and achievements of the HTP after one year of implementation (2015). The goals of the plan related to financial support included stabilizing the financial resources of the health sector and expanding health insurance coverage. The interventions carried out in 2015 included defining more sources of funding for the health sector by the government, expanding insurance coverage for people without insurance, reducing insurance premiums and OOP expenses for inpatients or outpatients, covering most of the costs of incurable diseases, and controlling the price of medicines and medical equipment. The achievements of this plan in 2015, compared to the year 2013 (before the implementation of the plan), included an increase in government spending in the health sector, a rise in the number of people covered by insurance in the country, a reduction of informal payments, and a decrease in the number of people faced with CHE.

According to Noura and Zanganeh's (2020) short letter to the editor, the HTP implemented in Iran in 2014, with the goals presented in its constitution, is an important step towards the Alma-Ata declaration. This declaration, presented in 1978 by the World Health Organization as a turning point in the public health of all people of the world in the 20th century, states that since the year 2000, access to primary health services has been considered a basic human right. The main goal of this declaration is "health for all".

Seyedin et al. (2020) adopted an analytical-descriptive approach and examined patients hospitalized in five hospitals affiliated with the Iran University of Medical Sciences in 2016. They showed that the implementation of the HTP did not significantly reduce the OOP expenses of these patients.

In addition to the above studies, other studies such as those by Nemati et al. (2020), Vahedi et al. (2020), Doshmangir et al. (2019), Olyaeemanesh et al.

(2018), Rahmany et al. (2018), Ferdosi et al. (2017), and Piroozi et al. (2017) also evaluated the HTP in the early years of the plan's implementation.

The World Health Organization (2021b) calculated $CHE_{\%10}$, $CHE_{\%25}$, $IHE_{\$1.9}$, and $IHE_{\$3.2}$ for Iran in 2013 as 15.8%, 3.8%, 0.01%, and 0.17%, respectively.

Rezaei et al. (2020) calculated the CHE for thresholds of 20%, 30%, and 40% of the CTP for six years, including 1991, 1996, 2001, 2006, 2011, and 2017. The CHE for thresholds of 20%, 30%, and 40% of the CTP in 2011 was 13.86%, 6.43%, and 3.38% and in 2017, it was 22.16%, 10.88%, and 5.26%, respectively. The results of this study generally showed that the incidence of CHE was increasing from 1991-2017 for all three thresholds, even after the implementation of the HTP.

Hsu et al. (2020) reported that during 2007-2015, $CHE_{\%10}$ increased from 11.4% in 2007 to 17% in 2015. The rise in OOP expenses occurred mostly in the upper-income deciles. The $CHE_{\%25}$ rose from 2.9% in 2007 to 3.9% in 2015. The $CHE_{\%40}$ increased at a milder rate during the period compared to previous indicators. During 2007-2015, $IHE_{\$1.9}$ and $IHE_{\$3.2}$ were almost constant and at very low levels. The greatest effects of impoverishment were directed at low-income deciles and rural residents.

Hsu et al. (2021) found that $CHE_{\%10}$ and $CHE_{\%25}$ increased and $CHE_{\%40}$ decreased during 2005-2017. The $CHE_{\%10}$ and $CHE_{\%25}$ occurred more in lower-income deciles, and the $CHE_{\%40}$ occurred more in upper-income deciles. In this study, the CHE of the household is calculated by using Equation 10.

$$\frac{\sum_h m_h w_h \, 1(OOP-share_h > t)}{\sum_h m_h w_h} \tag{10}$$

where h is a household, m_h is the number of household h members, and w_h is the weight of the household h from the total health expenditure. $OOP-share_h$ indicates the share of OOP expenses of household h from total household consumption expenditures (in the calculation of $CHE_{\%10}$ and $CHE_{\%25}$) and the share of OOP expenses from total household non-food consumption expenditures (in the calculation of $CHE_{\%40}$). t indicates the threshold of CHE, which can be considered 10%, 25%, or 40%. The function $1(OOP-share_h > t)$ is equal to 1 when the desired condition occurs, and 0 otherwise. For example, in the calculation of $CHE_{\%10}$, if OOP expenses are more than 10% of the total household h consumption expenditures, the household h has faced $CHE_{\%10}$, and this function is equal to 1; otherwise, it will be zero.

Woldemichael et al. (2021) examined the incidence of CHE in dental care applicants in 2018.

Some studies provided qualitative analyses of the achievement of UHC goals before 2016 in Iran, through the implementation of HTP (Kouhpaye-Zadeh and Kasaeeyan, 2018; Letafat et al., 2018; Sajadi and Majdzadeh, 2019; Sajadi et al., 2019; Sajadi et al., 2020).

Previous studies have not conducted a financial evaluation of HTP since 2017, which was parallel to the reduction of funding sources. However, this study carries out a financial evaluation of HTP by measuring the incidence of CHE and IHE caused by the reduction of the HTP budget and uses a different method called econometrics of policy impact evaluation. This method can show what changes have occurred in the incidence of CHE and IHE in the following years, only due to the reduction of the HTP budget in 2017. In addition, this method takes into account the specific characteristics of each household, including the place of residence (urban and rural), income status (income deciles), and the status of the head of the household (age, sex, employment, marital status, and educational level). More detailed explanations about the research method will be provided in the methodology section.

3. Methods and Materials

3.1 Data

The statistical population under study includes all households living in urban and rural areas of Iran. The statistical sample includes households whose information is provided in HIES.

The data used in the HIES in 2016-2019 include the socioeconomic status of household heads (age, sex, employment, marital status, and educational level), household consumption expenditures, and household incomes (in urban and rural areas) (Statistical Center of Iran, 2016-2019a).

It is worth mentioning that in 2016, 2017, 2018, and 2019, the number of sample households living in urban areas was 18809, 18701, 20350, and 19898 households, respectively, and the number of sample households living in rural areas was 19337, 19261, 18610 and 18430 households, respectively (Statistical Center of Iran, 2016-2019b).

From the national health accounts, the total health expenditures and the share of IHIO from the total health expenditures were extracted. The national health accounts were presented only up to 2019, and, therefore, the evaluations of this study were performed only up to this year (Statistical Center of Iran, 2013-2019).

The poverty line for different years was calculated using the PPP rate of Iranian rials against US dollars (The World Bank, 2017) and the consumer price index (Statistical Center of Iran, 2020).

3.2 Econometric Strategy

Data analysis was performed with the econometric method of policy impact evaluation by propensity score matching (PSM). The policy impact evaluation method measures the changes that can be attributed to the implementation of a policy. In the present study, the policy is the reduction of financial support for households in HTP due to the reduction of its budget in 2017. This method demonstrates the changes in the outcome variable (incidence of CHE and IHE) in two years after the implementation of the policy (2018-2019) compared to the year before its implementation (2016), taking into account the special characteristics of each household, including the place of residence, income status, and conditions of the household head.

In this method, the treatment and control groups are defined. The treatment group is the households exposed to the implementation of the policy (the households for which the public health insurance coverage was decreased due to the reduction of the HTP budget); the control group is the households not exposed to the implementation of the policy (the same households if the reduction of the HTP budget had not occurred and the public health insurance coverage had not decreased for them). According to Table 2, the share of the IHIO organization of the total health expenditures (in the form of public health insurance coverage) has dropped from 12.7 in 2016 to 9.8 in 2018 (equivalent to a decrease of 22.84%) and to 8.8 in 2019 (equivalent to a decrease of 30.7%). In 2018, compared to 2016, the IHIO organization paid 22.84% less from total health expenditures through the reduction of public health insurance coverage. These expenditures were inevitably paid by households in the form of OOP expenses. Therefore, in 2018, for the households that are members of the treatment group, the amount of OOP payments is considered according to the OOP data of the households in HIES; however, for the households that are members of the control group, the amount of OOP payments is considered 22.48% less than the OOP data of the households in HIES. Because the households in the control group would have paid 22.48% less (in the form of OOP expenses) if the reduction of the HTP budget had not occurred, in 2019, compared to 2016, the decrease in OOP expenses of the households in the control group is considered to be 30.7%.

Heinrich et al.'s (2010) model measures the impact of a policy with the PSM method. In this method, γ_i is the impact of a policy on a household i and is defined as the difference between the outcome variable (incidence of CHE or IHE) in case of treatment (W_{1i}) and the outcome variable in the absence of treatment (W_{0i}) (Equation 11).

$$\gamma_i = W_{1i} - W_{0i} \tag{11}$$

In general, in the policy impact evaluation model, the average effect of a policy on all households is estimated, which is known as the average treatment effect (ATE) (Equation 12).

$$ATE = E(\gamma) = E(W_1 - W_0) \tag{12}$$

where $E(.)$ represents the expected value (average effect on all households).

To evaluate the effect of the policy on the households participating in the program (treatment group), the average treatment effect on the treated (ATT) is calculated (Equation 13).

$$ATT = E(W_1 - W_0|D = 1) \tag{13}$$

In addition, the average treatment effect on the untreated (ATU) shows the effect of the policy on households that do not participate in the program (the control group) (Equation 14).

$$ATU = E(W_1 - W_0|D = 0) \tag{14}$$

Equation 13 can be rewritten as follows:

$$ATT = E(W_1|D = 1) - E(W_0|D = 1) \tag{15}$$

where $E(W_0|D = 1)$ is an average of the outcome variable for the households in the program group if they had not participated in the program, which is not observed. In fact, this term is a counterfactual value of the outcome variable. However, the term $E(W_0|D = 0)$, which is the outcome variable for the households in the control group, is visible. Therefore, Λ can be defined as follows:

$$\Lambda = E(W_1|D = 1) - E(W_0|D = 0) \tag{16}$$

$$\Lambda = E(W_1|D = 1) - E(W_0|D = 1) + E(W_0|D = 1) - E(W_0|D = 0) \tag{17}$$

$$\Lambda = ATT + E(W_0|D = 1) - E(W_0|D = 0) \tag{18}$$

$$\Lambda = ATT + SB \tag{19}$$

where SB is the selection bias: the difference between the counterfactual for treated households and the observed outcome for the control households.

In the PSM method, the households in the treatment group are matched to the households in the control group by comparing the observable characteristics of the two households (vector of X). In fact, X is the conditional variables including variables describing the socioeconomic and demographic status of the household (residence area, household income, age, sex, marital status, educational level, and employment status of the head of the household). If an appropriate control group is selected for the treatment group based on conditional variables X, SB is equal to 0, and the ATT can be estimated by the difference between the mean observed outcomes (incidence of CHE or IHE) for treated and control households (Equation 20).

$$\tau_{ATT}^{PSM} = E(W|D = 1) - E(W|D = 0) \tag{20}$$

where $E(W|D = 1)$ and $E(W|D = 0)$ show the mean outcomes (incidence of CHE or IHE) for the treatment and control groups, respectively. τ_{ATT}^{PSM} is the ATT estimator in the PSM method (Heinrich et al., 2010).

3.3 Validity of the Propensity Score Matching Method

The validity of τ_{ATT}^{PSM} depends on the establishment of the conditional independence assumption and common support assumption.

Based on the conditional independence assumption, the potential outcomes W_1 and W_0 are independent of the treatment status by taking into account the set X of observable variables (Equation 21).

$$(W_1, W_0) \perp \mathrm{D} \mid X \tag{21}$$

This assumption is checked through the balance test. Establishing this assumption ensures that an appropriate control group is considered to construct the counterfactual value of the treatment group.

Based on the common support assumption, there is sufficient overlap in the characteristics of the treated and control groups to find adequate matches. In other words, for each value of X, the probability of being both treated and untreated is positive (Equation 22).

$$0 < P(D = 1|X) < 1 \tag{22}$$

This assumption is checked by using the propensity score graph. Establishing this assumption ensures that households in the control group are near the distribution of the propensity score of the households in the treatment group (Heinrich et al., 2010).

3.4 Descriptive Statistics, Balance Tests Results, and Propensity Score Graphs

The sample descriptive statistics of conditional variables were analyzed separately for households in the treatment and control groups, living in urban and rural areas, and for the years 2016, 2018, and 2019. Descriptive statistics of conditional variables for 2016 are presented in Table 3. As an example, in the urban area, for households in the treatment group, the average logarithm of incomes was 19.26 rials, and the average heads' age was 53.43 years. In 2016, 9% of household heads were female and 91% were male; moreover, 90% of them were married, 8% were widowed, 1% were divorced, and 1% were unmarried. The average education level of heads in the treatment group was a middle-school degree (30.47); 97% of heads had completed their education, and 3% were studying. Furthermore, 85.17%, 0.08%, 0.35%, and 1.06% of them were employed, unemployed, homemakers, and others, respectively. Besides, 13.34% of heads had income without a job.

Table 3. Sample Descriptive Statistics of Conditional Variables (2016)

Conditional variables		In general		Urban area		Rural area	
		Treatment group Mean (std. dev.)	Control group Mean (std. dev.)	Treatment group Mean (std. dev.)	Control group Mean (std. dev.)	Treatment group Mean (std. dev.)	Control group Mean (std. dev.)
Ln household income		18.99 (0.69)	18.88 (0.69)	19.26 (0.64)	19.23 (0.71)	18.80 (0.67)	18.71 (0.62)
Age of the head		52.58 (13.33)	50.67 (13.08)	53.43 (13.18)	50.39 (12.11)	51.93 (13.40)	50.80 (13.50)
Sex of the head		1.09 (0.29)	1.08 (0.27)	1.09 (0.29)	1.04 (0.21)	1.09 (0.29)	1.10 (0.30)
Marital status of the head	Widowed	0.08 (0.28)	0.07 (0.26)	0.08 (0.27)	0.04 (0.19)	0.09 (0.29)	0.09 (0.29)
	Divorced	0.00 (0.09)	0.02 (0.14)	0.01 (0.13)	0.02 (0.60)	0.00 (0.02)	0.01 (0.13)
	Unmarried	0.01 (0.12)	0.01 (0.10)	0.01 (0.11)	0.03 (0.18)	0.01 (0.13)	0.00 (0.02)
The education level of the head		30.22 (21.00)	31.32 (20.49)	30.47 (19.6)	41.46 (20.60)	30.03 (22.05)	24.40 (17.29)
Education status of the head		1.98 (0.13)	1.98 (0.13)	1.97 (0.14)	1.95 (0.20)	1.98 (0.13)	1.99 (0.02)
Employment status of the head	Unemployed	0.0065 (0.0804)	0.0145 (0.1199)	0.0008 (0.0297)	0.0450 (0.2074)	0.0107 (0.1032)	0.0004 (0.0204)
	Making money without a job	0.0994 (0.2992)	0.1041 (0.3055)	0.1334 (0.3401)	0.1549 (0.3620)	0.0736 (0.2611)	0.0805 (0.2721)
	Studying	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Homemaker	0.0099 (0.0993)	0.0008 (0.0292)	0.0035 (0.0595)	0.0018 (0.0424)	0.0148 (0.1208)	0.0004 (0.2040)
	Others	0.0053 (0.7300)	0.0120 (0.1089)	0.0106 (0.1027)	0.0009 (0.0300)	0.0013 (0.0366)	0.0171 (0.1300)

Source: Research finding.

The balancing test of the conditional variables was performed to check the assumption of conditional independence, and propensity score graphs were plotted to check the assumption of common support for all the estimated ATTs (presented in the next section), separately for $CHE_{\%10}$, $CHE_{\%25}$, $CHE_{\%40}$, $IHE_{\$1.9}$, and $IHE_{\$3.2}$ and for all the characteristics of the heads of households living in urban and rural areas in 2018 and 2019. For example, Table A1 and Figure A1 respectively show the results of the balance test and the propensity score graph to estimate $ATT_{CHE\%10}$ in 2018.

In the balancing test, the square of the variables or their product can also be used to balance the conditional variables. As can be seen in Table A1, the null hypothesis of the equality of means of conditional variables for households in the treatment group and households in the control group cannot be rejected. Therefore, the assumption of conditional independence is valid.

Figure A1 shows that for each household in the treatment group, the same household was found in the control group, and there was no household for which the same control group was not found. Therefore, the assumption of common support is valid.

Both assumptions were also valid for other indicators in all years.

4. Results and Discussion

Figures 1 and 2 in general, and Figures 3 and 4 by urban and rural areas, show in 2018 and 2019 what percentage of households faced CHE and what percentage of them became poor precisely due to the instability of HTP financial resources and the reduction of financial support for households. In all cases, the assumptions of conditional independence and common support were established.

As can be seen in Figure 1, the instability of HTP's financial resources in 2017 led to the occurrence of CHE and IHE in the following years. However, these effects were more in 2019 than in 2018. In other words, the instability of HTP resources had more detrimental effects on households over time because the necessary treatments were not pursued by households when resources became unstable in 2017 and financial support decreased. All this affected their disease status. The adverse effects of diseases intensified in the following years, and more CHE and IHE occurred.

Moreover, more households faced CHE based on the $CHE_{\%10}$ definition compared to other indicators because $CHE_{\%10}$ is defined as a measure of households facing CHE based on a lower level of OOP expenditures. Thus, more households will be included in this group. The number of households falling below the poverty line due to the instability of HTP's financial resources is less than those who faced CHE. Additionally, the number of households facing $IHE_{\$1.9}$ is higher than those facing $IHE_{\$3.2}$ because the poverty line is defined at a lower income level at $IHE_{\$1.9}$. Therefore, more households will be included in this group due to OOP expenditures.

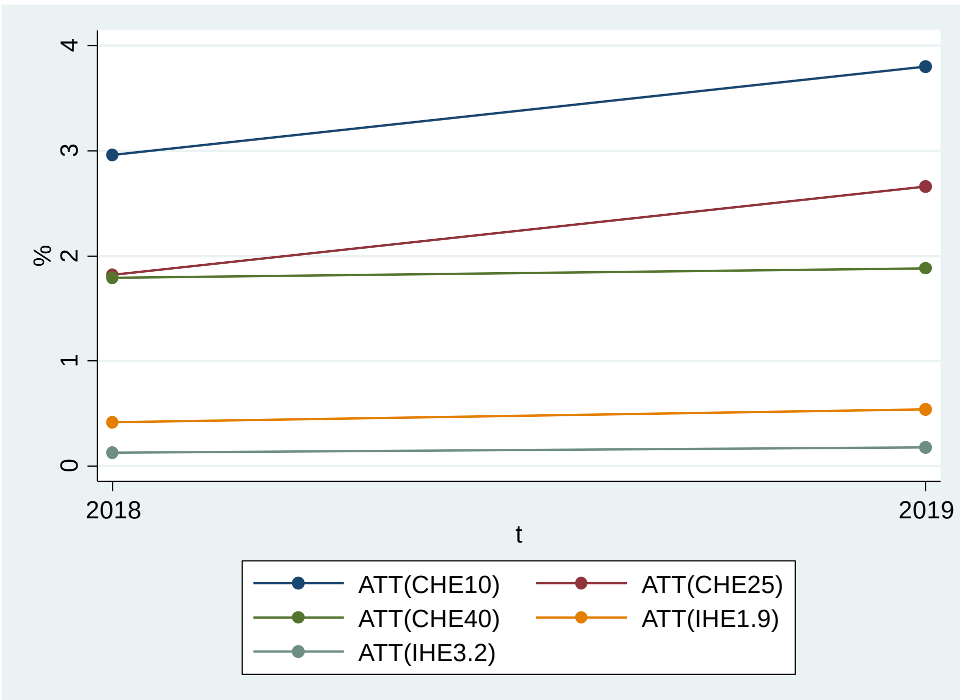


Figure 1. The Effects of the Instability of HTP Financial Resources on the Incidence of CHE and IHE in General

Source: Research finding.

In Figure 2, the heterogeneity in the incidence of CHE and IHE among households with different characteristics is investigated.

CHE indices significantly increased in each income decile in 2019 compared to 2018. However, IHE indices did not change significantly (Figure

2A). Low-income deciles encountered CHE and IHE a little more than middle-income deciles and much more than high-income deciles. The economic stability of the head of the household (having a suitable job and sufficient income) can generally make the household have a healthy lifestyle. The probability of disease occurrence is reduced due to the adoption of a healthy lifestyle by households because everything needed for a healthy life (healthy food and water, health services, etc.) can be purchased by them (U.S. Department of Health and Human Services, 2023, and World Health Organization, 1999). In other words, having a fixed income can decrease the probability of CHE and IHE occurrence for households because of having a healthy lifestyle, reduced probability of disease occurrence, and the increased ability to pay. Consequently, low-income deciles faced high CHE (Figure 2A).

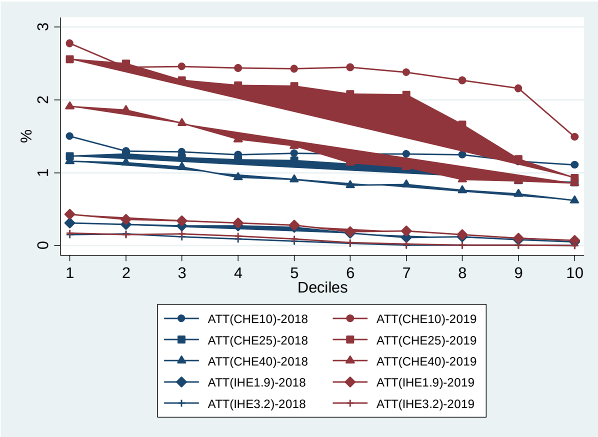
Household heads with an academic education (AE) faced less CHE than heads without AE because the former group is more aware of a healthy lifestyle, is more likely to be employed, has a fixed income, and can invest more in a healthy lifestyle. In other words, this group focuses more on disease prevention and is thus less likely to get sick. Thus, this group faced less CHE. Household heads without AE have less knowledge about a healthy lifestyle and probably do not have reliable jobs and income. For this reason, this group of household heads faced more IHE (Figure 2B).

CHE and IHE were significantly lower for households with employed heads or non-working income heads than for those with unemployed heads, because the former group has income and uses it for the prevention or timely treatment of diseases. Therefore, they faced less CHE and IHE. While heads without jobs and income cannot prevent, and treat diseases on time. On the other hand, this group of households had lower consumption expenses due to not having enough income, and (according to the definition of CHE and IHE indicators) the probability of incidence of CHE and IHE is higher for this group of households (Figure 2C).

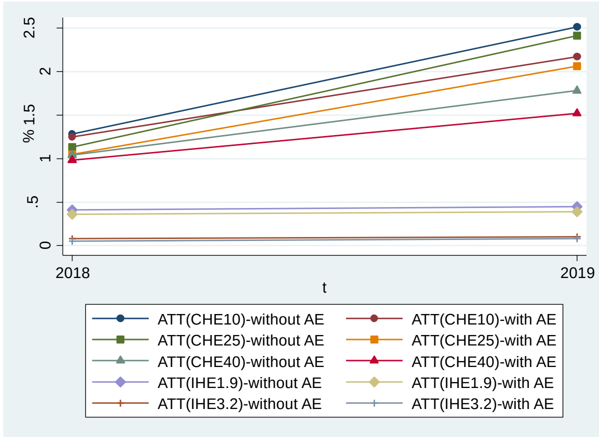
Household heads under the age of 15 faced more CHE and IHE than heads in the working-age range (15-64 years) because, on the one hand, they are often engaged in low-income jobs, and on the other hand, they are not of working age and are very likely to get sick from working. Household heads over 64 years of age who often did not have pensions faced more CHE and IHE as well (Figure 2D).

Household heads with spouses were less negatively affected by reduced HTP support. Single household heads (unmarried people or those who lost their spouses) faced more CHE and IHE perhaps because they have less control over a healthy lifestyle, disease prevention, and family health. In these households, the family income decreases, and the whole burden of the family is on one person. Household heads with spouses have more control over family members in the field of healthy lifestyle, disease prevention, and timely treatment (Figure 2E).

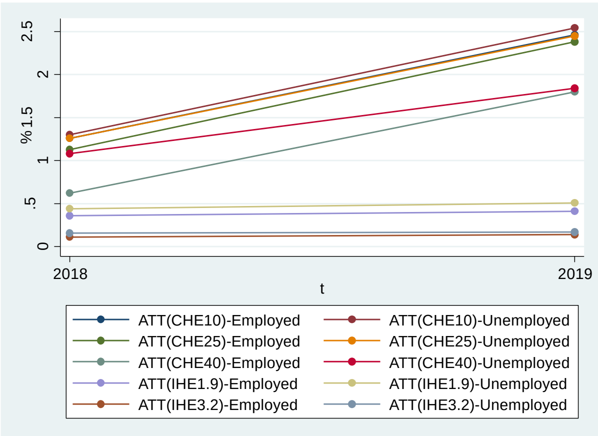
According to $CHE_{\%10}$ and $CHE_{\%25}$, female household heads faced more CHE than male heads because they often have less ability to finance the household compared to male heads. Obviously, in these households, investment in the field of a healthier lifestyle and disease prevention will be less realized. However, there were no significant differences between men and women in $CHE_{\%40}$, $IHE_{\$1.9}$, and $IHE_{\$3.2}$; this is perhaps because female household heads received special social benefits that only supported them against low levels of CHE and IHE, but these benefits did not prevent higher levels of CHE (Figure 2F).



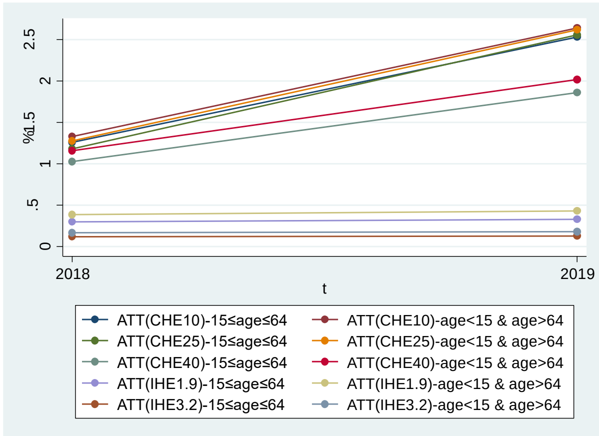
A



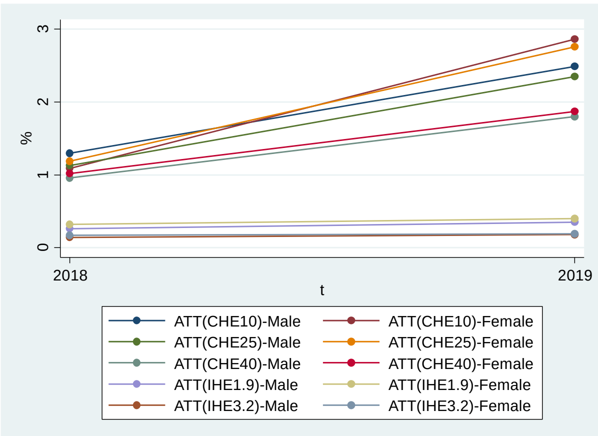
B



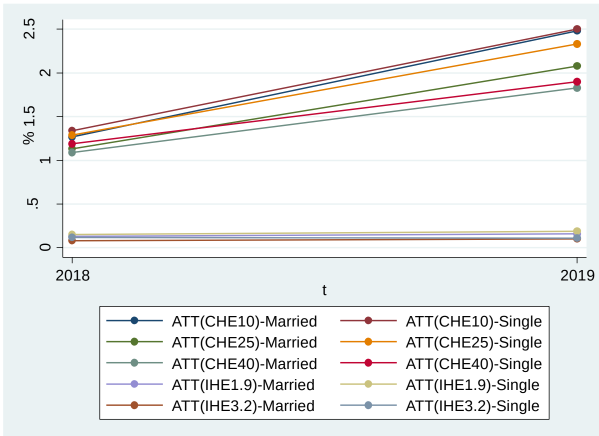
C



D



E



F

Figure 2. Heterogeneity in the Incidence of CHE and IHE in General

Source: Research finding.

As can be seen in Figure 3, rural residents faced more CHE than urban residents following the reduction in HTP financial support. This could be attributed to the less access of rural residents to specialized medical centers and the need to get an ambulance to go to these centers. Because specialized health services are not provided by health houses in rural areas. Rural residents should go to the nearest town or city for hospitalization. This increases the travel costs and accommodation costs of the patient's companions near the hospital. Besides, home visit costs are high for rural areas and are not covered by insurance. However, there is no significant difference between the two groups in terms of IHE. Figure 4 shows the details of the analysis.

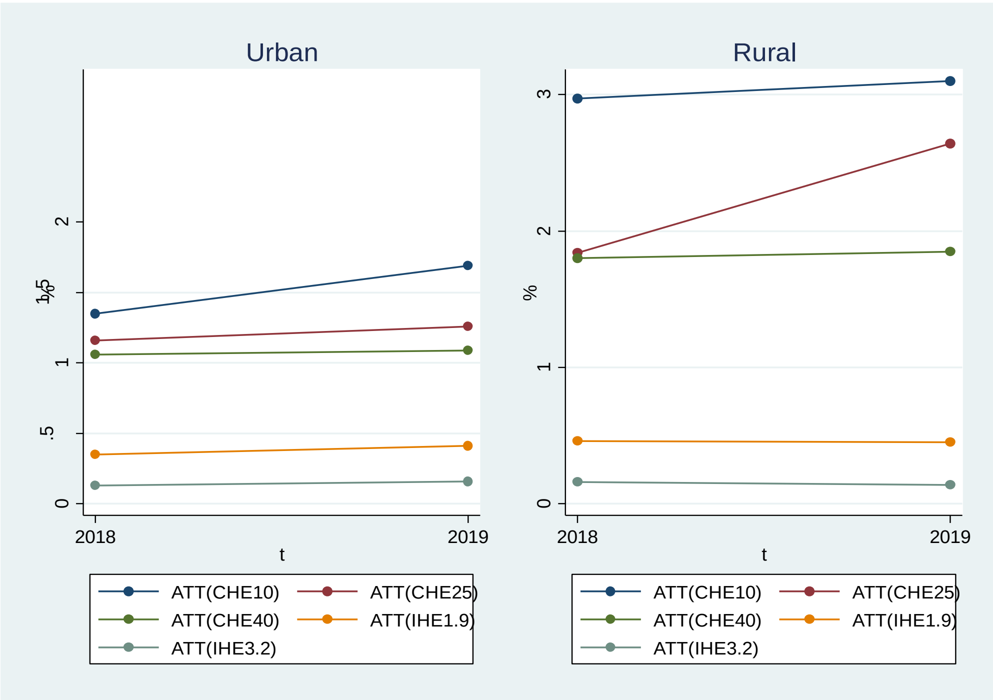


Figure 3. The Effects of the Instability of HTP Financial Resources on the Incidence of CHE and IHE by Regions
Source: Research finding.

The number of rural residents covered by health insurance sharply decreased in 2017 but remained almost constant in the years later. However, the IHIO payment for rural residents decreased by 10% in 2018 compared to 2017 and increased by 16% in 2019 compared to 2018 (Iran Health Insurance Organization, 2019). According to Figure 4A, only the first three deciles of rural areas seem to be subject to the increase in IHIO support in 2019, and payments were made more to this group because the first three income deciles in rural areas faced less CHE and IHE in 2019 than both the first three deciles of rural areas in 2018 and the first three deciles of urban areas in 2019. According to health insurance laws, the first three deciles in rural areas were covered by public health insurance for free in 2019 (Iran Health Insurance Organization, 2023). Another reason for the low levels of CHE and IHE among the first three deciles in rural areas is that they often do not visit a doctor when they are sick and take some home treatments. Therefore, they do not face high OOP. The high-income decile in rural areas was almost unaffected.

According to the insurance laws, the 4th to 8th deciles in rural areas were covered by health insurance in 2019 by paying between 10%-50% of the premium, and the 9th to 10th deciles by paying the full premium (Iran Health Insurance Organization, 2023). The coverage of services was reduced while the insurance premiums paid for the 4th and later deciles increased. This resulted in an increase in CHE for this group of households in rural areas.

Low-income deciles in urban areas faced more CHE and IHE. The insurance of this group seems to have failed to provide adequate coverage for them. The middle-income deciles were less affected by the decrease in HTP financial support. The upper-income deciles were not significantly affected by impoverishment. However, they faced CHE due to the exclusion of some services and private medical centers from health insurance coverage from 2017 onwards because the high-income deciles often used non-governmental medical centers, performed certain surgeries, especially cosmetic surgery, or made investments in their health (e.g., annual check-ups and imaging), all of which were excluded from the insurance coverage (Figure 4A).

Household heads with AE faced more CHE in rural than in urban areas. In general, rural households have a very healthy lifestyle, and the incidence of diseases is lower in rural areas. However, CHE is highly probable because people with AE in rural areas did not have high-paying jobs (proportionate to their education), thus facing more CHE. Statistics also show that in 2019, there was a significant difference in the unemployment rate of university graduates in urban and rural areas. The rate is 21.1% in rural areas and 16.3% in urban areas. This shows that improving the employment status of university graduates in rural areas can also be effective in reducing the incidence of CHE (Statistical Center of Iran, 2019). The academic education of household heads did not significantly affect the incidence of poverty in either rural or urban areas (Figure 4B).

CHE was higher in rural areas than in urban areas due to the reduction of HTP financial support for unemployed household heads, heads under 15 and over 64 years old, heads without spouses, and female heads (Figure 4C, 4D, 4E, and 4F). The details are provided in the following.

Agriculture is one of the common occupations in rural areas. Farmers are not employed all year round and have seasonal unemployment. The lack of fixed income in all months of the year among the heads of rural households may cause them problems in meeting health expenses. For this reason, the unemployed in rural areas faced more CHE compared to the unemployed in urban areas (Figure 4C).

However, the IHE is more prevalent among the urban unemployed than the rural unemployed. The incidence of chronic diseases and health shocks among rural households is less compared to urban households due to a healthy lifestyle and healthy air. For this reason, rural households are less likely to face OOP expenses that lead them below the poverty line. On the other hand, the cost of living in urban areas is higher than in rural areas. In case of chronic diseases that increase OOP expenses, the urban unemployed face more IHE in meeting health expenses compared to the rural unemployed (Figure 4C).

Most of the traditional jobs in rural areas, such as animal husbandry, agriculture, and carpet weaving, require a higher physical ability, which is often beyond the ability of heads under 15 or over 64 years old. Therefore, this group of heads in rural areas will have more problems in paying OOP health expenses and will face more CHE and IHE (Figure 4D).

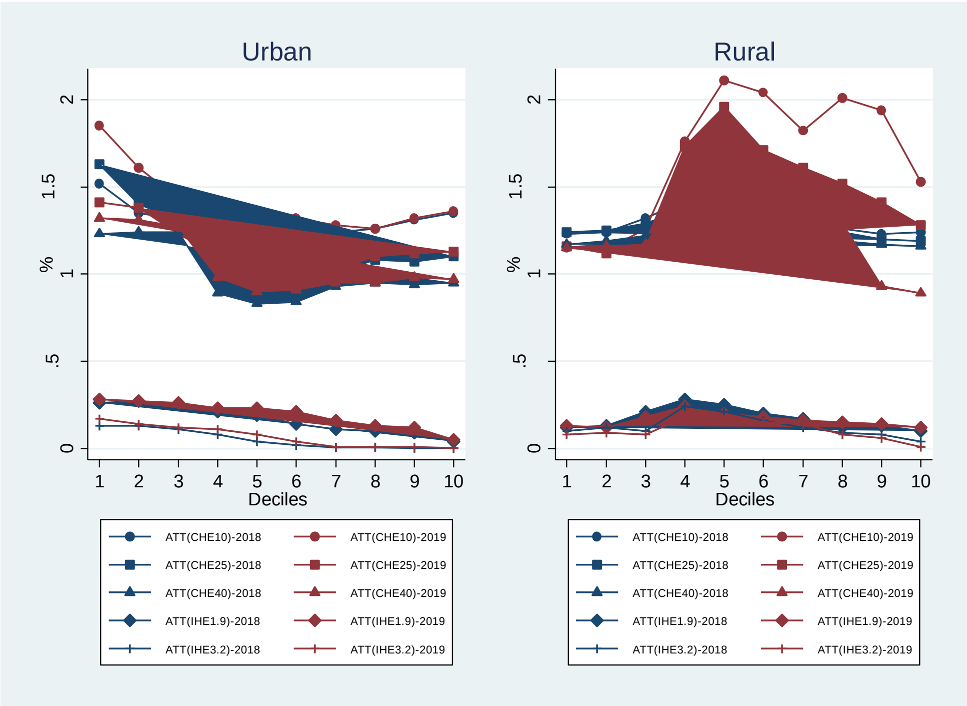
In rural areas, both the head of the household and the wife work in traditional jobs in the village and generate income. Therefore, in rural areas, heads of households with spouses have more income than single heads, and CHE is less for them. In addition, in rural areas compared to urban areas, single heads have faced higher CHE. This shows the importance of the presence of the wife and the income-generating role of rural women alongside men (Figure 4E).

Female heads of households in rural areas have faced more CHE and IHE compared to urban areas. As it was mentioned, rural jobs require higher ability and therefore women heads of households in rural areas cannot earn a high and stable income from these jobs. In other words, the main income of rural female heads comes from the social support of the government; otherwise, they will not have much income from their rural workplace. For this reason, this group of heads has faced more CHE and IHE (Figure 4F).

5. Conclusion

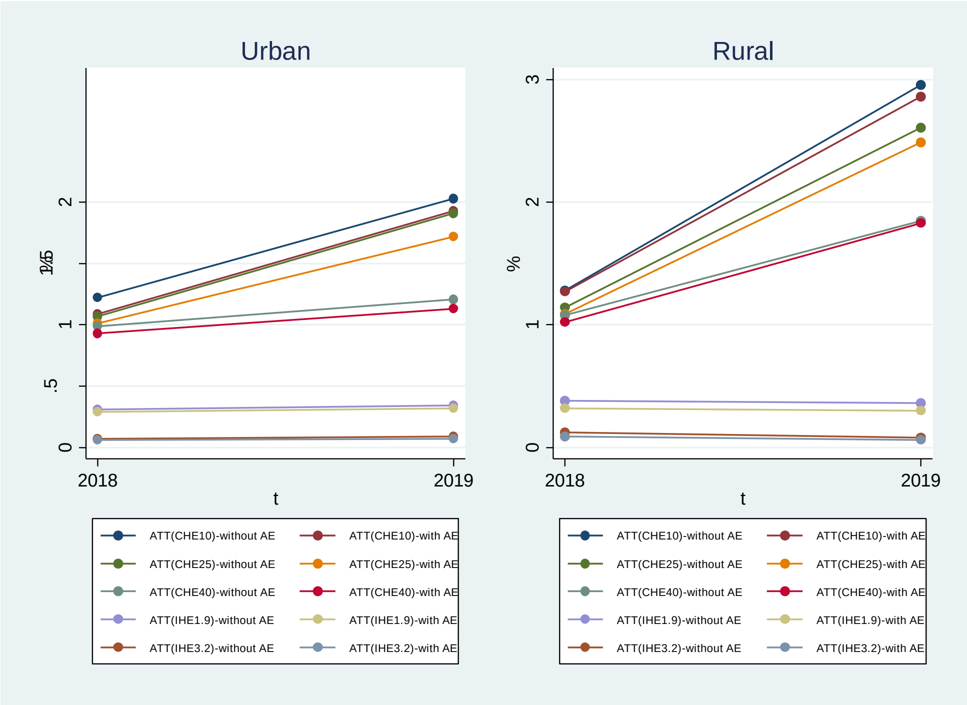
Adopting certain policies in all economic sectors (especially policies affecting disease prevention, income level, and household employment) can bring favorable results to move toward sustainable development, improve UHC in the health system, and reduce CHE and IHE. Policies to make the lifestyle of households healthy (allocating subsidies to healthy food, reducing pollution, etc.) and self-care will be effective in disease prevention. However, such policies did not receive much attention in HTP. Policy-making in the medical sector should thus be done by identifying vulnerable groups and giving them more financial support in the form of higher coverage insurance. This causes the optimal allocation of funds as well.

The OOP level increased in the years after 2017, especially in 2019, due to the reduction of HTP financial support in 2017. The low-income deciles in urban areas and the middle-income deciles in rural areas suffered the most. These deciles should be covered more by health insurance for medicine and treatment costs in new health policies. Moreover, CHE occurred among household heads with AE and IHE among household heads without AE in rural areas, indicating the need to improve the business situation, employment, and income, especially for rural educated people. IHE was more common among unemployed household heads, heads under 15 and over 64 years in urban areas, and female heads in rural areas. As such, they should be covered more by insurance.



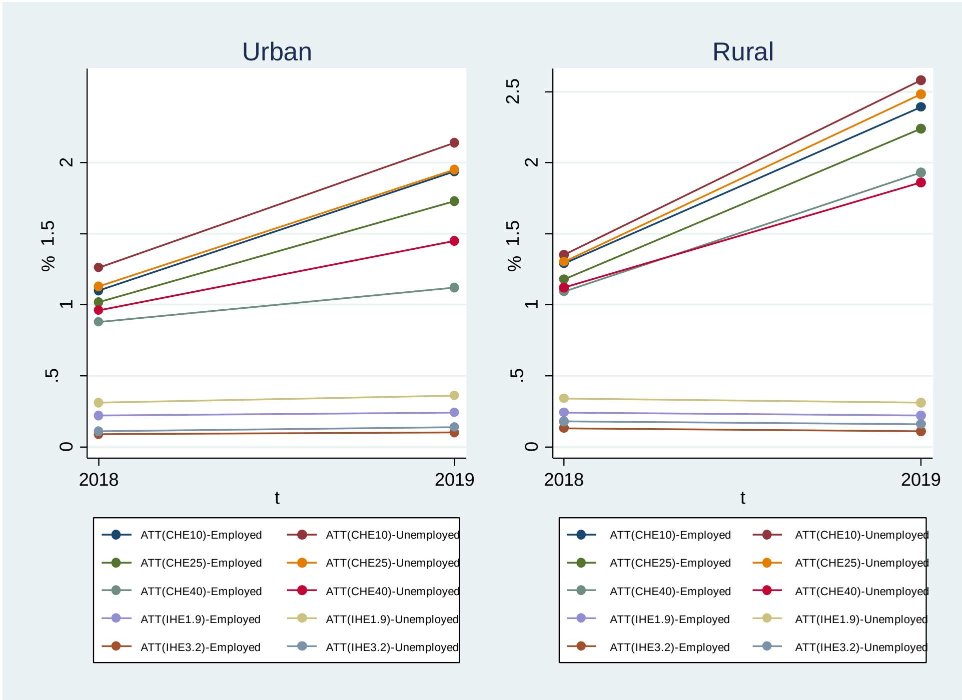
Urban
Rural
%
Deciles
ATT(CHE10)-2018
ATT(CHE10)-2019
ATT(CHE25)-2018
ATT(CHE25)-2019
ATT(CHE40)-2018
ATT(CHE40)-2019
ATT(IHE1.9)-2018
ATT(IHE1.9)-2019
ATT(IHE3.2)-2018
ATT(IHE3.2)-2019

A



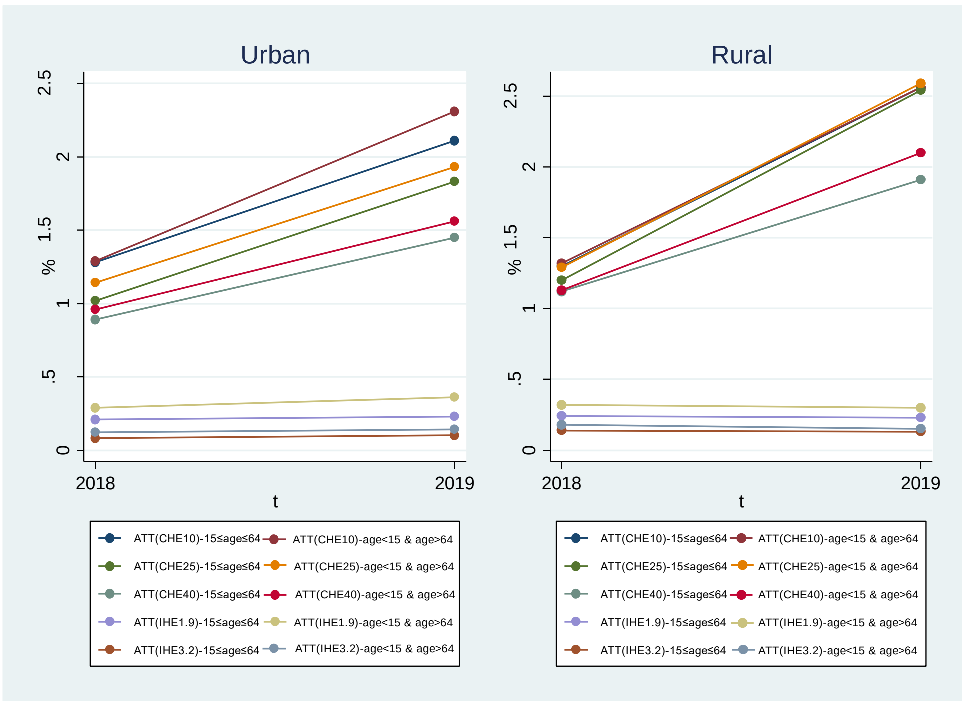
Urban
Rural
%
t
2018
2019
ATT(CHE10)-without AE
ATT(CHE10)-with AE
ATT(CHE25)-without AE
ATT(CHE25)-with AE
ATT(CHE40)-without AE
ATT(CHE40)-with AE
ATT(IHE1.9)-without AE
ATT(IHE1.9)-with AE
ATT(IHE3.2)-without AE
ATT(IHE3.2)-with AE

B



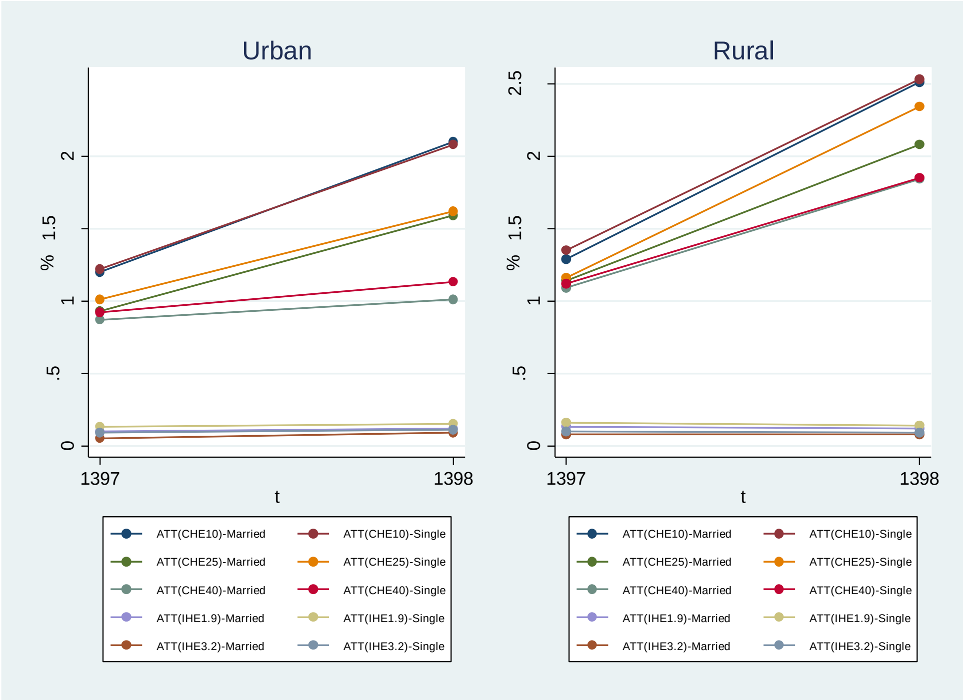
Urban
Rural
%
0
.5
1
1.5
2
2.5
2018
2019
t
ATT(CHE10)-Employed
ATT(CHE10)-Unemployed
ATT(CHE25)-Employed
ATT(CHE25)-Unemployed
ATT(CHE40)-Employed
ATT(CHE40)-Unemployed
ATT(IHE1.9)-Employed
ATT(IHE1.9)-Unemployed
ATT(IHE3.2)-Employed
ATT(IHE3.2)-Unemployed

C

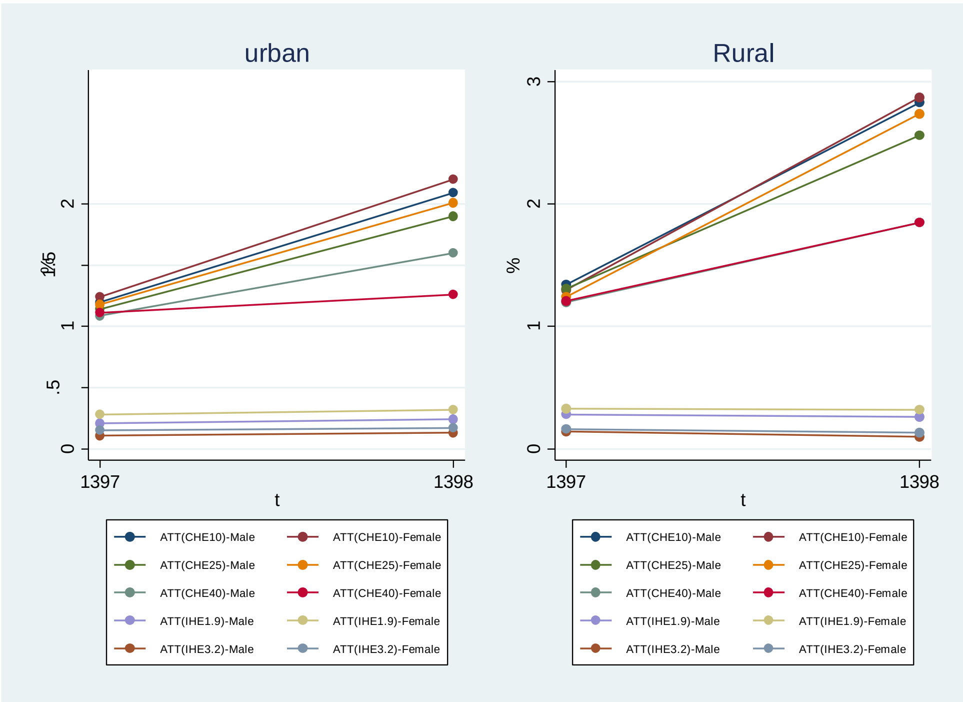


Urban
Rural
%
0
.5
1
1.5
2
2.5
2018
2019
t
ATT(CHE10)-15≤age≤64
ATT(CHE10)-age<15 & age>64
ATT(CHE25)-15≤age≤64
ATT(CHE25)-age<15 & age>64
ATT(CHE40)-15≤age≤64
ATT(CHE40)-age<15 & age>64
ATT(IHE1.9)-15≤age≤64
ATT(IHE1.9)-age<15 & age>64
ATT(IHE3.2)-15≤age≤64
ATT(IHE3.2)-age<15 & age>64

D



E



F

Figure 4. Heterogeneity in the Incidence of CHE and IHE by Regions

Source: Research finding.

Appendix

Table A1. The Results of the Balancing Test of Conditional Variables for $ATT_{CHE\%10}$ (2018)

Conditional variables	Mean		% bias	P-value
	Treated	Control		
Head's age^2	2522.40	2386.60	10.7	0.57
Head's sex	1.03	1.03	1.7	0.11
Head's employment	1.18	1.15	3.2	0.20
Head's marital status	1.09	1.03	10.1	0.87
Head's education status	1.97	1.97	-3.9	0.39
Head's sex* Head's employment	1.27	1.21	4.2	0.32
Ln household income * Head's age	1053.5	1084.3	-0.6	0.41
Head's marital status * Head's education status	2.15	2.04	9.4	0.80
Head's age * Head's education status	96.25	94.38	7.2	0.38

Source: Research finding.

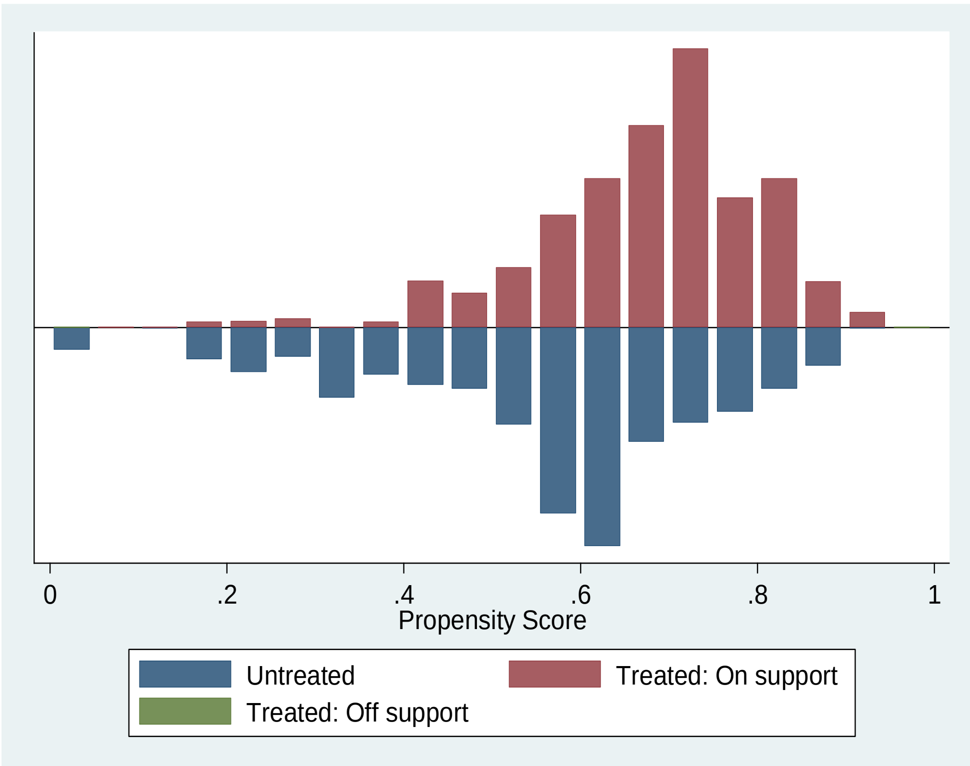


Figure A1. Propensity Score Graph for $ATT_{CHE\%10}$ (2018)
Source: Research finding.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Abdi, Z., Hsu, J., Ahmadnezhad, E., Majdzadeh, R., & Harirchi, I. (2020). An Analysis of Financial Protection before and after the Iranian Health Transformation Plan. *Eastern Mediterranean Health Journal*, *26*(9), 1015-1033. Retrieved from https://www.emro.who.int/emhj-volume-26-2020/volume-26-issue-9/an-analysis-of-financial-protection-before-and-after-the-iranian-health-transformation-plan.html?utm_source=chatgpt.com.

Ahmadi, M., Jalali, R., & Raees-Zadeh, M. (2021). Seven-Year Experience of Health System Transformation Plan in Iran: A Comparative Study. *Nursing Management*, *10*(1). Retrieved from https://ijnv.ir/browse.php?slc_lang=fa&slc_sid=1.

Alipour, V., Zandian, H., Yazdi-Feyzabadi, V., Avesta, L., & Moghadam, T. (2021). Economic Burden of Cardiovascular Diseases before and after Iran's Health Transformation Plan: Evidence from a Referral Hospital of Iran. *Cost Effectiveness and Resource Allocation*, *19*(1), 1-10. Retrieved from https://resource-allocation.biomedcentral.com/articles/10.1186/s12962-020-00250-8.

Bayati, M., Keshavarz, K., Lotfi, F., KebriaeeZadeh, A., Barati, O., Zareian, S., Amiri, A., & Delavari, S. (2020). Effect of Two Major Health Reforms on Health Care Cost and Utilization in Fars Province of Iran: Family Physician Program and Health Transformation Plan. *BMC Health Services Research*, *20*(1), 1-9. Retrieved from https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-020-05257-8.

Doshmangir, L., Moshiri, E., Mostafavi, H., Sakha, M., & Assan, A. (2019). Policy Analysis of the Iranian Health Transformation Plan in Primary Healthcare. *BMC Health Services Research*, *19*(1), 1-8. Retrieved from https://bmchealthservres.biomedcentral.com/articles/10.1186/s12913-019-4505-3.

Ferdosi, M., Kabiri, S., Keyvanara, M., & Yarmohammadian, M. (2017). Challenges of Iran Health Transformation Plan about Inpatients Payment: Viewpoint of Experts. *Health Scope*, *6*(3). Retrieved from https://brieflands.com/articles/healthscope-14388.

Harirchi, I., Hajiaghajani, M., Sayari, A., Dinarvand, R., Sajadi, H., Mahdavi, M., Ahmadnezhad, E., Olyaeemanesh, A., & Majdzadeh, R. (2020). How Health Transformation Plan Was Designed and Implemented in the Islamic Republic of Iran?. *International Journal of Preventive Medicine*, *11*. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC7554432/.

Heinrich, C., Maffioli, A., & Vazquez, G. (2010). *A primer for applying propensity-score matching*. Washington: Inter-American Development Bank. Retrieved from https://publications.iadb.org/publications/english/document/A-Primer-for-Applying-Propensity-Score-Matching.pdf.

Hsu, J., Majdzadeh, R., Harirchi, I., & Soucat, A. (2020). *Health System Transformation in the Islamic Republic of Iran: An Assessment of Key Health Financing and Governance Issues.* Geneva: WHO Publications. Retrieved from https://www.who.int/publications/i/item/978-92-4-000377-4?utm_source=chatgpt.com.

Hsu, J., Majdzadeh, R., Mills, A., & Hanson, K. (2021). A Dominance Approach to Analyze the Incidence of Catastrophic Health Expenditures in Iran. *Social Science & Medicine*, *285*. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0277953621003543?via%3Dihub.

Iran Health Insurance Organization. (2023). *Public Health Insurance Coverage*. Retrieved from www.ihio.gov.ir.

---------- (2019). *Statistical Yearbook of Iran Health Insurance Organization* (6). Tehran: Iran Health Insurance Organization Publications.

Iranian Ministry of Health and Medical Education. (2014). *Evaluation of the Health System Transformation Plan in the Field of Treatment.* Tehran: Ministry of Health and Medical Education Publications.

Islamic Consultative Assembly of Iran. (2014). *Law of adding some articles to the law of regulating part of the financial regulations of the government (2)*. Retrieved from https://rc.majlis.ir/fa/law/show/930339.

Kouhpaye-Zadeh, J., & Kasaeeyan, S. (2018). Determining and Prioritizing Indicators for Achieving Universal Health Coverage in Iran: A Qualitative Study. *Koomesh*, *20*(2). Retrieved from https://repository.brieflands.com/items/d240ccf6-e520-4c7e-b0c0-37ca2079cccf?utm_source=chatgpt.com.

Letafat, M., Beyranvand, T., Aryankhesal, A., Behzadifar, M., & Behzadifar, M. (2018). Universal Health Coverage (UHC) in Iran. *Iranian Journal of Public Health*, *47*(7), 1061-1062. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC6119564/?utm_source=chatgpt.com.

Nemati, E., Khezri, A., & Nosratnejad, S. (2020). The Study of Out-of-Pocket Payment and the Exposure of Households with Catastrophic Health Expenditures Following the Health Transformation Plan in Iran. *Risk Management and Healthcare Policy*, *13*, 1677-1685. Retrieved from https://www.tandfonline.com/doi/full/10.2147/RMHP.S264943?utm_source=chatgpt.com.

Noura, M., & Zanganeh, M. (2020). Health Transformation Plan in Iran: A New Return to the Declaration of Alma-Ata. *Health Scope*, *9*(2). Retrieved from https://brieflands.com/articles/healthscope-67268?utm_source=chatgpt.com.

Olyaeemanesh, A., Behzadifar, M., Mousavinejhad, N., Behzadifar, M., Heydarvand, S., Azari, S., Martini, M., Bakhtiari, A., & Bragazzi, N. (2018). Iran's Health System Transformation Plan: A SWOT Analysis. *Medical Journal of the Islamic Republic of Iran*, *32*. Retrieved from https://mjiri.iums.ac.ir/article-1-4705-en.html?utm_source=chatgpt.com.

Piroozi, B., Rashidian, A., Moradi, G., Takian, A., Ghasri, H., & Ghadimi, T. (2017). Out-of-Pocket and Informal Payment before and after the Health Transformation Plan in Iran: Evidence from Hospitals Located in Kurdistan, Iran. *International Journal of Health Policy and Management*, *6*(10), 573. Retrieved from https://www.ijhpm.com/article_3321.html.

Plan and Budget Organization of Iran. (2021). *Economic, Social, and Cultural Foundations and the Annual Program of Executive Organizations*. Tehran: Publications of the Management and Planning Organization of Iran.

Rahmany, K., Barati, M., Ferdosi, M., Rakhshan, A., & Nemati, A. (2018). Strategies for Reducing Expenditures in Iran's Health Transformation Plan: A Qualitative Study. *Medical Journal of the Islamic Republic of Iran*, *32*, 102. Retrieved from https://mjiri.iums.ac.ir/article-1-5526-en.html.

Rezaei, S., Woldemichael, A., Ebrahimi, M., & Ahmadi, S. (2020). Trend and Status of Out-of-Pocket Payments for Healthcare in Iran: Equity and Catastrophic Effect. *Journal of the Egyptian Public Health Association*, *95*(1), 1-8. Retrieved from https://jepha.springeropen.com/articles/10.1186/s42506-020-00055-w.

Sajadi, H., & Majdzadeh, R. (2019). From Primary Health Care to Universal Health Coverage in the Islamic Republic of Iran: A Journey of Four Decades. *Archives of Iranian Medicine*, *22*(5), 262-268. Retrieved from https://journalaim.com/Article/aim-8346?utm_source=chatgpt.com.

Sajadi, H., Ehsani-Chimeh, E., & Majdzadeh, R. (2019). Universal Health Coverage in Iran: Where We Stand and How We Can Move Forward. *Medical Journal of the Islamic Republic of Iran*, *33*, 9. Retrieved from https://pmc.ncbi.nlm.nih.gov/articles/PMC6504945/.

Sajadi, H., Goodarzi, Z., Takian, A., Mohamadi, E., Olyaeemanesh, A., Hosseinzadeh, F., Sharafi, H., Noori-Hekmat, S., Jowett, M., & Majdzadeh, R. (2020). Assessing the Efficiency of Iran's Health System in Making Progress towards Universal Health Coverage: A Comparative Panel Data Analysis. *Cost Effectiveness and Resource Allocation*, *18*(1), 1-11. Retrieved from https://resource-allocation.biomedcentral.com/articles/10.1186/s12962-020-00215-x.

Seyedin, H., Afshari, M., Isfahani, P., Sharifkazemi, K., Morshedi, M., & Akbari, A. (2020). Out-of-Pocket Payment by Inpatients after Health Sector Evolution Plan and Its Effecting Factors: A Report of Iran. *Shiraz E Medical Journal*, *21*(8), 1-5. Retrieved from https://brieflands.com/articles/semj-97127.

Sirag, A., & Nor, N. M. (2021). Out-of-Pocket Health Expenditure and Poverty: Evidence from a Dynamic Panel Threshold Analysis. *Healthcare, 9*(5), 536-556. Retrieved from https://www.mdpi.com/2227-9032/9/5/536.

Souri, A. (2022). *Insurance Economics*. Tehran: Noore Elm Publications.

Statistical Center of Iran. (2020). *Consumer price index of households by year*. Retrieved from https://www.amar.org.ir/statistical-information.

---------- (2019). *Summary of the results of labor force statistics in 2018*. Retrieved from https://www.amar.org.ir/statistical-information.

---------- (2016-2019a). *Household Income and Expenditure Survey*. Retrieved from https://www.amar.org.ir/statistical-information.

---------- (2016-2019b). *Summary of the Results of Urban and Rural Household Income and Expenditure Survey*. Retrieved from https://www.amar.org.ir/statistical-information.

---------- (2013-2019). *National Health Account*. Retrieved from https://www.amar.org.ir/HesabAghmari.

Sun, J., & Lyu, S. (2020). The Effect of Medical Insurance on Catastrophic Health Expenditure: Evidence from China. *Cost Effectiveness and Resource Allocation*, *18*(1), 1-11. Retrieved from https://resource-allocation.biomedcentral.com/articles/10.1186/s12962-020-00206-y.

The World Bank. (2017). *Purchasing Power Parities and the Real Size of World Economies*. Washington, DC: World Bank Publications. Retrieved from https://openknowledge.worldbank.org/entities/publication/2ffc5862-4582-521a-96cb-be82b6e4d04a.

U.S. Department of Health and Human Services. (2023). *Social Determinants of Health*. Retrieved from https://health.gov/healthypeople/priority-areas/social-determinants-health.

Vahedi, S., Rezapour, A., Khiavi, F., Esmaeilzadeh, F., Javan-Noughabi, J., Almasiankia, A., & Ghanbari, A. (2020). Decomposition of Socioeconomic Inequality in Catastrophic Health Expenditure: Evidence from Iran. *Clinical Epidemiology and Global Health*, *8*(2), 437-441. Retrieved from https://www.ceghonline.com/article/S2213-3984(19)30391-4/fulltext.

Woldemichael, A., Rezaei, S., Kazemi-Karyani, A., Ebrahimi, M., Soltani, S., & Aghaei, A. (2021). The Impact of Out-of-Pocket Payments of Households for Dental Healthcare Services on Catastrophic Healthcare Expenditure in Iran. *BMC Public Health*, *21*(1), 1-8. Retrieved from https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-11209-6.

World Health Organization. (2023a). *Financial Protection*. Retrieved from https://www.who.int/health-topics/financial-protection#tab=tab_1.

---------- (2023b). *Universal Health Coverage*. Retrieved from https://www.who.int/health-topics/universal-health-coverage#tab=tab_1.

---------- (2021a). *Primary Health Care on the Road to Universal Health Coverage: 2019 Monitoring Report*. Geneva: WHO Publications. Retrieved from https://www.who.int/publications/i/item/primary-health-care-on-the-road-to-universal-health-coverage-2019-monitoring-report.

---------- (2021b). *World Health Statistics 2021*. Geneva: WHO Publications. Retrieved from https://www.who.int/data/gho/publications/world-health-statistics.

---------- (1999). *Healthy Living: What Is a Healthy Lifestyle?*. Copenhagen: WHO Regional Office for Europe. Retrieved from https://iris.who.int/handle/10665/108180?utm_source=chatgpt.com.

Cite this article: Ghaemi, F., & Assari Arani, A. (2025). Impact Evaluation of Instability of Financial Resources in Health System Transformation Plan on Achieving Financial Protection in Universal Health Coverage. *Iranian Economic Review, 29*(4), 1256-1288.

Iranian Economic Review, 29(4), 1289-1317
DOI: https://doi.org/10.22059/ier.2023.366174.1007820

RESEARCH PAPER

Turkish Economy Currency Crisis and Depression: Different Start, Different Result

Turgut Yokuş[*,a], Ahmet Ay[a]

a. Department of Economics, Faculty of Economic and Administrative Sciences, University of Selçuk, Konya, Turkey.
* Corresponding author

Received: 04 October 2023, Revised: 28 December 2023, Accepted: 18 January 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

It is generally accepted in the literature that the currency crisis has negative macroeconomic consequences, such as bankruptcies, unemployment, and recession in economies. The economic consequences of different currency crisis severity will also be different. To reveal these differences, in our study, the severe currency crisis that puts the economies into recession is defined as the "Currency Depression". It is extremely important that cases of currency crisis/depression can be predicted before they arise, and allow the economic authorities enough time to implement recovery policies to prevent or at least soften the negative effects of the case. In reference to this importance, Cases of currency crisis/depression occurring in the Turkish economy during 1992:1-2020:12 were created by the early warning system signal approach and analyzed in comparison with the 20 set of indicators. The analysis concluded that these two cases had different initial conditions based on the indicators and their efficacy. The macroeconomic consequences of the currency crisis and currency depression are comparable; four-quarter observation period averages respectively, growth, (1.7%, -3.52%) unemployment (employment/employable population: down 2.1 and 2.85 points), inflation (7.37%, 13.38%), interest (43.89%, 63.04%) and real public domestic debt stock change, (11.54%, 20.7%). Thus, the judgment was reached that these two cases had different initial conditions and different outcomes.

Keywords: Currency Crises, Early Warning System, Signal Approach.
JEL Classification: E44, E60, F31, F37,G21.

1. Introduction

The collapse of socialist market economies in the 1990s and their transition to free market economies accelerated both international trade and, accordingly, financial globalization. The increase in the intensity and speed of the international flows of capital has made the conversion rate of currencies to each other extremely critical. Depending on this new economic period, the European Monetary System (EMS) 1992, Mexico 1994-1995, Asia 1997, Russia 1998, Turkey 2001, and Argentina 2002 crises resulted in major collapses in the currencies of countries (Glick and Hutchison, 2013; Li, 2017). As a result of processes such as the transition of the Eastern bloc countries from the socialist market economy to the free market economy and the transition of the EU countries to the Euro in 2002, a relatively quiet period was experienced in the world economy. The end of this calm period was a crisis known as the "2008 Global Financial Crisis" (GFC), which was unlike any crisis in the world before. This crisis, which started in the USA and spread all over the world, collapsed the financial systems of the economies and also caused major collapses in the currencies of the economies (Rose and Spiegel, 2012).

Economic crisis can be defined as the process of exceeding the price or amount of goods, services, production factors, or currencies in the supply and demand cycle in the market at a greater rate than an acceptable change (Kibritçioğlu, 2001). Crises occurring in the economy are classified into two main parts: real sector crises and financial crises. Currency crisis is called money/exchange/currency crisis, which is in the financial crisis category, and some authors distinguish it as a sudden stop/balance of payments crisis (Claessens and Köse, 2013; Reinhart and Rogoff, 2009). However, both arise as a result of the supply and demand imbalance of the foreign exchange (FX) market.

Although different names and definitions have been made for currency crises in the literature, crisis models have been developed and tried to explain them. The first-generation currency crisis models, which are accepted as the beginning of these models, emerged as a collision of the authority's efforts to create money, despite the current account deficit (CAD) in the fixed exchange rate system. In the second-generation models, the EMS crisis in 1992-1993 was tried to be explained with the first-generation crisis model, but it was seen that the first-generation models were insufficient to explain this crisis. Therefore, speculative attacks and self-fulfilling processes have been added to the first-generation models, deepening the crises by entering the cyclical process. In the following periods, the Asian 1997 Crisis emerged due to moral hazard despite the good economic foundations in the economies. Thus, the existence of different economic starting conditions from the second-generation crises revealed the necessity of constructing third generation models (Krugman, 2014). When the GFC emerged in 2008, it was seen that there was a crisis different from all these crisis models, and it could not be fully explained by any of the previous crisis models. As a result of this inadequacy, "Fourth Generation Currency Crises" have started to be encountered in the literature, albeit a little. The purpose of crisis generation models is to develop an Early Warning System (EWS) that will predict the crisis with indicator changes in the pre-crisis period.

The purpose of the EWS is to provide a warning before the crisis occurs and to give economic officials sufficient time to implement bailout policies to prevent or at least soften the negative effects of the crisis. However, the emergence of each crisis with new facts has revealed the necessity of updating the EWS for each crisis. The methods used in EWS construction are classified into two groups as traditional models and other models. Conventional models are the signal approach model (Kaminsky et al., 1997; Kaminsky and Reinhart, 1999) and dependent variable probit/logit models (Eichengreen et al., 1996; Frankel and Rose, 1996). Other models are Markov switching models (Cerra and Saxena, 2002; Martinez, 2002; Abiad, 2003), artificial neural networks (ANN), and machine learning-based analyzes such as genetic algorithms (Nag and Mitra, 1999; Apoteker and Barthelemy, 2000) and binary recursive tree (Ghosh and Ghosh, 2003; Frankel and Wei, 2004).

The reason for the effort to predict a currency crisis with so many different methods and models is that currency crises have negative macroeconomic consequences, such as bankruptcies, unemployment, and growth declines. Nakatani (2019) statistically analyzed the effects of the currency crisis on the growth of 49 countries in the emerging market and developing country group of the 1980-2011 period. According to the analysis, it was concluded that the currency crises caused an average of 4% to 8% loss in the growth of countries. In another study, it was found that currency crises triggered financial and real sector crises and had a significant negative effect on macroeconomic variables such as consumption, investment, and production (Claessens and Köse, 2013).

For this reason, in our study, the severe currency crisis dragging the real economy into a technical recession is defined as the "Currency Depression". The purpose of this definition is to identify the conditions that give rise to different severe currency crises and to analyze the macroeconomic consequences of these crises. In some studies, it has been determined that these two different currency crises have different effects on growth by defining a currency crisis and a severe currency crisis (Claessens and Köse, 2013; Nakatani, 2019). However, the economic conditions that led to different severe currency crises were not analyzed. In our study, the economic conditions that led to the currency crisis and currency depression, and their economic consequences, were analyzed comparatively.

In the study, firstly, the currency crisis and currency depression were defined, and the cases in the analysis period were determined. In addition, in this section, indicators specific to the Turkish economy that can be used in the signal approach are grouped and determined. Secondly, the signal approach was applied for the currency crisis and the currency depression EWS model, and the effectiveness of the indicators for predicting the cases was analyzed. In addition, this section covered the comparisons of the macroeconomic results of these two cases. The last section presented the differences in the initial conditions and economic consequences of the currency crisis and currency depression cases in the Turkish economy.

2. Signal Approach

Eichengreen et al. (1996) and Frankel and Rose (1996) examined the graphical changes of indicators in tranquil periods (crisis windows) to predict currency crises. The signal approach makes a graphical comparison of the performance of indicators during crisis periods with their performance during tranquil periods. Kaminsky et al. (1997) named this methodology the signal approach and brought it to the literature. This approach consists of three stages. In the first stage, exceeding 3 standard deviations (SD) from the Exchange Market Pressure Index (EMPI) average, which is formed with nominal exchange rates (NCR) and international reserves (R), is defined as a currency crisis, and the crises that occurred in the examined period are determined. In the second stage, indicators that are expected to play a role in the crisis, such as inflation, external debt, and current account deficit, are determined, and the changes in the graphics of the determined indicators are visually examined. Then, it is determined whether the indicators showed extraordinary behavior before the crisis. In the third stage, a threshold value is determined for each indicator by minimizing the probability of not signaling in a crisis (type I error) and the probability of signaling against a non-existent crisis (type II error). If the indicator exceeds a predetermined threshold, then it receives the value “1” as a crisis signal; otherwise, the value “0” is assigned. Depending on the threshold value of each indicator, a spreadsheet as in Table 1 is obtained.

A: represents the number of observations (signals) in which the model indicates a crisis actually occurring; B: corresponds to the number of observations for which the model indicates an unrealized crisis; C: the number of observations where the model does not indicate a crisis actually occurring; and D: the number of observations where the model did not indicate an unrealized crisis.

Table 1. Indicator Signal Performance Matrix

	Crisis (within 24 months)	No crisis (within 24 months)
Signal was issued	A	B (Type I Errors)
No signal was issued.	C (Type II Errors)	D

Source: Kaminsky et al. (1997).

Although the signaling window, in which the signals are monitored, varies according to the structure of the indicators, the 24, 18, and 12-month periods before the crisis are used. The threshold value that will take the value of “1” or “0” in the signaling window period allows the indicators to signal in a way that covers the number range of 10%-25% (out of 75%-90%) of the data. While determining the number of signals for each of these indicators, it is aimed to minimize the noise-to-signal ratios (NSR) given in equation (1) (Reinhart et al., 2000; Kaminsky et al., 1997).

$$NSR = \frac{B}{(B+D)} \Big/ \frac{A}{(A+C)} \tag{1}$$

The smaller the NSR, the better the indicator signals for the right crisis. If the NSR is greater than or equal to “1”, the crisis signal effectiveness of the indicator is not available. According to the NSR, false signals and signals that are not given during the crisis are handled with equal weights. The main advantage of the signal approach is that the method does not impose any parametric structure on the data, and the method provides more accessible and informative data than coefficient estimation tables (Frankel and Rose, 1996).

3. Literature Review

The method proposed by Kaminsky et al. (1997) and named as “KLR” in the literature has been applied to many countries. In the implementations of the KLR approach, changes such as the structure of the EMPI equation, the crisis threshold value, the analysis period, the indicators used, the signaling window, the optimum signal numbers of the indicators, the applied country/countries, and finally the indicators that are effective as a result of the analysis reveal the differences of the studies. In the literature reviewed, except for Heun and Schlink (2004), the EWS model for currency crisis has been proposed by applying the signal approach for Turkey or country groups including Turkey. Effective indicators and identified crisis periods are given in Table 2.

Table 2. Literature Review

NSR≤0.5 Indicators	Reference
Exports	Kaminsk et al. (1997,1998); Berg and Pattillo (1999); Brüggemann and Linne (2002); Heun and Schlink (2004); Kesbic et al. (2016)
Import, Import/GDP	Sevim (2012), Kesbic et al. (2016)
Current Account (CA)/Reserve (R), CA Foreign Trade Balance/GDP	Kaya (2006); Sevim (2012); Avcı and Altay (2013); Cicioğlu and Yıldız (2018);
Export/Import	Sevim (2012)
Terms of Trade	Sevim (2012); Avcı and Altay (2013)
Real Exchange Rate (RER)	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Brüggemann and Linne (2002); Heun and Schlink (2004); Kaya (2006); Avcı and Altay (2013); Kesbic et al. (2016)
GDP, TIPI, Output	Kaminsk et al. (1998); Altıntaş and Öz (2007); Avcı and Altay (2013); Kesbic et al. (2016); Cicioğlu and Yıldız (2018)
Stock Price	Kaminsk et al. (1997; 1998); Öz and Taban (2007); Sevim (2012); Avcı and Altay (2013)
M2/R, M2	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Heun and Schlink (2004); Sevim (2012),
Real Interest Differences, World Interest Rate, Lending/Deposit Rate	Kaminsk et al. (1998); Brüggemann and Linne (2002); Sevim (2012); Avcı and Altay (2013)
Foreign Currency Deposits (FCD)/M2, (M2+FCD)/GDP	Kaya (2006); Sevim (2012)
Foreign Debt, Short-Term External Debt (STED)/R	Kaminsk et al. (1998); Edison (2003); Kaya (2006); Sevim (2012)
Capital Outflow	Altıntaş and Öz (2007)
Real Domestic Debt	Sevim (2012)
Budget Deficit/GDP	Brüggemann and Linne (2002); Kaya (2006); Sevim (2012); Cicioğlu and Yıldız (2018)
Currency Crises in the Turkish Economy After 1992:01	
1994	Kaminsk et al. (1997; 1998); Edison (2003); Berg and Pattillo (1999); Kaya (2006); Altıntaş and Öz (2007); Sevim (2012); Avcı and Altay (2013)
1997	Edison (2003)
2001	Brüggemann and Linne (2002); Kaya (2006); Öz and Taban (2007); Altıntaş and Öz (2007); Sevim (2012); Avcı and Altay (2013); Cicioğlu and Yıldız (2018)
2006	Kesbic et al. (2016); Cicioğlu and Yıldız (2018)
2008	Cicioğlu and Yıldız (2018)
2011 and 2013	Kesbic et al. (2016)

The EMPI equation is established with the NCR and R variables, and the index is 3 SD from the mean (Kaminsky et al., 1997; 1998; Berg and Pattillo, 1999; Heun and Schlink, 2004). Edison (2003), using the same variables over the index mean of 2.5 SD defines a currency crisis. The same studies took the 24-month period as the signaling window. In signal approach studies applied only to the Turkish economy, the interest parameter was added to the EMPI equation of the KLR, and 1.5 SD from the index mean (Kaya, 2006; Avcı and Altay, 2013; Kesbic et al., 2016; Cicioğlu and Yıldız, 2018), Öz and Taban (2007) and Altıntaş and Öz (2007) 1.43 SD, and Sevim (2012) 3 SD overshoot defined as a currency crisis. The signaling window was used as 12 months in the study of Sevim (2012) and 24 months in other studies. A different definition of currency crisis is in the study of Brüggemann and Linne (2002) that applies a signal approach for Central and Eastern European countries, including Turkey. Currency crisis is defined as a minimum 20% decrease of the local currency against USD in a 10-day foreign exchange trading day, and the signal observation period is taken as 18 months. In the studies examined, the threshold value that minimizes the NSR of the data in the range of 5%-35% (such as 10%-20%, 10%-25%) of the optimal signal number of the data period was taken.

When the effective indicators are examined in Table 2, for the currency crisis in the Turkish economy; Effective signals are received from indicators such as the real exchange rate (RER) deviating from its trend, the increase in the current account deficit, the public's budget deficits, the inconsistent money supply and interest policies, the increase in foreign exchange orientation, growth losses and decreases in stock price. In other words, it has been seen that the effective Turkish currency crisis indicators determined in the literature are compatible with the first- and second-generation crisis models.

In Table 2, it is seen that there are 7 different crisis periods, and the 1994 and 2001 crises were identified in all studies covered by the analysis period. However, due to the differences in the definition of EMPI and the data analysis period, an important crisis such as the 2008 GFC could not be detected in some studies. Our signal approach study has contributed to the existing literature as it includes innovations such as the definition of currency crisis specific to the Turkish economy, the optimization method of the signal threshold value, the width of the analysis period, the scope and property of the indicators. The most important of these contributions is that which is not encountered in the current literature; It is a comparative analysis of the initial conditions and macroeconomic consequences of currency crisis and currency depression cases.

3. Methods and Materials

In the first stage of the signal approach; currency cases (currency crisis and currency depressions) were determined by using EMPI and quarterly growth figures for the 1992-2020 monthly period for the Turkish economy. In the second step; The economic indicator set, which is likely to signal by showing abnormal changes in the period before the currency cases, has been determined. In the third stage, for the signal tracking of this indicator set, it includes the procedures for how long an observation period will be followed before the case and which rate of change should be taken as a crisis signal for the indicators. In the fourth step, the effectiveness of the indicator set against currency cases is analyzed and analyzes are made regarding the cases prediction effectiveness of the indicator set. In the last stage, the Weighted Composite Index (I) was prepared for both the currency crisis and the currency depressions with the indicator set that was evaluated as effective. The estimation efficiency of this index on Turkey's currency cases has been examined.

4.1 Turkish Economy 1992 January-2020 December Currency Cases

Yokus and Ay (2020) proposed Turkey-specific EMPI by forming it in Equation (2). The equation consists of the nominal exchange rate (e), the change in the reserve (R*) to which the Net Error Omission (NHN) item is added and the Turkey-USA interest difference $(i - i^f)$ parameters. In this context, the EMPI value and case threshold values during the analysis period are given in Figure 1.

$$\mathrm{EMPI} = \frac{\Delta\%\mathrm{e}}{\sigma_{\mathrm{e}}} - \frac{\Delta\%\mathrm{R}^*}{\sigma_{\mathrm{R}^*}} + \frac{\Delta\%\left(\mathrm{i} - \mathrm{i}^{\mathrm{f}}\right)}{\sigma_{(\mathrm{i}-\mathrm{i}^{\mathrm{f}})}} \tag{2}$$

$$\mathrm{Y_t} = \begin{cases} 1, \mathrm{EMPI_t} > \mu_{\mathrm{EMPI}} + 1.5\sigma_{\mathrm{EMPI}} \\ 0, \mathrm{EMPI_t} \leq \mu_{\mathrm{EMPI}} + 1.5\sigma_{\mathrm{EMPI}} \end{cases} \tag{3}$$

For the 348-month data period, 21 cases of currency crisis were identified that exceeded 1.5 SD (3.55) of the EMPI average according to Equation (2,3). EMPI had the highest value of 15.85 in April 1994, and the lowest value of the analysis period with -5.46 in January 2001. The fluctuation of EMPI in this wide range shows the necessity of a new definition for the difference in the severity of the crisis, which is not included in the definitions of currency crisis.

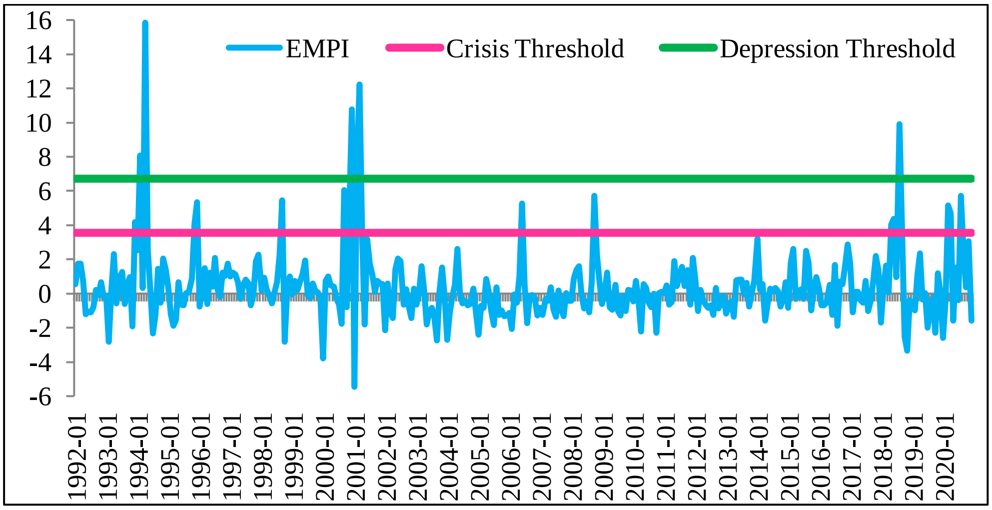


Figure 1. Turkish Economy 1992 January-2020 December Currency Cases
Source: Research finding.

Mazure and Mielcová (2013) state that different definitions of recession are used, but as a technical definition, it is more specific and effective to define GDP as two consecutive negative growth periods from quarter to quarter. Breuer and McDermott (2013) define the Economic Depression as the entry of the economy into a long-term and severe recession period. One of the technical definitions is a 20% decrease in per capita GDP cumulatively, and this decrease period lasts for at least 4 years. As a result of all these definitions and justifications, a new term, “Currency Depression”, has been proposed in the literature. The technical recession in the economies by the severe currency crisis affecting the real sector is defined as the “Currency Depression”. Technically, it is when the EMPI is exceeded by more than 3 SDs from the mean and the economy enters a technical recession within the quarter or within the first 2 quarters following that period.

$$Y_t = \begin{cases} 1, & EMPI_t > \mu_{EMPI} + 3\sigma_{EMPI} \wedge technical\ recession, \\ 0, & all\ other\ cases \end{cases} \quad (4)$$

There is a currency depression “1”, in other cases, that is, the months when there is no currency depression are classified in the “0” category. The currency depression is expressed mathematically by Equation (2,4), and the EMPI values and the depression threshold are given in Figure 1. The periods of currency crisis and currency depressionare given in Table 3.

The crisis months that take place within six months, starting from the first month of the crisis, are defined as the crisis of the same period (Eichengreen et al., 1996). For this reason, in the study, the cases of currency crisis in 8 periods and currency depression in 3 periods were taken.

Table 3. Turkey 1992 January-2020 December Currency Crisis and Depression

Date	EMPI	Case	Quarterly GDP Change (%)
1993-12	4.17	Crisis	93Q4 (8.4), 94Q1 (5.2)
1994-02	8.08	Depression	94Q2 (-10.7), 94Q3 (-7.8), 94Q4 (-5.5)
1994-04	15.85	Depression	
1995-11	4.06	Crisis	95Q3 (9), 95Q4 (6.6)
1995-12	5.36	Crisis	
1998-09	5.45	Crisis	98Q3 (2.7), 98Q4 (0.6)
2000-09	6.05	Crisis	2000Q3 (8.1)
2000-11	4.79	Crisis	2000Q4 (7), 2001Q1 (2.4)
2000-12	10.78	Depression	2001Q2 (-7.2), 2001Q3 (-7.3), 2001Q4 (-10)
2001-02	7.85	Depression	
2001-03	12.24	Depression	
2001-04	3.56	Crisis	
2006-06	5.27	Crisis	2006Q2 (9.2), 2006Q3 (6.9)
2008-10	5.71	Crisis	2008Q3 (0)
2018-05	4.03	Crisis	2018Q2 (5.5)
2018-06	4.35	Crisis	2018Q3(2.3)
2018-08	9.92	Depression	2018Q4 (-2.6),2019Q1 (-2.4)
2018-09	3.70	Crisis	
2020-03	5.15	Crisis	2021Q1 (%4.6)
2020-04	4.69	Crisis	2021Q2 (%-8.7)
2020-08	5.71	Crisis	2021Q3 (%5.4), 2021Q4 (%5)

Source: Research finding and https://evds2.tcmb.gov.tr/.

4.2 Turkish Economy Currency Crisis Determinants

Crises arise when one or more economic imbalances in the economic process turn into a speculative attack, a self-fulfilling process formed by contagion and herd psychology. Economic imbalances occur as a result of factors such as a wrong monetary-fiscal policy, a wrong financial application and regulations, asset price bubbles. In addition, human beings tend to use every aspect that they see for their own benefit, which will create an imbalance in the economy. In other words, moral hazard phenomenon is the biggest problem of the economy today and in the future as it was yesterday. As a result of the combination of the level of economic imbalances and the size of the speculative attack, a currency crisis occurs. Economists have tried to explain the formation processes of currency crises with crisis generation models. However, for each new unexplained crisis, additions and updates to the indicator sets have created new generation crisis models. These additions and updates are aimed at observing the economic imbalances that may occur with different phenomena and determining the potential of speculative attack. In the study, while choosing an indicator set that will determine the existence and degree of an unbalanced structure in the FX market, it has also been tried to select indicators that can determine the effect size of the speculative attack. The illustration regarding the grouping and selection of indicators is given in Figure 2.

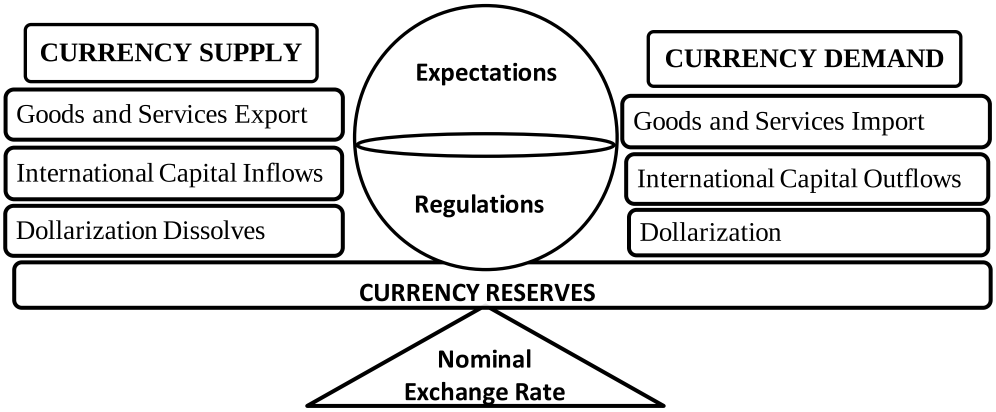


Figure 2. FX Market Supply and Demand Factors
Source: Research finding.

Foreign exchange market indicators direct the expectations of exchange rate market actors, and these expectations affect these indicators, resulting in a cyclical interaction process. In this context, 20 indicators are given in Table 4 by classifying the currency crisis indicators in three groups as Goods and Services Trade (GST), International Capital Flows (IFC) and Dollarization.

4.3 The Optimum Number of Signals

Within the scope of the study, a total of 20 leading indicators were selected, 8 in the GST group, 7 in the ICF group and 5 in the dollarization group. The ideal indicator is expected to receive the maximum number of signals during the 12-month signalling window when there is a crisis, while it is expected to give the least number of signals when there is no crisis. The optimum number of signals (OSN) was calculated based on a signal number (80-30) that minimizes the NSR and covers 10% to 25% of the data during the 12-month signalling window. The sign and OSNs of the indicators selected for the signal approach are given in Table5.

Table 4. FX Supply and Demand Indicators by Groups

Indicators	Description	Reference
Goods and Services Trade Indicator Group		
Current Account to Reserves (CA/R)	(R+CA)/R	CBRT
Export/Import (E/I)	Export/Import	
Real Effective Exchange Rate Deviation from Trend (RER)	[1991 December TL/USD (t. Period Turkey CPI/ICF CPI)-t. Term TL/USD]/t.Term TL/USD	IM,F:IFS,CBRT
Energy Cost Index (ECI)	t. Period Index/Past 12 Month Average Index	WB
World Export (WE)		IMF
Turkey Industrial Production Index (TIPI)		IMF:IFS
Totaly OECD Industrial Production Index (WIPI)		OECD
CBOE Volatility Index (VIX)		CBRT
OECD Turkey Composite Leading Indicator (TCLI)	Monthly Index Value	FRED
International Capital Flows Indicator Group		
Real Change in FED Assets (RFEDA)	t. Period FEDA/ ICF CPI	FED, FRED
Real Interest Rate Differences (RID)	(Turkey Interbank Rate/CPI)-(ICF Interbank Rate/CPI)	IMF:IFS
USD BIST Index Change (BIST)	BIST Index/USD Nominal Exchange	CBRT
Short-Term External Debt to Non-Gold Reserves (STED/R)	STED/R	CBRT
Net Portfolio Flows and Net Portfolio Revenues Ratio of Reserves Excluding Gold (NPF/R)	[R-(NPA+NPR)]/R	CBRT
Financial Account Reserves Excluding Gold Ratio (FA/R)	(R-FA)/R	
Dollarization Indicator Group		
Foreign Currency Deposits / Reserves (FCD/R)	FCD/R	CBRT
Banking Sector Total Credits /Gold Excluding Reserves (C/R)	(C/USD Nominal Exchange Rate)/R	
Real M2 (TL) Supply (RM2TL)	TL M2 Money Supply/CPI	
Real Local Interest Rate (RLI)	Turkey Interbank Rate/CPI	
Real Domestic Debt Stock (RDDS)	Public Domestic Debt Stock/CPI	

Source: Research finding.

Table 5. Signal Approach Crisis Indicator OSN

Indicator	Sign	OSN		Indicator Group	Indicator	Sign	OSN		Indicator Group
		Crisis	Depression				Crisis	Depression	
CA/R	-	40	30	GST	RID	-	49	30	ICF
E/I	-	32	30	GST	BIST	-	32	75	ICF
RER	+	32	53	GST	STED/R	-	43	50	ICF
ECI	+	39	56	GST	NPF/R	-	36	78	ICF
WE	-	51	36	GST	FA/R	-	79	37	ICF
TIPI	-	79	38	GST	FCD	+	73	80	Dol.
WIPI	-	52	54	GST	RDDS	-	78	41	Dol.
TCLI	+	33	47	GST	C/R	+	58	78	Dol.
VIX	+	34	78	ICF	RM2TL	+	36	30	Dol.
RFEDA	-	64	33	ICF	RLI	-	77	30	Dol.

Source: Research finding.

For 348-month observations in the 1992:01-2020:12 period, the OSN value that minimizes the NSR in at least 30 and at most 80 signal intervals was determined according to equation (5).

$$OSN = \{minNSR_{ik} = \frac{B}{(B+D)} / \frac{A}{(A+C)} \quad (5)$$

Indicator index : $i = 1,2,\ldots,20$, number of alternative signals: $k = 30,36,\ldots 80$, The solution of the optimization is the NSR values of all signals in the range of 30 to 80 signal numbers given by the indicators. The signal threshold value of the indicator that gives the minimum NSR value has been determined.

5. Results and Analysis

5.1 Efficiency of Indicators in Currency Crisis and Currency Depression

The signal ratios obtained from the signal approach EWS model for the 12-month signalling window in Turkey 1992:1-2020:12, are given in Table 6. The second column represents a measure of the correct signaling efficiency of the indicator. As the ratio of possible correct signals, "A/(A+C)" is interpreted as the ratio of the number of correct signals for each indicator before the crisis to the period when no signals were received during the signalling window. The "B/(B+D)" ratio in the third column gives the false signal rate of each indicator under the same conditions. The ratio "A/(A+B)" in the last column shows the conditional probability of a crisis if the indicator gives a signal (Kaminsky et al., 1997).

The value in the fourth column is the NSR of each indicator, and the lower this ratio is than "1", the more effective the indicator is interpreted. If this ratio is greater than "1", it is considered that the indicator is not an effective indicator for the crisis EWS established with the signal approach (Kaminsky et al., 1997; Berg and Pattillo,1999; Chui, 2002). The indicators in Table 6 are listed according to the NSR value. Since the NSR of the Turkish Industrial Production Index (TIPI) and World Exports (WE) indicators in the GST group belonging to the currency crisis periods were found to be greater than "1", they were not effective indicators, and their signals were not taken into account.

The Turkish Composite Leading Indicator Index (TCLI), developed by the OECD, aims to predict the trend of economic activity over the next 6 to 9 months. The indicator is composed of different data, such as orders, stock changes, financial indicators such as the country's stock market due to imports confidence surveys regarding the economy, trends in the main sectors, and the economic situation in the important trading partners of the countries. An increase in this indicator is considered an increase in future economic activities (OECD, 2021). Contrary to the general acceptance in the economic literature, the increase in this index appears as the most effective leading indicator for the Turkish currency crisis. However, this indicator interpretation, the expectation of an increase in economic activities in Turkey, can be concluded that the demand for foreign currency will increase for the Turkish economy, which is also effective in the currency crisis.

Table 6. Signal Approach Currency Crisis Indicator Effectiveness

Indicator	Correct Signal Ratio	False Signal Ratio	NSR	Conditional Crisis Probability
	A/(A+C)	B/(B+D)	B/(B+D) /(A/(A+C)	A/(A+B)
TCLI	0.28	0.03	0.10	0.82
E/I	0.21	0.05	0.26	0.63
ECI	0.25	0.07	0.27	0.62
RM2TL	0.18	0.09	0.49	0.47
RFEDA	0.31	0.16	0.499	0.47
CA/R	0.19	0.1	0.54	0.45
RID	0.23	0.12	0.54	0.45
VIX	0.16	0.09	0.56	0.44
RLI	0.33	0.21	0.62	0.42
RDDS	0.33	0.21	0.63	0.41
BIST	0.14	0.09	0.64	0.41
FA/R	0.33	0.21	0.64	0.41
WIPI	0.21	0.15	0.7	0.38
RER	0.13	0.09	0.73	0.38
STED/R	0.17	0.12	0.74	0.37
FCD/R	0.28	0.21	0.75	0.37
NPF/R	0.14	0.11	0.78	0.36
C/R	0.2	0.18	0.9	0.33
TIPI	**0.23**	**0.26**	**1.14**	**0.28**
WE	**0.11**	**0.18**	**1.59**	**0.22**

Source: Research finding.

In the currency crisis forecast, TCLI (0.1), E/I (0.26), ECI (0.27), RM2TL (0.49), and RFEDA (0.49) are calculated as effective indicators with NSR values less than 0.5. In addition, the signal taken from the TCLI indicator, during the signalling window, that economic activities will increase in the next period (ie, the need for foreign exchange will increase in the next period), is a preliminary indication that a currency crisis is expected in Turkey. In the signalling window in the Turkish economy, it was determined that the foreign currency that came with the capital flows was used to give the current account deficit (E/I). In addition to this situation, it has been determined that the expectations deteriorated with the increase in energy costs and the increase in the real money supply, the deteriorating expectations and capital flows reversed, and as a result, incompatible interest and money supply policies were implemented. At the last stage, it was concluded that the crisis cases were accompanied by the tendency of the local market to foreign currency.

Similarly, 15 out of 20 indicators were found to be effective in the early forecasting of the currency depression. Indicator signal rates regarding the currency depression are given in Table 7. Three periods (1994, 2001, 2018) were identified as currency depression cases. Regarding the effectiveness of the indicators, it was determined that WIPI, RER, and WE in the GST indicator group, NPF/R in the ICF indicator group, and C/R in the dollarization indicator were not effective signals.

Table 7. Signal Approach Currency Depression Indicator Effectiveness

Indicator	Correct Signal Ratio	False Signal Rate	NSR	Conditional Crisis Probability
	A/(A+C)	**B/(B+D)**	**B/(B+D) /(A/(A+C)**	**A/(A+B)**
E/I	0.47	0.04	0.09	0.57
TCLI	0.67	0.12	0.18	0.39
CA/R	0.33	0.08	0.23	0.34
ECI	0.39	0.14	0.36	0.25
RFEDA	0.22	0.09	0.38	0.24
FA/R	0.25	0.1	0.41	0.23
RLI	0.19	0.08	0.42	0.22
STED/R	0.31	0.14	0.47	0.2
RID	0.17	0.09	0.51	0.19
RDDS	0.19	0.12	0.63	0.16
FCD/R	0.36	0.24	0.66	0.15
BIST	0.31	0.22	0.72	0.14
TIPI	0.14	0.12	0.83	0.13
RM2TL	0.11	0.09	0.83	0.13
VIX	0.25	0.24	0.95	0.11
WIPI	**0.17**	**0.18**	**1.07**	**0.1**
C/R	**0.19**	**0.25**	**1.27**	**0.09**
WE	**0.08**	**0.12**	**1.46**	**0.08**
NPF/R	**0.17**	**0.26**	**1.54**	**0.07**
RER	**0.06**	**0.2**	**3.61**	**0.03**

Source: Research finding.

In the currency depression forecast, E/I (0.09), TCLI (0.18), CA/R (0.23), ECI (0.36), RFEDA (0.38), FA/R (0.41), RLI (0.42), and STED/R (0.47) are calculated as indicators with an NSR value less than 0.5. Since the Turkish economy has an import-dependent production structure, the currency depression begins with the reduction of the reserves accumulated by capital flows due to imports. In Turkey, the process of depression continues by taking the expectation that the demand for foreign currency will increase due to increased economic activities in the future, the emergence of a phenomenon that will reduce or reverse the international capital flows, the increase in interest rates in the local market, and the tendency to hold foreign currency. In addition to all these indicators, it has been evaluated that a case of currency depression may occur in the Turkish economy, with the signs of decline in Turkish industrial production (TIPI). Finally, if the currency crisis occurred in the few months before the crisis, it can be concluded that the currency depression process has been entered.

Although the effectiveness coefficients of the TCLI and E/I indicators are different, they are the leading and effective indicators of both cases. Similarly, Alagöz et al. (2019) and Saçık et al. (2020), in line with the conclusion that energy imports are the most critical item in the current account deficit for the Turkish economy and are also effective in currency crises, the ECI indicator has also been identified as an effective leading indicator of these two cases.

5.2 NSR Weighted Composite Index and Probability of Currency Cases

When a crisis prediction index is created with all the effective indicators of the signal approach, it is considered that the predictive power of currency crises will provide a more accurate estimation. Kaminsky (1999) proposed a method of calculating an index formed by all indicators to evaluate the probability of an impending crisis. This Weighted Composite Index (I);

$$I_t = \sum_{t=1}^{348} \frac{S_{ti}}{NSR_i} \tag{6}$$

$t = 1,2,\ldots,348$, analysis period, $i = 1,2,\ldots,18$, and $i = 1,2,\ldots,15$ are the sequence numbers of the effective indicators of both cases separately and are calculated by equation (6). NSR of NSR_i ith indicator, S_{ti} value is when the indicator exceeds its own threshold value in the t th period and gives a signal by taking a value of 1, while the status of 0 is not receiving a signal from the indicator. This index is also called the currency crisis fragility index.

The probabilities of following a crisis or depression against a given WCI (I) value are estimated using Equation (7) (Kaminsky, 1999).

$$P\left(C_{t,t+h}\middle|I_i < I_h < I_j\right) = \frac{\sum \text{Months with } I_i{<}I_h{<}I_j \text{ and crisis within 12 months}}{\text{Months with } I_i{<}I_h{<}I_j} \quad (7)$$

Where P denotes probability, I represents WCI crisis or depression indicator, and $P\,(C_{t,t+12}|I_i < I_h < I_j)$ denotes the probability of crisis or depression occurrence in the case window of 12 months given the value of I_t lies between I_i and I_j at time t.

Value of *I*	0-3.9	4-7.99	8-11.9	12-15.9	Above 16
Probability of Crisis	0.17	0.24	0.75	0.86	0.74

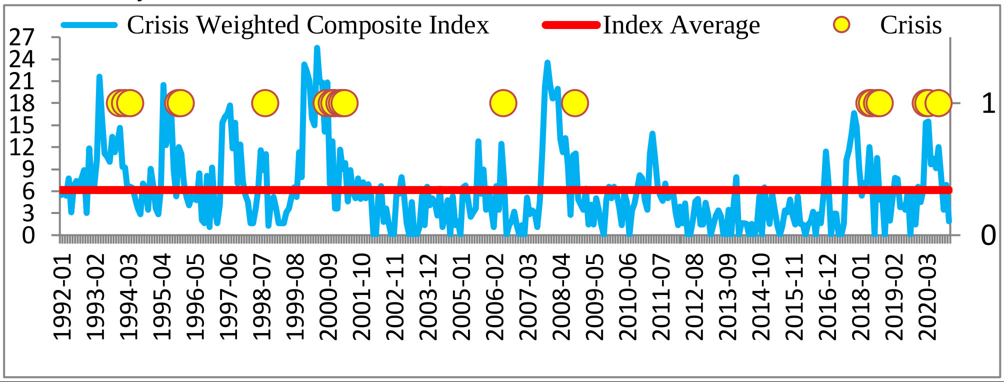


Figure 3. Currency Crises Weighted Composite Index and Probability of Crisis
Source: Research finding.

The representation of the currency crisis probabilities according to the WCI value range with the WCI graph is presented in Figure 3. It has been determined that the index average is 6.16 and fluctuates between 0 and 25.54 values. As seen in Figure 3, when the index takes the value of 12-15.9 during the crisis observation period, the probability of a currency crisis within 12 months is calculated as 86%.

Value of *I*	0-5.9	6-11.9	12-17.9	18-23.9	Above 24
Probability of Depression	0.01	0.07	0.52	0.62	0.75

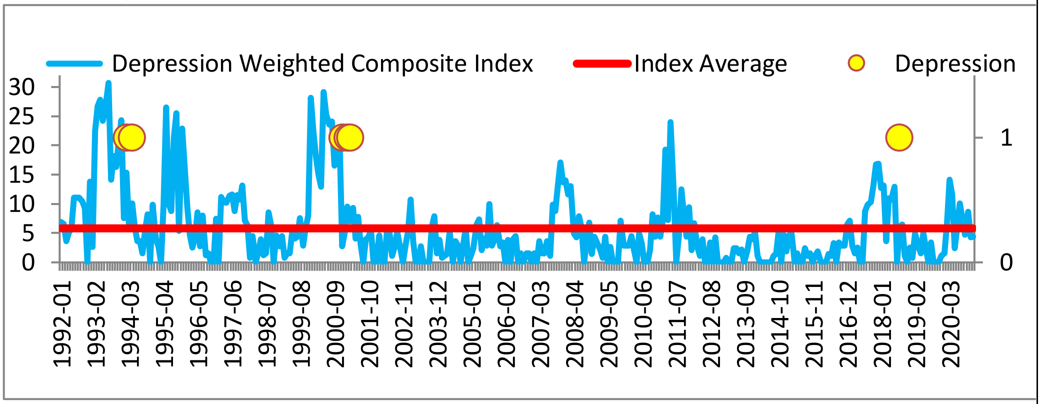


Figure 4. Currency Depression Weighted Composite Index
Source: Research finding.

The representation of the exchange rate depression probabilities according to the WCI value range with the WCI graph is given in Figure 4. The index average is 5.82, with the index fluctuating in the range of 0 to 30.7. As seen in Figure 4, when the index exceeds 24 during the depression observation period, the probability of a currency crisis occurring within 12 months is calculated as 75%.

When Figures 3 and 4 are examined, it is seen that estimating exchange rate events with WCI is an effective method. However, it has been determined that WCI did not give the same response in some cases, since each case period has a unique set of indicators.

5.3 Macroeconomic Consequences of Currency Crisis and Currency Depression Cases in the Turkish Economy

It is generally accepted in economics that financial crises have great economic costs. Many recessions are associated with financial crises, and financial crises often tend to make these recessions longer and deeper than a normal business cycle recession. It has been found that the average duration of a recession associated with a financial crisis is twice that of a normal recession and prevails over a period of about six quarters (Claessens and Kose, 2013).

The economic consequences of the currency crisis and currency depression that occurred in the 1992:1-2020:12 analysis period of the Turkish economy were analyzed. In the analysis period, 3 periods were identified as 1994, 2001, and 2018 as currency depression, and 5 periods as only currency crisis, 1995, 1998, 2006, 2008, and 2020. The course of macroeconomic indicators in the Turkish economy in the 4-quarters after the currency depression and only the currency crisis is given in Tables 8 and 9.

Table 8. Macroeconomic Consequences of Currency Depression

Post-Depression Period	GDP (%)	Employment/ Population over 15 years old	CPI (%)	Interest (%)	Real Public Domestic Debt Stock Change (%)	Gross External Debt Stock Change (%)	CA/R (%)	FA/R (%)	World GDP (%)
1994I	4.30	50.28	16.05	80.06	18.99	0.46	91.3	106.3	
1994II	-9.6	50.28	38.81	128.29	-6.47	-1.40	110.2	82.1	3.30
1994III	-6.1	49.69	11.48	71.37	50.58	-0.53	112.1	85.6	
1994IV	-5.4	49.69	20.18	71.44	30.99	-1.11	102.1	98.7	
2001I	-0.98	43.05	8.86	87.36	40.39	-1.40	98.1	89.8	
2001II	-9.80	47.27	20.53	81.05	60.44	-2.20	104.8	78.3	2.00
20011III	-7.53	48.74	10.42	67.75	27.81	4.72	106.7	96.5	
2001IV	-10.34	43.60	15.57	62.64	10.35	-5.16	102.7	87.3	
2018II	5.84	48.05	4.81	18.50	0.02	-1.95	88.6	100.9	
2018III	2.5	48.06	6.61	27.92	2.83	-2.94	102.4	84.3	3.26
2018IV	-2.6	45.33	6.50	30.75	-0.04	-1.93	104.1	97.9	
2019I	-2.5	45.93	0.75	29.40	12.52	1.47	99.2	103.8	2.60

Source: https://evds2.tcmb.gov.tr/ and https://data.imf.org/.

After the crisis and depression cases in the Turkish economy, the changes in GDP quarterly growth, the ratio of the number of employed people to the population over the age of 15, the Consumer Price Index (CPI), the interbank overnight interest rate, the gross external debt stock and the inflation-adjusted public domestic debt stock indicators were examined. Quarterly effect of current account deficit on total reserves (CA/R) is calculated according to (Reserves+Current Deficit/Excess)/ Reserves equation. A CA/R indicator greater than 100 indicates a current account surplus, and a value less than 100 indicates a current account deficit. The effect of capital flows in the financial account on total reserves is calculated according to the (FA/R) indicator (Reserves-Financial Account)/Reserves equation. If the FA/R indicator is greater than 100, it indicates capital inflow to the Turkish economy, and less than 100 indicates capital outflow. The last indicator is the world annual growth (GDP) change, and it was taken to compare the effects of the Turkish currency crisis and currency depression case results from the world economy.

Table 9. Macroeconomic Consequences of Currency Crises

Post-Crisis Period	GDP (%)	Employment/ Population over 15 years old	CPI (%)	Interest (%)	Real Public Domestic Debt Stock Change (%)	Gross External Debt Stock Change (%)	CA/R (%)	FA/R (%)	World GDP (%)
1995IV	7.19	50.39	18.20	77.18	8.20	0.29	89.9	92.0	3.09
1996I	8.90	49.51	18.25	84.34	40.00	0.23	98.1	111.6	
1996II	7.50	49.51	16.57	79.43	16.20	3.34	94.2	112.1	3.61
1996III	5.60	50.44	11.10	79.65	31.39	0.45	101.8	98.7	
1998II	3.50	47.82	12.60	80.22	19.30	5.41	99.2	110.1	
1998III	2.46	49.66	11.48	75.32	19.76	5.88	104.3	69.0	2.79
198IV	-1.00	49.66	16.58	82.21	11.64	0.67	106.0	111.1	
1999I	-8.15	49.52	12.36	82.30	27.27	-1.49	104.4	104.1	3.50
2006II	8.27	42.99	2.98	19.42	-0.11	4.55	86.8	110.0	
2006III	4.83	42.81	1.83	23.80	1.85	2.65	94.8	108.9	4.50
2006IV	5.18	40.94	2.94	23.79	-0.84	5.20	91.7	111.6	
2007I	6.79	40.58	2.19	23.38	5.64	2.06	90.8	116.7	4.44
2008III	0.99	42.75	0.82	23.14	4.93	1.69	94.1	110.1	2.00
2008IV	-6.02	39.96	3.25	25.39	0.74	-5.45	95.1	94.3	
2009I	-14.54	39.18	0.43	19.33	9.35	-5.32	98.6	96.4	-1.31
2009II	-6.81	42.50	1.10	17.99	2.51	1.85	95.8	103.2	
2020II	-10.40	42.97	2.66	11.27	21.36	-0.84	90.6	100.3	
2020III	6.33	44.00	2.71	12.52	12.33	2.14	92.9	97.6	-3.36
2020IV	6.16	41.70	5.10	17.42	-6.28	3.71	94.5	111.1	
2021I	7.41	44.02	4.29	19.72	5.61	-0.60	94.3	100.3	

Source: https://evds2.tcmb.gov.tr/ and https://data.imf.org/

In the Turkish economy, the average of 1992I and 2021III quarterly growth figures was 4.79%. During the observation period, after the depression, although the world GDP grew, the quarterly growth average of the Turkish economy was -3.52%. It was observed that the average of the observation period after the currency crisis period was 1.7%. In the post-crisis period, a growth was realized, albeit below the general average growth. It has been determined that the economy has entered a contraction phase after the depression. Especially the 2008 GFC (2008) and the COVID-19 pandemic (2020) have affected all world economies. The reflection of these global phenomena was seen as a currency crisis in the Turkish economy. Except for these two special case periods, the Turkish economy was affected during the curency crisis, but there was no significant shrinkage in the economy during the post-crisis observation period.

In the observation period after the 1994 currency depression, the employment rate fell by only 0.59. This decrease in value, despite the large decrease in growth value, restrained this decrease in employment due to the increase in exports (current surplus) in 1994. In the 2001 currency depression, however, the employment rate decreased by 5.14 due to the fact that exports could not respond to the increase in 1994. After the 2018 currency depression, the employment rate decreased by 2.73 due to the insufficient increase in exports. In the observation period of the currency crises, there was no significant decrease in the employment rate, except for the crises that took place during the 2008 GFC and 2020 COVID-19 pandemic periods.

While the average inflation rate for the 1994-2020 quarter was 6.67%, the average quarterly inflation rate during the currency depression observation periods was 13.38%, which is more than twice the general average. In the observation period of currency crises, inflation was realized with a value of 7.37%, which is close to the general average.

While the average interest rate for the 1994-2020 quarter was 36.85%, the quarterly average interest rate during the currency depression observation periods was 63.04%, which is close to twice the general average. In currency crises, this rate was realized with a value of 43.89%, which is close to the general average.

While the rate of increase in real public domestic debt in the quarter of 1994-2020 was 8.19%, the quarterly average real public domestic debt increase was 20.7% in the currency depression observation periods, and the quarterly average increase in the period of currency crises was 11.54%.

After the currency depression periods, the gross external debt decreased, and instead of borrowing, debt payment periods were realized. While the quarterly average change in gross external debt for the 1994-2020 period was 1.73%, the external debt decreased by 1% on average during the currency depression observation period. In addition, during the depression periods, capital inflows in the balance of payments financial account reversed and turned out to be an outflow. In the period of currency crises, the external debt increased, excluding 2008 GFC, and the quarterly average of the entire crisis observation period was 1.32%. Although the capital inflows to the financial account were interrupted after the observation periods of the currency crisis, the capital inflows were realized, albeit in a small way.

The 1994-2020 quarterly CA/R average was 94.85. In other words, the Turkish economy had a current account deficit in this period. The FA/R indicator, which is the financing of the current account deficit, was realized as 105.54 in the same period. In other words, in the analysis period, capital inflows from the financial account to the Turkish economy were realized. If these two indicators are evaluated together; The capital, which entered the financial account with international capital flows, went out again to the foreign world by importing more than the export of goods and services. The quarterly average of the currency depression observation period CA/R and FA/R indicators was 101.85 and 92.63, respectively. Contrary to the period of 1994-2020, the Turkish economy has a current account surplus during the currency depression and its post-observation period, capital inflows reverse and exit values are formed. The average of the currency crisis observation period was 95.91 and 103.45 for the CA/R and FA/R indicators, respectively. In other words, as in the general situation on average during the period of currency crises, the Turkish economy runs a current account deficit and meets this with capital inflows from the financial account.

5. Conclusion

It is generally accepted in the literature that currency crises have a negative economic impact. However, there is no study in the literature that analyzes the economic consequences of the cases that differ according to the currency crisis severity and the initial conditions that differentiate these cases. While our study reveals the differences in the initial conditions that reveal the currency crisis and the currency depression, with the signal approach, it has also contributed to the literature by showing that the macroeconomic consequences of the currency crisis and currency depression are different.

In the application of the currency crisis EWS model signal approach, it has been determined that 18 of the 20 indicators, excluding TIPI and WE, are effective. According to the signal approach analysis, it has been determined that indicators such as TCLI, E/I, ECI, RM2TL, RFEDA are the most effective indicators with NSR less than 0.5, respectively, in estimating the currency crisis.

For the currency depression EWS model, 15 out of 20 indicators were found to be effective. In predicting the case of depression, indicators such as E/I, TCLI, CA/R, ECI, RFEDA, FA/R, RLI and STED/R were found to be the most effective indicators with NSR less than 0.5, respectively.

If the effectiveness of the leading indicators of the currency depression and the currency crisis are compared; E/I (188%), FA/R (56%), CA/R (135%), RLI (48%), RFEDA (32%), STED/R (57%), while TCLI (80%), ECI (33%), RM2TL (69%) are indicators with lower efficiency values. In addition, the TIPI indicator was calculated as an effective indicator within the scope of the currency depression, unlike the currency crisis. Finally, in the analysis period, a currency crisis is definitely seen a few months before the currency depression occurs. However, not every crisis is followed by a depression. As a result, it is concluded that when the currency crisis occurs, the crisis can be prevented from turning into a depression with correct and effective policies.

If the macroeconomic consequences of the currency depression and the currency crisis are compared; the four-quarter averages values such as growth (-3.52%, 1.7%) unemployment (employment/workable population: 2.85 and 2.1 percentage points decrease), inflation (13.38%, 7.37%), interest rate (63.04%, 43.89%) and real change in public domestic debt stock (20.7%, 11.54%), were calculated. Similarly, after the currency crisis, capital inflows (FA/R: 103.45) turned into outflows (FA/R: 92.63) after the currency depression, and the gross external debt change from borrowing (1.32%) after the currency crisis to paying debt (-1%) after the currency depression and the current account deficit after the currency crisis (CA/R: 95.91) turned into a current account surplus after the currency depression (CA/R: 101.8). It has been determined that the capital inflows of the Turkish economy have reversed in the post-currency depression periods, the gross foreign debt has decreased by making the payment, the exports have increased, the imports have decreased, and as a result, there has been a current account surplus. It has been determined that the Turkish economy maintains its economy positively as long as there is foreign capital inflow, such as growth, employment, low inflation, and low interest rates.

It has been seen that unless the Turkish economy solves the chronic current account deficit problem before the crisis and depression periods, it will cyclically encounter either a currency crisis or a currency depression according to the signal efficiencies of the above economic indicators, but the currency depressions to be experienced will affect the Turkish economy much more negatively than the currency crises.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.
- This article is extracted from my doctorate dissertation entitled “Currency Crisis Early Warning Systems: Turkey Model”, supervised by Prof. Dr. Ahmet Ay, Selçuk University, Konya/Turkey, 2022.

References

Abiad, M. A. (2003). *Early warning systems: A survey and a regime-switching approach*. International Monetary Fund. Retrieved from https://scholar.google.com/scholar?hl=tr&as_sdt=0%2C5&q=Early+Warning+Systems%3A+A+Survey+and+A+Regime-Switching+Approach.+IMF+Working+Paper&btnG=.

Alagöz, M., Yokuş, N., & Yokuş, T. (2019). Photovoltaic solar power plant investment optimization model for economic external balance: Model of Turkey. *Energy & Environment*, *30*(3), 522-541. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0958305X18802762.

Altintas, H., & Oz, B. (2007). Predicting Currency Crises With Signal Approach: The Case of Turkey. *Anadolu University Journal of Social Sciences*, *7*(2), 19-44. Retrieved from https://ideas.repec.org/a/and/journl/v7y2007i2p19-44.html.

Apoteker, T., & Barthelemy, S. (2000, May). Genetic algorithms and financial crises in emerging markets. In *AFFI International Conference in Finance Processing* (Vol. 45, No. 1). Retrieved from https://core.ac.uk/reader/208046620.

Avcı, M. A., & Altay, N. O. (2013). Predicting The Financial Crises with Signal Approach: An Analysis for Turkey, Argentina, Thailand, and England. *Pamukkale University Journal of Social Sciences Institute*, *14*, 47-58. Retrieved from https://dergipark.org.tr/en/pub/pausbed/issue/34728/383954.

Berg, A., & Pattillo, C. (1999). Predicting currency crises: The indicators approach and an alternative. *Journal of International Money and Finance*, *18*(4), 561-586. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0261560699000248.

Breuer, J. B., & McDermott, J. (2013). Economic depression in the world. *Journal of Macroeconomics*, *38*, 227-242. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0164070413001134.

Brüggemann, A., & Linne, T. (2002). *Are the Central and Eastern European transition countries still vulnerable to a financial crisis? Results from the signals approach*. Retrieved from https://publications.bof.fi/handle/10024/48549.

Bussiere, M. (2013). Balance of payment crises in emerging markets: how early were the 'early'warning signals?. *Applied Economics*, *45*(12), 1601-1623. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/00036846.2011.633891.

Cerra, V., & Saxena, S. C. (2002). What caused the 1991 currency crisis in India? *IMF Staff Papers*, *49*(3), 395-425. Retrieved from https://link.springer.com/article/10.2307/3872503.

Chui, M. K. (2002). Leading indicators of balance-of-payments crises: A partial review. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=392302.

Cicioğlu, Ş., & Yıldız, A. (2018). Kriz dönemlerinde reel ekonomik göstergelerinin sinyal yaklaşımı ile değerlendirilmesi: 1999-2017 Türkiye örneği. *Bilgi Sosyal Bilimler Dergisi*, 1, 38-73. Retrieved from https://dergipark.org.tr/tr/pub/bilgisosyal/issue/37657/422940.

Claessens, S., & Köse, A. (2013). Financial Crises: Review and Implications. *Central Bank Review, 3*(13), 1-23. Retrieved from https://www.proquest.com/scholarly-journals/financial-crises-review-evidence/docview/1519492452/se-2?accountid=16716.

Edison, H. J. (2003). Do indicators of financial crises work? An evaluation of an early warning system. *International Journal of Finance & Economics*, *8*(1), 11-53. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/ijfe.197.

Eichengreen, B., Rose, A. K., & Wyplosz, C. (1996). Contagious currency crises. Retrieved from https://www.nber.org/papers/w5681.

Federal Reserve Economic Data. (2021). *Factors Affecting Reserve Balances*. Retrieved from https://fred.stlouisfed.org/series/WALCL#.

Frankel, J. A., & Rose, A. K. (1996). *Currency Crashes Emerging Markets: Empirical Indicators*. Retrieved from https://www.nber.org/papers/w5437.

Frankel, J. A., & Wei, S. J. (2004). Managing macroeconomic crises. Retrieved from https://www.nber.org/papers/w10907.

Ghosh, S. R., & Ghosh, A. R. (2003). Structural vulnerabilities and currency crises. *IMF Staff Papers*, *50*(3), 481-506. Retrieved from https://link.springer.com/article/10.2307/4149942.

Glick, R., & Hutchison, M. M. (2013). Models of currency crises. *The evidence and impact of financial globalization*, *3*, 485-497. Retrieved from https://people.ucsc.edu/~hutch/WebArticles/ModelsCurrencCrises-2012-Handbook.pdf.

Heun, M., & Schlink, T. (2004). *Early warning systems of financial crises: implementation of a currency crisis model for Uganda* (No. 59). HfB-Working Paper Series. Retrieved from https://www.econstor.eu/handle/10419/27925.

International Monetary Fund (IMF). (2021), IMF Data. *International Financial Statistics*: Retrieved from https://data.imf.org/?sk=4FFB52B2-3653-409A-B471-D47B46D904B5andsId=1485878855236.

Kaminsky, G. L., & Reinhart, C. M. (1999). The twin crises: the causes of banking and balance-of-payments problems. *American Economic Review*, *89*(3), 473-500. Retrieved from https://www.aeaweb.org/articles?id=10.1257/aer.89.3.473.

Kaminsky, G. L. (1999). *Currency and banking crises: the early warnings of distress*. International Monetary Fund. Retrieved from https://www.federalreserve.gov/Pubs/IFDP/1996/544/ifdp544.pdf.

Kaminsky, G., Lizondo, S., & Reinhart, C. M. (1998). Leading indicators of currency crises. *Staff Papers*, *45*(1), 1-48. Retrieved from https://link.springer.com/article/10.2307/3867328.

Kaya, V., & Yılmaz, Ö. (2005). Para Krizleri Öngörüsünde Sinyal Yaklaşimi: Türkiye Örneği. *Ankara Üniversitesi SBF Dergisi*, *61*(02), 129-155. Retrieved from https://dergipark.org.tr/en/pub/ausbf/article/42744.

Kesbiç, C. Y., Dündar, Ö., & Devrim, A. (2016). KLR "Mutlak Sinyal" Yaklaşımına Göre Türkiye Ekonomisine İlişkin Kriz Öngörüsü. *Finans Politik ve Ekonomik Yorumlar*, (617), 23-53. Retrieved from https://dergipark.org.tr/en/pub/fpeyd/issue/48027/607359.

Kibritcioglu, A. (2004). *Economic Crises and Governments in Turkey, 1969-2001 (Turkiye'de Ekonomik Krizler ve Hukumetler, 1969-2001)* (No. 0401008). University Library of Munich, Germany. Retrieved from https://ideas.repec.org/p/wpa/wuwpma/0401008.html?ref=SexShopu.Com?ref=Sex%C5%9Ehop.Com.

Krugman, P. (2014). Currency regimes, capital flows, and crises. *IMF Economic Review*, *62*(4), 470-493. Retrieved from https://link.springer.com/article/10.1057/imfer.2014.9.

Li, C. S. (2017). Banking Crisis, Currency Crisis, and Growth. *Currency Crisis and Growth (November 1, 2017)*. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=3063490.

Mazurek, J., & Mielcová, E. (2013). The evaluation of economic recession magnitude: Introduction and application. *Prague Economic Papers*, *22*(2), 182-205. Retrieved from https://www.researchgate.net/profile/Jiri-Mazurek/publication/283389013_The_Evaluation_of_Economic_Recession_Magnitude_Introduction_and_Application/links/5848095c08ae2d21757398c8/The-Evaluation-of-Economic-Recession-Magnitude-Introduction-and-Application.pdf.

Nag, A., & Mitra, A. (1999). Neural networks and early warning indicators of currency crisis. *Reserve Bank of India Occasional Papers*, *20*(2), 183-222. Retrieved from https://www.researchgate.net/profile/Ashok-Nag/publication/284480973_Neural_networks_and_early_warning_indicators_of_currency_crisis/links/59e048ada6fdcca98423759d/Neural-networks-and-early-warning-indicators-of-currency-crisis.pdf.

Nakatani, R. (2019). Output costs of currency crisis and banking crisis: Shocks, policies and cycles. *Comparative Economic Studies*, *61*(1), 83-102. Retrieved from https://link.springer.com/article/10.1057/s41294-018-0069-1.

Organisation for Economic Co-operation and Development (OECD). (2021). *Industrial Production*. *OECD Data*: Retrieved from https://data.oecd.org/industry/industrial-production.htm.

Oz, B., & Taban, S. (2007). Türkiye'deki Para Krizlerinin Reel Değişkenlerle Sinyal Yaklaşimiyla Öngörülebilirliği. *Beykent Üniversitesi Sosyal Bilimler Dergisi*, *1*(1), 1-28. Retrieved from https://dergipark.org.tr/en/pub/bujss/issue/3858/51583.

Martinez Peria, M. S. (2002). A regime-switching approach to the study of speculative attacks: A focus on EMS crises. *Empirical Economics*, *27*(2), 299-334. Retrieved from https://link.springer.com/article/10.1007/s001810100102.

Pinto, B., & Aizenman, J. (2005). Managing Economic Volatility and Crises: A Practitioner's Guide. Retrieved from https://www.cambridge.org/core/books/managing-economic-volatility-and-crises/3CA0A3087D53F25200A4F9A6C5DD7EC5.

Reinhart, C. M., & Rogoff, K. S. (2009). *This time is different: Eight centuries of financial folly*. Princeton: Princeton University Press. Retrieved from https://www.degruyterbrill.com/document/doi/10.1515/9781400831722/html.

Reinhart, C., Goldstein, M., & Kaminsky, G. (2000). Assessing financial vulnerability, an early warning system for emerging markets: Introduction. Retrieved from https://mpra.ub.uni-muenchen.de/13629/?v=1392752313000/_/jcr:system/jcr:versionStorage/14/07/26/14072602-86aa-403b-a3d0-a179084b2869/1.5/jcr:frozenNode.

Rose, A. K., & Spiegel, M. M. (2012). Cross-country causes and consequences of the 2008 crisis: early warning. *Japan and the World Economy*, *24*(1), 1-16. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0922142511000417.

Saçık, S. Y., Yokuş, N., Alagöz, M., & Yokuş, T. (2020). Optimum renewable energy investment planning in terms of current deficit: Turkey model. *Energies*, *13*(6), 1509. Retrieved from https://www.mdpi.com/1996-1073/13/6/1509.

Sevim, C. (2012). *Financial Crises and Türkiye Example According to the Leading Indicators Approach*. Ankara: Banking Regulation and Supervision Agency. Retrieved from https://www.researchgate.net/profile/Cuneyt-Sevim/publication/268147531_ONCU_GOSTERGELER_YAKLASIMINA_GORE_FINANSAL_KRIZLER_VE_TURKIYE_ORNEGI/Links/54621bde0cf27487b45582de/Oencue-Goestergeler-YAKLASIMINA-Goere-FINANSAL-KRIZLER-VE-Tuerkiye-Oernegi.Pdf.

Central Bank of The Republic of Turkey (CBRT). (2022). *CBRT Electronic Data Delivery System* (CBRT EVDS): Retrieved from https://evds2.tcmb.gov.tr/index.php?/evds/serieMarket.

World Bank (WB). (2021, November 3). *World Bank Commodity Price Data* (The Pink Sheet), 2021. Commodity Markets: Retrieved from https://www.worldbank.org/en/research/commodity-markets#1.

Yokuş, T., & Ay, A. (2020). Kur Krizleri Tanimi Ve Türkiye 2006-2018 Dönemi Kur Krizleri. *Yönetim ve Ekonomi Araştırmaları Dergisi*, *18*(1), 295-316. Retrieved from https://dergipark.org.tr/en/pub/yead/article/608003.

Cite this article: Yokuş, T., & Ay, A. (2025).Turkish Economy Currency Crisis and Depression: Different Start, Different Result. *Iranian Economic Review, 29*(4), 1289-1317.

Iranian Economic Review, 29(4), 1318-1341
DOI: https://doi.org/10.22059/ier.2023.355399.1007643

RESEARCH PAPER

A Phenomenological Study of Muslim Households in Surabaya City, Indonesia

Luluk Latifah[*,a], Lutfi Agus Salim[b], Abdurrahman Raden Aji Haqqi[c], Hermanto Siregar[d]

a. Department of Islamic Economic Law, Postgraduate Program, Muhammadiyah University of Surabaya, Indonesia.
b. Department of Biostatistics and Population, Faculty of Public Health, Airlangga University, Surabaya, Indonesia.
c. Faculty of Sharia and Law, Sultan Sharif Ali Islamic University, Bandar Seri Begawan, Brunei.
d. Department of Economics, Faculty of Economics and Management, Bogor Agricultural University, Indonesia.
* Corresponding author.

Received: 14 February 2023, Revised: 19 October 2023, Accepted: 26 November 2023, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
Financial management decisions in the household are not only dominated by women but also by Households. This study aims to determine the phenomenon of financial management of Muslim households in Surabaya. The research method employed is a qualitative, phenomenological approach. The results showed that the phenomenon of the Muslim community in the city of Surabaya in managing household finances was divided into three groups, namely: (1) having an inefficient and consumptive nature. (2) The role of financial management is divided into three: first wife, second husband, and third together. (3) Household expectations when associated with blessings: (a) Do not become a burden to the environment, (b) Can help social interests, (c) The emergence of a sense of sincerity, gratitude, and trustworthiness, (d) Realization of sincere intentions because of Allah SWT.
Keywords: Finance, Household, Phenomenology.
JEL Classification: D1, D14.

1. Introduction

Financial management decisions in the household are crucial factors that determine the quality and effectiveness of a decision, ensuring that there are no financial problems within the household. These problems include the occurrence of conflicts in spouses, inequality of power in the household, and domestic violence to the point of a divorce (Burgoyne, 1990).

The right decisions in managing household finances will bring beneficial results, such as partner satisfaction, happiness, and the welfare of partners in the household. So that the decision on who is the financial manager in the household requires more knowledge and ability from the husband and wife in the household to make optimal choices (Jappelli, 2010).

This decision on household financial management was researched by Freed van Raaij (2020), about the style of financial management in a household that examines household financial decision-making and financial management models from various disciplines. According to Freed van Raij's research, synchronized financial management and having a joint account result in fewer financial problems compared to couples who have separate bank accounts with male-dominated money management.

Currently, the knowledge gap is increasing, especially in the field of household finance. With the development of new technologies, such as the internet, the amount of financial information available to households is increasing rapidly. Good financial knowledge, or financial literacy, and the ability to use information in decision-making also increase (Dwiastanti, 2018). Therefore, it is very important to manage household finances for the welfare of the household. In addition to technological advances, the quality of household financial decision-making is important because government support in household financial matters is rapidly diminishing; the government leaves financial matters to the households themselves to have a high degree of independence and resilience, or hands over to the private sector to fill gaps (Hatidjah et al., 2017). For example, the submission of pension funds, several agencies have begun to hand over the management to the households themselves. Health insurance and the provision of medical care, increased use of digital communication channels, digital payment systems, infrastructure, telecommunications, and energy supply have been handed over to the private sector. So the quality of decisions is very dependent on the independence of citizens.

In some cases, a household has to choose between alternative providers and contracts, which often creates problems because without much help from others. At the same time, household members are increasingly treated as individuals in matters of taxation, social benefits, and legal contracts, further complicating financial affairs in the household (Rodrigues et al., 2016). Moreover, the participation of women in the labor market increases, thereby increasing the bargaining power of women in the household (Overney, 2019). In such an environment, bargaining between household spouses becomes more common, and differences in the bargaining power of spouses can lead to unequal or suboptimal financial outcomes for the household. So it is necessary to make quality household decisions in the financial sector.

Based on the above background, research on the phenomenon of Muslim household financial management is very important, especially in the city of Metropolis Surabaya, which is the second largest city after Jakarta, with the level of diversity of its people. This research will be directly constructed from the financial managers of Muslim households in the city of Surabaya by studying the socio-economic background of couples who use different financial management styles, and what phenomena occur in their household financial management. The results of this study are not only very useful for married life, but also relevant for the banking world to advise customers on banks and their savings accounts, for debt policy advisors to help households in managing their finances, and for households in general to improve their money management. Management of household finances is an important determinant of avoiding financial problems and improving financial well-being, and perhaps also relational and overall well-being, to avoid the storm of division that leads to divorce in the household.

2. Literature Review

2.1 Household Financial Management

A household consists of one or more people who live together in a residence and share food and living accommodations, consisting of a family or a group of people. In a broad sense, the household is not limited only to the family; it can be in the form of corporate households, state households, and so on (Cynthia Robin, 2003). According to BPS, a household is a person or group of people who inhabit part or all of a physical building or house, and usually live together and eat from the same kitchen (Nasional, 2017).

Household financial management, starting from initial financial planning, organizing or recording finances, financial spending, and controlling finances in a household, is very important to achieve good financial goals. Knowledge of finance is related to financial management behavior (Hakim et al., 2014a). Values of trust and trustworthiness are the values of a person's behavior in managing good and reliable finances. Management of household finances in Islam is not just a process of managing wealth, but also has a broad definition that is related to human duties as caliphs on earth (Endrianti and Laila, 2016).

The verse and hadith that underlie the management of household finances.

2.1.1 The Importance of Paying Attention to the Management of Assets or Finances Properly, According to Islamic Sharia, Allah SWT says:

زُيِّنَ لِلنَّاسِ حُبُّ الشَّهَوَاتِ مِنَ النِّسَاءِ وَالْبَنِينَ وَالْقَنَاطِيرِ الْمُقَنْطَرَةِ مِنَ الذَّهَبِ وَالْفِضَّةِ وَالْخَيْلِ الْمُسَوَّمَةِ وَالْأَنْعَامِ وَالْحَرْثِ ذَٰلِكَ مَتَاعُ الْحَيَاةِ الدُّنْيَا وَاللَّهُ عِنْدَهُ حُسْنُ الْمَآبِ ﴿۱۴﴾

Verse Translation:

"Made beautiful in (the view of) humans, the love of what they want, namely: women, children, wealth of many kinds of gold, silver, horses of choice, livestock, and fields. That is the pleasure of living in this world, and with Allah is a good place to return (heaven)" (Departemen Agama, 2007).

2.1.2 Household Financial Management

Household financial management is also reflected in the Qur'an Surah al-Kahf verse 46, assets, jewelry, and children must be managed properly to get the good of the world and the hereafter to face Allah SWT.

الْمَالُ وَالْبَنُونَ زِينَةُ الْحَيَاةِ الدُّنْيَا ۖ وَالْبَاقِيَاتُ الصَّالِحَاتُ خَيْرٌ عِنْدَ رَبِّكَ ثَوَابًا وَخَيْرٌ أَمَلًا ﴿46﴾

Verse Translation:

"Wealth and children are adornments of the life of this world, but eternal and pious deeds are better in reward with your Lord and better for hope" (Depag, 2007).

2.1.3 Allah SWT Mandates Humans to Manage and Utilize Assets in Accordance with his Provisions.

The real owner of human property is Allah SWT. As His word.

آمِنُوا بِاللَّهِ وَرَسُولِهِ وَأَنْفِقُوا مِمَّا جَعَلَكُمْ مُسْتَخْلَفِينَ فِيهِ ۖ فَالَّذِينَ آمَنُوا مِنْكُمْ وَأَنْفَقُوا لَهُمْ أَجْرٌ كَبِيرٌ ﴿7﴾

Verse Translation:

"Believe in Allah and His Messenger and spend part of your wealth which Allah has made you master. So those who believe among you and spend (part) of their wealth will have a great reward" (Departemen Agama, 2007).

2.1.4 The importance of managing household finances, especially in obtaining assets, from where the source of wealth obtained for a household to support the family is very important.

This is due to the phenomenon of human indifference to the source of wealth that has been evident in everyday life, such as what was conveyed by the Prophet centuries ago (Al-Bukhari, 2010):

«لَيأتِيَنَّ على الناسِ زمانٌ لا يُبَالِي المرءُ بما أخذَ المالَ، أَمِن حلالٍ أم من حرامٍ؟»

Translation:

"There will come a time for mankind when they will no longer care where they get their wealth from, whether it is from the lawful or the unlawful" (Narrated by Bukhari, no. 2083, from Abu Hurairah).

Rasulullah Muhammad SAW also strongly emphasizes that his people seek lawful wealth, and also spend it on good things. Human responsibility for property includes two sides, from where it is obtained and where it is spent.

2.2 Financial Blessing

2.2.1 The Meaning of Blessing

The meaning of blessing or Barokah in Arabic means the persistence of something, and also means the increase or development of something. Blessing or blessing has the meaning of growth, addition, and happiness. Ibn Hajar al-Asqallânî explained the meaning of blessing, namely the increase or number of goodness and grace. Blessing is a constant and continuous addition (Farchanti, 2017).

The definition of blessing according to Ibn Hajar al-Asqallânî strengthens the understanding of blessing according to Ibn al-Atsir and an-Nawawi by showing a hadith of the Prophet as the basis for taking its meaning. The center of blessing is only in Allah alone, any creature will not be able to present and bring blessings from itself. Allah declares that He is the source of blessings (Farchanti, 2017).

Financial Freedom or financial freedom popularized by Robert T. Kiyosaki in his book "Rich Dad Poor Dad", says that financial freedom is when someone is in the business path, where people work for him, and in the investment field, money will work for him so that the person has free to work or not to do physical work (Kiyosaki, 2018).

The term rich according to Kiyosaki, is how long he can survive while maintaining his level of life without having to work physically, including his family. According to Father Spam in his book "Wealth Magic". Financial freedom is when the income from investment is more or greater than the annual expenditure (Peter Span, 2001). The definition of rich, according to him, is when someone has a lot of money with no minimum limit. From the information above, the definition of wealth is not specified in a certain amount, because the amount of wealth is relative. But they put more emphasis on financial freedom solely for the life of the world, with all material needs. There is no visible future ukhrawi value after death or spiritual touch.

Islam chooses the perfect concept of wealth or wealth, namely, how to obtain it, and spend it, and how to place the heart towards wealth. Property is a deposit (Amanāh) of Allah because it must be accounted for in the hereafter (Muhammad, 2006). Custody means that there are other people's rights in it (8 asnaf). The definition of Rich according to Islam is that if you can share with 8 asnaf, the more you share, the richer you are. Wealth is not private property, and wealth spent in the way of Allah is real wealth.

Freedom Financial in Islam not only talks about freedom and poverty, but also freedom from wealth, so that blessings are achieved. So that the blessing of wealth is a condition where whatever is owned in any amount will provide optimal benefits for the hereafter and give a feeling of well-being, "*ziyādatul khaiṛ fii khoir,"* which means increased goodness. Financial blessing is an easy way to manage finances and multiply wealth with spiritual intelligence.

2.2.2 The Techniques for Obtaining Wealth Blessing

Wealth obtained in an illegal way will cause no blessing, even though the wealth is abundant. Such assets are, for example, the proceeds of corruption, the proceeds of theft, the proceeds of usury, the proceeds of becoming a prostitute, and others, which are obtained by violating Islamic Sharia. This treasure, besides not being a blessing, will also quickly disappear without realizing it. There are several ways to achieve a blessing in wealth, including:

2.2.2.1 Be Cautious

By fearing Allah and His Messenger, you will surely get a life full of blessings. To be pious in this case is the same as staying away from prohibitions and following all His commands (Freepik, 2021).

To obtain blessings in life in general and in obtaining property in particular, some conditions must be met, namely piety. To be pious is faith in Allah SWT. This is the most important condition so that our sustenance is blessed by Allah SWT, namely by realizing faith in Allah SWT (Bafdi, 2008).

2.2.2.2 Give Charity or Share

The true rich life is rich and full of blessings. Blessings can be achieved through a logical way. This method is a habit of sharing if you already have the advantages of the needs of daily life. Sharing will not bring harm. Especially if the sharing is in accordance with the will of Allah SWT. Wealth that is issued with the intention of seeking the pleasure of Allah will bring blessings that cannot be counted in money (wealth). Blessing brings peace of mind, peace of mind, and a comfortable life (Yunus, 2019).

2.2.3 Forgiving

Islam teaches all its people not to be vindictive; in this case, Muslims can use the story of the struggle of the Prophet as a guide. Apologize for all the actions that make Muslims noble. In addition, Allah SWT will give blessings to His people who always do good in His way.

2.3 The Blessing Indicator

Blessings cannot be seen with the naked eye, but can only be felt, because blessings are filled with divine values for goodness in this world and goodness in the hereafter. The indicators of wealth blessing from several sources are listed below:

2.3.1 Fortune Sufficiency

The indicator of sufficiency of fortune is an indicator of blessing from research conducted by Tubagus Chaeru Nugraha in 2019. His research is entitled Sustainability of Blessings in the Culinary Business Community: CDA. The purpose of this study was to determine the values of blessing in the culinary business community. The research method used is by using CDA. The results of the study show that the values of blessing in the culinary business community include: 1- Strong belief that Allah is the giver of sustenance. 2- Paying zakat. 3- Obey and practice Islamic trade ethics (Nugraha, 2019).

2.3.2 Health

Health indicators are indicators of blessings that were studied by Pradipta Aditya in 2015. His research was conducted on Muslim laundry entrepreneurs about the meaning of blessing. The results of his research stated that the laundry business can be a blessing as long as it is carried out in accordance with Islamic law (Muamalah). The indicator of blessed sustenance is to bring a peaceful, happy, healthy life, always growing and bringing the owner closer to Allah SWT.

The main informant, namely a laundry entrepreneur who is the owner of a laundry business, stated that the emergence of gratitude was the greatest blessing from the sustenance he got. The fortune he got became a blessing in itself for him and his family. The blessing felt from the fortune then brings health and sincerity which is a form of non-material happiness (Aditya, 2015).

2.3.3 Well-being

Welfare indicators are indicators of blessing in the research conducted by Muthofar with the title "Analysis of indicators of zakat blessing for muzaki in the Joglosemar route" produces indicators of perceived blessing for muzaki respondents. The Muzaki describe the types of blessings they have experienced including ease of affairs, feelings about the pleasure of Allah, effectiveness of wealth, welfare of life, and avoiding things that are harmful (Muthohar, 2018).

2.3.4 Peace of Soul

The indicator of inner peace is an indirect indicator of blessing from security, according to the writings of Syafii Antonio in his book "Encyclopedia: Prophetik Leadership and Management Wisdom, Amanah Inter-Personal Capital (Inside the Success of Muhammad SAW"). Syafii Antonio writes that the nature of Amanah will lead to a belief, and trust will give birth to an inner peace (Antonio, 2013).

The inner peace written in Syafii Antonio's book is one indicator of blessing, according to research conducted by J. Nasution in his research entitled: "Analysis of the Effect of Compliance Paying Zakat on Blessing (Nasution, 2017). Nasution (2017) said that the form of blessing that was most experienced by respondents after obediently paying zakat was smoothness and increased sustenance. Furthermore, respondents stated that their income is sufficient to meet the needs of life, family harmony, perseverance in worship, property is protected from theft, and peace of mind.

3. Methods and Materials

The research method used is a qualitative method with a phenomenological approach to obtain results about the existing phenomena in household financial management. This phenomenology comes from the philosophy that surrounds human consciousness, which was coined by Edmund Husserl, who lived between 1859 and 1938, a German philosopher (Husserl, 1971). According to Husserl, the definition of phenomenology is a subjective or phenomenological experience, or a study of consciousness from the principal perspective of a person. Raco in his book on qualitative approaches, translates the definition of phenomenology from Edmund Husserl as what is experienced and felt about something and how to interpret and interpret something (Raco, 2018).

The phenomenological approach is used to approach the object of research with an innocent mind without assumptions, presumptions, prejudices or concepts. The views, ideas, assumptions, and concepts held by the researcher about the research phenomenon must be temporarily locked or bracketed and let the informant express his experience so that the deepest essence of the experience is obtained (Sugiyono, 2013).

This study uses a phenomenological approach to describe what is experienced and felt by the Household as the object of research, who directly experiences married life will interpret and describe what is felt in the management of their household finances during this time. Household are allowed to express their experiences without any assumptions, presumptions or concepts from the researcher, so that the deepest essence of the experience of the housewife will be obtained (Assyakurrohim et al., 2022).

3.1 Methods and Tools

The method used is in-depth interviews (indept interviews) with semi- structured questions, the goal is that informants in this case are Household have the opportunity to express their opinions, judgments, feelings and knowledge related to the phenomenon under study, namely in-depth information about the experience of managing their household finances. The use of open-ended questions was used so that the informants could choose their own words. Researchers explored the experiences of informants in interpreting their experiences in managing household finances and interpreting the experiences of informants directly.

The use of data collection tools using notes and voice recording devices with cellphones, to record in-depth interviews with Household as informants. Voice recording tools were also used during in-depth interviews with key informants, from experts. The interview guide is in the form of semi-structured questions to help researchers so that the questions asked continue to lead to the research objectives.

3.2 Determination of Informants

According to Cresswell, the determination of informants depends on the capability of the person being interviewed to be able to articulate their life experiences (Creswell, 2006). According to Evi and Marta, the determination of informants is based on theories and presumptions about the depth of understanding of the informants' experiences (Marta, 2016).

Household members as informants will be able to articulate their life experiences in managing household finances. The selection of informants in this study used a purposive sampling technique, or sampling with the aim of determining the way to deliberately select the informants based on certain criteria, goals, and considerations. 36 Considerations in this case are people who have the criteria and are considered to know the most about the research topic.

3.3 Criteria for Research Informants

The selection of informants in this study is based on people who meet the criteria and are considered capable of providing complete information related to the topic and research objectives so that the data to be obtained can be recognized as true (Sugiyono, 2020). The criteria for selecting the informants in this study were Household who were Muslim.

4. Research Result

4.1 Overview of Indormants

4.1.1 Number of Informants

The number of informants is based on the information that needs to be obtained (Polit et al., 2004). This study used 13 (thirteen) informants, consisting of 6 (six) main informants and 7 (seven) key informants. The six main informants are households that live scattered in the Surabaya area. The seven key informants are experts consisting of Sharia economists, Islamic Religion experts, Psychology experts, and Sociologists. The basis for determining the number of informants is the achievement of data saturation, or the data is saturated; there are no new themes arising from the data collection, in other words, no new themes have been found. This is in accordance with what was stated by Speziale and Carpenter (2003), who said that data collection was carried out until the researcher was sure that data saturation had been reached. The thirteen informants consisted of seven key informants or experts and 6 main informants or households.

The number of key informants used in this study has represented every expert or field of expertise from the field of Islamic Economics, Psychology, Sociology, and Islamic Religion, with representation from scholars or academics from various Islamic community organizations (Ormas), namely from NU (Nadlatul Ulama), from Muhammadiyah, and from Hidayatullah.

4.1.2 Characteristics of Informants

Characteristics of informants in this study were divided into 2 groups, the first group was key informants consisting of experts from various fields of science, namely Islamic economics, Religion, psychology, and sociology. The second group is the main informant, consisting of Muslim households who live in the city of Surabaya. Households are direct subjects or actors in matters relating to household finances.

The characteristics of the informants in this study are presented in Table 1 below:

Table 1. Characteristics of Informants

Kode Informan	Usia (Tahun)	Pekerjaan	Jenis Kelamin	Pendidikan Terakhir	Status Pernikahan	Expert dibida
Ag1	63	Ketua LKAJ	Female	S-3	Marrige	Agama Islam
		Peneliti di Litbang Depag				
Ag2	51	Pembina LPMI Al-Izza	Male	S-3	Marrige	Agama Islam
Ag3	59	Rektor PTS	Male	S-3	Marrige	Agama Islam
Ag4	53	Dai	Male	S-2	Marrige	Agama Islam
Es	57	Rektor PTS Guru Besar	Male	S3	Marrige	Ekonomi Syariah
Psi	64	Guru Besar	Male	S3	Marrige	Psikologi
Sos	61	Guru Besar	Male	S3	Marrige	Sosiologi
Dn	50	IRT	Female	S1	Marrige	Inf. Utama
Ir	47	IRT	Female	S1	Marrige	Inf. Utama
Ev	35	Peg. Swasta	Female	S1	Marrige	Inf. Utama
Tn	45	IRT	Female	SMA	Marrige	Inf. Utama
Is	47	Peg.Swasta	Female	D-3	Marrige	Inf.Utama
Nn	50	IRT	Female	SMP	Marrige	Inf. Utama

Source: Research finding, 2021.

4.1.2.1 Key Informants

Characteristics of informants are as follows:

1. Ag1 is an Indonesian female figure who has received awards both from within and outside the country, such as: Indonesian female character from Femina magazine, Tempo magazine, and Muri. International Women of the Year in 2009 and the Yap Thaim Hien award, as well as the International Women of Courage Award USA in 2007.
2. The informant with the code Ag2 is a builder and owner of a modern Islamic boarding school with thousands of students studying at his pesantren and coming from various corners of the country. Ag2 has a doctoral education (strata 3), who has been active in educational institutions since he was young, until he was given the responsibility as a research and development center for education (research and development) in a community organization. Until finally managed to establish a boarding school based on religion and general knowledge with the number of students in the thousands.
3. The informant with the code Ag3 is a chancellor at the largest private university in Indonesia. Ag3 is known as a Muslim intellectual who has multidisciplinary expertise. Ag3 is known as an educational figure who was born from the Muhammadiyah association and devoted most of his time to taking care of the people and nation through education.

4. The informant with the code Ag4 is an ustad and preacher who has traveled to several corners of Indonesia. He obtained religious knowledge from the Darussalam Gontor Islamic boarding school and from Selangor, Malaysia; besides that, he also received general knowledge from the University of Wales, UK, England. Has many worshipers from various cities and has become a reference in studies of Islamic religious science.
5. In the field of Sharia Economics, there is an informant with the code Es, who is a professor at a well-known PTN in West Java. He is also the main commissioner of BRI Syariah, commissioner of PNM (Civil National Capital), and Vice Chancellor at one of the leading state universities in Indonesia. West Java, and the Chancellor at a private university (PTS) in West Java. In addition, he also works as a member of the supervisory board of the Indonesian Sharia Bank Association (ASBISINDO), served as an advisory team to the president of the Susilo Bambang Yudoyono era in the economic field, and also sits on the National Economic Committee (KEN), so there is no doubt about his expertise in the economic field. especially Islamic economics.
6. In the field of Psychology, there is an informant with the code Psi, who is a Professor in the field of psychology at a large PTN in East Java. He has expertise in industrial and organizational psychology, with research areas on group performance, group culture, intergroup relations, and is an expert in psychology research methodology.
7. In the field of Sociology, there is an informant with the code SOS, is a professor at a well-known PTN in East Java, and currently serves as Deputy Dean. He has expertise in Sociology, which has produced research on corporate social responsibility and its implications for the development of Indonesian society.

4.1.2.2 Main Informants

1. The informant with the code Dn is a housewife who is 50 years old and has been married for 14 years, and has one daughter. Educational background is an undergraduate. Before the pandemic, exactly 2 years ago, he was still active in the private sector for approximately 20 years and decided to stop his career 2 years ago. Informant Dn lives in the area of South Surabaya.
2. The informant with the code *Ir* is a housewife who is 47 years old and has been married for 21 years, has four sons and daughters, her educational background is a bachelor, previously had a career outside, and after having two children decided to stop and become a housewife. Informant Ir lives in the Central Surabaya area.
3. The informant with the code *Ev* is a 35-year-old housewife who is married and has three daughters, the age of marriage is 13 years. *Ev* since graduating from

college has a career outside the home until now. This *Ev* informant lives in the West Surabaya area.

4. The informant with the code Tn is a 45-year-old housewife who is married and has three children, the age of marriage is 20 years. The last education that was successfully completed was SMA (High School). Before getting married, he worked as a restaurant manager owned by his family and after marriage he was no longer the manager of a food stall because he had to follow his husband. The informant, Mr. lives in the East Surabaya area.
5. The informant with the code *Is*, is a career woman who is 47 years old, has a D-3 education, has 3 sons and a daughter. Since before getting married to having three children, Is has had a career in a private company. *Is* marriage age until it has reached 19 years. The informant *Is* lives in the North Surabaya area.
6. Informant Ms., is a housewife who is 50 years old, has a junior high school education, has 3 children with a marriage age of 30 years. Her daily husband as a shoe sole repairman earns uncertain income, often not even enough for household needs. Informant Ms. lives in the North Surabaya area.

4.2 The Phenomenon of Muslim Household Financial Management in Surabaya

The phenomenon of trust in household financial management based on the results of this study is described into 3 sub-themes and each sub-theme produces 3 categories. The first sub-theme is about the phenomenon of trust that occurs in today's society in managing household finances, the second sub-theme is the phenomenon of financial management in the household, and the third sub-theme is the phenomenon of financial management in the household associated with blessings. Schematically, the second theme is shown in Table 2:

Table 2. A Phenomenon in Household Financial Management

Theme	Sub Theme	Category
Phenomenon in managing household finances	Society today	Not efficient
		Consumptive
		Problem
	Finance Management	Wife
		Husband
		Couple
	Relation to blessing and well-being	Don't be a burden to the environment
		Helping social interests
		The emergence of a sense of sincerity, gratitude, and trust
		Sincere intention for Allah

Source: Research finding.

4.2.1 The first sub-theme is about the phenomenon of today's society

The phenomenon in today's society in managing household finances is illustrated in 3 categories, namely the first category is inefficiency, the second category is consumptive and the third category is problematic. This can be seen from the interview transcript below*:*

1) The first sub-theme of category one is inefficient:

"In general, wives manage household finances in a reliable and responsible manner, but are not efficient in doing so.". "(Es, n.d.)

"Trust in the form of finance so far is still very problematic (problematic). It is still a problem because there is still a lot of insecurity in various forms, types and models."(Sos, n.d.)

2) The first sub-theme of the second category is consumptive:

"If I see they are not trustworthy because they are consumptive. What I said above things that are not important they buy they buy."(Ag1, n.d.)

"I always invite myself and my children to limit the desire for everything and put needs first"(Ir, n.d.)

3) The first sub-theme of the third category is problematic:

"I feel in today's society. can be classified into two, for the upper middle class is more concerned with lifestyle, so a woman has to work to fulfill that lifestyle, and this happened to me when I was still working in a private company. For the lower middle class, women working for a living are really meant to fulfill their daily needs."(Dn, n.d.)

"When I worked in a private company, my salary, which was relatively larger than my husband's, always ran out because it was to meet my needs, even though my husband fulfilled my household needs."(Dn, n.d.)

4.2.2 The Second Sub-theme is Financial Management in the Household

In the second sub-theme about who is the financial manager in a household, informants have different opinions; some mention their wives for cultural reasons, some say husbands for religious reasons, some say together, as quoted from the interview transcript below:

1) The second sub-theme, the first category is the wife:

"But actually, the mothers even manage the finances that are consumptive spending daily. In terms of religion, actually, in religion, there is no special verse that discusses managing finances. But the culture in Java is held by mothers, but this is limited to consumptive spending; if for productive spending, it is gentlemen, for example, if the purchase of land, even though the idea came from the mothers, but who manages the father (Husband)."(Ag2, n.d.)

"I manage my household finances,"(Ev, n.d.)

"I manage my household finances with the supervision of my husband."(Dn, n.d.)

"In my opinion, it is better if the household finance manager is the wife and husband together. However, the time allocation is divided by about 80 percent by the wife and 20 percent by the husband."(Es, n.d.)

"Ideally, the husband focuses on making a living, so the wife, who better understands the needs of the household and her children, can take the mandate to manage household finances."(Ag3, n.d.)

2) The second sub-theme, the second category, is husband:

"All my household needs are handled by my husband; I only know that I need to shop for daily meals."(Ir, n.d.)

"In my opinion, in a household where managing household finances is the husband. Then on a certain side entrusted to a wife."(Ag4, n.d.)

3) The second subtheme, the third category, is together:

"We both do financial management in our household, including daily household needs, and other unexpected needs."(Ev, n.d.)

"Husband and wife have the same obligations in the household, including in financial management."(Ag1, n.d.)

"It's really managed together. Since getting married, until Sakmeniko mboten wonten sing is covered up."(Nn, n.d.)

4.2.3 The Third Sub-theme is Relation to Blessing

The third sub-theme is about the relationship of trust in household financial management with blessings and welfare. Blessing will be achieved if in life there are four categories: the first category is that it will not be a burden to the environment, the second category is helping social interests, the third category is the emergence of sincerity, gratitude, trustworthiness and the fourth category is sincere intentions because of Allah SWT. Schematically seen in the snippet below.

1) The third sub-theme of the first category will not be a burden to the environment.

"Part of the blessing, then it doesn't become a burden for the environment: In the hadith, the characteristic of a blessed person is that where we are and the environment feels comfortable then it becomes a blessing, but on the other hand, if a community refuses it means it is not a blessing."(Ag2, n.d.)

2) The third sub-theme of the second category is helping social interests

"Blessings will arise to help social interests, philanthropic interests, that is the term by helping the construction of Islamic boarding schools, to help others."(Ag1, n.d.)

"I feel happy if I can give something to people who are under me economically, whether it's giving money or goods, because for me money is a deposit from God which will be accounted for in the afterlife."(Ir, n.d.)

3) The third sub-theme of the third category is the emergence of a sense of sincerity, gratitude and trust

"As promised by Allah SWT, if you are grateful, the blessings obtained by the household will be increased. This increase can be in quantity, quality, or both, so it can be said to bring or increase blessings to the household."(Es, n.d.)

"We always feel grateful under any circumstances, so that the children are also in good health, the household is also harmonious, this is a gift that is priceless."(Ev, n.d.)

"We are always grateful if our purchases are in accordance with Islamic rules."(Is, n.d.)

4) The third sub-theme of the fourth category is sincere intentions because of Allah

"Amanah itself is closely related to blessing. If we manage household finances honestly, strategically, with sincere intentions for the sake of Allah, then blessing is an integral part, insha Allah.."(Ag3, n.d.)

5. Interpretation and Discussion

The current state of society in managing household finances is formed from three categories, namely inefficient, consumptive and problematic. For the first category, there are informants who say that in general, wives manage household finances in a reliable and responsible manner, but have not been efficient in doing so. So even though a household has implemented reliable and responsible financial management, the phenomenon that exists in the community is that wives still cannot be efficient in carrying out household financial management.

Other experts in this study said that the current phenomenon is that many people are consumptive because many things that are not important are bought. There are even experts who say that the management of household finances in the community is currently problematic or problematic.

The research that is in line with the above results is that conducted by St. Marzuki (Nugraha, 2019). The results of his research indicate that the wife's behavior is extravagant and unable to manage finances, and the desire to shop excessively or large stakes from the spending is one of the causes of divorce. This is corroborated by the results of quantitative research, which states that 29% of wives dominate as shoppers and 43% of wives only as shoppers. This means that 72% of wives in households in the city of Surabaya are their household's financial shoppers. The husband as the household financial spender is only 1%, the rest is household financial expenditure jointly between husband and wife.

Other studies that are in line with the results of the research above are those conducted by Hakim et al (2014b). The results showed that one in four wives had good financial management, and one in ten wives had a high level of financial satisfaction. The wife's financial management and education have a significant positive effect on the wife's financial satisfaction. Knowledge of financial management needs to be given to families with low incomes and education to achieve financial satisfaction.

From the results of the discussion above, it can be said that the wife's knowledge of financial management is very relevant, and affects the level of attitude and financial management that the wife runs. Only a small number of wives have good financial management, so this is what causes inefficiency in household financial management. This is evident from the results of the 2019 National Financial Literacy Survey which shows that based on gender, the index of financial literacy and inclusion for women is 36.13% and 75.15% are still lower than the index for financial literacy and inclusion for men, which are 39, respectively, 94% and 77.24%.

From the statement above, it can be concluded that the phenomenon of household financial management in the midst of society is currently still problematic, namely the lack of efficiency marked by the size of the stake rather than the pole, high consumptive nature with spending without any priority.

5.1 Household Financial Manager

Qualitatively, household finance managers in this study were formed by three categories, namely wives, husbands and jointly between wives and husbands. Informants differ in their response to who should manage finances in a household. Only one expert said that the wife is the manager of household finances, when asked why, he then said that culture, especially in Indonesia and especially in Java, the wife is the manager of household finances, especially in the management of consumptive goods for daily use. day, if for goods that are large assets, such as land, then the husband is the one who manages the finances.

There is also an opinion from an expert who says that financial management in a household is the husband's responsibility. He said that in a household, managing household finances is the husband. Then, on a certain side entrusted to a wife. There are 3 (three) reasons for the husband to be the manager of household finances, namely: 1) First, it is the husband's mandate to get the money himself. 2) Second trust to spend it. 3) Both of them are very responsible for the husband's responsibility before Allah Ta'ala.

The majority of informants said that household financial management is a shared responsibility between husband and wife; it can't be just one thing, for example, the wife or husband. Several other informants said that 80% of the responsibility for household financial management rests with the wife and 20% only with the husband. The management of household finances is also inseparable from the needs of the family. Who is responsible for making a living? The informants differ in their response to it, the same opinion on the management of family finances above.

This is in accordance with research conducted by Jalil (2019) that financial management in the family is not seen from how small the income is received, but is seen from how the finances are managed properly in meeting family needs. Other research conducted by Trisnaningsih,(Trisnaningsih et al., 2010) said that women have multi-role jobs, apart from being educators for children, they also have to play a role in the division of expenditure, financial management, family accountants, to financial consultants for their husbands. From the information above, it can be concluded that anyone who manages family finances, be it a wife or husband or jointly is not an important problem that financial management is carried out properly and is trustworthy in meeting family needs.

The research target at the beginning of the qualitative phenomenological research in this study was Household as household finance managers. However, after undergoing the research process, it turned out that the research developed so that the problem was expanded and deepened. The initial target of Household as household finance managers changed to not only mothers or women as Household who became household financial managers but could be between mothers and fathers (husband and wife) or only fathers, so there were changes and improvements to the original title. Household turn into household finance managers.

The research target in the second stage with a quantitative approach is household finance managers, this follows the results of the research in the first stage because there are changing targets. Or adjust to the results in the first phase of research. Because this research is carried out sequentially, qualitative first then steps into quantitative or called sequential exploratory.

The results of quantitative research in the people of the city of Surabaya state that 63% of household financial management is mostly done jointly between the wife and husband. The domination of the wife as household finance manager is 30% and the husband's dominance is 6%.

5.2 The Relation of Amanah Phenomenon in Household Financial Management with Blessing

The third sub-theme is the phenomenon of trust associated with blessings, formed by four categories, namely not being a burden to the environment, helping social interests, the emergence of a sense of sincerity, gratitude, compassion and sincere intentions for Allah. Some experts in this study say that part of the blessing is that there is convenience, not to be a burden to the environment, and the person who is blessed is where they are, the surrounding environment will feel comfort that is a blessing, but if, on the contrary if a community or environment rejects us, it means it is not a blessing. Other experts say that blessing itself arises; it will help social interests, philanthropic interests, for example, to help build Islamic boarding schools, to help others, and others.

This is in accordance with research conducted by Nilawati (Nilawati, 2018), that the payment of zakat influences the blessing of business. The variable of merchant zakat payment has a significant effect on the business blessing product. From the information above, it can be said that zakat as a form of one of the existing philanthropy, can help social interests and can create blessings.

Experts also say that, as promised by Allah SWT, if you are grateful, the blessings obtained in the household will be increased. This increase can be in quantity, quality, or both, so it can be said to bring or increase blessings to the household. In addition, there are experts who say that trust itself is closely related to blessings. If we manage our household finances honestly, strategically, with sincere intentions for the sake of Allah, then blessing is an integral part, inshaAllah.

6. Conclusion

The current phenomenon of society in managing household finances is divided into three groups, namely:

1. The current state of society

When viewed from the current state of society, the phenomenon that occurs is that people in managing their household finances tend to have problems because they are inefficient and consumptive.

2. The role of financial managers

When viewed from the role of financial managers in the household, in the community, financial managers are divided into three: first, the wife, the second husband, and the third, together.

3. Its relationship with blessing and well-being
4. The phenomenon of financial management, when associated with blessing or the achievement of a financially blessed household, the criteria are:
    a. Don't be a burden to the environment
    b. Can help social interests
    c. The emergence of a sense of sincerity, gratitude, and trust
    d. Realization of sincere intentions because of Allah SWT

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Aditya, P. (2015). The Meaning of Blessings of Fortune for Muslim Laundry Entrepreneurs (Case Study at Lavender Laundry in Gubeng Kertajaya Surabaya). *JESTT (Jurnal Ekonomi Syariah Teori Dan Terapan)*, *2*(2), 179–195.

Ag1. (n.d.). Interview Date: March 2, 2021. [In Indonesian]

Ag2. (n.d.). Interview Date: March 9, 2021. [In Indonesian]

Ag3. (n.d.). Written Answer Date: March 8, 2021. [In Indonesian]

Ag4. (n.d.). Written Answer March 22, 2021. [In Indonesian]

Al-Bukhari, M. B. I. (2010). *Shahih Bukhari (E-Book Version)*. Retrieved from https://www.ibnumajjah.com.

Antonio, M. S. (2013). *Ensiklopedia: Prophetik Leadership & Management Wisdom, Amanah Inter-Personal Capital (Inside the Success of Muhammad SAW)*. Jakarta: Tazkia Publishing.

Assyakurrohim, D., Ikhram, D., Sirodj, R. A., & Afgani, M. W. (2022). Case Study Method in Qualitative Research. *Jurnal Pendidikan Sains Dan Komputer*, *3*(01), 1–9.

Bafdi, M. A. (2008). The Meaning of Blessing. *Almanhaj*. Retrieved from https://almanhaj.or.id/3723-agar-rizki-mendapat-keberkahan.html.

Burgoyne, C. (1990). Money in Marriage: How Patterns of Allocation Both Reflect and Conceal Power. *Sociological Review*, *38*. Retrieved from https://journals.sagepub.com/doi/10.1111/j.1467-954X.1990.tb00933.x.

Creswell, J. (2006). Five Qualitative Approaches to Inquiry. In *Qualitative Inquiry and Research Design*.

Robin, C. (2003). New Direction in Classic Maya Household. *Journal of Archeological Research*, *1*(1), 307–358. Retrieved from https://www.scholars.northwestern.edu/en/publications/new-directions-in-classic-maya-household-archaeology.

Depag. (2007). Miracle the Reference, Syaamil Al-Qur'an.

Departemen Agama. (2007). *Syamil Al-Qur'an*. [In Indonesian]. Retrieved from https://kemenag.go.id/.

Dn. (n.d.). Interview Date: 23 April 2021. [In Indonesian]

Dwiastanti, A. (2018). Financial Knowledge to Shape Family Financial Behavior (Case Study of Housewives in Malang City). *Jurnal Pengembangan Humaniora*, *23*(1411), 1–15. [In Indonesian]

Endrianti, R. D., & Laila, N. (2016). Islamic Family Financial Management in Muslim Families of Padang and Makassar Ethnicities in Surabaya. *Jurnal Ekonomi Syariah Teori Dan Terapan*. [In Indonesian]

Es. (n.d.). Written Answer Date: March 1, 2021. [In Indonesian]

Ev. (n.d.). Interview February 22, 2021. [In Indonesian]

Farchanti, D. F. (2017). Studi Perbandingan Penafsiran Berkah dalam Tafsir al-Qurthubi dan Ibn Katsir. In *IIQ Jakarta*.

Fred van Raaij, W., Antonides, G., & Manon de Groot, I. (2020). The Benefits of Joint and Separate Financial Management of Couples. *Journal of Economic Psychology*, *80*(August), 1–11. Retrieved from https://doi.org/10.1016/j.joep.2020.102313.

Freepik. (2021). The Key to a Blessed Life. *Kumparan*. Retrieved from https://kumparan.com/berita-hari-ini/kunci-hidup-berkah-4-hal-yang-wajib-diterapkan-umat-muslim.

Hakim, F. A., Sunarti, E., & Herawati, T. (2014a). Families with Working Husband and Wife: Financial Management and Wife's Financial Satisfaction of Dual Earner Families Abstract. *Ilm. Kel. & Kons*, *7*(3), 174–182. Retrieved from https://journal.ipb.ac.id/index.php/jikk/article/download/10010/7829.

Hakim, F. A., Sunarti, E., & Herawati, T. (2014b). Financial Management and Wives' Financial Satisfaction in Families Where Both Husband and Wife Work. *Ilm.Kel. & Kons*, *7*(3), 174–182. [In Indonesian].

Hatidjah, S., Sulfaidah, & Musdalifah. (2017). Analysis of Household Financial Management Strategies in Makassar City. *Journal Economix*, *8*(2), 83–103. [In Indonesian].

Husserl, E. (1971). *The Idea of Phenomenology*. Springer Belanda. Retrieved from https://doi.org/10.1007/978-94-010-2371-9.

Ir. (n.d.). Interview February 22, 2021. [In Indonesian]

Is. (n.d.). Interview February 27, 2021. [In Indonesian]

Jalil, A. (2019). Family Financial Management: A Solution for a Harmonious Family. *Al Maqashidi: Jurnal Hukum Islam Nusantara, 2*(1), 67-84. [In Indonesian]. Retrieved from https://ejournal.unzah.ac.id/index.php/assyariah/article/download/1921/1020.

Jappelli, T. (2010). Economic Literacy: An International Comparison. *Economic Journal*, *120*, 425–451. Retrieved from https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1468-0297.2010.02397.x.

Kiyosaki, R. T. (2018). *Rich Dad Poor Dad*. Jakarta: Gramedia Pustaka Utama.

Martha, E., & Kresno, S. (2016). *Qualitative research methods for the health sector*. Jakarta: Penerbit Rajawali Pers. [In Indonesian]

Muhammad, S. (2006). *Keberkahan Finansial Cara Mudah Mengelola Keuangan Dan Melipatgandakan Kekayaan Dengan Kecerdasan Spritual*. Retrieved from https://www.perpus.sman8jkt.sch.id/index.php?p=show_detail&id=5936&keywords=.

Muthohar, A. M. (2018). Analisis Indikator Keberkahan Berzakat bagi Muzaki di Jalur Joglosemar. *Ijtihad : Jurnal Wacana Hukum Islam Dan Kemanusiaan*, *17*(2), 217. Retrieved from https://doi.org/10.18326/ijtihad.v17i2.217-240.

Nasional, S. S. E. B. (2017). Konsep dan definisi. In *BPS RI*.

Nasution, J. (2017). Analysis of the Influence of Compliance in Paying Zakat on Blessings. *At-Tawassuth*, *II*(2), 282–303. Retrieved from https://www.researchgate.net/.

Nilawati. (2018). The Influence of Zakat Payments on Business Blessings. *I-Economic*, *4*(1), 1–17. [In Indonesian]

Nn. (n.d.). Interview February 29, 2021. [In Indonesian]

Nugraha, T. C. dan D. C. (2019). Sustainable Blessings in the Culinary Business Community: CDA. *Jurnal Kajian Peradaban Islam*, *2*(1), 29–35. Retrieved from https://doi.org/10.47076/jkpis.v2i1.22.

Overney, L. (2019). Women and money management: Problematising working-class subjectivities in French television programmes during and after the post-war boom. *Culture Unbound*, *11*(3–4), 443–465. Retrieved from https://doi.org/10.3384/CU.2000.1525.19V11A24.

Span, P. (2001). *Wealth Magic: From broke to multimillionaire in just 7 years*. Australia: HarperCollins Publishers.

Polit, D. F., Beck, C. T., & Hungler, B. P. (2004). Fundamentals of Nursing Research: Methods, Evaluation, and Utilization. In *Nursing Research Principles and Methods*. [In Portuguese]. Retrieved from https://www.scirp.org/reference/referencespapers?referenceid=1585829.

Raco, J. (2018). Qualitative Research Methods: Types, Characteristics, and Advantages. In C. R. Semiawan (Ed.), *Grasindo*. Retrieved from https://doi.org/10.31219/osf.io/mfzuj.

Rodrigues, S. P., Sousa, L., & Alarcão, M. M. (2016). Financial management in households experiencing long-term poverty: a comparison of perspectives from professionals and families in Portugal. *European Journal of Social Work*, *19*(6), 977–991. [In Portuguese]. Retrieved from https://doi.org/10.1080/13691457.2015.1032895.

Sos. (n.d.). Written Answers Date February 22, 2021. [In Indonesian]

Speziale, H. S., & Carpenter, D. R. (2003). Triangulation as a qualitative research strategy. In *Qualitative Research in Nursing: Advancing the Humanistic Imperative* (1–10).

Sugiyono. (2020). *Qualitative, Quantitative and Combination Research Methods (Mixed Methods)*. Jakarta: Alfabeta. [In Indonesian].

---------- (2013). *Qualitative Research Methods*. Jakarta: Alfabeta. [In Indonesian]

Trisnaningsih, S., Widyasari, F., & Timur, J. (2010). Family Finances of Housewives in the Siwalan Kerto Area of Surabaya. *Jurnal Strategi Akuntansi*, *2*(1990), 1–32. [In Indonesian].

Yunus, H. A. (2019). The Concept of a Rich and Blessed Life. *Jurnal MADINASIKA Manajemen Dan Keguruan*. [In Indonesian].

Cite this article: Latifah, L., Salim, L. A., Haqqi, A. R. A., & Siregar, H. (2025). A Phenomenological Study of Muslim Households in Surabaya City, Indonesia. *Iranian Economic Review, 29*(4), 1318-1341.

Iranian Economic Review, 29(4), 1342-1360
DOI: https://doi.org/10.22059/ier.2023.365556.1007812

RESEARCH PAPER

Does the Equity Premium Puzzle exist in Iran?

Sahar Zare Joneghani[a], Bahram Sahabi[*, a], Hassan Heydari[a], Mehdi Zolfaghari[a]

a. Faculty of Management and Economics, Tarbiat Modares University, Tehran, Iran.
* Corresponding author.

Received: 02 October 2023, Revised: 21 January 2023, Accepted: 15 February 2023, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
Investors decide on the type and amount of their investment by considering the two components of risk and return. In general, investing in risky and risk-free assets should be made according to their yield. The equity premium is obtained from the difference between the rate of return on risky and risk-free assets. In the theoretical literature, the failure of financial theory to explain the equity premium is known as the premium puzzle. In this context, the present study aims to empirically examine the equity premium puzzle in Iran for the quarterly period 1993–2021. Using the C-CAPM model, we obtained the value of the negative risk aversion coefficient, and it was outside the accepted range, which indicates the existence of the puzzle of equity premium in Iran. Indeed, it is not possible to justify a negative risk aversion coefficient in an economy where agents are concerned about their consumption flow. Considering this issue and in order to resolve this puzzle, we incorporated exogenous consumption habits in the C-CAPM model. This measure resulted in a relatively positive risk aversion coefficient within an acceptable range. Thus, we could resolve the equity premium puzzle by applying habits to the C-CAPM model.

Keywords: C-CAPM, Equity Premium Puzzle, Financial Markets, Habit of Consumption, Risk Aversion Coefficient.
JEL Classification: E2, G12, O16.

1. Introduction

One of the central issues in financial economics is the question of choosing intertemporal households and firms in relation to the allocation of their resources. Their choice is influenced by the two components of risk and return, and any trade-off between risk and return will offer different investment combinations. If decision-makers are risk-averse, in choosing their asset portfolio, they will need a higher rate of return for the risky asset than the risk-free asset. In recent years, stocks have become the most preferred asset by investors. Besides offering large profits, stock investment also has a risk factor that can occur at any time (Hersugondo et al., 2023). In case the risky asset is stocks, because shareholders' consumption is more volatile than that of risk-free asset holders, their consumption will be more related to excess returns in the stock market (Mena and Tirley, 2014). In the stock market, this additional return is described as equity premium or risk premium. Risk premium is obtained from the difference between the fixed rate of return of a risk-free asset and the rate of return of a risky asset.

In this article, following Keshavarz and Esfahani (2014), Safari and Erfani (2015), Donadelli and Prosperi (2011), and Mehra (2007), the average one-year and short-term bank deposit rates are considered as substitutes for risk-free asset rates, and stocks are considered as risky assets.

Figure (1) shows the quarterly trend of the rate of return on stocks and risk-free assets in the period 1993–2021.

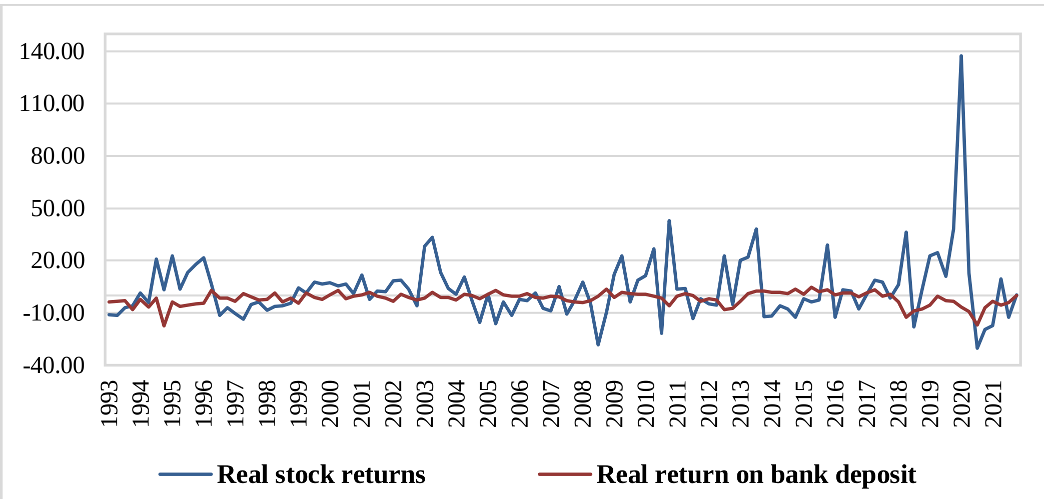


Figure 1. The Quarterly Trend of the Rate of Return on Stocks and Risk-Free Assets between 1993 and 2021

Source: Central Bank of Iran.

According to Figure (1), the real average rate of the risk-free asset is -1.78, and the real average of the stock return is 3.43. From the difference of these two rates, the real average of equity premium for Iran during the period under review will be 5.21%. It seems that with this amount of difference, more people should have been motivated to direct their capital toward the capital market and reduce the amount of their deposits with banks. But this is not what has transpired.

Polkonichenko (2004) showed that curbing participation in risk-free assets cannot guarantee a significant increase in risk-taking (cited in Mena and Tirley, 2014).

Tobin (1958) and Pratt (1964) were the first economists who investigated the relationship between market risk premium and investors' risk aversion. William Sharpe (1964) later introduced the capital asset pricing model (CAPM). These models all try to explain the stock market premium in such a way that the expected stock premium (excess of stock returns over risk-free asset returns) is proportional to the market's excess returns (the coefficient of this variable is called market beta).

The consumption-based capital asset pricing model (C-CAPM) is also a traditional model in which changes in stock returns are related to changes in consumption expenditures. These models were proposed two decades after the introduction of the basic model of capital asset pricing. Lucas (1978) and Breeden (1979) were the first to propose a consumption-based asset pricing model. In the C-CAPM model, the risk-averse person is faced with an important economic fluctuation, namely, consumption fluctuation. In this model, assets that have a positive correlation with consumption growth (i.e., have a negative correlation with the final utility of consumption) are less attractive. Therefore, it is not desirable to maintain such assets in times when the final utility of consumption is high. In such circumstances, risk-averse investors are willing to keep such assets only if the risk-reward of holding is higher than the rate of return on a risk-free asset (Radnia, 2016; Mehra, 2003).

In C-CAPM models, consumption expenditure is included as a risk factor; therefore, the expected stock premium changes with the covariance of stock returns and consumption. The coefficient of this variable is called relative risk aversion or consumption beta. In general, it is considered an investment model whose utility function is based on consumption, and the investor can exchange between risky assets (stocks) and risk-free assets to pay for goods and services.

What most studies and Mehra and Prescott (1985, 2003) have shown is that Strong risk aversion outside the range of 2 to 10 is unreasonable, because the household must be strictly risk-averse to match the observed high return with consumption behavior. This issue is known as the equity premium puzzle. Therefore, if a person is averse to consumption fluctuations, risky assets will pay high returns because the consumer is strongly risk-averse. The equity premium puzzle does not mean that equity returns are higher than risk-free asset returns.

Rather, it means stock returns are too high to be explained by fluctuations in real consumption growth. In other words, financial theory is not able to explain it.

Many studies have investigated the equity premium puzzle and have tried to solve it, but so far, no study has investigated the comparison of the equity premium puzzle in Iran with the two approaches of Mehra and Prescott, Campbell and Cochran, in two cases, without consumption habits and with consumption habits. With this view in this article, we are looking for an answer to the question, “Does the Equity Premium Puzzle exist in Iran? If yes, how can we solve it?”

The structure of the current research is as follows: In the second part, the concept of the Equity Premium Puzzle has been introduced using two methods, C-CAPM of Mehra and Prescott, and Campbell, and in the rest of this part, the empirical literature has been described. In the third part, Variables and descriptive statistics have been investigated, and the Equity Premium Puzzle in Iran has been investigated with Mehra and Prescott and Campbell and Cochran methods. The fourth part, by introducing consumption habits, mentions it as an approach to solve the Equity Premium Puzzle; this parameter was entered in the models of Mehra and Prescott, as well as Campbell and Cochran, and once again Equity Premium Puzzle has been re-examined with this approach. The fifth part is the conclusion of this study.

2. Equity Premium Puzzle

2.1 Equity Premium Puzzle and Mehra and Prescott's Standard Preference Function

Using the standard neoclassical consumption model based on intertemporal consumption optimization, Mehra and Prescott (1985) were the first to prove the existence of the equity premium puzzle. Modifying the model introduced by Lucas (1978), they presented the function of household preferences on the path of random consumption as follows:

$$E_0[\sum_{t=0}^{\infty} \beta^t U(C_t)] \quad . \quad 0 < \beta < 1 \tag{1}$$

where c_t is the growth rate of per capita consumption and β is the mental time discount rate that shows the household's tolerance for consumption. If β is small, it means that people are very intolerant to consumption and have strong preferences for present consumption as opposed to future consumption. E_0 is the operator of conditional expectations on the set of information available at zero time (present time). The utility function of constant relative risk aversion (CRRA) is presented as follows:

$$U(C.\alpha) = \frac{C^{1-\alpha}-1}{1-\alpha} \quad , \; 0 < \alpha < \infty \tag{2}$$

The parameter α calculates the reverse of the elasticity of substitution of consumption or the relative risk aversion coefficient (Mehra and Prescott, 1985).

Suppose that y_t is the dividend of the productive unit, and a share is exchanged at the price of p_t per unit of consumption. If the consumer decides to postpone their consumption to the next period, it will cause a loss in their current utility. Therefore, it compensates for the loss by discounting the expected utility from consumption in the next period, which is obtained from the purchase of an additional unit of stock in the current period. The amount of loss in the utility function is equal to $P_t\acute{U}(c_t)$. By selling the additional unit of the share in the next period, the amount of $p_{t+1}+y_{t+1}$ additional unit can be consumed. Therefore, the expected value of the utility function in the next period is equal to $\beta Et[(p_{t+1}+y_{t+1})\acute{U}(c_{t+1})]$; these values should be equal to each other. The result of this equality is the basis of the asset pricing relationship (Mehra, 2003):

$$P_t\acute{U}(C_t) = \beta Et\left[(p_{t+1} + y_{t+1})\acute{U}(C_{t+1})\right] \tag{3}$$

The above equation for risky assets and risk-free assets is presented as follows:

$$1 = \beta E_t\left[\frac{\acute{U}c_{t+1}}{\acute{U}c_t} R_{e.t+1}\right] \tag{4}$$

$$1 = \beta E_t\left[\frac{\acute{U}c_{t+1}}{\acute{U}c_t} R_{f.t+1}\right] \tag{5}$$

where $R_{e,t+1}$ is the stock return rate and is equal to $\frac{(p_{t+1}+y_{t+1})}{p_t}$, $R_{f,t+1}$ is the net risk-free asset rate equal to $\frac{1}{q_t}$, and q_t is the price of the risk-free asset. Drawing on some algebraic relationships, one can show that the expected net return of stock assets is equal to:

$$E_t[R_{e.t+1}] = R_{f.t+1} + COV_t\{\frac{-(\acute{U}c_{t+1})}{E_t(\acute{U}c_{t+1})} R_{e.t+1}\} \tag{6}$$

Equity premium is equal to $E_t(R_{e,t+1})-R_{f,t+1}$. According to the above equation, the expected stock returns are equal to the risk-free asset return plus the reward for risk tolerance. Here, risk depends on the covariance of asset returns and the marginal utility of consumption.

Mehra and Prescott (1985) estimated a US equity premium of 6%; however, the question is whether the covariance of asset returns and the marginal utility of consumption is high enough to explain the resulting equity premium?

To answer this question, Mehra and Prescott (1985) considered the following standard assumptions to calculate the equity premium:

- Consumption growth rate $x_{t+1}=\frac{Ct+1}{Ct}$ and the growth rate of dividends $z_{t+1}=\frac{yt+1}{yt}$ are identically and independently distributed (i.i.d);
- (xt, zt) are jointly lognormally distributed, so (x_t, $R_{e,t}$) will have a joint lognormal distribution. We assume a utility function with constant risk aversion (CRRA), substitute $\acute{U}(c_t) = c_t^{-\alpha}$ in the main pricing relationship, and then apply the following conditions:

$$\mu_X = E(lnx)\ ,\ \sigma_x^2 = var(lnx)\ ,\ \sigma_{x.z} = cov(lnx.lnz)\ ,\ R_f = \frac{1}{\beta e^{-\alpha\mu_x + 1/2\alpha^2(\sigma_x^2)}}$$

Consequently, we will have the following equations:

$$\text{Ln}R_f = -ln\beta + \alpha\mu_x - \frac{1}{2}\alpha^2\sigma_x^2$$

$$\ln E(R_e) - \ln R_f = \alpha\sigma_{x,z}\quad ,\quad \ln E(R_e) - \ln R_f = \alpha\ \sigma_{x,Re} \tag{7}$$

$$\sigma_{x\ ,\ Re} = \text{cov}(\ln x\ ,\ \ln R_e)$$

In this model, the equity premium is obtained by multiplying risk aversion and the covariance between the consumption growth rate and the asset return or dividend. In the case of equilibrium x=z, asset returns will be completely correlated with the consumption growth rate.

$$\ln E(R_e) - \ln (R_f) = \alpha\sigma_x^2 \tag{8}$$

$$\sigma_x^2 = Ln\left\{1 + \frac{var(x)}{[E(x)]^2}\right\} \tag{9}$$

$$\text{Ln}\ E(x) = \mu_x + \frac{1}{2}\sigma_x^2\ \ ,\ \ \mu_x = Ln\ E(x) - \frac{1}{2}\sigma_x^2$$

$$\alpha = \frac{\ln E(Re) - \ln (Rf)}{\sigma_x^2} \tag{10}$$

According to Equation (8), the equity premium is obtained by multiplying the risk aversion coefficient (α) and the variance of the consumption growth rate (σ_x^2).

Using the equations introduced above, Mehra and Prescott (1985) and Mehra (2003) set the value of the risk aversion coefficient to 10, the discount rate to 0.99, the risk-free asset rate to 12.7%, and the stock return to 14.1%. From the difference of these two rates, an equity premium equal to 1.4% was obtained, which was lower than the observed value of 6%. This is due to the existence of a puzzle that risk considerations alone cannot solve. In fact, Mehra and Prescott (1985) showed that if we replace the returns of risky and risk-free assets in the C-CAPM model according to historical data, the calculated risk aversion coefficient for people is higher than its normal value. The findings of most studies also support that in order to match the observed high return with consumption behavior, the household must be very risk-averse, yet extremely high risk aversion outside the range of 2–10 is unreasonable. In short, this situation is known as the equity premium puzzle (Aras, 2020). In this puzzle, a high equity premium leads to an unreasonable and high level of risk aversion among investors, which will affect the smoothing of consumption and precautionary savings of households.

2.2 Campbell's Equity Premium Puzzle Model

In the present paper, in addition to Mehra and Prescott (1985), we use Campbell's approach to the equity premium puzzle (1996; 2003). The representative agent's utility function that seeks to maximize utility is as follows:

$$Max\ E_t \sum_{j=0}^{\infty} \delta^j U(C_{t+j}) \tag{11}$$

where δ is the discount factor, C_{t+j} is the future consumption flow, and $U(C_{t+j})$ is the future consumption utility. The budget limit is as follows:

$$s.t:\ W_{t+1} = (W_t - C_t)(1 + R_{p.t}) \tag{12}$$

where W_t is wealth and $R_{p.t}$ is the return on financial assets (stocks). The representative agent maximizes utility according to their budget constraint. The first-order condition resulting from this action is Euler's equation of consumption, which explains the path of consumption and investment of the representative agent as follows:

$$\acute{U}(C_t) = \delta E_t\left[(1 + R_{i.t+1})\acute{U}(C_{t+1})\right] \tag{13}$$

$R_{i.t+1}$ represents the net returns of asset i. The representative agent considers the reduction of the current consumption equal to the increase in expected utility resulting from the discounted consumption of the next period. If the utility function is in the form of Equation (14), Euler's equation will be as Equation (15):

$$Max\ E_t \sum_{j=0}^{\infty} \delta^j \frac{C_{t+j}^{1-\alpha}}{1-\alpha} \tag{14}$$

$$1 = E_t[\delta(\frac{C_{t+1}}{C_t})^{-\alpha}(1 + R_{i.t+1})] \tag{15}$$

According to Campbell (1996), it is assumed that the joint distribution of stock returns and consumption growth rate is log-normal with time-varying volatility. Therefore, we get the following logarithm from Equation (15):

$$0 = E_t r_{i.t+1} + log\delta - \alpha E_t[\Delta c_{t+1}] + 0/5(h_{rt} + \alpha^2 h_{ct} + 2\alpha h_{r.c}) \tag{16}$$

$$E_t\left[r_{i.t+1} - r_{f.t+1}\right] + \frac{h_{rt}}{2} = \alpha h_{r.c} \tag{17}$$

The term on the right side of Equation (17) is the variance. According to this Equation, the equity premium is equal to the difference between the return on risk-free assets and the return on stocks. Also, the equity premium is equal to multiplying the relative risk aversion coefficient by the covariance of stock returns and the consumption growth rate. According to the existing theories, the relative risk aversion coefficient should be in the range of 2 to 10. According to the empirical observations of the equity premium, if the value of this coefficient is very high or outside the defined range, this coefficient will be unjustified and will indicate the existence of a puzzle.

2.3 Literature Review

Mohammadzadeh et al. (2016) proved the existence of a puzzle in the framework of C-CAPM for the period 1989–2013 in Iran, and reported a negative risk aversion coefficient. While pointing out the shortcomings of the C-CAPM model in that it only considers a linear relationship between consumption beta and asset returns, they adjusted the C-CAPM model by introducing savings into this model. Consequently, the risk aversion coefficient became positive and lay within the permissible range.

Erfani et al. (2016) investigated the puzzle of the stock exchange in Iran in the framework of two-variable GARCH and virtual fuzzy nested variable. They obtained the value of the relative risk aversion coefficient as -2.89. Stressing that the risk aversion coefficient is considered constant in the C-CAPM model, they used the fuzzy method to solve the equity premium puzzle and presented a model called CCAPM-F. While pointing out that relative risk aversion increases in a recession and decreases in a boom, they considered four periods by applying boom and bust periods to the capital market and the entire economy. Accordingly, consumption fluctuations in the economy and return fluctuations in the capital market (stocks) were examined under boom and recession conditions, and only two periods could adequately justify the puzzle of stocks with economic realities.

Constantinides (1990) was the first to use the idea of habit formation to justify the puzzle of the equity premium and presented his research using the terms of the continuous neoclassical growth model.

Brandt and Wang (2002) developed the asset pricing model based on consumption in the framework of habits, taking into account the change in risk aversion to inflation news, and the results of this study in the framework of the GMM estimator showed that risk aversion changes in response to inflation and equity premium increase.

Chen et al. (2018) in a research with a real business cycles model, investigated the fluctuations of asset prices and macro variables under high risk aversion. According to the results of this research, investment and production, high volatility, and consumption and risk-free rate of return have little volatility under high risk aversion in the real business cycle model.

3. Variables and descriptive statistics

3.1 Variables

In this article, we use the data and information available in the Central Bank of the Islamic Republic of Iran and the Tehran Stock Exchange. The data are quarterly and from the first quarter of 1993 to the fourth quarter of 2021. The first variable is the total price index of the Tehran securities market.

$$r_e = \frac{p_t - p_{t-1} + d_t}{p_{t-1}} \tag{18}$$

In Equation (18), p_t is the annual price index of common stocks, r_e is the growth rate of stock returns, and d_t is the distributed dividend of the stock. Since there are no reliable data on the dividends for the mentioned time period, the d_t amount was omitted (Erfani and Safari, 2016). It should be emphasized that the amount spent on shares would be higher than the equity premium of 5.21 if we considered dividends.

The second variable is the time series of household final consumption. The data of this variable were obtained from the Central Bank of Iran website every quarter.

The third variable is providing a suitable tool for the rate of return on risk-free assets *rf*. In the financial literature, in economies where there are no long-term treasury bonds, the current rate in the money market is used as the rate of risk-free assets (Keshavarz and Esfahani, 2013; Safari and Erfani, 2016; Donadelli and Prosperi, 2012; and Mehra, 2008). The present study uses the average one-year and short-term bank deposit rate as a proxy for the risk-free asset rate.

3.2 Descriptive Statistics of Variables

Descriptive statistics of the abovementioned variables are as follows:

Table 1. Descriptive Statistics of Variables

Variable name	Symbol	Average	Standard Deviation	Skewness	Kurtosis	Jarque-bera Probability
Real Stock Returns	re	3.43	18.75	3.34	23.84	(0.00)*
Real Growth Rate of Household Final Consumption	rc	0.84	3.78	0.25	6.15	(0.00)*
The Average Real Yield of a One-Year and Short-term Bank Deposit	rf	-1.77	3.72	-1.51	6.81	(0.00)*
Equity Premium	ep	5.21	19.46	3.41	23.88	(0.12)

Note: The sign (*) means the significance of the test.
Source: Research finding.

3.3 Equity Premium Puzzle in Iran

In this article, in order to investigate the equity premium puzzle in Iran, we drew on the C-CAPM model introduced by Mehra and Prescott (1985) and the study by Campbell and Cochran (1999). The results are as follows:

Table 2. Estimating the Equity Premium Puzzle in Iran

Method	The Coefficient Value
Mehra and Prescott (C-CAPM)	-0.25
Campbell and Cochrane	7.13

Source: Research finding.

According to the C-CAPM model proposed by Mehra and Prescott (1985), the estimation results in Iran show that the coefficient of relative risk aversion (α) is -0.25. Considering Mehra's study (2003), since the relative risk aversion coefficient is out of the permissible range, one is faced with an equity premium puzzle; Because A negative relative risk aversion coefficient is unreasonable in an economic model where people pay attention to their consumption flow. In fact, this finding in Iran shows that investors are risk-takers and tend to accept risk in the stock market. This is contrary to the findings of the C-CAPM model, which stipulates that people are risk-averse and desire to smooth consumption. This result is similar to Mohammadzadeh et al. (2016) and Erfani et al. (2016). Also, the estimation results show that the covariance between the consumption growth rate and the stock return rate is negative; This means that with the increase in stock returns, consumption decreases, so consumption fluctuations cannot explain the observed equity premium in the Tehran Stock market based on the quarterly average of 5.21% in the analyzed time period.

The results of the equity premium puzzle, according to the approach taken by Campbell and Cochrane, also show that the value of the coefficient η is greater than or equal to 7.13. When η is equal to 7.13, it is not a puzzle, but if this coefficient is more than 10, we are faced with an equity premium puzzle.

4. Habit Formation Models

When preferences entail habit formation, the present consumption will heighten the marginal utility of consumption in the next period. In such a way that, if an agent consumes more in a certain period, they will be even more passionate to consume in the following period. Meanwhile, in terms of durability, the current consumption provides utility for the following periods, such that as the household consumes more in the current period, it will need less to spend in the next period, so as to gradually smooth the marginal utility of consumption. In this situation, consumption goods could be substituted across contiguous periods (Uribe, 2002).

Menna and Tirelli (2014) stated that under normal conditions, consumption growth drives households to reduce their savings. But in the case of consumption habits and by taking into account the strong correlation between dividends and household consumption, fluctuations in consumption due to fluctuations in dividends increase precautionary savings and reduce the demand for bonds. As a result, the risk-free asset rate declines because the existence of consumption habits causes the marginal utility of consumption to increase, precautionary savings to grow, and the risk-free asset rate to decrease (Menna and Tirelli, 2014).

Models with the formation of habits are introduced in two ways: Models with endogenous habits and models with exogenous habits. In models with endogenous habits, the contribution of the human factor from these habits is a function of the entire history of its past consumption (Erfani et al., 2016). On the other hand, the models proposed by Pollack (1970) and Abel (1990) suggest that habits are determined exogenously. Some methods of modeling consumption habits are as follows:

$$u(0) = u\left(C_t . \bar{\mathrm{h}}\bar{\mathrm{C}}_{t-1}\right) \quad (19)$$

In the above relation, $\overline{C_{t-1}}$ is an exogenous factor and shows the average consumption level of the society in the previous period, $\bar{\mathrm{h}}$ measures the sensitivity to it. In equilibrium, we have C_t=$\bar{C}_{t-1}$, but it does not mean that the formation of exogenous or endogenous habits leads to equivalent pricing relations.

Following this study, we discuss exogenous consumption habits as an approach to solving the puzzle of the equity premium in Iran:

4.1 C-CAPM and the Framework of Consumption Habits

Accordingly, Constantine (1990) and Sun (1989), the utility function is not only a function of current consumption but also depends on past consumption due to incorporating the mechanism of habit formation; It is as follows:

$$U(c) = E_0[\sum_{t=0}^{\infty} \beta^t U(C_t - hC_{t-1})] \quad , \quad X_t = hc_{t-1} \tag{20}$$

where C_{t-1} is the consumption of the past period, X_t is exogenous consumption habits, and h shows the degree of dependence on consumption habits (0<h<1). In other words, it determines how much the consumer is willing to adjust their consumption level compared to the per capita consumption of the previous period. Due to the existence of habits, we have $C_t > C_{t-1}$. That is, at time t, household consumption must be h% larger than the average per capita consumption of the economy in period t-1. By entering the consumption habits in the C-CAPM model of Mehra and Prescott, we rewrite relations 3 to 6 as follows:

$$P_t \acute{U}_c(\mathrm{C_t} - \mathrm{X}_t) = \beta \mathrm{Et}[(\mathrm{p_{t+1}} + \mathrm{y_{t+1}})\acute{U}_c(\mathrm{C_{t+1}} - \mathrm{X}_{t+1})] \tag{21}$$

The above relationship is the relationship of asset pricing based on consumption habits, in which y_t is the dividend. Since the agent postpones consumption to the next period, this causes a loss in the current utility is equal to $P_t \acute{U}_c$ (C_t−X_t). By selling additional units of shares in the following period, the amount of p_{t+1}+y_{t+1} additional units can be consumed. Therefore, the expected value of the utility function in the next period is equal to $\beta E_t[\acute{U}_c(C_{t+1} - X_{t+1})(p_{t+1}+y_{t+1})]$.

Equation (21) can be reformulated for risky stocks and risk-free assets as Equations (22) and (23), respectively:

$$1=\beta E_t\left[\frac{\acute{U}_c(\mathrm{C_{t+1}}-\mathrm{H_{t+1}})}{\acute{U}_c(\mathrm{C_t}-\mathrm{H_t})} R_{e.t+1}\right] \quad . \quad R_{e.t+1} = \frac{\mathrm{p_{t+1}}+\mathrm{y_{t+1}}}{\mathrm{p_t}} \tag{22}$$

$$1=\beta E_t[\frac{\acute{U}_{C_t}(\mathrm{C_{t+1}}-\mathrm{H_{t+1}})}{\acute{U}_c(\mathrm{C_t}-\mathrm{H_t})} R_{f.t+1}] \tag{23}$$

where $R_{e.t+1}$ and $R_{f.t+1}$ are the real return rates of stock assets and risk-free assets. Again, Equations (22) and (23) can be presented as follows:

$$1=\beta E_t[\mathrm{M_{t+1}} \,.\, R_{e.t+1}] \quad . \quad R_{e.t+1} = \frac{\mathrm{p_{t+1}}+\mathrm{y_{t+1}}}{\mathrm{p_t}} \tag{24}$$

$$1=\beta E_t[\mathrm{M_{t+1}} \,.\, R_{f.t+1}] \tag{25}$$

$\mathrm{M_{t+1}}$ is the random discount factor**:**

$$M_{t.t+1} = \frac{\acute{U}_c(C_{t+1}-H_{t+1})}{\acute{U}_c(C_t-H_t)} = \boldsymbol{\delta}(\frac{C_{t+1}}{C_t})^{-\boldsymbol{\alpha}} (\frac{S_{t+1}}{S_t})^{-\alpha} = \boldsymbol{\delta}\,(\frac{C_{t+1}}{C_t})^{-\boldsymbol{\alpha}} (\frac{RRA_t}{RRA_{t+1}})^{-\alpha} \tag{26}$$

This definition (the stochastic discount factor) guarantees that the economy will be arbitrage-free and prices will be kept the same. Using algebraic relationships, the return on net assets is as follows:

$$E_t[r_{e.t+1}] = r_{f.t+1} - COV_t\{\frac{(m_{t+1}.r_{e.t+1})}{E_t(m_{t.t+1})}\} \tag{27}$$

where $E_t[r_{e.t+1}] - r_{f.t+1}$ is the equity premium.

4.2 The Mechanism of Campbell and Cochran's Model (1999)

Campbell and Cochran (1999), by introducing exogenous consumption habits in the utility function of constant relative risk aversion, assume that:

$$U(C_t - X_t) = \frac{(C_t - S_t)^{1-\gamma}}{1-\gamma} \text{ و } \eta = -\frac{C_t u_{cc}(C_t X_t)}{u_c(C_t X_t)} \tag{28}$$

So that C_t is factor consumption and $S_t = \left(\frac{C_t - X_t}{C_t}\right)$ is extra consumption habits. The agent's view is exogenous to S_t. They also assume that:

1. Consumption growth has a log-normal distribution:

$$\Delta C_{t+1} = logC_{t+1} - logC_t \equiv g + \tilde{v}_t \quad , \quad \tilde{v}_t \sim i.i.d.N(0, \sigma_V^2) \tag{29}$$

2. The logarithm of additional consumption (S_t) follows the log-normal distribution to be consistent with condition (1).

$$S_{t+1} = (1-\varphi)\bar{S} + \varphi S_t + \vartheta(S_t)(\Delta C_{t+1} - g) \tag{30}$$

φ and $\bar{S}$ and g are parameters, and $\vartheta(St)$ is the sensitivity function. The pricing core of time t and t+1 is as follows:

$$\begin{aligned} MRS_{t,t+1} &= \beta\frac{u_c(C_{t+1}, S_{t+1})}{u_c(C_t, S_t)} = \beta\left(\frac{C_{t+1}}{C_t}\frac{S_{t+1}}{S_t}\right)^{-\gamma} \\ &= \beta e^{-\gamma[(1-\varphi)(\bar{S}-S_t)+(1+\vartheta(S_t)\Delta C_{t+1}-\vartheta(S_t)g} \\ &= \beta e^{-\gamma[(1-\varphi)(\bar{S}-S_t)+(1+\vartheta(S_t)\tilde{v}_{t+1}} \end{aligned} \tag{31}$$

Under these characteristics, it is clear that the standard deviation of MRS and its correlation with the growth rate of consumption (both of which are important factors for the equity premium) will be determined by the shape of the sensitivity function. In the following, Campbell presents an assumption for the construction of the sensitivity function $\vartheta(S_t)$:

$$\vartheta(S_t) = \begin{cases} \frac{1}{s}\sqrt{1-2(\bar{S}-S_t)} - 1 \;, & S_t \leq \max S_{max} \\ 0 \;, & S_t \leq \max S_{max} \end{cases} \tag{32}$$

$$\bar{S} = \sigma\sqrt{\frac{\beta}{1} - \varphi} \quad , \; S_{max} = \bar{S} + \left(\frac{1}{2}\right)(1 - \bar{S}^{\,2}) \tag{33}$$

These relationships allow not only the formation of habits to reflect some key features of the data; they also produce a process of acceptable habits. Campbell and Cochran (1999) further introduced the following relationship to investigate the equity premium puzzle:

$$\frac{E(r_i)}{\sigma(r_i)} \leq \sqrt{e^{\eta^2\sigma^2} - 1} \approx \eta\sigma \quad (34)$$

In Equation (34), $\frac{E(r_i)}{\sigma(r_i)}$ is Sharpe ratio, $E(r_i)$ is average excess rate of return, $\sigma(r_i)$ is the standard deviation of the rate of excess return, and σ is Standard deviation of consumption growth rate; where $\eta < 2$, $\eta > 10$; there is mehra and Prescott's (1985) equity premium puzzle.

According to the study by Smets and Wouters (2007), the value of the habit parameter is 0.70. Considering this assumption, the results according to the models by Mehra and Prescott (1985) and Campbell and Cochran (1999) are as follows:

Table 3. Estimating the Equity Premium Puzzle in Iran with Consumption Habits

Method	The Coefficient Value
Mehra and Prescott (C-CAPM)	7.98
Campbell and Cochrane	2.00

Source: Research finding.

Following the study by Mehra and Prescott (1985) and Campbell and Cochrane (1999), the estimation results in Iran show that the value of the relative risk aversion coefficient (α) and (η) was positive 7.98 and 2.00, while considering consumption habits. Since this coefficient is in the permissible range of 2 to 10, it can be concluded that the consumption habits can solve the equity premium puzzle in Iran. Also, the estimation results show that the covariance between the consumption growth rate and stock return rate becomes positive while considering consumption habits. This means that with the increase in stock returns, consumption also increases. In order for risk-averse agents to be willing to hold stocks, they must receive a higher return due to accepting the risk of holding stocks. This is the equity premium. The existence of consumption habits causes economic factors to be risk-averse, refraining from a large reduction in consumption. The opposite of this also happens, so that consumption habits do not mean growth in consumption once and for all. Since the habit of increasing consumption will create the greater marginal utility consumption in the future than in the present, and agents will be stimulated to postpone current consumption for the future period; For this reason, agents will rationally seek to smooth consumption by creating a habit; therefore, according to observations, the existence of consumption habits in Iran causes that makes investors reasonably risk-averse; Since they do not like sudden changes in consumption, compensate these changes with changes in savings or deposits in the bank, which can affect the risk-free interest rate and the equity premium (5.21 percent) observed in the stock market should be explained; This is according to the findings of the C-CAPM model of Mehra and Prescott (1985), which states that people are risk averse and tend to smooth consumption.

Therefore, the risk aversion of agents and parameters of consumption habits in Iran can prevent the stagnation of other financial and investment markets in the country and affect the return of risk-free assets. Therefore, in addition to the parameter of risk aversion coefficient, policymakers should also pay attention to the parameter of consumption habits in the country. The figure below shows the growth rate of quarterly consumption under two states: with and without considering consumption habits.

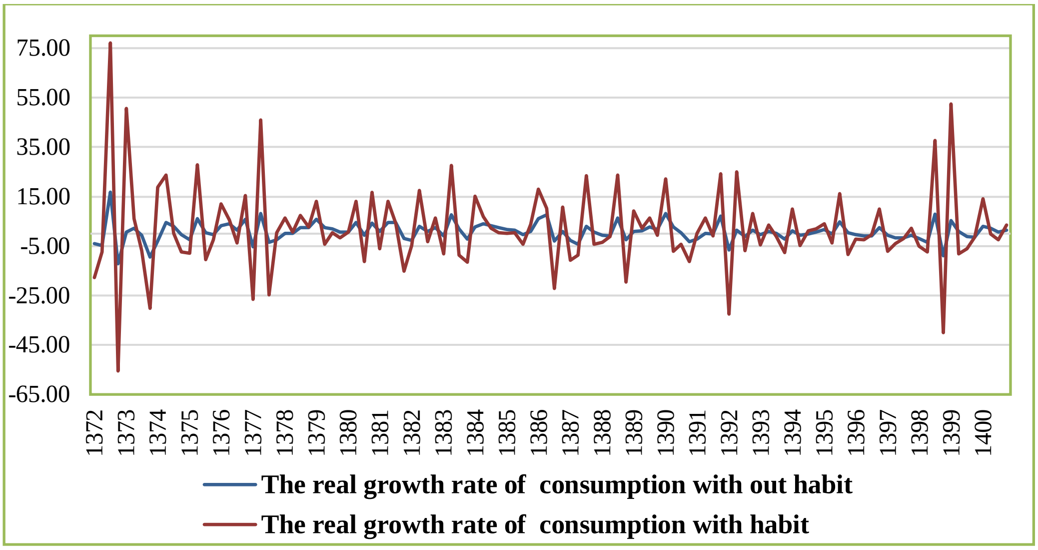


Figure 2. The Quarterly Trend of the Growth Rate of Consumption with and without Considering Consumption Habits in the Period 1993–2021

Source: Central Bank of Iran.

In Figure (2), consumption volatility in the state without habits is higher than when consumption habits are considered. Since the economy of Iran has been accompanied by economic fluctuations, the consumption of factors has also been affected by these fluctuations. During the recession in the economy and the stock market, agents' consumption is low, and they prefer to invest in risk-free bank deposits; in this case, they will need higher risk coverage to accept risk and invest in the stock market. On the contrary, in times of the boom in the economy and the stock market, they are willing to accept risk and invest in the stock market, and the equity premium will not be high compared to recession conditions.

5. Conclusion

The equity premium puzzle is one of the most famous puzzles that was first proposed by Mehra and Prescott (1985), who introduced the C-CAPM model in order to formulate the equity premium puzzle. In the C-CAPM model, consumption expenditure is considered a risk factor. So that the expected equity premium is correlated with the covariance of stock returns and consumption (the coefficient of this variable is called relative risk aversion or consumption beta). The value of the risk aversion coefficient in the C-CAPM model for Iran between 1993 and 2021 (quarterly) was -0.25. Since this coefficient is negative and outside the range proposed by Mehra and Prescott and other economic researchers (i.e., 2–10), the existence of the puzzle of equity premium in Iran is confirmed. This coefficient is unreasonable in an economic model where people are extremely cautious about their consumption flow, because the negative coefficient suggests that people are willing to accept risk in the stock market. In such conditions, the results showed that risk considerations are not able to explain the equity premium with a quarterly average of 5.21% that was observed in the Tehran market in the mentioned period.

Considering these points, we tried to resolve the equity premium puzzle in Iran by applying exogenous consumption habits (proposed by Constantinides (1990)) in the C-CAPM model. After the consumption habits were incorporated in the C-CAPM model of Mehra and Prescott, the value of the relative risk aversion coefficient was +7.98 (this coefficient is within the acceptable range and indicates that people are risk-averse). Thus, risk considerations were able to explain the equity premium in the Tehran market with a quarterly average of 5.21%. This model is based on the agents' strong aversion to high-frequency consumption fluctuations. In fact, the habit formation model illustrates the equity premium by showing extreme sensitivity to high-frequency fluctuations, and it is because of this sensitivity that one sees consumption fluctuations in the last 28 years in Iran.

References

Aras, A. (2020). Solution to the Equity Premium Puzzle. *Research of Financial Economic and Social Studies*, *7*(5), 612-631. Retrieved from https://dergipark.org.tr/en/download/article-file/2460315.

Constantinides, G. M. (1990). Habit Formation: A Resolution of the Equity Premium Puzzle. *Journal of Political Economy, 98*(3), 519-543. Retrieved from https://www.journals.uchicago.edu/doi/abs/10.1086/261693.

Campbell, J. Y. (2003). Consumption-Based Asset Pricing. In G. Constantinides, M. Harris, and R. Stulz (Ed.), *Handbook of the Economics of Finance* (803-887). Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S1574010203010227.

Campbell, J. Y., & Cochrane, J. H. (1999). By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior. *Journal of Political Economy*, *107*(2), 205–251. Retrieved from https://www.journals.uchicago.edu/doi/abs/10.1086/250059.

Donadelli, M., & Prosperi, L. (2012). The Equity Premium Puzzle: Pitfalls in Estimating the Coefficient of Relative Risk Aversion. *Journal of Applied Finance & Banking*, *2*(2), 177-213. Retrieved from https://iris.unive.it/bitstream/10278/3703537/1/2012_04_JAFB_Pitfalls%20in%20Estimating%20the%20Coefficient%20of%20Relative%20Risk%20Aversion.pdf.

Erfani, A., & Safari, S. (2015). The puzzle of spending shares in the framework of habits model with fuzzy response functions: Evidence from Iran. *Scientific and Research Quarterly Journal of Financial Knowledge of Securities Analysis*, *11*(37), 73-89. Retrieved from https://sid.ir/paper/200227/en.

Erfani, A., Abu Noori, I., & Safari, S. (2016). *Investigating the Puzzle of Stock Exchange in Iran: Bivariate GARCH Framework and Fuzzy Nested Virtual Variables* (Doctoral Dissertation). Semnan University, Semnan. Retrieved from http://www.jik-ifea.ir/article_11000.html.

Hersugondo, H., Ghozali, I., Nasir, M., Trimono, T., & Idris, I. (2023). Upper Bounds of Stock Portfolio Investment Risk Using Value at Risk (Case Study of Indonesian Blue-Chip Stocks in 2022). *Iranian Economic Review*, *29*(3), 794-818. Retrieved from https://ier.ut.ac.ir/article_103893_80c0470df89a191a50929751d9a26621.pdf.

Keshavarz Haddad, G., & Esfahani, M. (2014). The mystery of spending shares in the Tehran Stock Exchange in the framework of random dominance tests. *Iranian Economic Research Quarterly*, *18*(56), 1-40. Retrieved from https://ijer.atu.ac.ir/article_95_fc7c85dca0ebe7c6716895217adc66f7.pdf.

Kashyap, R. (2018). Solving the Equity Risk Premium Puzzle and Inching Towards a Theory of Everything. *The Journal of Private Equity*, *21*(2), 45-63. Retrieved from https://doi.org/10.48550/arXiv.1604.04872.

Mohammadzadeh, A., Shahiki Tash, M. N., & Roshan, R. (2015). Adjustment of the Pricing Model of Consumption Capital Assets Based on the Marshallian Preferences Function (Case Study of Iran). *Economic Modeling Research Quarterly*, *7*(25), 7-42. Retrieved from https://jemr.khu.ac.ir/article-1-1242-en.html.

Lucas, R. E. (1978). Asset Prices in an Exchange Economy. *Econometrica, 46*(6), 1429–1445. Retrieved from https://www.jstor.org/stable/1913837.

Menna, L., & Tirelli, P. (2014). The Equity Premium in a DSGE Model with Limited Asset Market Participation. *University of Milan-Bicocca*, *Working Paper*, *286*, 1-47. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2456100.

Mehra, R., & Prescott, E. C. (2008). Non-risk-based explanations of the equity premium. In R. Mehra (Ed.), *Forthcoming in Handbook of the Equity Risk Premium*. Retrieved from https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e319506a84fd8145c427dfed28b316dfa0db91be.

Mehra, R., & Prescott, E. C. (2003). The equity premium in retrospect. In G. M. Constantinides, M. Harris, and R. Stulz (Ed.), *Handbook of the Economics of Finance*. Retrieved from https://www.academicwebpages.com/preview/mehra/pdf/epp_retrospect.pdf.

--------- (1985). The equity premium: a puzzle. *Journal of Monetary Economics*, *15*(2), 161-145. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/0304393285900613.

Odonoghue, T., & Somerville, J. (2018). Modeling Risk Aversion in Economics. *Journal of Economic Perspective*, *32*(2), 114-191. Retrieved from https://www.aeaweb.org/articles?id=10.1257/jep.32.2.91.

Pratt, J. W. (1964). Risk aversion in the small and in the large. *Econometrica*, *32*(½), 122-136. Retrieved from https://msuweb.montclair.edu/~lebelp/PrattRiskSmalllargeEC1964.pdf.

Rodnia, M. (2016). *Asset pricing model based on return utility functions, a case study of Iran's capital market* (Doctoral Dissertation). University of Sistan and Baluchistan, Sistan and Baluchistan. Retrieved from https://ijes.shirazu.ac.ir/article_4251.html.

Smets, F., & Wouters, R. (2007). Shocks and Frictions in US Business Cycles. *Working Paper Series*, *97*(3), 586-606. Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp722.pdf.

Tobin, J. (1958). Liquidity preference as behavior towards risk. *The Review of Economic Studies*, *25*(2), 65-86. Retrieved from https://academic.oup.com/restud/article-abstract/25/2/65/1550009.

Uribe, M. (2002). The Price–Consumption Puzzle of Currency Pegs. *Journal of Monetary Economics*, *49*(3), 533–569. Retrieved from https://www.columbia.edu/~mu2166/habit.pdf.

Weil, P. (1989). The Equity Premium Puzzle and the Risk-Free Rate Puzzle. *Journal of Monetary Economics*, *24*(3), 401-421. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/0304393289900287.

Cite this article: Zare Joneghani, S., Sahabi, B., Heydari, H., & Zolfaghari, M. (2025). Does the Equity Premium Puzzle exist in Iran? *Iranian Economic Review, 29*(4), 1342-1360.

Iranian Economic Review, 29(4), 1361-1376
DOI: https://doi.org/10.22059/ier.2024.360371.1007743

RESEARCH PAPER

The Profitability of Afghanistan's Coal Industry: An ARDL Analysis of the North Coal Enterprise

Abbas Erfan[a] , **Mohammad Fidakar**[b] , **Atefa Hussaini**[*,c]

a. North Coal Enterprise, Baghlan, Afghanistan.
b. Faculty of Economics, Emory University, Atlanta, Georgia.
c. Department of Economics, Baghlan University, Baghlan, Afghanistan.
* Corresponding author.

Received: 02 July 2023, Revised: 01 November 2023, Accepted: 26 November 2023, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

This study examines the determinants of profitability in the North Coal Enterprise (NCE), Afghanistan's only state-owned profit-generating company authorized to operate coal mines. Despite the partial privatization of several collieries, four major mines remain under NCE's management. Using annual data from 1989 to 2019 obtained from the Ministry of Industries and Mines and the Northern Coal Office, the study employs the ARDL model to estimate short- and long-term relationships between profitability (net profit-to-capital ratio), capital structure (debt-to-capital ratio), and liquidity (current ratio). The findings indicate that sales revenue has a positive long-term impact on profitability, while liquidity has a short-term positive influence. Conversely, capital structure shows a negative relationship with profitability. These results underscore the importance of sound financial management and effective liquidity control in maintaining NCE's profitability.

Keywords: ARDL, Coal Mining, Capital Structure, North Coal Enterprise, Profitability.
JEL Classification: C32, E22, G32, L32, L72, M11.

1. Introduction

The reports from the World Bank demonstrate that Coal mining, as an important production staple, is highly lucrative, whether for internal consumption or exports. As of 2017, 1.2 million tons were exported annually, and 2.2 million tons were produced for domestic use (DeWitt et al., 2021). However, coal production and consumption are being increased, especially in Asia, but overall, the world, hundreds of countries, cities, and businesses are trying to phase out of coal extraction or lending coal mining because of the decreasing coal-related impacts on health (Auger et al., 2021). For this purpose, as Ministry of Mining and Petroleum [MoMP] has provided some best international standards of environmental policies that are based on NEPA[1] and ANSA[2] (McMahon and Tracy, 2011; MoMP, 2011).

The Ministry of Mines and Petroleum of Afghanistan has reported that there are 847 million tons of coal reserves among the 18 most important mines (Byrd and Noorani, 2017). According to a 2004 World Bank report, 6 out of 11 coal mines are the main coal sources in Afghanistan, located in Baghlan, Bamyan, and Nangarhar provinces (Evans, 2004).

According to the World Bank report, numerous companies with various organizations are putting efforts together to expand coal mining in Afghanistan, of which The North Coal Enterprise [NCE] is one of the largest scales (DeWitt et al., 2021). This enterprise is located beside the north-south highway in Baghalan province as a state-profit enterprise, established in 1971 by the name of "The Coal Mine Union" which included "Kargar and Dodkash" coal mines. Right after the Ashposhta and Dar-e-sof coal mines were discovered, the name was changed to The North Coal Enterprise (MoMP, 2019).

Since a political relation and a particular type of government ownership at the company are being considered as a competitive advantage as a political source, and its effect on the value of the company and profitability has always been shown by empirical research (Liu et al., 2018). Given that profit maximization is much complicated in governmental companies compared to private ones, the question is that does the profitability of a state-owned company whose product is made of perishable resources only depends on internal economic factors, or external economic variables should also be considered. A temporary stop or reduction in production because of structural change can be a strong reason for the high opportunity cost of mining production of the country (Shroder, 2019; Ludington et al., 2007). As well as the managerial and structural factors of the company, which can change profitability, should not be ignored. Hotelling's theory and its empirical research have greatly contributed to the exploitation and price[3] trends of perishable resources (Gaudet, 2007). The famous Hotelling law is the framework of the natural resources market and determines the path of the net price for finite resources, which can measure the current value of the capital according to the expected discount rate and as profit that can be obtained in the future according to

---

[1]. National Environmental Protection Agency

[2]. Afghanistan National Standards Authority

[3]. The coal supply of NCE is made according to the market demand, and the royalty rate is charged per ton of coal. The amount of royalties that have been paid to the government in the last four decades was 1,500 until 2017, and after this year, it was set at 2,500 Afghanis.

the market price of the resources (Ferreira da Cunha and Missemer, 2020). If the enterprise knows that the discount rate is higher than the net price in the future, it sees the profit in the sales of the mine as much as possible and continues mining until the final cost and the opportunity cost of mining are equal to the market price (Ali et al., 2012).

This study will assess the trend and effective factors of profitability during the four recent years for North Coal Enterprise. Given that different factors can contribute to increasing or decreasing the profitability of a state-owned company, considering the different leverages such as capital structure, liability, and annual sales, are aligned together to form the profitability function. To do so, a short introduction to the North Coal Enterprise, related literature reviews, the ARDL model, and findings are discussed, respectively, in this paper.

Profitability is the mirror and the final results of decisions and policies made in a company, which is calculated by two different methods, namely its sales (marginal gross profit) and capital. The second method can be measured by asset returns and stock returns (Aadel et al., 2012; Fajri and Surjandari, 2016; Hirdinis, 2019). A study defines profitability as the ability of a company to generate profit and design efficient actions in terms of using assets. On the other hand, Darabi and Baygi believe that companies can accelerate their expansion path by calculating profitability and providing strategic information (Baygi and Darabi, 2016).

Figure 1 shows the gross profit of the North Coal Enterprise for forty years. As can be seen, the 90s show a high growth rate compared to its previous decades. Historically, the exploitation of Afghanistan's mineral reserves in all these periods has faced two types of invasions, namely by the Soviet Union and the Taliban (Sheraz, 2014). Again, the prosperity and progress of resource processing are attributed to the attention and concentrated efforts of the United States (Shroder, 2019). In the early 60s and 70s, this administration realized with huge losses that, due to the lack of personnel and sufficient tact, it was also possible to compensate. It was not possible during that period. The trend of gross profit until the beginning of the 80s was very little, and sometimes was followed by negative growth. As it can be clearly seen, at the beginning of the republican period and the democratic system in the 80s, North Coal Company had a steep slope of marginal profit, and the most ups and downs period began with the transition to the 90s. Although the 90s do not have the upward trend of the 80s, there is an incomparable amount of opinion compared to other periods. If the maximum profit in 2013 was 201,025,865,1 Afghanis, but unfortunately, this figure reached 362,331,880 by

2018. The reason for the 80% decrease in the growth rate is due to the recent insecurity in the mining areas.

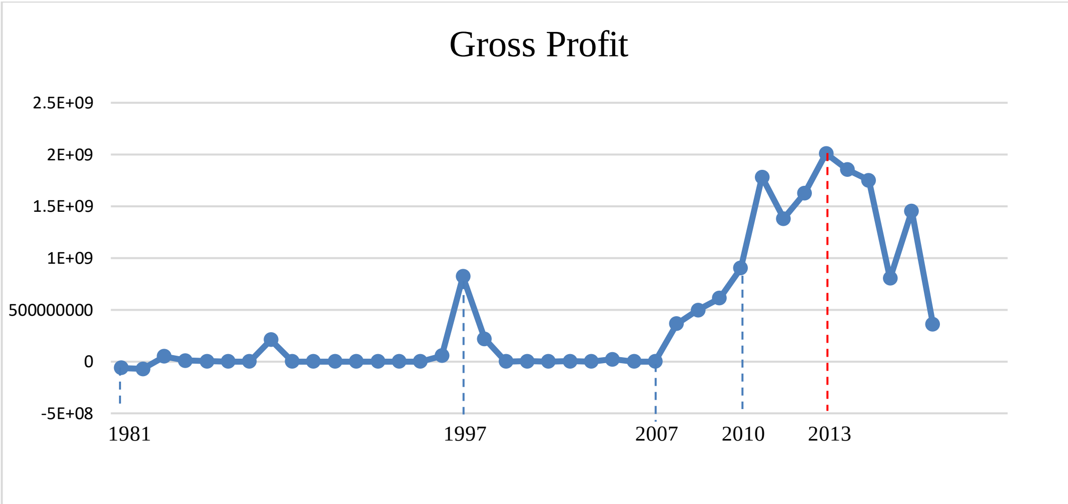


Figure 1. Gross Profit of NCE
Source: Research finding.

The capital structure and property of NCE are fully state-owned, which, as a government financial fund, can play a significant role in the economic growth of the country (Mohajerani et al., 2019). The third band of law of Afghanistan state-owned companies clearly states that state-owned companies are dependent on the stockholders, in which the government should have a share of at least 25 percent. In terms of institutional arrangements and order, the Ministry of Finance is the largest stockholder of state-owned companies (Law of State-Owned Companies, 2018). The NCE was under the control of the Ministry of Mines and Industries, but in the year 2016, this company was merged with the National Development Authority and came under the control of the presidency office (Renaud, 2020).

The theory of capital structure refers to estimating the combination and traits of capital used by a company (Brav, 2009). The capital structure is known as an important estimator of profitability in the world, and extensive studies are done in this field. Miller, he founder of financial leverage, with research and reforms on the causality of capital structure, stated that the tax savings can affect the value and function of a company due to the existence of interest rate (Miller, 1988). With increasing attention to this issue, the scientists realized that debt not only reduces the value of a company but also increases its costs of bankruptcy (Scott, 1976). Even so, some studies demonstrated that profitability is highly related to debt. This means that reaching a higher profitability is possible through higher debts (Adel et al., 2012).

Myers developed the Pecking Order theory by prioritizing financial resources from profit accumulation to debt and stock. Based on the symmetric information pattern, he believes that profitability of a company related to the debt financial pyramid negatively debt financial pyramid is negatively related to profitability of a company (Myers, 1984; Shaba et al., 2016) . With the existence of strong and rational theories in this field, Agency Theory, Asymmetric Information Theory, Signaling Theory, Stakeholders Theory, and Pecking Order Theory still hold complicated and weak observational data (Feld et al., 2013).

Barton, in his study of 1986, stated that there is no satisfying theory or study to show that capital structure and how it affects a company's performance has on profitability. In his next study in 1988 pointed out that the understanding and management of capital composition requires a managerial behavior theory and strategy. While senior managers at big companies prefer internal resources compared to external, including debt and stock, considering that the limitations of management authority in debt are greater than stock (Barton and Gordon, 1988).

Overall, public companies have greater resources and expenses compared to private companies, which this advantage led them to be a vital source of health and energy. However, in the context of agency theory, the conflict between economic and political goals is one of the challenges that increases the complexity of activities (Mohajerani et al., 2019). According to the agency theory, the managers, as the representatives of the owners, do not necessarily act in the interest of the owners (Bakhshi et al., 2019).

The management and ownership structure is more separated in state-owned companies compared to private companies. The managers at such companies are looking to increase stock values to reduce the control of stockholders over the company; this will eventually lead to lower conflict of interest, but instead, the higher stock value leads to a lower demand for stocks (Brav, 2009). Another study believes that centralized management and ownership are related to the level of control, which directly affects the dividend (Lemmon and Lins, 2003).

The debt share due to its high expenses is limited in both private and public domestic companies. Our interview and documents show that the NCE, as a state-owned enterprise, does not use any of the internal and external income sources of the government merely its current debts are due to the advances' accounts and some other debt items that form the capital structure of the enterprise (NCE, 2021). Given that research by Kieschnick and Moussawi (2018) found that the traits and size of a company can be effective on its capital structure. In general, public companies have different financial policies compared to private companies; as such, the degree of financial leverage in public companies is 50 percent lower, while the level of stocks is higher. However, Modigliani and Miller believe that the optimum capital is structured by debt, rather than stocks (Miller, 1988). As more debt in the company requires liquidity management, otherwise the risk of bankruptcy will increase. As a result, to identify the important and effective factors and the correct financial management of this company, the relationship between capital structure, liquidity, and profitability has been investigated.

2. Methods and Materials

Profitability is the most important index of financial decision-making in manufacturing companies, which determines the permanency trend and closing points (The Law of State-owned Companies, 2018). Without loss of generality, it is accepted that the capital structure, level of expenses, sales revenue, and management system are the effective factors of profitability (Brav, 2009). Taking advantage of the function modeled by Amarjit Gill (2011) and Nur Aqilah (2014). This research is looking for the answer to whether financial leverage, sales, and liquidity can affect the profitability of the enterprise or not.

The function for short is:

$$\overbrace{Roi}^{\text{dependent variable}} \quad = \quad \overbrace{Cs, Cr, Lsale}^{Explanatory\ variables} \tag{1}$$

where Roi, Cs, Cr, and Lsale stand for Profitability, Capital Structure, Level of Liquidity, and Sales Revenue, respectively. Roi, the return on investment, is a dependent variable that is the outcome of gross profit over total capital. It indicates the amount of annual gross profit of the enterprise. We used gross profit variable (without tax expense) because we believe that the level of taxes is not related to capital expenses or the interest rate. Cs shows the effect of financial leverage on the capital structures of the enterprise. We considered the current debts or advance payments registered in the balance sheet because no external debt has been used by the enterprise so far. Truly, the financial leverage of the enterprise is the ratio of debt to total assets. Liquidity is the current ratio, which comes from the ratio of current assets to current debt. Lsale is the log point of the annual Sales Revenue, as an independent variable included in logarithmic order. Our statistical model is designed as follows:

$$\mathrm{Roi}_t = \beta_0 + \beta_1 cs_t + \beta_2 \mathrm{Cr}_t + \beta_4 lnsale_t + u_t$$

where u_t is error, t stands for time, and *ln* is the natural logarithm. Logarithm is considered for heteroscedasticity and reduces the gap among variables (Frimpong and Marbuah, 2010). β_i is the coefficient of parameters that shows the constant tensions.

3. Results and Discussion

This study aims to evaluate the 38 years' experience of the NCE from 1981 to 2019 using Eviews. Since the statistical information of manufacturing and service companies, including North Coal Enterprises in Afghanistan, is not available to the public, therefore, it was possible to use the data through administrative and official correspondence. Therefore, the estimated statistics have been collected from the Directorate of Tenure of the Ministry of Mines and Industries. According to the time series data available in this tenure. We applied the ARDL[1] econometric model to find and analyze the dynamic effect of each factor on the dependent variable. This model is developed by Psarian et al. (Sari et al., 2008), which can help us find the Co-integration and the long-term and short-term relationship between variables. This estimation model is applied in three stages, namely the Unit Root Test, Optimal lag distribution, and Co-integration Test to determine the relationships, and applying the Bound, ECM, or VECM[2] Testing methods to adjust and correct the errors. All stages are discussed in detail as follows.

3.1 Unit Root Test

We use this test to make sure that the ARDL model works best when the dependent variable does not possess a unit root (Suri, 2012). Unit Root Test in the ARDL model can find the relationship among different variables in I(0), I(1), or a combination of both levels. However, this way, the Co-integration test comes to a questionable end. Looking at Table 1, we realize that the null hypothesis of the ADF test statistic demonstrates that the dependent variable and Cr have a unit root, and capital structure and Lsale are stationary.

[1]. Autoregressive Distributed Lag

[2]. Error Correction Model and Vector-autoregressive Error Correction Model stand for one and more than one endogenous variable respectively.

Table 1. The Result of the Unit Root Test (ADF***)

Variable	At Level*	I(First difference)*
Roi**	-0.515130	-3.503408
Cs**	-3.707799	-
Cr**	-1.227253	-4.885652
Lsale**	-2.840325	-

Source: Research finding.

Note: *Indicates (5%) level of Significance, respectively, ** Roi for Profitability, CS for capital structure, Cr for current ratio, Lsale for log sales revenue. *** ADF for Augmented Dicky-Fuller.

Thus, the nonstationary variables integrated at their first difference, it is possible to use the ARDL model by considering the above. ARDL dynamic model with Schwartz criterion and automatic optimal lag length, as Table 2 shows that the dependent variable of the model (profitability) and capital structure with one lag, liquidity current ratio with two lags, and the logarithm of sales are as holding size at the level. From the estimation of the model, it can be explained that all the variables of the dynamic model, except the capital structure at the level, are all significant.

Table 2. The Dynamic Result of ARDL (1,1,2,0)

Regressor	Coefficient	Std. Error	t- Statistic
C(intercept)	-0.119567	0.101262	-1.180760
Roi(-1)	0.730166	0.139553	5.232164
Cs	-0.084434	0.119996	-0.703641
Cs(-1)	-0.185265	0.090775	-2.040919
Cr	-0.022125	0.004245	-5.212542
Cr(-1)	0.030056	0.005836	5.150325
Cr(-2)	-0.023236	0.004101	-5.665792
LSale	0.018866	0.007927	2.379768

Source: Research finding.

Note: * Indicates (5%) level of Significance, respectively.

The estimation results show that the amount of profitability with a period of interruption and the sales-income of the enterprise at the level can have a direct impact on the profitability process. Also, liquidity with two lag periods can affect profitability. Based on the dynamic model of the variables, the relationship of the equation can be written as follows:

$$Roi = \propto_0 + \sum_{i=1}^{p} \beta_i Roi_{t-i} + \sum_{j=0}^{q} \gamma_i Cs_{j-1} + \sum_{k=0}^{\mathrm{h}} \varphi_i \mathrm{Cr}_{k-1} + \delta_3 lnsale_t + u_t \tag{3}$$

In the above equation, p, q, and h are the optimal lag lengths of profitability, capital structure, and liquidity variables, respectively. On the other hand, Table 3 tests of autocorrelation, variance, heterogeneity, and normality of the dynamic model, which in fact have provided and established the classical assumptions. By rejecting the existence of collinearity and variance of heterogeneity and, of course, the existence of normality of disturbance components, it can be clearly stated that the short-term model can correctly address the research question.

Table 3. Diagnostic Tests (Classic Assumptions)

Result	F test	Test
No homogenous variance	0.1087	Heteroskedasticity (ARCH)
No collinearity	0.8835	Autocorrelation (LM test)
Existence of normality	1.585915	Normality Test

Source: Research finding.

3.2 Co-integration Test

Based on Table 1, the unit root test, some of the variables are not stationary. Therefore, the linear regression of variables with different roots will lead to an error (Gujarati, 2022). The co-integration test is used to determine the long-term relationship. The estimated regression will be real and accurate if the test can confirm the coherence of all variables. This study, instead of Banerji, Donald, and Mister Test, uses the Bound Test.

Given that the ARDL model, conditional error correction regression includes the long-term and equilibrium relationships, therefore, our statistical model is designed to determine the relationship. Given that the F statistic in this test is 4.18, which is greater than the critical value I(1), so, the null hypothesis, which indicates no long-term relationship, is rejected with a 90% confidence level. Therefore, the lack of co-integration is rejected, meaning that there is a relationship between profitability and the expository factors.

Table 4. The Result of the ARDL *F*-Bounds Test for Cointegration

	Test Statistic	Value	K	Signif	I(0)	I(1)
F-Bounds Test	*F*-statistic	4.187912	3	10%	2.618	3.532
				5%	3.164	4.194
				1%	4.428	5.816

Source: Research finding.

3.3 Long-run and Short-run Estimation

According to Table 4a, the long-term relationship between dependent and independent variables has been confirmed, so we will estimate the long-term model and the error correction model reflected in Table 5:

Table 5. Long-run and Short-run Results of the ARDL Approach

A: long-run estimation				
Regressor	**Coefficient**	**Std. Error**	**t- Statistic**	**Prob**
C(intercept)	-0.443111*	0.349775	-1.266845	0.2164
Cs	-0.999500	0.317045	-3.152551	0.0041
Cr	-0.056721	0.031081	-1.824959**	0.0795
Lsale	0.069915	0.023590	2.963808	0.0064
B: Short-run estimation				
ECM_{t-131}*	“	“31”	-4.915387	0.0000
Cs	-0.084434	0.086033	-0.981415	0.3354
D(Cr)	-0.022125	0.003359	-6.58769	0.0000
D(Cr(-1))	0.023236	0.003452	6.731802	0.0000

Source: Research finding.
Note: *, ** indicates (5%) & (10%) level of Significance, respectively.

Table 5 demonstrates the long-term relationship or the equilibrium function of profitability. The first part of this table indicates the significance of all the estimated coefficients with a confidence level of 90%, but if we analyze the variable with a probability of 5%, then the variables of the capital structure and sales revenue of the enterprise can be considered to affect the dependent variable of the enterprise. As is evident, the results of the data are completely in accordance with the empirical and theoretical literature. The capital structure, as a financial leverage of the enterprise through increasing the share of debt, can have a negative effect on the profitability process, as it is evident that by changing (increasing) one unit of the capital structure, the profitability can decrease by 0.99 units in the long term. This type of finding can also be seen in research (Pham et al., 2022; Shubita and Alsawalhah, 2012). Sales revenue also has a direct effect, with an increase in revenue of one percent, profitability also increases by 0.0699 percent. This finding precisely conveys the concept that strengthening and specializing mining production and its optimal extraction through more use of technology and reducing expenses to increase sales income can be a significant contribution to the development of the usefulness and profitability of the enterprise (Bahman and Tehmineh; Fajri and Surjandari, 2016). The findings with a weak confidence level have shown that the reverse effect of liquidity is also predictable in such a way that an increase of one unit of liquidity can reduce 0.05 units of profitability. This result can also be found in similar results (Pham et al., 2022; Shubita and Alsawalhah, 2012).

Table 4 identifies the errors that deviated from the long-term trend in the short run. These errors are being fixed based on their coefficients with negative signs. As can be seen, the residual of the long-term regression with an interval has a negative coefficient and is quite significant, and it shows that the short-term model exponentially fills this gap with a value of 26% in each period and will be infinitely close to the long-term model. The short-run estimate reflects the important role of liquidity, which, after a period, can be recognized as the only effective factor that increases profitability. If an increase of one unit can have a positive effect of 0.02 units, but before this period, the current variable of liquidity has a negative effect on profitability.

4. Conclusion

Investigating the financial situation (profitability) of Afghanistan North Coal Company (the largest and only state-owned company in Afghanistan) is the aim of this research. The hypothesis of the research was that the capital structure, cash flows, and annual sales revenue have a positive relationship with the profitability of the enterprise. The estimation and analysis of the annual data for this company were done through the ARDL model and using Eviews software. The obtained results and estimates are in accordance with the theory, if in the short term there is no confirmed relationship between profitability and capital structure, and in the long term, it is in the opposite direction and reducing profitability. Liquidity also has different reactions in different periods of time. If the reported results show that the current ratio will have a negative effect in the current state and a positive effect in the previous period, and an opposite effect in the long term. This finding clearly shows that the cash flow of the enterprise cannot be the answer to the existing debts. At the same time, positive sales growth has been reported in different time periods. Due to the existing estimated gap and help to adjust it and still increase the profitability of some cases, it is recommended. Since profitability is also affected by the previous year's profitability, it is necessary to prevent losses and emphasize maintaining and strengthening the company's profitability as a financial basis. On the other hand, the proper capital structure in the enterprise is considered a necessity of financing to avoid possible deficits. This study is limited to only one state-owned company, although with a long tradition, but an inappropriate capital structure. Of course, many public and private companies with similar financial leverage characteristics will have almost the same results, and this research can be easily extended to them, but it is better to compare public and private companies in the form of a panel. It should be examined more closely.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Auger, T., Trüby, J., Balcombe, P., & Staffell, I. (2021). The future of coal investment, trade, and stranded assets. *Joule*, *5*(6), 1462-1484. Retrieved from https://www.cell.com/joule/fulltext/S2542-4351(21)00243-9?uuid=uuid%3A2d61f766-e17e-4985-aa45-0d2642053079.

Bakhshi, S., Piri, P., & Hiadari. M. (2019). The Effect of Ownership Structure (Government and Private) on the Relationship between the Quality of Disclosure and the Cost of Capital in Companies Listed on the Tehran Stock Exchange. *Journal of Empirical Studies in Financial Accounting*, *16*(62), 21-43. Retrieved from https://qjma.atu.ac.ir/article_10412_en.html.

Bani Mahd, B., & Baghbani, T. (2010). The effect of accounting conservatism, governmental ownership, firm size and financial leverage on unprofitability of companies. *Accounting and Auditing Review*, *16*(4). Retrieved from https://acctgrev.ut.ac.ir/article_20800_en.html?lang=fa.

Barton, S. L., & Gordon, P. J. (1988). Corporate Strategy and Capital Structure. *Journal of Strategic Management*, *9*(6), 623-632. Retrieved from https://sms.onlinelibrary.wiley.com/doi/abs/10.1002/smj.4250090608.

Batrancea, I., Batrancea, L., Nichita, A., Gaban, L., Masca, E., & Moscviciov, A. (2019). An Econometric Approach on Production, Costs and Profit in Romanian Coal Mining Enterprises. *Journal of Economic Research-Ekonomska Istraživanja, 32*(1), 1019-1036. Retrieved from https://hrcak.srce.hr/228744.

Brav, O. (2009). Access to Capital, Capital Structure, and the Funding of the Firm. *The Journal of Finance, 64*(1), 263-308. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-6261.2008.01434.x.

Byrd, W. A., & Noorani, J. (2017). Industrial-Scale Looting of Afghanistan's Mineral Resources: USIP. *Journal of Jstor*, Retrieved from http://www.jstor.com/stable/resrep12342.

DeWitt, J. D., Sunder, S., & Boston, K. M. (2021). Afghanistan Artisanal and Small-Scale Mining Sector. Delve: USGS. *Working Paper, 52*, Retrieved from https://pubs.usgs.gov/publication/70223206.PDF.

Emami Meybodi, A., Haqdost, E., & Pakdin, J. (2010). The Growth Sustainability Test on Unrecoverable Resources (Review of Hoteling Model) Case Study: OPEC Oil. *Journal of Iran Economic Studies, 14*(42), 149-167.

Evans, A. (2004). A Guide to Government in Afghanistan. *Working Paper*, Retrieved from http://hdl.handle.net/10986/14937.

Fajri, G. R., & Surjandari, D. A. (2016). The Influence of Profitability Ratios, Capital Structure and Shareholding Structure Against on Value Company (Empirical Study of Coal Mining Companies Listed on the Stock Exchange of Indonesia, Year 2011-2013). *Journal of Accounting, 1*(02), 57-68. Retrieved from file:///C:/Users/User/Downloads/33-61-2-PB%20(1).pdf.

Feld, L. P., Heckemeyer, J. H., & Overesch, M. (2013). Capital Structure Choice and Company Taxation: A Meta-Study. *Journal of Banking & Finance, 37*(8), 2850-2866. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S037842661300160X.

Ferreira da Cunha, R., & Missemer, A. (2020). The Hotelling Rule in Non-Renewable Resource Economics: A Reassessment. *Canadian Journal of Economics/Revue Canadienne d'Économique, 53*(2), 800-820. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/caje.12444.

Frimpong, J. M., & Marbuah, G. (2010). The Determinants of Private Sector Investment in Ghana: An ARDL Approach. *Journal of Social Sciences*, *15*(2), 250-261. Retrieved from https://d1wqtxts1xzle7.cloudfront.net/78545605/The_Determinants_of_Private_Sector_Inves20220112-22965-y6zz0h.pdf?1738465965=&response-content-disposition=inline%3B+filename%3DThe_determinants_of_private_sector_inves.pdf.

Gaudet, G. (2007). Natural Resource Economics Under the Rule of Hotelling. *Journal of Economics/Revue Canadienne d'Économique*, *40*(4), 1033-1059. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2966.2007.00441.x.

Gujarati, D. N. (2022). Basic Econometrics (1st Ed). Retrieved from https://books.google.com/books?hl=en&lr=&id=2CI_EAAAQBAJ&oi=fnd&pg=PA9&dq=Gujarati,+D.+N.+(2022).+&ots=byMyb8hr_j&sig=kUHOa58GTrbaD41SraGdCnF3bx8#v=onepage&q&f=false.

Habibzadeh Baygi, S. J., & Darabi, R. (2016). The Role of Government Ownership on the Financial and Economic Measures of Firm Performance Using Fuzzy Regression. *Journal of Government Accounting*, *3*(1), 9-20. Retrieved from https://gaa.journals.pnu.ac.ir/article_3620_en.html?lang=fa.

Hirdinis, M. (2019). Capital Structure and Firm Size on Firm Value Moderated by Profitability. *Journal of Economics & Business Administration*, *7*(1), 174-191. Retrieved from https://www.um.edu.mt/library/oar/handle/123456789/43966.

Kieschnick, R., & Moussawi, R. (2018). Firm Age, Corporate Governance, and Capital Structure Choices. *Journal of Corporate Finance*, *48*, 597-614. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S092911991730319X.

Lemmon, M. L., & Lins, K. V. (2003). Ownership Structure, Corporate Governance, and Firm Value: Evidence from the East Asian Financial Crisis. *Journal of Finance, 58*(4), 1445-1468. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/1540-6261.00573.

Liu, L., Liu, Q., Tian, G., & Wang, P. (2018). Government Connections and the Persistence of Profitability: Evidence From Chinese Listed Firms. *Journal of Emerging Markets Review, 36*, 110-129. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S156601411730167X.

Ludington, S., Orris, G. J., Bolm, K. S., Peters, S. G., & Team, A. (2007). Preliminary Mineral Resource Assessment of Selected Mineral Deposit Types in Afghanistan. *USGS, Working Paper, 1005*, 47. Retrieved from https://www.researchgate.net/publication/263350621pdf.

McMahon, G., & Tracy, B. (2011). The Afghanistan Mining Sector as a Driver of Sustainable Growth: Benefits and Opportunities for Large-Scale Mining. *Oil, Gas and Mining (SEGOM), Working Paper, 68259*. Retrieved from http://documents.worldbank.org/curated/en/792751467994662289/pdf.

Miller, M. H. (1988). The Modigliani-Miller Propositions After Thirty Years. *Journal of Economic Perspectives, 2*(4), 99-120. Retrieved from https://www.aeaweb.org/articles?id=10.1257/jep.2.4.99.

Mohajerani, A. A., Mashayekhi, A., & Talebian, M. (2019). Corporate governance in Iran: the case of state-owned enterprises. *Iranian Journal of Management Sciences*, *14*(53), 1-35. Retrieved from https://journal.iams.ir/article_305.html?lang=en.

Myers, S. C. (1984). Capital Structure Puzzle. *Journal of Finance, 39*(3), 575-592. Retrieved from https://www.nber.org/papers/w1393.

Pham, N. H., Hoang, T. M., & Pham, N. T. H. (2022). The Impact of Capital Structure on Bank Profitability: Evidence from Vietnam. *Journal of Cogent Business & Management, 9*(2096263), 1-25. Retrieved from https://www.tandfonline.com/doi/full/10.1080/23311975.2022.2096263.

Raymond, P. N. (1986). *Fundamentals of Managerial Finance*. Cincinnati, OH: South-Western Publishing Company.

Sari, R., Ewing, B. T., & Soytas, U. (2008). The Relationship Between Disaggregate Energy Consumption and Industrial Production in the United States: an ARDL approach. *Journal of Energy Economics, 30*(5), 2302-2313. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0140988307001326.

Scott Jr, J. H. (1976). A Theory of Optimal Capital Structure. *Journal of Economics, 7*(1), 33-54. Retrieved from https://www.jstor.org/stable/3003189.

Seydnourani, S. M. R., Amiri, H., & Mohamadian, A. (2012). The Causal Relationship Between Bank Capital and Profitability. *Journal of Economic Growth and Development Research, 2*(6), 11-44. Retrieved from https://www.sid.ir/paper/192055/en.

Shaba, Y., Yaaba, N., & Abubakar, I. (2016). Capital Structure and Profitability of Deposit Money Banks: Empirical Evidence from Nigeria. *European Journal of Business and Management, 8*(23), 110-121. Retrieved from https://www.academia.edu/download/98939833/234627454.pdf.

Sheraz, U. (2014). Afghanistan Mineral Resources and Implications on India's Future. *Futures, 56*, 94-97. Retrieved from https://www.sciencedirect.com/science/article/pii/S0016328713001365.

Shroder, J. F. (2019). *The USSR and Afghanistan Mineral Resources in International Minerals* (1st Ed.). New York: Routledge. Retrieved from https://www.taylorfrancis.com/chapters/edit/10.4324/9780429045264-6/afghanistan-mineral-resources-john-shroder.

Shubita, M. F., & Alsawalhah, J. M. (2012). The Relationship Between Capital Structure and Profitability. *Journal of Business and Social Science*, *3*(16), 104-112. Retrieved from https://www.academia.edu/download/36902181/out37.pdf.

Suri, A. (2012). *Econometrics With its Application in Eviews7* (6th Ed.). Tehran: Cultural Publishing.

Cite this article: Erfan, A., Fidakar, M., & Hussaini, A. (2025). Profitability of Afghanistan's Coal Industry: An ARDL Analysis of the North Coal Enterprise. *Iranian Economic Review*, *29*(4), 1361-1376.

Iranian Economic Review, 29(4), 1377-1399
DOI: https://doi.org/10.22059/ier.2024.368239.1007851

RESEARCH PAPER

Shariah Supervisory Board and Shariah Compliance Risk: Empirical Evidence from Indonesia

Hasan Mukhibad[*,a], **Muhammad Ihlashul'amal**[a], **Dwi Ratmono**[b], **Mitsalina Tantri**[b]

a. Department of Accounting, Faculty of Economics and Business, Universitas Negeri Semarang, Semarang, Indonesia.
b. Department of Accounting, Faculty of Economics and Business, Universitas Diponegoro, Semarang, Indonesia.
* Corresponding author.

Received: 19 November 2023, Revised: 03 January 2024, Accepted: 30 January 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
This study examines the effect of educational level, educational background in Shariah/Islamic law/Islamic law jurisprudence, cross-membership, and tenure of Shariah supervisory board (SSB) members, as well as market competition on Shariah compliance risk. The research sample is 14 full-fledged Islamic banks (IB) from Indonesia during the 2009-2020 observation period. The data analysis method uses panel data analysis with a fixed effect model or a random effect model with a robust standard error approach. We found that cross-membership, educational background, and tenure of SSB have a positive effect on Shariah compliance risk. Also, we show that banks that have high market power take high Shariah compliance risks. This study supports the upper echelons theory, overboarding hypothesis, human capital resource theory, and competition-fragility hypothesis in explaining the role of SSB on shariah compliance risk. This study is helpful for regulators and IB owners in determining the qualifications of SSB members, including education level, educational background, cross-membership, and tenure, because these SSB attributes affect the effectiveness of SSB in controlling shariah compliance risk.
Keywords: Competition-fragility Hypothesis, Experience, Knowledge, Shariah Compliance Risk, Shariah Supervisory Board.
JEL Classification : G4, G31, G32, M410.

1. Introduction

The study of Shariah compliance risk in Islamic banks (IB) is the main concern of researchers (Mukhibad et al., 2023). There are two main reasons for this statement. First, an IB was established to provide products and services that are Shariah-compliant (Aribi and Arun, 2015). Islamic law, as the basis for IB operations, prohibits transactions related to interest (*riba*), *gharar* (legal ambiguity or excessive risk), *maysir* (gambling), and providing financing or investment to companies producing/distributing haram products (alcohol, tobacco, etc.). This situation causes IB to have complex operations (Trinh et al., 2020) because IBs are required to provide a competitive return, shariah-compliant returns with current regulatory infrastructure tailored towards conventional banks (CB) operations (Safiullah and Shamsuddin, 2018).

Second, IBs face complex risks and tend to have more significant risks than CBs (Mukhibad and Setiawan, 2022). Investment instruments available in the market (i.e., derivatives, options, bonds) are not halal (Siddiqui, 2008). Meanwhile, IBs are facing demands from customers to be able to provide more competitive returns than CBs. This encouragement allows IBs to make non-halal investments to improve their performance.

Third, the risk study on IB by researchers focused more on general risks (risks that CBs also face), not related to unique IB operations, including credit, insolvency, liquidity, and market risk (Mukhibad and Setiawan, 2022; Mukhibad et al., 2022). The limited previous research on shariah compliance risk motivated Basiruddin and Ahmed (2019) and Mukhibad et al. (2022) to focus their studies on shariah compliance risk in IB.

In explaining the Shariah compliance risk, Basiruddin and Ahmed (2019) use the variable number of members, number of meetings, and compensation from the board of directors (BOD) and SSB. Their study found that IBs with small BOD members and a higher proportion of independent BOD members tend to have lower Shariah compliance risks. Meanwhile, financial expertise and a higher frequency of SSB meetings reduce shariah compliance risks (Basiruddin and Ahmed, 2019).

In the corporate governance structure of IB by regulators, the board responsible for ensuring that IB operates according to Shariah is the SSB (Nurkhin et al., 2018; Mukhibad et al., 2023). SSB is mandated to provide advice and recommendations to directors and supervise banking activities to comply with Shariah principles (Law of the Republic of Indonesia Number 21 of 2008). Moreover, the Accounting and Auditing Organization for Islamic Financial Institutions (AAOFI) states that the SSB is entrusted with directing, reviewing, and supervising Islamic financial institutions' activities. The fatwas (legal opinions) and board rulings need to be binding. Following Mukhibad et al. (2023) and Mukhibad et al. (2022), this study emphasizes the role of SSB attributes in reducing the shariah compliance risk. To explain the role of SSB, the evaluation of the individual characteristics of SSB is very substantial. The reason is that the individual characteristics of SSBs affect their effectiveness in carrying out their duties.

Mukhibad et al. (2023) use the number of members, educational level, cross-membership, expertise in finance/banking/accounting fields, and gender of SSB to explain the effectiveness of SSB. Mukhibad et al. (2022) added the factors of SSB experience and the educational background of SSB in Islamic law jurisprudence/shariah to explain the effect of SSB attributes on shariah compliance. Mukhibad et al. (2023) used a sample of 102 fully-fledged IBs from 27 countries. They reported that cross-membership and economic/finance/accounting expertise of SSB members had a positive impact on shariah compliance. However, the number of SSB members negatively influences Shariah compliance. Mukhibad et al. (2022) report that the number of SSB members has a positive effect on Shariah compliance. However, the SSB's educational background in Islamic law jurisprudence/shariah has a negative effect on shariah compliance.

The model developed by Mukhibad et al. (2023) and Mukhibad et al. (2022) explains the effect of SSB on shariah compliance, ignoring the market competition. Customers can choose bank products in a perfectly competitive market according to their preferences. IB operates to provide shariah-compliant banking products and services. However, IB customers tend to be rational-oriented and pay little attention to Shariah compliance when determining bank product choices. In addition, IB operates in a dual-banking system where IB and CB compete for the same market. Banks can act as price takers in this competition to maintain performance (Allen et al., 2000). Thus, competition affects bank credit risk-taking (Louhichi et al., 2019). Following Mukhibad et al. (2022), we add market competition factors using the Lerner index to the model to explain the effect of SSB attributes on shariah compliance risk.

In the board demographic study, board tenure may predict the effectiveness of its duties. The tenure of a firm's board is an aggregate measure and is a proxy for both the level of the board's specific firm knowledge as well as the extent of board independence (Valenti and Horner, 2020). SSB is a unique board on IB and a multi-layer board in IBs (Nomran and Haron, 2019). Therefore, evaluating the impact of tenure on board outcomes can also be applied to SSBs. The longer an SSB is on a firm's board, the more familiar SSB becomes with the resources and capabilities of the firm, and the better able SSB is to assess business decision-making and improve both the quality of counselors and monitoring mechanisms for directors. A long tenure of boards within a company will have higher business knowledge and be more likely to make effective decisions to raise firm performance (Reguera-Alvarado and Bravo, 2017).

On the contrary, long-tenured boards may become closer to directors, and as a result, the development of their tasks can be compromised (Vafeas, 2003). It may develop friendships with the directors, reducing board monitoring and the protection of shareholders' interests (Mollah et al., 2021). The importance of the role of board tenure, empirical evidence on SSB tenure, and firm outcomes is scarce. The second contribution of the study is to extend the literature that investigates the link between SSB tenure and Shariah compliance risk.

The rest of the paper proceeds as follows. The literature review and hypothesis development are introduced in Section 2. Section 3 provides the data, measurement variables, and data analysis methods. Section 4 presents the empirical results. Section 5 discusses, and Section 7 is the robustness test. The last section is a conclusion.

2. Literature Review

2.1 Shariah Compliance Risk

IBs differ from CBs in their functions, structure, objectives, principles, operations, and governance (Mukhibad et al., 2022). This difference is because IB uses shariah/Islamic law as the basis for bank operations. Shariah has to restrain IBs from all kinds of operations that involve *riba* (interest), *gharar* (excessive uncertainty), and *maysir* (gambling) (Tarique et al., 2021). Shariah/Islamic law also prohibits IB from providing financing to companies producing/distributing illicit products (alcohol, tobacco, etc.) (Ahmed, 2010). Thus, Shariah compliance is the main guarantee that directors must provide to stakeholders.

IB regulators appointed SSB as a multi-layer governance structure in IBs (Nomran and Haron, 2019). SSBs, besides the board of directors (BOD), work together to provide consulting and monitoring services to directors to carry out IB operations and contribute to the sustainability of stakeholders' interests. Law of the Republic of Indonesia number 21 of 2008 regulates the provisions regarding SSB as follows:

1. The IB must designate a person as a member of the SSB.
2. The SSB is appointed by shareholders' meetings on the recommendation of the Indonesian Ulema Council.
3. The SSB has the task of providing advice and suggestions to the directors and supervising the bank's activities so that they comply with shariah principles.

Abdul-Baki and Uthman (2017) state that the operation of IBs to provide shariah-compliant products faces major challenges along with a profit-oriented business environment. Studies from Ismal (2011) and Aysan et al. (2018) reinforce this argument because customers of IBs will withdraw their deposits if IBs do not receive income from their financing, the interest of CB increases, and the return for deposits decreases.

This challenge is getting more prominent because of customer demands for IBs to provide competitive returns for deposits, accompanied by investment instruments on the market suitable for CB (Mukhibad and Setiawan, 2022). IB cannot take advantage of investment instruments available on the market (i.e., derivatives, options, bonds) because these instruments are not halal (Siddiqui, 2008). IBs must adjust to comply with IBs' requirements to conduct law-abiding Islamic transactions (Safiullah and Shamsuddin, 2018). Thus, IB faces a high Shariah compliance risk.

2.2 Agency Conflict in Islamic Banks

Mukhibad et al. (2022) have developed a fourth type of agency conflict in IB. This conflict is produced from type 1 agency conflict, between agent and principal; the second type, between majority and minority owners; and the 3rd type, between the owner and the creditor. This agency conflict occurs because one party takes advantage of its power to enact policies that can enhance its own interests and endanger the interests of other parties. In agency conflict type 4, this conflict occurs if the IB director makes investments or product schemes with low Shariah compliance (Mukhibad et al., 2023). Zainuldin et al. (2018) state that IBs are also likely to encounter additional agency problems if, in any case, managers deviate from their duty to ensure shariah compliance on IB's transactions.

AAOIFI in governance standard number 1 states that the SSB is an independent board that directs, reviews, and supervises bank operations to comply with principles and Shariah law. The quality of supervision from the SSB is needed to reduce agency conflict. The role of SSB to reduce agency conflict is to certify (ex-ante) and monitor (ex-post) all financial contracts, transactions, and further activities of the bank on behalf of shareholders, stakeholders, and clients to ensure that the contract complies with Shariah (Alman, 2012). Researchers use various ways to prove the role of SSB in reducing agency conflict. Safiullah and Shamsuddin (2018) expand Shariah compliance indicators by avoiding the director's excessive risk policy. The results of their research found that supervision from SSB can avoid risks. Mukhibad et al. (2022) and Muhammad et al. (2021)

use the disclosure of annual reports as Shariah compliance and report that SSB influences accountability through increasing disclosure of annual reports.

2.3 Hypothesis Development

Evaluation of the effectiveness of SSB in carrying out the duty to ensure Shariah compliance on IB's transactions can be based on the individual characteristics of SSB members. One of SSB's individual characteristics and supporting IB operations according to Shariah is SSB's expertise in Shariah, which is the educational background of SSB members. Regulators require expertise in Shariah as the main requirement to become a member of the SSB. IB regulators in Indonesia issued Bank Indonesia regulation number 6/24/PBI/2004, stating that the requirement to become a member of the SSB is to have knowledge and experience in the shariah muamalah and expertise in the field of banking and or finance. However, this SSB capability indicator is not clearly regulated in this regulation. So, the Financial Services Authority requires a recommendation from the Indonesian Ulema Council as an indicator that SSB members know Shariah. However, Mukhibad et al. (2022) and Mukhibad et al. (2022) use the educational background in Islamic law/shariah/Islamic law jurisprudence as an indicator to measure SSB knowledge and expertise in Shariah. Academic background is an indicator of expertise because it follows the upper echelons theory that education is a good proxy for measuring knowledge (Hambrick and Mason, 1984).
H1: The educational background of Shariah/Islamic law/Islamic law jurisprudence of SSB members has a negative influence on the Shariah compliance risk.

The upper echelons theory was introduced by Hambrick and Mason (1984), stating that educational background may yield rich but complex information and indicate a person's knowledge and skill base (Hambrick and Mason, 1984). Based on the upper echelons theory, a highly educated management team is associated with a high predisposition for information processing and competence in strategic decision-making (Hambrick and Mason, 1984). The educational level is an intellectual competence and professionalism proxy (Mukhibad et al., 2022).

Darmadi (2013) proved the upper echelons theory by demonstrating the educational background of Chief Executive Officers (CEOs) on financial performance in 160 listed firms and found that the academic background of CEOs influences financial performance. Muhammad et al. (2021), using a sample of IBs in Asia and the Gulf Cooperation Countries (GCC), found that the educational level of SSB has a positive influence on shariah compliance.

H2: The educational level of SSB members has a negative influence on Shariah compliance risk.

Following Nomran et al. (2018) and Nomran et al. (2017), cross-membership is an indicator that can improve SSB abilities and expertise. Cross-*memberships* are SSB that sit on more than one board in other entities. Based on the Resources Dependence Theory (RDT), IB can connect with the external environment through the interlocks of SSB. This is because cross-membership can enable the SSB interlocks to monitor the external bank and disseminate information about these banks (Nomran et al., 2018). In addition, cross-membership allows SSB members to discuss with SSB members and directors of other banks, thereby increasing their knowledge and experience (Mukhibad and Setiawan, 2022). In addition, SSB interlocks generate a reputation effect because SSBs sitting with other IBs are considered to have extraordinary experience and capabilities to increase the performance of IBs. Some researchers claim that cross-memberships of the SSB members may have a positive impact on the board's performance (Alman, 2012), reducing risk (Mukhibad and Setiawan, 2022), improving the performance (Nomran et al., 2017), and enhancing shariah compliance (Mukhibad et al., 2023).
H3: Cross-membership of SSB members has a negative effect on Shariah compliance risk.

One of the most discussed issues in the CG studies is tenure, which implies that the SSB sits for a long time as a member of the board. Recent literature has led to two contradictory impacts of board tenure. First, board tenure enhances board experience and knowledge (Valenti and Horner, 2020), and they will be more likely to make effective decisions in order to raise firm performance (Reguera-Alvarado and Bravo, 2017). A longer tenure accords the board the advantage of experience within the bank, more profound business arguments and knowledge, and broader access to and networking with all the stakeholders (Wijayanti et al., 2020). This hypothesis supports the human capital resource theory that board tenure is likely to influence strategy and is critical to firm innovation (Valenti and Horner, 2020).

Second, board tenure increases the closeness of the board to the CEO, and this reduces board independence (Valenti and Horner, 2020) and, as a result, the development of their tasks can be compromised (Vafeas, 2003). The friendships among boards and directors have had an impact on reducing board monitoring and the protection of shareholders' interests (Mollah et al., 2021). Along with this negative argument, Miller (1991) argued that experience renders boards with a long tenure indifferent to environmental changes. A recent study on tenure led to the conclusion of an unclear relationship between tenure and the performance of SSB. Mukhibad and Setiawan (2022) report the negative impact of SSB tenure on liquidity risk, strategic risk, and return rate risk. On the contrary, Anisykurlillah et al. (2020) and Mukhibad et al. (2022) did not find a relationship between SSB tenure on financial statement quality and zakah performance.

H4: Tenure of SSB members influences Shariah compliance risk.

IB's big challenge is implementing Shariah principles and rules in bank operations. The first reason for this statement is that the IB operating community is rational, profit-oriented, and tends not to pay attention to aspects of shariah compliance (see Ismal (2011) and Aysan et al. (2018)). Demands from the public for IBs to provide competitive returns allow IBs to offer returns for depositors that are the same as conventional bank interest, and further increase the shariah compliance risk. Thus, market competition factors can affect bank risk-taking.

Recent literature develops two opposite effects of market competition: fragile market competition and stable market competition (Louhichi et al., 2020). The competition-fragility view assumes that more competition makes banks more fragile because high competition erodes market power, reducing bank performance (Noman et al., 2017). In contrast, the competition-stability view implies that high competition promotes the financial stability of banks because high market power enjoys lower competition in the loan market, which encourages them to set high-interest rates for borrowers, which in turn increases their (borrowers') risk-taking tendency and default risk (Noman et al., 2017). Mukhibad et al. (2022) and Louhichi et al. (2019) have provided evidence that market competition influences bank risk-taking. Studies on market competition in IBs lead to a fragile market competition hypothesis because low competition is a tendency for banks to practice monopoly and dominate the market. These conditions cause decreased Shariah compliance risk (Mukhibad et al., 2022).

H5: Market competition has a negative influence on Shariah compliance risk.

4. Methods and Materials

This study uses a full-fledged sample of Islamic banks in Indonesia with a 12-year observation period (2009-2020). However, three banks do not report non-halal income, so we excluded these three banks. In addition, two banks converted from CBs to IBs in the current year, so we used unbalanced data with 118 units of analysis.

The independent variable of this study is Shariah compliance risk as measured by the non-halal income ratio (NHIR). This NHIR is measured by the ratio of non-halal income to total income from bank financing (Basiruddin and Ahmed, 2019). A high NHIR indicates a bank has a high shariah compliance risk.

Independent variables use four SSB attributes: educational background in Shariah/Islamic law/Islamic law jurisprudence, educational background in economics/finance/accounting, cross-membership, and tenure. Educational background in shariah/Islamic law/Islamic law jurisprudence of SSB members (SSBSYARIAH) is measured by the ratio of SSB members who have an educational background in shariah/Islamic law/Islamic law jurisprudence to all SSB members (Mukhibad et al., 2022). Educational background in accounting/finance/economics of SSB members (SSBFINANCE) is measured by the ratio of SSB members who have an educational background in accounting /finance/economics to all SSB members.

Table 1. Measurement Variables

Variables	Abbreviation	Description	References
1. Shariah compliance risk	SCR	$SCR_{i,t} = \frac{\sum non-halal\ income_{i,t}}{\sum financing\ income_{i,t}} x100$ High SCR scores indicated high Shariah compliance risk.	Mukhibad et al. (2022); Basiruddin and Ahmed (2019)
2. The educational background in Shariah/Islamic law/Islamic law jurisprudence of SSB members.	SSBSHARIAH	Dummy: score one if the SSB has at least one educational background in Shariah/Islamic law/Islamic law jurisprudence; score zero otherwise.	Mukhibad et al. (2022); Bukair and Abdul-Rahman (2013)
3. Educational level of SSB members.	SSBEDU	The percentage of scholars who have a PhD degree.	Nomran et al. (2018)
4. Cross-membership of SSB	SSBCROSS	The average score of cross-membership of SSB.	Mukhibad et al. (2023)
5. Tenure of SSB	SSBTENURE	The number of months the SSB has been in that position.	Anisykurlillah et al. (2020)
6. Market competition	LERNER	$Lerner_{i,t} = \frac{Price_{i,t} - MC_{i,t}}{Price_{i,t}}$ Price $_{i,t}$ is the price of banking outputs for bank i at time t,	Alam et al. (2019)

		MC is the marginal cost for bank i at time t. The Lerner index is averaged over time under the study for each bank i. Lerner takes values between 0 and 1. Scores tend toward 0, meaning a purely competitive market and no pricing power otherwise. Scores tend toward 1, which means a low competitive market, reflecting a high markup of price above marginal cost, a high markup of price above marginal cost, the banks have monopoly power, and the market power is increased.	
7. Deposit Fund Ratio	DEPOSIT	The percentage of deposit funds to total assets	Abdul-rahman et al. (2017)
8. Total Assets	SIZE	Natural logarithm of total assets	Mukhibad et al. (2022)
9. Pandemic COVID-19	COVID	Dummy, score 1 if the COVID-19 pandemic period; Score 0 otherwise	Mukhibad et al. (2022)

All data are collected by hand for annual reports published on each bank's official website. Model feasibility analysis used variable inflation factors (VIF) for the multicollinearity test, the Wooldridge test for the autocorrelation test, and the modified Wald test for heteroskedasticity.

The data analysis technique uses panel data regression with a fixed effect model or a random effect model approach. The selection of the model used in answering the hypothesis is based on the Breusch and Pagan Lagrangian multiplier test for selecting the common effect model (CEM) and the random effect model (REM). If this test produces a probability result of less than 0.05, then the recommended model is REM; otherwise. The second test is the Hausman test, where the probability results are less than 0.05, so the recommended model is the fixed effect model (FEM), and vice versa.

We developed the following research models:

$$SCR_{i,t} = \beta_0 - \beta_1 SSBSHARIAH_{i,t} - \beta_2 \mathrm{SSBEDU}_{i,t} - \beta_3 \mathrm{SSBCROSS}_{i,t} - \beta_4 SS\mathrm{BTENURE}_{i,t} - \beta_5 \mathrm{LERNER}_{i,t} + CONTROL + \varepsilon$$

In this model, α is the intercept, i and t correspond respectively to IBs and years. The dependent variable is Shariah compliance risk, representing SCR. The independent variables include SSBSHARIAH, which refers to educational background in shariah/Islamic law/Islamic law jurisprudence of SSB members, SSBEDU refers to the educational level of SSB members, SSBCROSS refers to cross-membership of SSB, SSBTENURE refers to tenure of SSB, and LERNER refers to market competition. CONTROL refers to a set of control variables with three proxies (DEPOSIT, SIZE, and COVID), and ε refers to the error term.

5. Results

5.1 Descriptive Analysis

Table 2 shows that the average ROA is 0.037%, with a minimum of 0.00 to a maximum of 0.164%. The average SSBEDU is 0.548%, with a minimum of 0.00 and a maximum of 1. The sample has an SSB with a doctoral degree of 0.548%. The average SBSSHARIAH is 0.993%, with a minimum of 0.000 and a maximum of 1.000. This score shows that 99.30% of banks have at least 1 SSB member with shariah education. Table 2 also shows that the average SSBCROSS is 2.296, with a minimum of 0.00 and a maximum of 5.5. The sample of SSB members serving as SSB in other Islamic institutions is 2.296. The average SSBTENURE is 4.363 years. The minimum score of SSB tenure is 0.017 years, and the maximum is 9.092 years.

Table 2 also shows that the sample has a Lerner average of 0.107, with a minimum of 0.004 and a maximum of 0.857. This score shows high inter-bank competition. Lerner shows the numbers 1 to 0, where the number 1 shows weak competition and a monopoly situation, and vice versa (Salma and Younes, 2014). Table 2 states that the conventional panel unit root tests, such as the Fisher-type test proposed by Choi (2001), are used to test for the stationarity of variables. In summary, there is mixed evidence of the integration properties of the variables in our dataset.

Table 2. Descriptive Statistics

Variables	Mean	Std. Dev.	Min.	Max.	Unit Root Test (P-value)	
					Inverse Normal	Modified inv. chi-squared
SCR	0.037	0.019	0.000	1.614	-4.434 (0.000)	5.95 (0.000)

SSBSHARIAH	0.993	0.081	0.000	1.000	-5.545 (0.000)	12.174 (0.000)
SSBEDU	0.548	0.338	0.000	1.000	-4.284 (0.000)	7.570 (0.000)
SSBCROSS	2.296	1.264	0.000	5.500	-1.906 (0.028)	0.832 (0.2029)
SSBTENURE	4.363	3.611	0.017	9.092	-5.299 (0.000)	16.659 (0.000)
LERNER	0.107	0.337	0.004	0.857	-0.826 (0.204)	2.866 (0.0021)
DEPOSIT	1.450	7.411	0.000	74.076	-2.599 (0.005)	5.608 (0.000)
SIZE	29.741	1.434	24.240	32.474	-7.488 (0.000)	21.304 (0.000)
Covid	0.154	0.362	0.000	1.000	5.442 (1.000)	-3.458 (0.999)

Source: Research finding.

Correlation test results between variables to identify a serious correlation between variables in the model (multicollinearity). The correlation between the allowed independent variables is not greater than 0.8. Table 3 shows that the most significant correlation is 0.377. This test shows no serious correlation between variables.

Table 3. Correlation between Independent Variables

Variables		1	2	3	4	5	6	7	8	9
SCR	1	1								
DEPOSIT	2	-0.016	1							
SSBTENURE	3	0.170	-0.309	1						
SSBSHARIAH	4	-0.050	0.019	-0.024	1					
SSBCROSS	5	-0.023	-0.033	0.014	0.182	1				
SSBEDU	6	-0.070	0.168	-0.021	-0.114	0.010	1			
SIZE	7	-0.047	-0.249	-0.189	0.377	0.333	0.089	1		
LERNER	8	0.106	0.031	0.005	0.017	-0.159	-0.158	0.001	1	
Covid	9	-0.124	-0.069	0.283	0.048	-0.035	-0.109	0.140	0.150	1

Source: Research finding.

5.2 Panel Data Regression Analysis

Table 4 shows that the mean VIF is 1.31. This score is below five and indicates there is no serious correlation between the variables in the model. Wooldridge and the modified Wald test are 0.026 and 895.52, respectively, and the probability score is more than 0.05. The results of these two tests indicate that there are heteroscedasticity and autocorrelation problems in the model. To overcome this problem, following the steps of Mukhibad and Setiawan (2022) and Abdeljawad et al. (2020), we use standard errors that were robust and clustered in years to overcome possible problems of heteroscedasticity and autocorrelation in the model. The Breusch and Pagan Lagrangian multiplier test yields a chibar2 score of 46.24 and a probability of 0.000. The Hausman test produces a chi2 of 0.91 and a probability score of more than 0.005. The results of these two tests recommend Random-Effects GLS regression as a data analysis method. Table 4 presents the results of the regression test using the Random-Effects GLS method.

Table 4. Random-Effects GLS regression

Variables	**Coef.**	**Robust Std. Err.**	**z**	**P > z**
SSBSHARIAH	-3.669***	0.987	-3.720	0.000
SSBEDU	-1.963**	0.956	-2.050	0.040
SSBCROSS	-0.447*	0.238	-1.880	0.061
SSBTENURE	0.515*	0.283	1.820	0.069
Lerner	0.513***	0.184	2.800	0.005
DEPOSIT	0.053**	0.021	2.570	0.010
SIZE	0.622**	0.273	2.280	0.023
Covid	-1.984**	1.001	-1.980	0.048
_cons	-17.369**	8.018	-2.170	0.030
Mean VIF		1.31		
Wooldridge test		0.026		
Modified Wald test		895.52		
Hausman test		0.91		
Breusch and Pagan Lagrangian multiplier test		46.24***		
R-Sq		0.136		
Prob > chi2		0.000		

Source: Research finding.
Note: ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

5.3 Discussion

Table 4 shows that SBSSHARIAH has a coefficient of -3.669 and a probability score of 0.000. These findings indicate that SSB's expertise in Islamic law/shariah/Islamic law jurisprudence has a negative effect on shariah compliance risk. SSB has the duty to provide counseling and supervision of bank operations so that bank operations comply with Shariah. Customer needs and bank products are dynamic, and the director needs approval from SSB. SSB will analyze new bank products that the Council of Scholars has not yet regulated. To carry out this task, SSB requires the knowledge of Islamic law/shariah/Islamic law jurisprudence. SSB's expertise prevents prohibited transactions from being avoided and can further reduce Shariah compliance risk. This result is in line with the Upper Echelons theory that education is a good proxy for measuring knowledge (Hambrick and Mason, 1984), knowledge of fiqh muamalah obtained by SSB to increase effectiveness in carrying out their duties.

The panel data test results show that SSBEDU has a coefficient of -1.963 and a probability of 0.05. These results indicate that SSB education has a negative effect on Shariah compliance risk. SSB members with doctoral education will cause the director to reduce bank cooperation with CB, and accordingly reduce non-halal income and reduce shariah compliance risk. This result of research is in line with the upper echelons theory, which is that a highly cognitive board causes the board to be able to provide suggestions and come up with creative ideas in the development of products or policies that are Shariah-compliant. In addition, pressure from regulators and the public to guarantee IB operations are in accordance with Shariah and provide competitive returns, coupled with investment instruments available on the market that are not suitable for IB, has caused IB to launch creative products to meet public demands. A highly educated management team increases board capability to a high predisposition for information processing and competence in strategic decision-making (Hambrick and Mason, 1984), including the capability to provide solutions to public requirements. This result is in line with the result from Muhammad et al. (2021), who report that the educational level of SSB has a positive influence on shariah compliance.

The results of the study show that SSBCROSS has a coefficient of -0.447 and a probability score of 0.061. The results of this study indicate that SSB cross membership has a negative effect on Shariah compliance risk. Based on these results, this study rejects the hypothesis. Based on RDT, there are advantages for the IB to have SSB members sit on more than one board in other entities. First, the SSB enables the SSB interlocks to monitor the external bank and to disseminate the information of these banks (Nomran et al., 2018). Secondly, SSB discusses with SSB members and directors of other banks so as to increase their knowledge and experience (Mukhibad and Setiawan, 2022), and third, SSB has access to resources and connections and gains knowledge from other firms (Salancik and Pfeffer, 1978; Zhou et al., 2018). Cross-membership of SSB generates a reputation effect because SSB, when sitting with another IB, is considered to have extraordinary experience and capabilities to manage the assets of IBs.

In contrast, based on the overboarding hypothesis view, serving on multiple boards can overcommit a director, shirk their monitoring responsibilities for directors, and consequently adversely affect bank performance (Kutubi et al., 2018). SSB sits at the head of many entities. They share their available time to provide advice and supervise the director. The consequence is a reduction in the quality of supervision. This study is in line with the overarching hypothesis view, which implies that SSB cross membership induces IBs to take on riskier transactions, which can increase the Shariah compliance risk. The low level of supervision and encouragement from IB customers to provide competitive returns is the same as that of CBs, with the potential for directors to adopt policies that do not pay attention to Shariah compliance. Trinh et al. (2020) show that in IBs, sitting in another entity is likely to be associated with lower scrutinizing effectiveness. Studies from Nomran et al. (2018) and Nomran et al. (2017) also show that SSB cross-membership has a negative effect on profitability. Our results provide a positive counterpoint to the negative relationship that exists between cross-membership of SSB and SSB outcomes, and accordingly decrease shariah compliance risk.

The results of the regression test on the SSBTENURE variable yield a coefficient of 0.515 and a probability score of 0.069. The test results show that SSB tenure has a positive influence on Shariah compliance risk. Our results provide a positive relationship between the tenure of SSB and SSB outcome, and accordingly, increase Shariah compliance risk. This research is in line with recent literature that shows that board tenure enhances board experience and knowledge (Valenti and Horner, 2020). Consequently, the board will be more likely to make effective decisions to raise firm performance (Reguera-Alvarado and Bravo, 2017). In addition, this research supports the human capital resource theory that longer tenure gives the advantage of experience, profound business arguments, knowledge, and broader access to and networking with all the stakeholders (Wijayanti et al., 2020), as likely to influence strategy and are critical to firm innovation (Valenti and Horner, 2020). This study supports research findings from Mukhibad and Setiawan (2022), which report the positive impact of SSB tenure on supervision from the SSB and further prevent directors from taking bank risks, consequences of reducing liquidity risk, strategic risk, and return rate risk.

Table 4 shows that LERNER produces a coefficient of 0.513 and a probability score of 0.005. These results indicate that LERNER has a positive influence on Shariah compliance risk. A Lerner index score of 1 tends toward a low competitive market, reflecting that there is a high markup of price above marginal cost, the banks have monopoly power, and the market power is increased (Alam et al., 2019). The results of this study indicate that banks with high market power cause banks to take significant Shariah compliance risks. The results of this study corroborate the findings of Mukhibad et al. (2022) and Alam et al. (2019). The results are in line with the "competition-fragility" view, which implies that a highly competitive environment induces banks to take on riskier transactions (Alam et al., 2019), which can increase the shariah compliance risk. To derive a high return and maintain their high market power, banks tend to take on riskier transactions through increased cooperation with conventional banks and a further increase in non-halal income.

5.4 Robustness Test

Following Mukhibad and Setiawan (2022), we add the income diversity variable in our model for the robustness test. Income diversity measures the income a bank receives from sources other than financing. The magnitude of the bank's income diversity indicates that the bank obtains other sources, not relying on a single financing product to improve bank performance. Hence, income diversity can influence risk-taking (Mukhibad and Setiawan, 2022; Safiullah, 2021; Pennathur et al., 2012).

In this robustness test, we followed the steps for testing the research hypothesis, and our test results are presented in Table 5. The results of this test indicate that all our main variables influence Shariah compliance risk. These findings are in line with the results of the research presented in Table 4.

Table 5. Robustness Test with Random-Effects GLS Regression Methods

Variables	Coef.	Robust Std. Err.	Z	P > z
SSBSHARIAH	-2.181**	0.995	-2.190	0.028
SSBEDU	-4.521***	1.146	-3.950	0.000
SSBCROSS	-0.569**	0.233	-2.440	0.015
SSBTENURE	0.662***	0.251	2.630	0.009
Lerner	0.497***	0.149	3.340	0.001
DEPOSIT	0.061***	0.020	2.970	0.003
SIZE	0.892***	0.261	3.420	0.001
Covid	-1.895**	0.823	-2.300	0.021
DIVERINCOME	7.287***	2.091	3.490	0.000
_cons	-25.701***	7.889	-3.260	0.001
Mean VIF		1.31		
Wooldridge test		0.646		
Modified Wald test		242.62***		
Hausman test		1.09		
Breusch and Pagan Lagrangian multiplier test		53.74***		
R-Sq		0.268		
Prob > chi2		0.000		

Source: Research finding.

Note: ***, **, and * denote 1%, 5% and 10% significance levels, respectively. We use standard errors that were robust and clustered over years to overcome possible problems of heteroscedasticity and autocorrelation in models. Breusch and Pagan Lagrangian multiplier and Hausman tests recommend the Random-Effects GLS regression.

6. Conclusion

The research aims to explain the effect of four SSB attributes: education level, educational background in shariah/Islamic law/Islamic law jurisprudence, cross-membership, and tenure on shariah compliance risk. We also prove the effect of market competition on Shariah compliance. The results showed that the educational level and educational background of SSB in Shariah/Islamic law/Islamic law jurisprudence had a negative effect on Shariah compliance risk. Our research results support the upper echelons theory, which is that a highly educated management team increases SSB's capability to a high predisposition for information processing and competence in strategic decision-making, including the ability to provide solutions to public requirements to create shariah-compliant products.

We also found that cross-membership of SSB has a positive effect on Shariah compliance risk. This study is in line with the overboarding hypothesis view, which implies that SSB cross membership reduces supervision of SSB quality and induces IBs to take on the riskier transactions, which can increase the shariah compliance risk. The results of the regression test on the SSB tenure variable have a positive influence on shariah compliance risk. This research supports that board tenure enhances board experience, knowledge, profound business arguments, and broader access to and networking with all the stakeholders, as well as the consequences of reducing Shariah compliance risk. Finally, we show that banks that have high market power take high Shariah compliance risks. The results align with the "competition-fragility" view, which implies that a highly competitive environment induces banks to take on riskier transactions, including transactions that can increase the shariah compliance risk.

The practical contribution from the results of this study is that regulators and IBs need to consider the level of education, educational background, and tenure of SSBs when appointing SSB members. Regulators and IB management also need to limit the cross-membership of SSB members because SSBs that sit in multiple entities reduce SSB outcomes and increase Shariah compliance risk. This research makes a theoretical contribution by strengthening the upper echelons theory, overboarding hypothesis, human capital resource theory, and competition-fragility hypothesis in explaining the role of SSB on shariah compliance risk.

The limitation of this study is the limited sample because we only used IB samples in Indonesia. We only use this sample because each IB must comply with the Shariah rules that the scholars of each country have formulated. Shariah originates from qiyas, which the association of scholars decides, and this difference in association allows for differences in fatwas, including in determining the rules that IB may or should avoid. For this reason, we suggest future researchers use the IB sample in other countries by paying attention to the fatwa/rules determined by ulema/religious experts from a country. This method expands the findings of this study.

Statements and Declarations

- Funding: This work has not received any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Abdeljawad, I., Oweidat, G. A. I., & Saleh, N. M. (2020). Audit committee versus other governance mechanisms and the effect of investment opportunities: evidence from Palestine. *Corporate Governance (Bingley)*, *20*(3), 527–544. Retrieved from https://doi.org/10.1108/CG-06-2019-0185.

Abdul-Baki, Z., & Uthman, A. B. (2017). Exploring The "Social Failures" Of Islamic Banks: A Historical Dialectics Analysis. *Journal of Islamic Accounting and Business Research*, *8*(3), 250–271. Retrieved from https://doi.org/10.1108/JIABR-06-2014-0021.

Abdul-rahman, A., Said, N. L. H. M., & Sulaiman, A. A. (2017). Financing Structure and Liquidity Risk : Lessons from Malaysian Experience. *Journal of Central Banking Theory and Practice*, *6*(2), 125–148. Retrieved from https://doi.org/10.1515/jcbtp-2017-0016.

Ahmed, A. (2010). Global financial crisis : an Islamic finance perspective. *International Journal of Islamic and Middle Eastern Finance and Management*, *3*(4), 306–320. Retrieved from https://doi.org/10.1108/17538391011093252.

Alam, N., Abdul, B., & Ting, D. (2019). Does competition make banks riskier in a dual banking system? *Borsa Istanbul Review*, *19*(1), S34–S43. Retrieved from https://doi.org/10.1016/j.bir.2018.09.002.

Allen, F., Gale, D., Journal, S., February, N., Allen, F., & Gale, D. (2000). Financial Contagion. *Journal of Political Economy*, *108*(1), 1–33. Retrieved from https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x.

Alman, M. (2012). Shari'ah Supervisory Board Composition Effects on Islamic Banks' Risk-Taking Behavior. *Journal of Banking Regulation*, *14*(1), 134–163. Retrieved from https://doi.org/10.2139/ssrn.2140042.

Anisykurlillah, I., Jayanto, P. Y., Mukhibad, H., & Widyastuti, U. (2020). Examining the role of Sharia supervisory board attributes in reducing financial statement fraud by Islamic banks. *Banks and Bank Systems*, *15*(3), 106–116. Retrieved from https://doi.org/10.21511/bbs.15(3).2020.10.

Aribi, Z. A., & Arun, T. (2015). Corporate Social Responsibility and Islamic Financial Institutions (IFIs): Management Perceptions from IFIs in Bahrain. *Journal of Business Ethics*, *129*(4), 785–794. Retrieved from https://doi.org/10.1007/s10551-014-2132-9.

Aysan, A. F., Disli, M., Duygun, M., & Ozturk, H. (2018). Religiosity versus rationality : Depositor behavior in Islamic and conventional banks. *Journal of Comparative Economics*, *46*(1), 1–19. Retrieved from https://doi.org/10.1016/j.jce.2017.03.001.

Basiruddin, R., & Ahmed, H. (2019). Corporate governance and Shariah non-compliant risk in Islamic banks: evidence from Southeast Asia. *Corporate Governance (Bingley)*, *20*(2), 240–262. Retrieved from https://doi.org/10.1108/CG-05-2019-0138.

Bukair, A. A., & Abdul-Rahman, A. (2013). The Influence of the Shariah Supervision Board on Corporate Social Responsibility Disclosure by Islamic Banks of Gulf Cooperation Council Countries. *Asian Journal of Business and Accounting*, *6*(2), 65–104. Retrieved from https://doi.org/10.5296/jmr.v7i2.6989.

Choi, I. (2001). Unit root tests for panel data. *Journal of International Money and Finance*, *20*(2), 249–272. Retrieved from https://doi.org/10.1016/S0261-5606(00)00048-6.

Darmadi, S. (2013). Board members' education and firm performance: evidence from a developing economy. *International Journal of Commerce and Management*, *23*(2), 113–135. Retrieved from https://doi.org/10.1108/10569211311324911.

Hambrick, D. C., & Mason, P. A. (1984). Upper Echelons: The Organization as a Reflection of Its Top Managers. *Academy of Management Review*, *9*(2), 193–206. Retrieved from https://doi.org/10.5465/amr.1984.4277628.

Ismal, R. (2011). Depositors' withdrawal behavior in Islamic banking: Case of Indonesia. *Humanomics*, *27*(1), 61–76. Retrieved from https://doi.org/10.1108/08288661111110187.

Kutubi, S. S., Ahmed, K., & Khan, H. (2018). Bank performance and risk-taking — Does directors' busyness matter? *Pacific Basin Finance Journal*, *50*, 184–199. Retrieved from https://doi.org/10.1016/j.pacfin.2017.02.002.

Louhichi, A., Louati, S., & Boujelbene, Y. (2019). Market-power, stability, and risk-taking: an analysis surrounding the Riba-free banking. *Review of Accounting and Finance*, *18*(1), 2–24. Retrieved from https://doi.org/10.1108/RAF-07-2016-0114.

Louhichi, A., Louati, S., & Boujelbene, Y. (2020). The regulations–risk-taking nexus under competitive pressure: What about the Islamic banking system? *Research in International Business and Finance*, *51*(January 2018), 101074. Retrieved from https://doi.org/10.1016/j.ribaf.2019.101074.

Miller, D. (1991). Stale in the saddle: CEO tenure and the match between organization and environment. *Management Science*, *37*(1), 34–52. Retrieved from https://doi.org/10.1287/mnsc.37.1.34.

Mollah, S., Liljeblom, E., & Mobarek, A. (2021). Heterogeneity in independent non-executive directors' attributes and risk-taking in large banks. *Journal of Corporate Finance*, *70*(August), 102074. Retrieved from https://doi.org/10.1016/j.jcorpfin.2021.102074.

Muhammad, R., Annuar, H. A., Taufik, M., & Nugraheni, P. (2021). The influence of the

SSB's characteristics toward Sharia compliance of Islamic banks. *Cogent Business and Management*, *8*(1), 1–20. Retrieved from https://doi.org/10.1080/23311975.2021.1929033.

Mukhibad, H., Jayanto, P. Y., Jati, K. W., & Khafid, M. (2022). Attributes of Shariah Supervisory Board and Shariah Compliance. *Corporate Governance and Organizational Behavior Review*, *6*(3), 173–180. Retrieved from https://doi.org/10.22495/cgobrv6i3p16.

Mukhibad, H., Nurkhin, A., Anisykurlillah, I., Fachrurrozie, F., & Jayanto, P. Y. (2023). Open innovation in shariah compliance in Islamic banks – Do shariah supervisory board attributes matter? *Journal of Open Innovation: Technology, Market, and Complexity*, *9*(1), 1–10. Retrieved from https://doi.org/10.1016/j.joitmc.2023.100014.

Mukhibad, H., Nurkhin, A., Jati, K. W., & Yudo, P. (2022). Corporate governance and Islamic law compliance risk. *Cogent Economics & Finance*, *10*(01), 1–17. Retrieved from https://doi.org/10.1080/23322039.2022.2111057.

Mukhibad, H., & Setiawan, D. (2022). Shariah supervisory board attributes and corporate risk-taking in Islamic banks. *Cogent Business & Management*, *9*(1), 1–25. Retrieved from https://doi.org/10.1080/23311975.2022.2158607.

Mukhibad, H., Yudo Jayanto, P., Suryarini, T., & Bagas Hapsoro, B. (2022). Corporate governance and Islamic bank accountability based on disclosure—a study on Islamic banks in Indonesia. *Cogent Business & Management*, *9*(1), 13–19. Retrieved from https://doi.org/10.1080/23311975.2022.2080151.

Noman, A. H., Gee, C. S., & Isa, C. R. (2017). Does competition improve financial stability of the banking sector in ASEAN countries? An empirical analysis. *Plos One*, *12*(5), 1–27. Retrieved from https://doi.org/10.1371/journal.pone.0176546.

Nomran, N. M., & Haron, R. (2019). Dual board governance structure and multi-bank performance: a comparative analysis between Islamic banks in Southeast Asia and GCC countries. *Corporate Governance (Bingley)*, *19*(6), 1377–1402. Retrieved from https://doi.org/10.1108/CG-10-2018-0329.

Nomran, N. M., Haron, R., & Hassan, R. (2017). Bank Performance and Shari'ah Supervisory Board Attributes of Islamic Banks : Does Bank Size Matter ? *Journal of Islamic Finance*, *6*(Special Issue), 174–187. Retrieved from https://doi.org/10.12816/0047348.

Nomran, N. M., Haron, R., & Hassan, R. (2018). Shari'ah supervisory board characteristics effects on Islamic banks' performance: Evidence from Malaysia. *International Journal of Bank Marketing*, *36*(2), 290–304. Retrieved from https://doi.org/10.1108/IJBM-12-2016-0197.

Nurkhin, A., Rohman, A., Rofiq, A., & Mukhibad, H. (2018). The role of the Sharia Supervisory Board and corporate governance mechanisms in enhancing Islamic performance-evidence from Indonesia. *Banks and Bank Systems*, *13*(4), 85–95. Retrieved from https://doi.org/10.21511/bbs.13(4).2018.08.

Pennathur, A. K., Subrahmanyam, V., & Vishwasrao, S. (2012). Income diversification and risk: Does ownership matter? An empirical examination of Indian banks. *Journal of Banking and Finance*, *36*(8), 2203–2215. Retrieved from https://doi.org/10.1016/j.jbankfin.2012.03.021.

Reguera-Alvarado, N., & Bravo, F. (2017). The effect of independent directors' characteristics on firm performance: Tenure and multiple directorships. *Research in International Business and Finance*, *41*(February), 590–599. Retrieved from https://doi.org/10.1016/j.ribaf.2017.04.045.

Safiullah, M. (2021). Stability efficiency in Islamic banks: Does board governance matter? *Journal of Behavioral and Experimental Finance*, *29*(March 2021), 100442. Retrieved from https://doi.org/10.1016/j.jbef.2020.100442.

Safiullah, M., & Shamsuddin, A. (2018). Risk in Islamic Banking and Corporate Governance. *Pacific-Basin Finance Journal*, *47*, 129–149. Retrieved from https://doi.org/10.1016/j.pacfin.2017.12.008.

Salancik, G. R., & Pfeffer, J. (1978). A social information processing approach to job attitudes and task design. *Administrative Science Quarterly*, *23*(2), 224–253. Retrieved from https://doi.org/10.2307/2392563.

Salma, L., & Younes, B. (2014). Market power vs. financial stability: Evidence from the MENA region's Islamic and conventional banking industries. *International Journal of Monetary Economics and Finance*, *7*(3), 229–247. Retrieved from https://doi.org/10.1504/IJMEF.2014.066495.

Siddiqui, A. (2008). Financial contracts, risk and performance of Islamic banking. *Managerial Finance*, *34*(10), 680–694. Retrieved from https://doi.org/10.1108/03074350810891001.

Tarique, K. M., Islam, R., & Mohammed, M. O. (2021). Developing and validating the components of Maqasid al-Shari'ah-based performance measurement model for Islamic banks. *International Journal of Islamic and Middle Eastern Finance and Management*, *14*(2), 366–390. Retrieved from https://doi.org/10.1108/IMEFM-12-2018-0432.

Trinh, V. Q., Aljughaiman, A. A., & Cao, N. D. (2020). Fetching better deals from creditors: Board busyness, agency relationships and the bank cost of debt. *International Review of Financial Analysis*, *69*(September 2019), 101472. Retrieved from https://doi.org/10.1016/j.irfa.2020.101472.

Trinh, V. Q., Elnahass, M., Salama, A., & Izzeldin, M. (2020). Board busyness, performance and financial stability: Does bank type matter? *European Journal of Finance*, *26*(7–8), 774–801. Retrieved from https://doi.org//10.1080/1351847X.2019.1636842.

Vafeas, N. (2003). Length of Board Tenure and Outside Director Independence. *Journal of Business Finance & Accounting*, *30*(7), 1043–1064. Retrieved from https://doi.org//10.1111/1468-5957.05525.

Valenti, A., & Horner, S. V. (2020). Leveraging board talent for innovation strategy. *Journal of Business Strategy*, *41*(1), 11–18. Retrieved from https://doi.org/10.1108/JBS-12-2018-0207.

Wijayanti, R., Diyanty, V., & Laela, S. F. (2020). Education strategy misfit, board effectiveness and Indonesian Islamic bank performance. *Journal of Islamic Accounting and Business Research*, *11*(3), 929–944. Retrieved from https://doi.org/10.1108/JIABR-04-2017-0052.

Zainuldin, M. H., Lui, T. K., & Yii, K. J. (2018). Principal-agent relationship issues in Islamic banks: a view of Islamic ethical system. *International Journal of Islamic and Middle Eastern Finance and Management*, *11*(2), 297–311. Retrieved from https://doi.org/10.1108/IMEFM-08-2017-0212.

Zhou, H., Owusu-Ansah, S., & Maggina, A. (2018). Board of directors, audit committee, and firm performance: Evidence from Greece. *Journal of International Accounting, Auditing and Taxation*, *31*(May 2013), 20–36. Retrieved from https://doi.org/10.1016/j.intaccaudtax.2018.03.002.

Cite this article: Mukhibad, H., Ihlashul'amal, M., Ratmono, D., & Tantri, M. (2025). Shariah Supervisory Board and Shariah Compliance Risk: Empirical Evidence from Indonesia. *Iranian Economic Review, 29*(4), 1377-1399.

Iranian Economic Review, 29(4), 1393-1415
DOI: https://doi.org/10.22059/ier.2024.368564.1007862

RESEARCH PAPER

The Impact of Economic Shocks on the Competitiveness of Leading Vegetable Oil in the International Market

Rizka Amalia Nugrahapsari[*,a], **Harianto**[b], **Rita Nurmalina**[b], **Anna Fariyanti**[b]

a. Department of Agricultural Economics, Faculty of Economics and Management, IPB University, Bogor, Indonesia; National Research and Innovation Agency, Kota Jakarta Pusat, Indonesia.
b. Department of Agribusiness, Faculty of Economics and Management, IPB University, Bogor, Indonesia.
* Corresponding author.

Received: 23 November 2023, Revised: 23 January 2024, Accepted: 18 February 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
The development of the biofuel industry has increase the price of world vegetable oil, resulting in changes in competitiveness among world-leading vegetable oils. The research aims to analyze factors influencing the competitiveness of the leading vegetable oils and the impact of economic shocks on the competitiveness of the leading vegetable oils in international market. This research utilized secondary data spanning from 1990 to 2022, encompassing information from UNCOMTRADE and World Bank with the Almost Ideal Demand System model. This research used the Seemingly Unrelated Regression as estimation method for estimating coefficients. The research results showed that the price of other vegetable oils, expenditure, and the price of crude oil are factors that influence the competitiveness of palm oil. Factors that influence the competitiveness of soybean oil are palm oil prices, expenditure and population. Factors that influence the competitiveness of sunflower oil are the price of soybean oil, expenditure, crude oil prices, and population. Palm oil competitiveness benefited from the economic shocks coming from the increase in world vegetable oil prices (own price elasticity -0.670), crude oil prices (crude oil price elasticity 10.055) and income (expenditure elasticity 1.372). This research recommends that major vegetable oil exporters should formulate policies to synergize domestic and export needs. Main biofuel-producing countries need to collaborate with the leading palm oil exporting countries because, in the future, more palm oil will be used to meet domestic needs. This study contributes to the international trade strategy, competitiveness, and biofuel industry development. It also supports the existing findings.

Keywords: Biofuel, Demand System, Income Elasticity, International Trade, Price Elasticity.
JEL Classification: F10, F14, Q17.

1. Introduction

The biofuel industry's growth drives the demand for vegetable oil (Gaskell, 2015;

World Bank, 2022), motivated by the rising crude oil prices. From 2016 to 2022, crude oil prices increased at 15.49 percent anually (World Bank, 2022), promoting a shift from fossil fuels to biofuels (Lucotte, 2016). Understanding the vegetable oil market is crucial due to its role in the biofuel era and concerns about emissions (Santeramo et al., 2021). Major vegetable oil-exporting countries must decide whether to prioritize their domestic biofuel industry or export vegetable oil. They also need to choose between using domestic vegetable oil for biofuels or importing more competitively priced and higher productivity vegetable oils. These decisions significantly impact the competitiveness of vegetable oils in the global market.

The biofuel expansion leads to higher prices for vegetable oils used as raw materials (Gomes et al., 2018; Santeramo et al., 2021). This policy affects not only the primary vegetable oil used for biofuel but also other types (Thompson et al., 2010). According to the Council of Palm Oil Producing Countries (2021), the price spike in Q4 2020 indicated a demand recovery post-COVID-19 from major consumers like India and China. Sunflower oil commands the highest price, while palm oil has the lowest price (UNCOMTRADE, 2023). Rising global vegetable oil prices may prompt price-sensitive consumers to switch to palm oil due to its competitive pricing.

Competition among vegetable oils, particularly between palm and non-palm varieties like soybean and sunflower oil, is intensifying. The challenge stems from the concentration of palm oil exporting countries in the ASEAN region (Indonesia and Malaysia), while non-palm oil exporting leaders are found in the European and American regions (Argentina, Brazil, the United States, Ukraine, and Russia). Notably, the leading importers of palm oil are also the primary importers of non-palm vegetable oil, leading to market share competition. World Bank (2023) indicates an increase in global GDP, specifically in the GDP of major vegetable oil-importing countries, during the economic recovery following the COVID-19 pandemic. Global GDP per capita grew by 6% in 2021 and 3.1% in 2022. In India, GDP per capita grew by 8.18% in 2021 and 6.28% in 2022, in China by 8.35% (2021) and 3% (2022), in the Netherlands by 4.32% (2021) and 3.47% (2022), and in Turkey by 10.51% (2021) and 4.86% (2022). Several other major vegetable oil-importing countries also witnessed growth in GDP per capita. Therefore, it is crucial to investigate whether the rising global income can drive specific vegetable oils to succeed in this competitive landscape.

Various studies have addressed the issue of vegetable oil trade in world markets (Fitrianti et al., 2019), country-specific (Shang et al., 2022), regions (Santeramo and Searle, 2019; Santeramo et al., 2021), as well as in the context between countries or regions (Bentivoglio et al., 2018; Hamulczuk et al., 2021). However, these studies have not focused on the competitive position between types of vegetable oil and how the impact of increasing vegetable oil prices, crude oil prices, and income can change the competitive position of leading vegetable oil in the international vegetable oil market. Several studies of competitiveness were conducted descriptively on sunflower oil in the world (Pilorge, 2020), and Brazilian soybean oil (Filassi and De Oliveira, 2022). Meanwhile, Paula et al. (2018) used RCA and CMS for soybean oil. These various studies have not explained the position of leading vegetable oils in global vegetable oil competition and how changes in the competitiveness of one type of vegetable oil can affect the competitiveness of other vegetable oils.

The importance of analyzing vegetable oil competitiveness is underscored by the existing research gap. This study aims to address this gap by investigating how economic shifts (increasing world price of vegetable oil, rising income, and increasing the price of crude oil) affect the competitiveness of global vegetable oils. Such insights can empower major vegetable oil exporters to devise effective strategies for enhancing their competitiveness. Santeramo et al. (2021) emphasize that efficient and effective environmentally friendly biofuel policies hinge on understanding the interplay among vegetable oils as biofuel raw materials, thus advocating for policies that foster sustainable biofuel markets by considering different vegetable oil types. This study aims to assess competition among the world's primary vegetable oils using a demand-driven approach, the factors influencing the competitiveness of these oils, and the impact of economic shocks on their competitiveness. This research, employing a demand-driven approach to evaluate global vegetable oil competitiveness, will offer novel insights by illustrating how demand dynamics for various vegetable oil types can affect the competitiveness of a single type.

In the next section, we present the theoretical background to justify the parameters' selection for the study, evaluate the current state of research topic on an international scale, and present the research innovation of this study. Section 3 provides the research objective, methodology, and data, which includes detailed equations used in this study. Results and discussions are analyzed and elaborated in Section 4. Conclusions are presented in the last section based on the study results, and to ensure that this study's objectives were fulfilled.

2. Literature Review

Numerous studies have examined the market connections among the world's primary vegetable oils: palm oil, soybean oil, sunflower oil, and rapeseed oil. These analyses were conducted by Gomes et al. (2018), Santeramo et al. (2021), and Thompson et al. (2010). Some research has focused specifically on the top three vegetable oils globally: palm oil, soybean oil, canola oil (Shang et al., 2022). Moreover, some research has focused specifically on the top two vegetable oils globally—palm oil and soybean oil—explored by Bentivoglio et al. (2018), Santeramo and Searle (2019), and Taheripour and Tyner (2020).

Factors influencing vegetable oil demand include the increase in crude oil prices, which encourages the positive development of the biofuel industry (Alam et al., 2019; Brummer et al., 2015; Gomes et al., 2018; Hamulczuk et al., 2021; Judit et al., 2017; Lajdova et al., 2017; Pal and Mitra, 2018; Santeramo et al., 2021; Schaefer et al., 2022). When biofuel entrepreneurs use certain types of vegetable oil that are in high demand as raw materials, the price of that type of vegetable oil will increase. The implication is that other entrepreneurs will switch to other types of vegetable oil so that prices will also increase (Thompson et al., 2010). In addition crude oil has an important role on agricultural production due to its high energy consumption during production dan distribution of agricultural product (Abbasian et al., 2019). The relationship between crude oil and vegetable oil can be seen from the similarities in the price fluctuation patterns of crude oil and vegetable oil (Alam et al., 2019). The positive correlation between crude oil prices and vegetable oil indicates that more vegetable oil will be used as raw material for biofuel as crude oil prices increase (Pal and Mitra, 2018). For example, US energy policy has significantly increased the responsiveness of soybean oil, canola oil and corn oil to movements in crude oil prices (Schaefer et al., 2022). However, there are also studies which based on the view that the relationship between crude oil and vegetable oil can vary according to the type of vegetable oil (Paris, 2018), and there are changes in the correlation between crude and vegetable oil over time (Lucotte, 2016).

Increasing demand for leading vegetable oils as raw materials for biofuel can create demand-driven expansion in the vegetable oil market (Santeramo et al., 2021). Palm oil demand can be linked to biofuel production growth, especially The policies of European government (Bentivoglio et al., 2018). Another factor that can influence demand for vegetable oil is income (Ahmad et al., 2022; Fitrianti et al., 2019; Ismail et al., 2022; Kea et al., 2020; Khalilian and Yuzbashkandi, 2021; Montania et al., 2021; Narayan and Bhattacharya, 2019; Purba et al., 2018).

Increasing the income of India and the Netherlands has the greatest influence on palm oil prices (Zaidi et al., 2022). Abbasian et al. (2019) highlights the important connection between the ratio of financial instruments to GDP and international trade in the Middle East countries. Demographic factors, especially population, can significantly influence the demand for vegetable oil. Gaskell (2015) highlights the crucial role of population in driving the demand for palm oil. From the demand side, Kiani et al. (2017) research results emphasizes that consumers' willingness to pay for renewable energy sources is also determined by how consumers view the importance of environmental sustainability.

Numerous studies have examined consumption pattern using AIDS model, among others by Anindita et al. (2022); Ceylan (2019); Forgenie et al. (2023); Hina et al. (2022); Khalilian and Yuzbashkandi (2021); Kharisma et al. (2020); Kutortse (2022); Onyeneke, et al. (2020); Rathnayaka et al. (2019); Selvanathan et al. (2023); and Siddique et al. (2020). These research analyzes the demand for a particular commodity in a particular country and has not utilized the AIDS model to describe competition. The AIDS model can also be used to analyze competitiveness, one of which is competition of leading exporting countries of dairy products in the Brazilian market (Arancibia and Guiguet, 2020) and competition of Pakistan, India and USA in Chinese cotton yarn market (Khan et al., 2023). This research uses the almost ideal demand system (AIDS) model to examine the demand behavior for each of the world's main types of vegetable oil, as well as how the demand for one type of vegetable oil influences the demand for other types of vegetable oil, so as to describe the competition between vegetable oils.

Numerous studies have examined the price relationships among different types of vegetable oil, the relationship between the price of vegetable oil and crude oil, and the interplay of income, population, and demand for specific vegetable oils. The objective of this research is to augment existing studies by analyzing the competition between various types of vegetable oils using a demand-driven approach, factors that influence the competitiveness of each major type of vegetable oil and the repercussions of economic shocks, such as escalating prices of vegetable oils, crude oil, and income, on the global competitiveness of vegetable oils. Given the global shift towards biofuels and away from fossil raw materials, investigating the competitiveness among vegetable oils is exceedingly vital, as it could reshape their competitive standing as raw materials. Understanding the competition among vegetable oils from the demand side can help explain how consumer preferences influence the competitiveness of a particular type of vegetable oil. Incorporating crude oil price variables into the AIDS model of competition among vegetable oils also helps provide an overview of how biofuel development affects the competitiveness of vegetable oil. Moreover, this research is instrumental in aiding major vegetable oil exporting countries in devising policies to enhance their vegetable oils competitiveness.

3. Methods and Materials

This research utilized secondary data spanning from 1990 to 2022, encompassing information on import value (UNCOMTRADE), import quantity (UNCOMTRADE), real price of crude oil (World Bank), and population (World Bank). The data consisted of annual figures for prominent vegetable oils traded globally, specifically palm oil, soybean oil, and sunflower oil. The selection of these three types of leading vegetable oil was based on their significant market share and consistent availability over the years. The research employed the HS codes for crude palm oil (151110), soybean oil (150710), and sunflower oil (151211). According to UNCOMTRADE (2023) data, the trade in vegetable oils was primarily dominated by sunflower oil (28.77%), followed by soybean oil (21.98%), coconut oil (12.41%), and palm oil (12.04%) in 1990. The dominance of palm oil in the international vegetable oil trade continued to grow, reaching its peak in 2022 with the largest share (28.92%), followed by sunflower oil (27.86%) and soybean oil (20.40%).

The rest of the world's vegetable oil referred to in this research is the average of vegetable oils other than palm oil, soybean oil and sunflower oil. The HS code of these other vegetable oils include 150810 (peanut oil), 150910 (olive oil), 151221 (cottonseed oil), 151311 (coconut oil), 151511 (linseed oil), 151521 (corn oil), 151411 (canola oil), 151530 (castor oil), 151550 (sesame oil). Table 1 shows the value and share of world vegetable oil trade in 1990 and 2022.

This research utilized the Almost Ideal Demand System (AIDS) model, a framework developed by Deaton and Muellbauer. This model is characterized by its capacity to present a first-order approach to a demand system, where budget share is a linear function of the logarithm of total income. Moreover, it adheres accurately to the axioms of commodity selection behavior and can aggregate consumer behavior without relying on a linear Engel curve. The AIDS model enables the testing of homogeneity and symmetry restrictions through linear resistance to fixed parameters, and it facilitates precise and reflective estimation of elasticities (Deaton and Muellbauer, 1980).

Table 1. Import Value and Share of World Vegetable Oil Trade in 1990 and 2022

Type of Vegetable Oil	1990		2022	
	Import Value (US$)	Share (%)	Import Value (US$)	Share (%)
Peanut oil	41,343,766	3.07	654,209,165	1.38
Olive oil	136,174,318	10.11	43,184,887	0.09
Cottonseed oil	15,446,864	1.15	19,169,023	0.04
Coconut oil	167,124,086	12.41	1,774,029,587	3.74
Linseed oil	33,040,128	2.45	197,979,355	0.42
Corn oil	54,985,546	4.08	0	0.00
Soybean oil	295,949,414	21.98	9,686,090,327	20.40
Palm oil	162132169	12.04	13,732,688,753	28.92
Sunflower oil	387422782	28.77	13,230,006,516	27.86
Canola oil	0	0.00	6,621,346,252	13.94
Castor oil	38,952,387	2.89	1,204,607,296	2.54
Sesame oil	14,085,401	1.05	322,194,974	0.68

Source: UNCOMTRADE (2023).

The AIDS model is used to analyze competition between the world's leading vegetable oils (palm oil, soybean oil, and sunflower oil). The estimation method for estimating coefficients (parameters) in the linear AIDS (LA/AIDS) model used the Seemingly Unrelated Regression (SUR) method with the following basic model:

$$Si = \alpha_i + \sum_{i=1}^{n} \gamma_{ij}\, lnp_j + \beta i\; ln\left(\frac{M}{P^*}\right) + \sum \theta i\; lnZ + e_i \tag{1}$$

Dimana:

S = Export share of vegetable oil i in the world

P = Price of vegetable oil i

M = Total import value

P* = Geometric mean price index stone = ∑wi.pi

Z = Other variables that affect trade

The vegetable oil demand model was as follows:

$$\begin{aligned} S_{PO} = \alpha_1 + \gamma_{11}\; ln\, P_{PO} \\ + \gamma_{12}\; ln\, P_{SO} \\ + \gamma_{13}\; ln\, P_{SFO} \\ + \gamma_{14}\; ln\, P_{RW} + \beta_1\; ln\left(\frac{M}{P^*}\right) + \theta_1\; ln\, PCO \\ + \theta_2\; ln\, POP + e_1 \end{aligned} \tag{2}$$

$$S_{SO} = \alpha_2 + \gamma_{21}\ ln\,P_{PO} + \gamma_{22}\ ln\,P_{SO} + \gamma_{23}\ ln\,P_{SFO} + \gamma_{24}\ ln\,P_{RW} + \beta_2\ ln\left(\frac{M}{P^*}\right) + \theta_1\ ln\,PCO + \theta_2\ ln\,POP + e_2 \quad (3)$$

$$S_{SFO} = \alpha_3 + \gamma_{31}\ ln\,P_{PO} + \gamma_{32}\ ln\,P_{SO} + \gamma_{33}\ ln\,P_{SFO} + \gamma_{34}\ ln\,P_{RW} + \beta_3\ ln\left(\frac{M}{P^*}\right) + \theta_1\ ln\,PCO + \theta_2\ ln\,POP + e_3 \quad (4)$$

where:

S_i	=	Export share of vegetable oil i in the world
P_i	=	Price of vegetable oil i (US$/Kg)
M	=	Total value of vegetable oil import (US$)
P^*	=	Geometric mean price index stone = $\sum w_i.p_i$
PCO	=	Real-world crude oil price (US$/barrel)
POP	=	Population (Billian people)
e_i	=	*Error*
i	=	PO=palm oil, SO=soybean oil, SFO=sunflower oil, RW= the rest of the world's vegetable oil

Moschini (1995) suggests using a corrected stone price index that uses a log-linear version of the Laspeyres index as follows:

$$lnP^* = \sum_{i=1}^{n} S_i \ln\frac{P_{it}}{P_t^0} \quad (5)$$

The above equations are constrained using homogeneity and symmetry conditions. The model inherently accommodates aggregation, representing one of the benefits of the AIDS model. Data processing for the AIDS model used the STATA 14 application. The regression coefficients in the model was determined by using the Seemingly Unrelated Regression (SUR) method. This research used elasticity values of the AIDS parameters to describe the impact of economic shocks on the competitiveness of world vegetable oils.

The elasticity values in this research were: (1) own price elasticity, (2) cross-price elasticity, and (3) expenditure elasticity. These elasticities are calculated based on the following formula (Rifin, 2010):

Own price elasticity $: e_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{s_i} - \beta_i \left(\frac{s_j}{s_i}\right)$ (6)

Cross price elasticiy $: e^*_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{s_i} + s_j$ (7)

Expenditure elasticity $: \eta_i = 1 + \frac{\beta_i}{w_i}$ (8)

where:

δ	=	knocker delta (where δij = 1 and δij = 0 for i is not equal to j)
$\hat{y}_{ij}$	=	parameter for the export price of vegetable oil i
β_i	=	Parameter for the value of expenditure on vegetable oil i
s_i	=	Share vegetable oil i
s_j	=	Share of another type of vegetable oil

The own-price elasticity was calculated using the uncompensated or Marshallian formula (6). The cross-price elasticity was determined using the compensated or Hicksian formula (7) to depict competition among leading vegetable oil oil exporters. The expenditure elasticity was represented by formula (8). To assess the impact of changes in the price of crude oil on leading vegetable oil competitiveness position, elasticity value was calculated following the approach outlined (Kautsoyiannis, 1977):

$$E = \frac{\partial Y_t}{\partial Xi_t} \frac{\mathrm{Xi}}{Y} = \beta \frac{Xi}{Y} \tag{9}$$

where:

E : Short-term elasticity

β : Estimated parameter value for explanatory variable i

X_i : Mean value of explanatory variable i

Y : Mean value of endogenous variable

4. Results and Discussion

4.1 Factors Influencing the Competitiveness of World Vegetable Oil

The AIDS model estimation results were used to investigate factors influencing the vegetable oils demand for in international market. The estimation results of the global vegetable oil AIDS model are presented in Table 2. The R-square value of the palm oil equation was 81.3 percent. This value means that the variation in the proportion (share) of palm oil imports could be explained by the independent variables in the model, amounting to 81.3 percent, while the remaining 18.7 percent was explained by other independent variables outside the model. The R-square value of the soybean oil equation was 60.5 percent. This value means that the variation in the proportion (share) of soybean oil imports could be explained by the independent variables in the model of 60.5 percent, while the remaining

39.5 percent was explained by other independent variables outside the model. The R-square value of the sunflower oil equation was 92.07 percent. This value means that the variation in the proportion (share) of sunflower oil imports could be explained by the independent variables in the model amounting to 92.07 percent, while the remaining 7.93 percent was explained by other independent variables outside the model.

Table 2. The Estimation Results of AIDS Model for Leading Vegetable Oil

Variable	Palm Oil	Soybean Oil	Sunflower Oil
Constant	-1.446	-0.426	1.845
Palm oil price	0.098	-0.081***	0.034
Soybean oil price	-0.051	0.012	0.150*
Sunflower oil price	0.103	-0.009	-0.028
Other vegetable oil price	-0.301*	-0.002	0.032
Expenditure	0.087*	0.089*	-0.148*
Crude oil price	0.041**	-0.009	-0.035*
Population	-0.069	-0.614*	0.809*
RMSE	0.034	0.026	0.012
R Square	0.813	0.606	0.921
P-Value	0.000	0.000	0.000

Source: Research finding.

Note: * significant at 1%, ** significant at 5%, *** significant at10%.

Apart from a high R-square value, other measures of the goodness of the model were a small RMSE value (close to 0) and the significance of the F statistical p-value. The three equations had small RMESE values (close to 0), namely 0.034 for the palm oil equation, 0.026 for the soybean oil equation and 0.012 for the sunflower oil equation. The P-value F statistic obtained was significant at the 1 percent real level. This value means that the independent variables together could explain the dependent variable, namely the variable proportion (share) of imports of leading vegetable oil.

Variables that had a significant influence on the market share of palm oil were the price of other vegetable oils, expenditure and the price of crude oil. The variables that significantly influence the share of soybean oil were palm oil prices, expenditure and population. The variables that significantly influence the share of sunflower oil were the price of soybean oil, expenditure, crude oil prices and population.

4.2 Impact of Economic Changes on the Competitiveness of World Vegetable Oils

The results of price and expenditure elasticity of demand for leading vegetable oils are presented in Table 3. Table 3 shows that the own price elasticity of soybean oil was -1.040 (elastic), meaning that a 1 percent increase in the price of soybean oil can reduce soybean oil share by 1.040 percent. The price elasticity of palm oil was -0.670 (inelastic), meaning that a 1 percent increase in the price of palm oil can reduce the palm oil share by 0.670 percent. The own price elasticity of sunflower oil was -1.024 (elastic), meaning that an increase in the price of sunflower oil by 1 percent can reduce sunflower oil by 1.024 percent.

The cross price elasticity of soybean oil was negative with palm oil, namely -0.104 (complement), but positive with sunflower oil, namely 0.119 (substitution), and other vegetable oils, namely 0.359 (substitution). An increase in palm oil prices of 1 percent can reduce the share of soybean oil by 0.104 percent. An increase in the price of sunflower oil by 1 percent can increase soybean oil share by 0.119 percent. An increase in the price of other vegetable oils can increase soybean oil's share by 0.359 percent.

Table 3. Price and Expenditure Elasticities of Leading Vegetable Oil

Share	Price elasticity				Expenditure Elasticity
	Soybean Oil	Palm Oil	Sunflower Oil	Other Vegetable Oil	
Soybean oil	-1.040	-0.104	0.119	0.359	1.375
Palm oil	0.023	-0.670	0.598	-0.916	1.372
Sunflower oil	1.180	0.447	-1.024	0.570	0.074

Source: Research finding.

The cross-price elasticity of palm oil exhibited a positive correlation with soybean oil, specifically 0.023 (indicating substitution), and with sunflower oil, at 0.598 (also indicating substitution). Conversely, the elasticity was negative with other vegetable oils, specifically -0.916 (indicating complement). A 1 percent increase in soybean oil price resulted in a 0.023 percent increase in palm oil share. Similarly, a 1 percent increase in sunflower oil price led to a 0.598 percent increase in palm oil share. Conversely, a 1 percent increase in other vegetable oils price resulted in a 0.916 percent decrease in palm oil share.

The cross price elasticity of sunflower oil was positive with soybean oil, namely 1.180 (substitution), palm oil, namely 0.447 (substitution) and other vegetable oils, namely 0.570 (substitution). A 1 percent increase in soybean oil price can increase sunflower oil share by 1.180 percent. A 1 percent increase in the price of palm oil can increase sunflower oil share by 0.447 percent. A 1 percent increase in other vegetable oils price can increase sunflower oil share by 0.570 percent.

The elasticity of soybean oil expenditure was 1.375, meaning that an increase in world expenditure of 1 percent will increase soybean oil share by 1.375 percent. The elasticity of palm oil expenditure was 1.372, meaning that an increase in world expenditure of 1 percent will increase the share of palm oil by 1.372 percent. The expenditure elasticity for sunflower oil was 0.074, meaning that an increase in world income of 1 percent will increase sunflower oil share by 0.074 percent.

The price elasticity of crude oil for palm oil was 10.05, meaning that an increase in crude oil price by 1 percent will increase palm oil share by 10.05 percent. The price elasticity of crude oil for soybean oil was -2.14, meaning that an increase in crude oil prices of 1 percent will reduce the soybean oil share by 2.14 percent. The price elasticity of crude oil for sunflower oil was -12.68, meaning that a 1 percent increase in the price of crude oil will reduce sunflower oil by 12.68 percent. Table 4 shows the effect of crude oil shock on the leading vegetable oil competitiveness in international trade.

Table 4. Impact of Changes in Crude Oil on the Competitiveness of Leading Vegetable Oil

Share	Crude Oil Price Elasticity
Palm oil	10.055
Soybean oil	-2.146
Sunflower oil	-12.679

Source: Research finding.

4.3 Discussion

As a vegetable oil with the largest share in the world vegetable oil trade, palm oil price can influence the competitiveness of world soybean oil. On the other hand, soybean oil with the third largest share in world vegetable oil trade, can influence the competitiveness of sunflower oil, with the second largest share in world vegetable oil trade. Even though palm oil is the leading vegetable oil with the largest share, the competitiveness of palm oil is also influenced by the prices of other vegetable oils. This proves that there is interconnectedness in the vegetable oil market.

The price elasticity of palm oil is inelastic, while soybean oil and sunflower oil are elastic. This situation is favorable for palm oil because world demand for palm oil is not responsive to changes in palm oil prices. Palm oil prices are the most competitive. Even though there has been an increase in the price of palm oil, the price of palm oil is still lower when compared to other vegetable oils. Figure 1 shows the development of world vegetable oil prices.

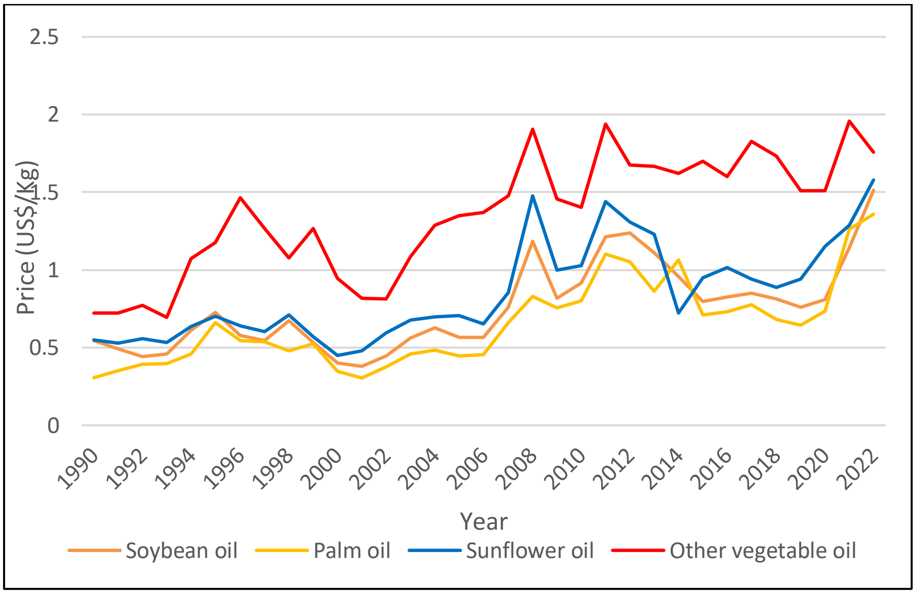


Figure 1. Price of World Leading Vegetable Oil
Source: UNCOMTRADE (2023).

Table 5 explains the relationship between vegetable oils based on cross-price elasticity values. The research results showed that competition between types of vegetable oils is sometimes two-way. The two-way competitive relationship only occurs between palm oil and sunflower oil and between soybean oil and sunflower oil. Palm oil is a complement to soybean oil, whereas soybean oil is a competitor to palm oil. Soybean oil's competitiveness decreases when the price of palm oil increases, while palm oil's competitiveness decreases when the price of other vegetable oils increases. The results of this research strengthen the results of research by Santeramo and Searle (2019) that an increase in the price of soybean oil can encourage an increase in the supply of palm oil. It is also in line with the research results of Bentivoglio et al. (2018) which show that in the long term, the price of soybean oil has a positive and significant effect on Indonesian palm oil production.

The elasticity of expenditure for soybean oil was 1,375, palm oil was 1,372, and sunflower oil was 0,074. Vegetable oils that will benefit most from the increase in world income are soybean oil and palm oil. The research results of Zhao et al. (2021) show that soybean oil has the highest vitamin E content when compared to sunflower oil and palm oil. Soybean oil also has a high level of suitability for human fatty acid needs. So, it is recommended for consumption. However, the productivity of soybean oil is lower compared to palm oil, while increasing income can increase the need for the use of oleochemical-based ingredients in the food industry, pharmaceuticals, shortening, and cosmetics. Palm oil requires 2.42 m^2 to produce 1 kg of oil, soybean oil requires 10.52 m^2, and sunflower oil requires 17.66 m^2 (Ministry of Foreign Affairs of the Republic of Indonesia, 2020). Therefore, increasing world income encourages an increase in the competitiveness of soybean oil as a vegetable oil that has a better level of suitability in meeting human fatty acid needs, and palm oil as a vegetable oil with the highest productivity.

Table 5. The Relationship among Leading Vegetable Oil Based on Cross-Price Elasticity

Share	Type of Relationship			
	Soybean Oil	**Palm Oil**	**Sunflower Oil**	**Other Vegetable Oil**
Soybean oil	-	complement	competitive	competitive
Palm oil	competitive	-	competitive	complement
Sunflower oil	competitive	competitive	-	competitive

Source: Research finding.

The price elasticity of crude oil towards the share of vegetable oil is 10.05 for palm oil, -2.14 for soybean oil, and -12.68 for sunflower oil. It means that an increase in crude oil prices can increase the competitiveness of world palm oil but reduce the competitiveness of world soybean oil and sunflower oil. US Energy Information Administration (2023) data shows that the three leading exporting countries of soybean oil are the leading producers of biofuel, namely Brazil, the USA, and Argentina. The leading exporting countries of palm oil, which are the leading producers of biofuel, are Indonesia and Thailand. The biofuel production of the leading exporter of soybean oil is greater than that of the leading exporter of palm oil. The development of the biofuel industry in the leading exporting countries of soybean oil and sunflower oil has caused more vegetable oil to be used for domestic needs. So, this has resulted in the decrease of exports of crude vegetable oil. The increase in crude oil prices causes a greater decline in the competitiveness of sunflower oil compared to soybean oil. The biofuel industry of the main exporting countries of soybean oil, namely Brazil and the USA, has already developed, while the biofuel industry of the main exporting countries of sunflower oil is starting to grow, namely Argentina and Franc. The main exporter of sunflower oil, namely Ukraine, also produces biofuel even though it is not a major producer. Table 6 shows the world's leading producers of biofuels.

Table 6. The Production of World-Leading Biofuel Producers

Country	Year 1990		Year 2021	
	Production (Mb/d)	**Share (%)**	**Production (Mb/d)**	**Share (%)**
Indonesia	0	0	164	6.25
Thailand	0	0	51	1.94
Argentina	0	0	51	1.94
Brazil	203	79.60784	569	21.68
USA	49	19.21569	1129	43.03
Netherland	0	0	36	1.37
France	0	0	44	1.68
China	0	0	98	3.73
Germany	0	0	70	2.67
India	0	0	54	2.06

Source: US Energy Information Administration (2023).

The increase in palm oil competitiveness due to the increase in crude oil prices can indicate two things. First, the development of the biofuel industry in the leading exporting countries of palm oil has been slower than the leading exporting countries of soybean oil and sunflower oil. Second, according to Balat (2011), palm oil has the highest contribution to biofuel production, which is 4.736 liters/ha, while sunflower oil is 952 liters/ha, and soybean oil is 6.32 liters/ha. Therefore, an increase in world crude oil prices can increase world demand for palm oil as a raw material for biofuel. US Energy Information Administration (2023) data shows that several leading importing countries of palm oil are leading producers of biofuel, namely India, the Netherlands, Germany, China, Franc. Even though it is not a major importer, US also continuously imports palm oil. Besides, palm oil has the most competitive price compared to other vegetable oils as a raw material for biofuel.

As Santeramo and Searle (2019) stated, the increasing demand for soybean oil as a biofuel raw material in the US can increase the price of soybean oil. The impact of increasing palm oil imports as a result of increasing soybean oil prices is greater than the impact of increasing soybean oil production as a result of increasing soybean oil prices. Therefore the US biofuel policy can contribute to increasing the area of oil palm. Almost the same thing also happens in the EU, where the biofuel development policy in the EU creates competition between rapeseed oil produced in the EU and imported palm oil, which has a lower price as a raw material for biofuel (Bentivoglio et al., 2018).

The consequence of increasing the competitiveness of palm oil due to increasing crude oil prices is increasing competition between food and energy needs, especially in palm oil exporting countries. Pal and Mitra (2018) explained that fluctuations in crude oil prices cause fluctuations in food prices, where crude oil prices are positively correlated with food prices (Judit et al., 2017). The important role of crude oil volatility is also emphasized by Sayadi et al. (2022) in the industry market and by Bala and Chin (2020) in economic growth.

5. Conclusion

The relationship between leading vegetable oils can be seen from how palm oil price significantly influences the competitiveness of world soybean oil, soybean oil price significantly influences the competitiveness of sunflower oil, and other vegetable oils price significantly influence the competitiveness of palm oil. Expenditure significantly affects soybean oil, palm oil and sunflower oil competitiveness. Crude oil prices significantly influence the competitiveness of palm oil and sunflower oil, while population significantly influences the competitiveness of soybean oil and sunflower oil.

The increase in world vegetable oil prices, crude oil prices and income have different influences on each of the leading vegetable oil. The increase in world vegetable oil prices benefits the competitive position of palm oil because the own price elasticity for palm oil is inelastic (-0.670). The relationship between vegetable oils is somewhat competitive. Palm oil is a complement to soybean oil (cross price elasticity of soybean oil was -0.104 with palm oil), but not vice versa (cross price elasticity of palm oil was 0.023 with soybean oil). Increasing world income benefits the competitiveness of soybean oil (elasticity of soybean oil expenditure was 1.375) and palm oil (elasticity of palm oil expenditure was 1.372). The increase in crude oil prices benefits palm oil's competitive position (crude price elasticity of palm oil was 10.055) because soybean oil and sunflower oil are used to meet the needs of the domestic biofuel industry.

Research finding conclude that global economy changes can have a significant impact on the competitiveness of vegetable oils. Understanding the competitiveness of vegetable oils provides valuable insights into the sustainability of biofuel development. The leading exporting countries of palm oil need to improve their palm oil quality, while the leading exporting countries of soybean oil need to increase their productivity to be able to win the competition. The world demand for palm oil as a vegetable oil with the highest productivity in producing biofuel increases along with increases in crude oil prices, resulting in increasing competition between food and energy needs, especially in palm oil exporting countries. The development of the world biofuel industry needs to pay attention to the availability of palm oil because the biofuel industry of the leading exporting countries of palm oil is emerging so that in the future, more palm oil will be destined for the domestic needs of the leading exporting countries of palm oil.

Statements and Declarations

- Funding: All authors gratefully acknowledge the Ministry of Agriculture and the National Research and Innovation Agency, Indonesia, for financially supporting the education study of the first author.

- Conflict of interest: The authors declare that there is no conflict of interest.

References

Abbasian, M., Shahraki, A. S., & Shahraki, J. (2019). The Modeling and Comparison of GMDH and RBF Artificial Neural Networks in Forecasting Consumption of Petroleum Products in the Agricultural Sector. *Iranian Journal of Economic Studies, 8*(1), 91–105. Retrieved from http://journals.shirazu.ac.ir/article_5021_afe15c0244f306882f7fbe8cb94b0c5c.pdf

Abbasian, M., Shahraki, A. S., & Tabar, M. H. (2019). The Relationship Between Financial Development and International Trade in Countries Selected for Outlook 1404. *Quarterly Journal of The Macro and Strategic Policies, 7*(27), 396–409. Retrieved from http://dx.doi.org/10.32598/JMSP.7.3.4.

Ahmad, M. Y., Seng, K. W. K., & Kamarulzaman, N. H. (2022). Selected Factors Influencing China's Palm Oil Import Demand from Malaysia. *Agraris Journal of Agribusiness and Rural Development Research, 8*(2), 261–274. Retrieved from http://dx.doi.org/10.18196/AGRARIS.V8I2.15511.

Alam, I. A., Hairani, & Singagerda, F. S. (2019). Price Determination Model of World Vegetable and Petroleum. *International Journal of Energy Economics and Policy, 9*(5), 157–177. Retrieved from http://dx.doi.org/10.32479/ijeep.7916.

Anindita, R., Amalina, F., Sa'diyah, A. A., Khoiriyah, N., & Muhaimin, A. W. (2022). Food Demand for Carbohydrate Sources: Linear Approximation-Almost Ideal Demand System/LA-AIDS Approach. *International Journal of Horticulture, Agriculture, and Food Science, 6*(2), 11–19. Retrieved from http://dx.doi.org/10.22161/ijhaf.6.2.

Arancibia, R. G., & Guiguet, E. D. (2020). Brazilian Import Demand of Dairy Products with Emphasis in the Mercosul Context. *Nova Economia, 30*(2), 551–577. Retrieved from http://dx.doi.org/10.1590/0103-6451/4946.

Bala, U., & Chin, L. (2020). Asymmetric Impacts of Oil Price Shocks on Malaysian Economic Growth: Nonlinear Autoregressive Distributed Lag Approach. *Iranian Economic Review, 24*(4), 959–981. Retrieved from https://ier.ut.ac.ir/article_78830.html.

Balat, M. (2011). Potential Alternatives to Edible Oils for Biodiesel: A Review of Current Work. *Energy Conversion and Management, 52*(2), 1479–1492. Retrieved from http://dx.doi.org/10.1016/j.enconman.2010.10.011.

Bentivoglio, D., Finco, A., & Bucci, G. (2018). Factors Affecting the Indonesian Palm Oil Market in Food and Fuel Industry: Evidence from a Time Series Analysis. *International Journal of Energy, Economics and Policy, 8*(5), 49–57. Retrieved from https://savearchive.zbw.eu/bitstream/11159/2614/1/1046054023.pdf.

Brummer, B., Korm, O., Schlubler, K., & Jaghdani, T. J. (2015). Volatility in Oilseeds and Vegetable Oils Markets: Drivers and Spillovers. *Journal of Agricultural Economics,* 1–21. Retrieved from http://dx.doi.org/10.1111/1477-9552.12141.

Ceylan, F. B. T. (2019). Economic Crisis and Consumption: an Almost Ideal Demand System Estimation for Turkey with Time-Varying Parameters. *Development Studies Research, 6*(1), 13–29. Retrieved from http://dx.doi.org/10.1080/21665095.2019.1566012.

Council of Palm Oil Producing Countries. 2021. *Palm Oil Supply And Demand Outlook Report 2021*. Retrieved February 1, 2023, from https://www.cpopc.org/wp-content/uploads/2020/12/2021-PO-SUPPLY-AND-DEMAND-OUTLOOK-REPORT-1.pdf.

Deaton, A., & Muellbauer, J. (1980). *Economics and Consumer Behaviour*. New York: Cambridge University Press.

Filassi, M., & De Oliveira, A. L. R. (2022). Competitiveness Drivers for Soybean Exportation and Fundamental Role of the Supply Chain. *Revista de Economia e Sociologia Rural, 60*(3), 1–22. Retrieved from http://dx.doi.org/10.1590/1806-9479.2021.235296.

Fitrianti, W., Syaukat, Y., Hartoyo, S., & Fariyanti, A. (2019). The Spillover Effect of Shocks of Fundamental Factors and Speculative Activity on Prices Volatility of World Vegetable Oil. *International Journal of Economics and Financial Issues, 9*(2), 230–240. Retrieved from http://dx.doi.org/10.32479/ijefi.7621.

Forgenie, D., Khoiriyah, N., Mahase-Forgenie, M., & Adeleye, B. N. (2023). An Error-Corrected Linear Approximate Almost Ideal Demand System Model for Imported Meats and Seafood in Indonesia. *Heliyon, 9*(e21390). Retrieved from http://dx.doi.org/10.1016/j.heliyon.2023.e21390.

Gaskell, J. C. (2015). The Role of Markets, Technology, and Policy in Generating Palm-Oil Demand in Indonesia. *Bulletin of Indonesian Economic Studies, 51*(1), 29–45. Retrieved from http://dx.doi.org/10.1080/00074918.2015.1016566.

Gomes, G., Hache, E., Mignon, V., & Paris, A. (2018). On the Current-Biofuels Link in Emerging and Developing Countries: Do Oil Price Fluctuations Matter? *Energy Policy*, *116*, 60–67. Retrieved from http://dx.doi.org/10.1016/j.enpol.2018.01.054.

Hamulczuk, M., Makarchuk, O., & Kuts, T. (2021). Time-varying Integration of Ukrainian Sunflower Oil Market with the EU Market. *Agris On-Line Paper Economics and Informatics*, *XIII*(3), 35–48. Retrieved from http://dx.doi.org/10.7160/ao1.2021.130304.

Hina, H., Faisal, A., & Qayyum, U. (2022). Selecting Correct Functional Form in Consumption Function: An Analysis of Energy Demand at Household Level. *PLoS One 17*(12), 1–25. Retrieved from http://dx.doi.org/10.1371/journal.pone.0270222.

Ismail, N. W., Kamal, S. N. M., Firdaus, M., & Hariri, N. M. (2022). Export Demand of Palm Oil in Malaysia: Analysis Using ARDL Approach. *Asian Journal Agricultural and Rural Development, 12*(3), 157–163. Retrieved from http://dx.doi.org/10.55493/5005.v12i3.4531.

Judit, O., Peter, L. Y., Peter, B., Monika, H. R., & Jozsef, P. (2017). The Role of Biofuels in Food Commodity Prices Volatility and Land Use. *Journal of Competitiveness, 9*(4), 81–93. Retrieved from http://dx.doi.org/10.7441/joc.2017.04.06.

Kautsoyiannis, A. (1977). *Theory Of Econometrics: An Introductory Exposition of Econometrics Methods*. London: The Macmillan Press.

Kea, S., Li, H., Shahriar, S., & Abdullahi, N. M. (2020). Relative Export Competitiveness of the Cambodian Rice Sector. *British Food Journal, 122*(12), 3757–3778. Retrieved from http://dx.doi.org/10.1108/BFJ-12-2019-0950.

Khalilian, S., & Yuzbashkandi, S. S. (2021). Analysis of Vegetable Oil Demand and Its Price Reform in Iran: Using Rural and Urban Household Level Data. *International Journal of Agriculture, Environment and Food Sciences, 5*(1), 122–132. Retrieved from http://dx.doi.org/10.31015/jaefs.2021.1.15.

Khan, S., Khan, S. A., Kamal, M. A., & Syed, A. A. (2023). Competitiveness Analysis of Pakistan's Cotton Yarn Exports Relative to India and USA: A Demand System Application with Focus on China's Market. *Global Business Review, 0*(0). Retrieved from http://dx.doi.org/10.1177/09721509231199302.

Kharisma, B., Alisjahbana, A. S., Remi, S. S., & Praditya, P. (2020). Application of the Quadratic Almost Ideal Demand System (QUAIDS) Model in the Demand of the Household Animal-Sourced Food in West Java. *Agris On-Line Papers in Economics and Informatics, XII*(1), 23–35. Retrieved from https://ageconsearch.umn.edu/record/303932/files/442_agris-on-line-2020-1-kharisma-alisjahbana-remi-praditya.pdf.

Kiani, S., Shahraki, J., Shahraki, A. S., & Akbari, A. (2017). Application of Double-Bounded Dichotomous Choice Contingent Valuation to Study the Possibility of Using New Energy in Iran's Power Generation. *Iranian Energy Economics Research, 6*(22). Retrieved from http://dx.doi.org/10.22054/jiee.2017.7998.

Kutortse, D. K. (2022). Residential Energy Demand Elasticity in Ghana: an Application of the Quadratic Almost Ideal Demand Systems (QUAIDS) Model. *Cogent Economics and Finance. 10*(2082670), 1–22. Retrieved from http://dx.doi.org/10.1080/23322039.2022.2082670.

Lajdova, Z., Kapusta, J., & Bielik, P. (2017). Assessing Interdependencies between Food and Energy Prices: the Case of Biodiesel in Germany. *Agris On-Line Papers in Economics and Informatics*, *IX*(3), 51–59. Retrieved from https://ageconsearch.umn.edu/record/263956/files/Assessing%20Interdependencies%20Between%20Food%20and%20Energy%20Prices%3A%20The%20Case%20of%20Biodiesel%20in%20Germany_2.pdf.

Lucotte, Y. (2016). Co-movements between Crude Oil and Food Prices: a Post-Commodity Boom Perspective. *Economics Letters, 147*, 142–147. Retrieved from http://dx.doi.org/10.1016/j.econlet.2016.08.032.

Ministry of Foreign Affairs of the Republic of Indonesia. (2020). *Contribution of Vegetable Oils towards Sustainable Development Goals: A Comparative Analysis*. Retrieved February 1, 2023, from https://kemlu.go.id/download.

Montania, C. V., Nunez, T. F., & Marquez, M. A. (2021). The role of the Leading Exporters in the Global Soybean Trade. *Agricultural Economics-Czech, 67*(7), 277–285. Retrieved from http://dx.doi.org/10.17221/443/2020-AGRICECON.

Moschini, G. (1995). Units of Measurement and the Stone Index in Demand System Estimation. *American Journal of Agricultural Economics, 77*(1), 63–68. Retrieved from https://www.jstor.org/stable/pdf/1243889.pdf.

Narayan, S., & Bhattacharya, P. (2019). Relative Export Competitiveness of Agricultural Commodities and Its Determinants: Some Evidence from India. *World Development, 117*, 29–47. Retrieved from http://dx.doi.org/10.1016/j.worlddev.2018.12.013.

Onyeneke, R.U., Emenekwe, C. C., Amadi, M. U., Munonye, J. O., Njoku, C. L., & Izuogu, C. U. (2020). Demand Analysis of Rice in Nigeria: Application of Quadratic Almost Ideal Demand System Model. *Asian Journal of Agriculture and Rural Development, 10*(1), 364–378. Retrieved from http://dx.doi.org/10.18488/journal.1005/2020.10.1/1005.1.364.378.

Pal, D., & Mitra, S. K. (2018). Interdependence between Crude Oil and World Food Prices: A Detrended Cross Correlation Analysis. *Physica A, 492,* 1032–1044. Retrieved from http://dx.doi.org/10.1016/j.physa.2017.11.033.

Paris, A. (2018). On the Link between Oil and Agricultural Commodity Prices: Do Biofuels Matter? *International Economics, 155*, 48–60. Retrieved from http://dx.doi.org/10.1016/j.interco.2017.12.003.

Paula, M. F. D., Angelo, H., Santos, A. J., Almeida, A. N. D., Vasconcelos, P. G. D. A., Schwans, A., Miguel, E. P., & Ribas, A. J. F. (2018). Competitiveness of Brazilian Soybean Exports. *African Journal of Agricultural Research, 13*(44), 2499–2509.

Pilorge, E. (2020). Sunflower in the Global Vegetable Oil System: Situation, Specificities and Perspectives. *Oilseeds Fats Crop and Lipids, 27*(34), 1–11. Retrieved from http://dx.doi.org/10.1051/ocl/2020028.

Purba, H. J., Sinaga, B. M., Novianti, T., & Kustiari, R. (2018). The Impact of Changes in External Factors on The World Vegetable Oil Market. *International Journal of Economics and Financial Issues, 8*(6), 176–186. Retrieved from http://dx.doi.org/10.32479/ijefi.7069.

Rathnayaka, S. D., Selvanathan, S., Selvanathan, E. A., & Kler, P. (2019). Modelling Sri Lankan Consumption Patterns Using Corrected LA-AIDS. *Economic Modelling, 80*, 185–191. Retrieved from http://dx.doi.org/10.1016/j.econmod.2018.11.006.

Rifin, A. (2010). An Analysis of Indonesia's Palm Oil Position in the World Market: a Two-Stage Demand Approach. *Oil Palm Industry Economic Journal, 10*(1), 35–42. Retrieved from https://www.researchgate.net/

Santeramo, F. G., Gioia, L. D., & Lamonaca, E. (2021). Price Responsiveness of Supply and Acreage in the EU Vegetable Oil Markets: Policy Implications. *Land Use Policy*, *101*(105102), 1–16. Retrieved from http://dx.doi.org/10.1016/j.landusepol.2020.105102.

Santeramo, F. G., & Searle, S. (2019). Linking Soy Oil Demand from the US Renewable Fuel Standard to Palm Oil Expansion Through an Analysis on Vegetable Oil Price Elasticities. *Energy Policy, 127,* 19–23. Retrieved from http://dx.doi.org/10.1016/j.enpol.2018.11.054.

Sayadi, M., Rafei, M., & Syekha, Y. (2022). Asymmetric Volatility Spillovers of Oil Price and Exchange Rate on Chemical Stocks: Fresh Results from a VAR-TBEKK-in-Mean Model for Iran. *Iranian Economic Review, 26*(4), 885–904. Retrieved from http://dx.doi.org/10.22059/IER.2021.81545.

Schaefer, K. A., Myers, R. J., Johnson, S. R., Helmar, M. D., & Radich, T. (2022). Biodiesel Feedstock and Crude Oil Price Relationship-the Effects of Policy and Shale Oil Expansion. *Agricultural and Resource Economic Review, 51*, 222–239. Retrieved from http://dx.doi.org/10.1017/age.2022.6.

Selvanathan, S., Jayasinghe, M., Selvanathan, E., & Rathnayaka, S. D. (2023). Dynamic Modelling of Consumption Patterns Using LA-AIDS: a Comparative Study of Developed Versus Developing Countries. *Empirical Economics*. Retrieved from http://dx.doi.org/10.1007/s00181-023-02465-z.

Shang, Y., Cai, H., & Wei, Y. (2022). The Impacts of Infectious Disease Pandemic on China's Edible Vegetable Oil Futures Markets: a Long-Term Perspective. *Economic Research-Ekonomska Istrazivanja,* 1–20. Retrieved from http://dx.doi.org/10.1080/1331677X.2022.2119425.

Siddique, M. A. B., Salam, M. A., & Rahman, M. C. (2020). Estimating the Demand Elasticity of Rice in Bangladesh: an Application of the AIDS Model. *Asian Journal of Agriculture and Rural Development, 10*(3), 721–728. Retrieved from http://dx.doi.org/10.18488/journal.ajard.2020.103.721.728.

Taheripour, F., & Tyner, W. E. (2020). US Biofuel Production and Policy: Implications for Land Use Changes in Malaysia and Indonesia. *Biotechnology for Biofuels, 13*(11), 1–17. Retrieved from http://dx.doi.org/10.1186/s13068-020-1650-1.

Thompson, W., Meyer, S., & Green, T. (2010). The US Biodiesel Use Mandate and Biodiesel Feedstock Markets. *Biomass and Bioenergy, 34*, 883–889. Retrieved from http://dx.doi.org/10.1016/j.biombioe.2010.01.033.

UNCOMTRADE. (2023). *UNCOMTRADE Database*. Retrieved February 1, 2023, from https://comtradeplus.un.org/.

US Energy Information Administration. (2023). *Biofuels Production*. Retrieved September 1, 2023, from https://www.eia.gov/international/data/world/biofuels/biofuels-production?.

World Bank. (2023). GDP Growth (Annual %) All Countries and Economies. Retrieved February 1, 2023, from https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG.

---------- (2022). Commodity Market Outlook: The Impact of the War in Ukraine on Commodity Markets. Washington, DC: World Bank. Retrieved February 1, 2023, from https://openknowledge.worldbank.org/entities/publication/4f55f6a4-a780-5119-8bbf-be6990042c4b.

Zaidi, M. A. S., Karim, Z. A., & Zaidon, N. A. (2022). External and Internal Shocks and the Movement of Palm Oil Price: SVAR Evidence from Malaysia. *Economies, 10*(7), 1–17. Retrieved from http://dx.doi.org/10.3390/economies10010007.

Zhao, X., Xiang, X., Huang, J., Ma, Y., Sun, J., & Zhu, D. (2021). Studying the Evaluation Model of the Nutritional Quality of Edible Vegetable Oil Based on Dietary Nutrient Reference Intake. *ACS Omega, 6*(10), 6691–6698. Retrieved from http://dx.doi.org/10.1021/acsomega.0c05544.

Cite this article: Nugrahapsari, R.A., Harianto, Nurmalina, R., & Fariyanti, A. (2025). The Impact of Economic Shocks on the Competitiveness of Leading Vegetable Oil in the International Market. *Iranian Economic Review, 29*(4), 1393-1415.

Iranian Economic Review, 29(4), 1423-1442
DOI: https://doi.org/10.22059/ier.2024.369602.1007883

RESEARCH PAPER

Foreign Capital Flows and Industrial Output in Selected African Countries

Abubakar Sule[*,a], Raymond Liambee Aor[b], Naomi Onyeje Doki[b], Ibrahim Danlami Mohammed[c]

a. Department of Economics, Faculty of Social Sciences, Kogi State University, Anyigba, Nigeria.
b. Department of Economics, Faculty of Social Sciences, State University, Makurdi, Nigeria.
c. Monetary Policy Department, Central Bank of Nigeria, Abuja, Nigeria.
* Corresponding author.

Received: 14 December 2023, Revised: 26 March 2024, Accepted: 15 April 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
African nations grapple with limited domestic resources due to low tax revenues and savings levels. This necessitated the need to examine the cause of the negative implications and then enhance the positive areas of the impact. The study aims to investigate how institutional quality moderates the impact of foreign financial flows on industrial output, focusing on these top recipients of foreign flows in Africa from 1992 to 2022. We use a panel autoregressive distributed lag modeling approach, which is relevant in evaluating large cross-sections and periods. This allows us to account for both short and long-run dynamics as well as the interaction of capital flows variables and institutional quality. We find that institutional quality has a mediating positive impact on foreign inflows to the industrial performance of the selected countries. For instance, the PMG result for the model without interaction shows that an increase in FDI will lead to a 3.473unit increase in industrial output in the long run. The PMG model with interactions reveals that FDI and FPI exert 13.04unit and 125.4unit impact on industrial output. However, the impact appears to vary based on short and long-run dynamics. The ECM for both models without and with interactions is negatively significant at -0.246% and -0.241%. We equally documented the dynamics of the relationship using country-specific analysis and found similar outcomes, exhibiting mixed outcomes across both short and long-run periods. The findings show that foreign capital flows perform better in an environment of quality institutions with a higher predictive power in the long run.

Keywords: Foreign Direct Investment, Foreign Financial Flows, Foreign Portfolio Investment, Industrialization, Institutional Quality, Official Development Assistance.
JEL Classification: F21, F30, F35, L60, O43.

1. Introduction

Industrial development or industrialization has been identified as a critical component for economic growth. Industrialization enhances productivity, creates employment opportunities by introducing new equipment and technologies, and creates new and stronger sectoral linkages within and among economies. Firms and industries benefit from this as output and earnings increase. There are expected fallouts also of poverty reduction, economic resilience boost, and better responses to external shocks. These ideals are recognized by African leaders, evidenced by the commemoration of African Industrialization Day on the 20th of November, as declared in their 25th Ordinary session held in 1989. Similarly, Agenda 2063, adopted by Heads of States and Governments of the African Union AU in January 2015, is Africa's blueprint to evolve into the powerhouse of the future. The agenda is based on seven aspirations, which include a Prosperous Africa, based on Inclusive Growth and Sustainable Development. The goals and priority areas of this particular aspiration make special room for industrialization, just as the Sustainable Development Goals also do. Further, the AfDB lists the Banks' "High Five" for transforming Africa as Feed Africa, Improve the quality of lives of the people, Industrialize Africa, Integrate Africa, and Light up and Power Africa. The goals do not leave any doubts about the importance that the Bank places on industrialization (Abbasian et al., 2019). The industrialized Africa project recognizes that Africa is at the bottom of the global value chain, with a global share of 1.9 percent in 2015 (AfDB) and World Manufacturing Value Added of 2 percent in 2019 (UNIDO, 2020), and efforts to support industrialization are central to building and sustaining the wealth of the continent.

Along these lines, the African Development Bank AfDB proposed six flagship programs to accelerate industrialization of key sectors, which are to foster successful industrial policies by providing policy advisory services and technical assistance to governments and funding key PPP projects, and to support funding of infrastructure and industry projects, thereby increasing and channeling funds into GDP catalytic programs. The third is to grow liquid and effective capital markets by improving access to market finance for African enterprises. Fourth, promote and drive enterprise development by facilitating access to financing by expanding SME-focused lines of credit, providing technical assistance to SME development institutions (e.g., incubators, SME-focused financial institutions, and those targeting underserved demographics such as women), and building SMEs' capacity via linkage programs with private sector investment. Fifth, is to promote strategic partnerships in Africa by linking African enterprises and major projects with potential partners and investors through promotional activities, notably the African Investment Forum; and, finally, develop efficient industry clusters by supporting governments in developing efficient industry clusters across Africa, through technical assistance and funding in implementation and monitoring.

The implication of the fourth and especially the fifth programs is that the continent will need to seek finance and other partnerships to pursue this, making a case for foreign financial flows. This may also mean that the financial resources that need to be mobilized internally are not sufficient to drive the industrialization agenda of either individual countries or the continent as a whole. This scenario does not come as a shock because the region and, by that, the nations in Africa have been bedeviled with several phenomena that constrain the human and financial resource mobilization. Slow economic growth rates, the inability to sustain periods of growth for up to two or three decades, political instability, social unrest, terrorism, and communal and other social conflicts, to mention a few.

Domestic resources are limited because of poor tax revenue and low savings levels, among others. Specifically, Nigeria, Ethiopia, DR Congo, Egypt, Kenya, Morocco, and South Africa’s tax-to-GDP ratios in 2020 were 5.5%, 6.2%, 9.1%, 12.5%, 15.3%, 19.5%, and 25.2% respectively. Set against the IMF and African Countries in Revenue Statistics in Africa benchmarks of 15% and 16% (IMF, 2022), only Kenya and Morocco meet both. Similarly, Egypt, DR Congo, South Africa, Kenya, Ethiopia, Morocco, and Nigeria’s savings to GDP ratios at 11%, 16%, 16.7%, 14%, 26%, 29% and 34% all fall below the IMFs criteria of 30 percent (Aslam et al., 2022, Global Economy.com, World Bank) except Nigeria’s.

Oqubay (2015), in his book Made in Africa, shares a lot of remarkable insights on Industrial policy in Africa, based on elaborate qualitative research on Ethiopia. His experience in research and policy makes his insights very convincing, such that they would justify including Ethiopia as part of the cases under study, even if it were not one of the top recipients of foreign capital flows. Oqubay’s account of the economic transformation in Ethiopia is christened “Ethiopia rising”, from an economy once synonymous with impoverishment. The 2015 record of industrialization’s success story in Ethiopia captured some of the major players. They included Castel, a French company that established a winery, the Turkish Textile and Garment plants had a significant presence, the Tanneries and the Floriculture industries established by foreigners, as well as indigenes were also key players. UNCTAD reports that Ethiopia received the highest volumes of financial flows in 2021 as it became a central hub for China’s Belt and Road Initiative. Foreign Direct Investment flows rose by 79% to $4.3 billion in 2021.

The World Investment Report 2016 reported that in spite of weakening global economic growth and a decline in both demand and price for minerals, the

DRC's economy was expected to remain resilient. The expectation was based on the increase in public and private investments, particularly in infrastructure, that accompanied the mineral boom in the country. Specifically, the report estimated the annual average foreign direct investment in the DRC to be about $2.07 billion, rising after the decline to $1.7 billion in 2015. In 2021, UNCTAD reported that investment flows to Congo fell by 8% to $3.7 billion, but two international project finance deals were announced later in the country. The largest involved the construction of an oil facility for $166 million. This makes Congo the highest recipient in Central Africa. UNCTAD also reported that investment flows to Morocco rose by 52% to $2.2 billion in 2021, while Egypt saw its FDI drop by 12% to $5.1 billion. The decline notwithstanding, Egypt was still Africa's second-largest FDI recipient. Egypt also received pledges from Gulf States to invest about $22 billion in various economic sectors in 2023. The Report also confirmed that Greenfield projects in these countries more than tripled to $5.6 billion in 2021, making Egypt and Morocco the top gainers in North Africa. This evidence shows that foreign capital inflows can be advantageous because they open up new opportunities for capital accumulation and firm productivity, which can speed up economic development in countries with inadequate capital. This is anticipated to assist the growth of infrastructure, technology, and human capital, as well as the development of a knowledge-based economy with the ability to expand export goods (Phimmavong, 2017; Rakhshani et al., 2021; Shahraki et al., 2023).

African economies have attracted significant capital inflows over the years (Nyang`oro, 2017; IMF, 2019; Olaoye et al., 2022). The top recipients on the continent in 2020, according to the World Investment Report (2021*)*, were Nigeria, South Africa, and Egypt. Despite these inflows, the continent and these countries still grapple with high levels of poverty, weak development of human capital, structural imbalances, weak institutions, and inadequate infrastructure (Ogbonna et al., 2021). For instance, infrastructural stock as a percentage of GDP amounted to 23.73%, 80.19%, and 88.74% in Nigeria, South Africa, and Egypt in 2021 (Statista, 2021). However, only Nigeria falls short of the international benchmark of 70% set by the World Bank. As it stands, Africa's economic growth rate was 4.8% in 2021, falling to 3.8% in 2022 (AfDB, 2023). Also in 2021, about 37.9% of the sub-Saharan Africa population lived on less than $1.90 a day (UNSTATS, 2022). For Egypt, it stood at 31.9%, Nigeria at 42.0%, and South Africa at 32.63% in 2020.

Another important argument that Oqubay (2015) puts forward about industrialization is that the state can and must play an activist and developmental role beyond being merely a facilitating actor. He argues that states must be willing to take risks that businesses will not, and should not bow down easily to interest groups who are rent-seeking and/or seeking privileges that obstruct the priority. This argument puts the searchlight on the quality of institutions and how they work to ensure that foreign capital flows achieve the desired outcomes. This study is an effort to investigate, in Nigeria, Morocco, DR Congo, South Africa, Egypt, and Ethiopia, how institutional quality can influence the way that foreign financial flows influence industrialization in Africa. Specifically, it will examine the moderating effect of institutions on capital inflows and their impact on industrial output. The choice of these countries is justified by their being the top recipients of foreign flows across the regions in the continent.

2. Review of Literature

Some of the extant literature on the role of quality institutions in the nexus between capital inflows and industrialization is reviewed. Adekunle et al. (2020) used a two-step Engle-Granger estimation procedure and the Granger Causality to investigate some drivers of industrial output. They found that labor participation, gross fixed capital formation, FDI, and portfolio investment all have a significant positive relationship with industrial performance in Nigeria. Igan et al. (2020) employed a panel-based fixed effects method to examine the relationship between equity inflows and long-term growth. The results indicated that private capital inflows are related to better growth in industries that are more reliant on external finance. The study also demonstrated that equity inflows and long-term growth are positively connected, particularly with well-functioning banks with evidence of higher institutional quality. The ARDL-bound approach was adopted by Sule (2019) on the dynamics of foreign capital flows and industrial growth. Findings showed that external loans exert a positive and significant impact on industrial growth, whereas foreign direct investment and remittances have a negative impact and are not significantly correlated.

Similarly, Ndiweni and Bonga-Bonga (2021) employed threshold regression analysis to investigate the impact of capital inflows on economic growth in Sub-Saharan Africa and found a positive and significant relationship once a defined threshold level of institutional quality has been exceeded. The result implies that the relationship between capital inflows and growth is dependent on the level of institutional development in sub-Saharan Africa. Equally, Adams et al. (2017) adopted ARDL and Granger causality in their analysis of the effects of capital flows on economic growth in Senegal, but their results, however, did not show cointegration between aid and growth or between FDI and growth. However, remittance caused economic growth in Senegal in the long run, while debt exerted a negative effect on growth**.** Foreign portfolio investment and industrial growth are analyzed by Okonkwo (2016) in Nigeria, using the Ordinary Least Squares estimation, and it is found that there is a positive relationship between foreign portfolio investment and industrial growth. Hossain and Rahman (2017) investigated the implications of governance in facilitating foreign direct investment in developing countries. Using pooled OLS results, they showed that improved governance increases FDI inflows. Regression analysis was utilized by Murdipi et al. (2023), and their results showed that the benefits of portfolio investments for boosting the economy are still fairly responsive to various institutional measures. Adams et al. (2017) employed the ARDL and Granger causality techniques in their analysis of the effects of capital flows on economic growth in Senegal, but their results, however, did not show cointegration between aid and growth or between FDI and growth. However, remittance caused economic growth in Senegal in the long run, while debt exerted a negative effect on growth. Keji (2023) adopted the Autoregressive Distributed Lags (ARDL) and Cointegration and Error Correction Mechanisms (ECM) techniques, and results pointed to the existence of a long-term relationship between foreign direct investment and industrial output growth in Nigeria. However, FDI followed a negative time-path link with industrial output growth in Nigeria.

Recent studies have utilized various empirical techniques to analyze the role of institutional quality on economic resilience and growth outcomes across different contexts. Igan et al. (2020) found private investment tended to spur more growth in external finance-dependent industries, highlighting this transmission channel using panel data models. Rios and Gianmoena (2020) concluded that regional government quality is strongly influential for resilience based on Bayesian approaches. Ezcurra and Ríos (2019) revealed positive spatial spillovers of institutional development onto resilience among European regions applying spatial econometrics. Similarly, Sondermann (2018) established institutional quality as enhancing resilience in Europe, combining time series and regression methods. Despite differences in specific methodologies and samples, these papers consistently demonstrate strong linkages between higher quality institutions and frameworks and improved resilience and growth performance. The findings are geographically robust across European economies at both regional and national levels of analysis.

The preceding reviews indicate that the findings are not unanimous about the impacts of the different forms of foreign capital flows on growth and on industrialization. It is therefore not clear how foreign direct investment, portfolio investment, and official development assistance explain the diversity and progress in these countries' industrial sectors. The continent continues to seek capital to industrialize, and the effects, as moderated by institutions on the continent, have not received as robust a focus within the scope of literature engaged. The disaggregated impacts of these flows will provide insights into their individual potentials. Studies on the top recipients of capital flows have not empirically validated the moderating effect of governance quality on these flows, i.e., the capital-inflow-industrial output growth nexus in selected African countries.

3. Methods and Materials

We apply the Panel Autoregressive Distributed Lag (PARDL) model of Peseran and Smith (1995) and Peseran et al. (1997; 1999) to analyze the nexus between foreign capital flows and industrial output in selected African countries (Egypt, Nigeria, Ethiopia, South Africa, Morocco and DR. Congo) aimed at teasing out both the short and long-run dynamics of the relationship. This model is considered plausible for the study due to the following reasons. First, the model allows for nonstationary variables to be introduced in the model, which is envisaged given the nature of the economic series under investigation. Second, it allows for a degree of heterogeneity in the slope coefficient, which is inevitable considering the nature of the cross-sections being considered. We argue that economies may not experience homogeneous responses in the event of capital flows, which necessitates modeling any inherent heterogeneity in the beta or factor loading. Third, the model is suitable for large N and large T panels. On the theoretical front, the study is grounded in the neoclassical growth model of the Cobb-Douglas approach, which emphasizes capital accumulation (capital inflows) as a key driver of economic growth. This framework is further augmented to capture issues of governance quality. Hence, the generic representation of the panel ARDL model following Peseran and Smith (2014) and Peseran et al. (1997; 1999) is expressed below:

$$\sum_{k=1}^{p}\lambda_{ik}y_{it_{-k}}+\sum_{j=0}^{q}\psi_{ij}X_{i,t_{-j}}+\mu_i+\varepsilon_{it};i=1,...,N;t=1,...,T \tag{1}$$

where i is the number of countries (Cross-Sections); t is the number of periods (time dimension);

μ_i is the country-specific effect; ε_{it} is the panel disturbances term; X_{it} is a K×1 vector of explanatory variables; ψ_{ij} are the coefficients of vectors; and λ_{ij} are scalers for the cointegrated series of order 1. Hence, the error correction for equation 1 can be written as:

$$\Delta y_{it} = \rho_i (y_{it_{-1}} - \phi_i X_{it}) + \sum_{j=1}^{p-1} \lambda_{ij} \Delta y_{it_{-1}} + \sum_{j=0}^{q-1} \psi_{ij} \Delta X_{it_{-j}} + \mu_i + \varepsilon_{it} \quad (2)$$

where $\rho_i = -(1 - \Sigma_j = 1\lambda_{ij})$ is the speed of adjustment, $\phi_i = \Sigma_j = 1\rho\lambda_{ij} / (1 - \Sigma_k \lambda_k)$ is the vector of long-run parameters, while $\lambda_{ij} = -\Sigma_m = j + 1\rho\lambda_m$ and $\psi_{ij} = \Sigma_m = j + 1\psi_{im}$ are the short-run parameters. In accordance with equation 2, we can write the estimable linear PARDL for the study as follows:

$$\begin{aligned}
&\Delta IND_{it} = \alpha_{0i} + \beta_{1i} IND_{t_{-1}} + \beta_{2i} FDI_{t_{-1}} + \beta_{3i} FPI_{t_{-1}} + \beta_{4i} ODA_{t_{-1}} + \\
&\beta_{5i} GOV_{t_{-1}} + \beta_{6i} EXR_{t_{-1}} + \\
&\sum_{j=1}^{N1} \lambda_{1ij} \Delta IND_{i,t-j} + \sum_{j=0}^{N2} \lambda_{2ij} \Delta FDI_{i,t-j} + \\
&\sum_{j=0}^{N3} \lambda_{3ij} \Delta FPI_{i,t-j} \sum_{j=o}^{N4} \lambda_{4ij} \Delta ODA_{i,t_{-j}} + \sum_{j=0}^{N5} \lambda_{5ij} \Delta GOV_{i,t_{-j}} + \sum_{j=0}^{N6} \lambda_{6ij} \Delta EXR_{i,t_{-j}} + \\
&\mu_i + \varepsilon_{it}, where, i = 1.2, N; t = 1, 2, ..., T
\end{aligned} \quad (3)$$

where IND_{it} is the industrial output of each unit i at time t; *FDI, FPI, ODA, GOV, EXR* denote the foreign direct investment, foreign portfolio investment, official development assistance, governance quality, which are all measured in current US dollars and exchange rate measured in local currency units respectively, μ_i is the country-specific effect; i is the sampled units; and t is the number of periods. β and λ factors account for both the long and short-run dynamics of the relationship. We further account for the relevance of the error correction mechanism in the relationship, and the model is further specified as follows:

$$\Delta IND_{it} = \sum_{j=1}^{N1} \lambda_{1ij} \Delta IND_{i,t-j} + \sum_{j=0}^{N2} \lambda_{2ij} \Delta FDI_{i,t-j} + \sum_{j=0}^{N3} \lambda_{3ij} \Delta FPI_{i,t-j} \sum_{j=o}^{N4} \lambda_{4ij} \Delta ODA_{i,t_{-}j} + \sum_{j=0}^{N5} \lambda_{5ij} \Delta GOV_{i,t_{-}j} + \sum_{j=0}^{N6} \lambda_{6ij} \Delta EXR_{i,t_{-}j} + \gamma ECT_{t-1} + \varepsilon_{it} \quad (4)$$

However, for robustness of our analysis, we equally conducted country-specific analysis using the conventional ARDL modeling framework to tease out salient unique dynamics that may not be expressly accounted for by applying the panel framework. We used annual time series data for indices of capital flows and industrial value added from 1992 to 2022. The choice of countries was guided by the desire to explain the effectiveness of capital inflows into these economies within the period. This analysis was also influenced by the availability of credible data on aggregates of capital inflows and their associated implications. The choice and measure of capital inflows (foreign direct investment, official development assistance, and portfolio equity) were based on empirical studies (Keji, 2023; Adekunle et al., 2020). However, industrial output growth was measured utilizing industry value added as in Bezić et al. (2016); Filer and Stanišić (2016); Galović et al. (2018); Adekunle et al. (2020); Keji (2023). The analysis relied on data from the World Bank Database (World Bank, 2017).

4. Results

The applicability of heterogeneous panel data models previously constructed in the context of this study was primarily informed by the variable under consideration's likely non-stationarity feature. To that purpose, we employ the traditional method for modeling panel data with large time series (T) dimensions by subjecting the relevant variables to the unit root test. The current study analyzes four different types of panel unit root testing for robustness. As shown in Table 1, the first type involves panel unit root with the null hypothesis of unit root with common process (Harris and Tzavalis, 1999; Breitung, 2000; Levin et al., 2002; Im et al., 2003), the second assumes unit root with individual unit root process (Im et al., 2003; Maddala and Wu, 1999), while the third also assumes unit root in the null hypothesis but in the presence of cross-sectional dependence (Peseran, 2007), which is relevant in addressing if the cross-sections are homogenous or heterogeneous. It assumes homogenous non-stationary against the alternative of possible heterogeneous alternatives. The results affirm that the cross-sections are heterogeneous among all the variables except for foreign portfolio investment. The fourth category, however, tests the hypothesis of no unit root with a common unit root process; Hadri's (2000) Lagrange multiplier test. For the unit root results, we find industrial output is integrated of order one I(1) for all the test specifications except Hadri (2000); equally, foreign direct investment, foreign portfolio investment, official development assistance, and the measure of governance indicator all indicated a mixed order of integration with the maximum order of I(1). Nominal exchange rate, however, consistently across all test options, is integrated of order one [I(1)]. Since the underlying framework for estimation allows for the combination of both I(0) and I(1) as long as the level of integration does not exceed I(1), mixed order of integration of some variables in the model is not expected to bias our estimates.

Table 1. Panel Unit Root Test

Methods	**IND**	**FDI**	**FPI**	**ODA**	**GOV**	**EXR**
Null Hypothesis: Unit Root with common process						
Harris-Tzavalis [rho]	-13.920^{***b}	-13.369^{***a}	-11.698^{***b}	-6.670^{***a}	-14.935^{***a}	-13.518^{***b}
Breitung [t-stat.]	-6.115^{***b}	-8.856^{***b}	-4.062^{***a}	-8.260^{***b}	-5.042^{***b}	-3.694^{***b}
Levin, Lin & Chu [t*]	-3.776^{***b}	-3.275^{***b}	-2.359^{***a}	-6.701^{***b}	-4.742^{***b}	-2.869***^{b}
Null Hypothesis: Unit Root with Individual Process						
Im, Pesaran & Shin [Z-t-tilde]	-5.213^{***b}	-7.649^{***b}	-3.912^{***a}	-7.619^{***b}	-7.499^{***b}	-3.537^{***b}
ADF Fisher [Chi-square]	2.5649^{***b}	6.4041^{***b}	2.5761^{***a}	6.3076^{***b}	8.572^{***b}	3.235^{***b}
Null Hypothesis: Unit Root with cross-sectional dependence						
Pesaran CD test [z[t-bar]] (lag 2)	-4.600^{***b}	-3.728^{***b}	-2.973^{***a}	-5.888^{***b}	-4.468^{***b}	-1.729^{**b}
Null hypothesis: No unit root with a common unit root process						
Hadri [Z-stat.]	34.921^{***a}	6.9431^{***a}	5.1969^{***a}	10.816^{***a}	14.348^{**a}	2.733^{***b}
Number of Cross-Sections	6	6	6	6	6	6
Number of Periods	27	27	27	27	27	27
Total Number of Observations	162	162	162	162	162	162

Source: Research finding, using Eview 12.

Note: a and b denote stationarity at level and at first difference, respectively; *p < 0.01; **p < 0.05; ***p <0.001.

Table 2. Panel ARDL Results

Panel A: Panel Regression without Interaction		**Panel B: Panel Regression with Interactions**	
Short-run	PMG	Short-run	PMG
Variables	Estimates	Variables	Estimates
ECM	-0.246*** {0.0817}	ECM	-0.241*** {0.0792}
Δ FDI	-0.184 {0.206}	Δ FDI*GOV	0.535 {0.478}
Δ FPI	-19.53 {19.62}	Δ FPI*GOV	12.42 {11.88}
Δ ODA	-0.707 {0.588}	Δ GOV	6.110 {0.0751}
Δ GOV	0.008137 {0.171}	Δ EXR	-1.183** {5.436}
Δ EXR	-1.241* {0.064}		
Long-run	PMG	Long-run	PMG
FDI	3.473*** {1.245}	FDI*GOV	13.04* {7.163}
FPI	108.6 {76.18}	FPI*GOV	125.4** {60.55}
ODA	-7.371 {9.380}	ODA	-7.371 {9.380}
GOV	-9.720 {7.270}	GOV	-3.356 {4.713}
EXR	-3.810 {2.982}	EXR	-2.302 {1.604}
Constant	-1.616 {2.357}	Constant	-7.386 {1.612}
Hausman χ^2	0.127 (0.9802)	Hausman χ^2	0.912 (0.1038)

Source: Research finding, using Eview 12.

Note: Values in parentheses represent standard errors; *p < 0.01; **p < 0.05; ***p <0.001 reflect the level of significance, respectively.

The two main techniques used in the estimation of a dynamic heterogeneous panel data model are the pooled mean group (PMG) estimator and the mean group (MG) estimator. While the mean group estimator relies on estimating N time series regressions and averaging the coefficients, the PMG involves the combination of pooling and averaging of coefficients. Hence, we first estimated the equations using both the MG and PMG estimators; thereafter, we subjected the results from these estimators to the Hausman test to establish if there is a systematic difference between the two estimators. A non-rejection of the null hypothesis implies the adoption of the PMG estimator, which in our case is applicable. The Hausman result, as shown in Table 2, indicates the adoption of PMG, and we report and interpret only the estimates from the PMG model.

First, we seek to account for the impact of capital inflows on industrial output in the selected African countries. Second, we account for the intermediating/interaction role of governance infrastructure (institutional quality) and how it further impacts the industrial output. The result highlights that in the short-run all the three main sources of capital inflow (foreign direct investment, foreign portfolio investment, and official development assistance) maintain a negative and non-significant association with industrial output within the study period, implying the short-run dynamics of foreign capital inflows hinders industrial output growth; however, in the long-run foreign direct investment exudes a positive and significant nexus with industrial output growth. This affirms that the positive impact of foreign direct investment in these economies is long-term, and it holds important implications for business investors and policymakers. Equally relevant are the long-run positive but non-significant effects of foreign portfolio investment on the selected economies, implying the limited long-run effect of the inflow on industrial output. Overall, FPI fails to render a significant impact on industrial output both in the short and long run. Also of note is the consistent negative, albeit non-significant, association between official development assistance and industrial output. This may not be unconnected with the nature of development assistance that is not connected with the industrial structure of these economies in terms of its use.

Next, focus is shifted to the intermediating role of institutional quality by way of its interaction effect with the foreign capital flows variables. The result reveals that in the short run, the interaction terms render a positive but non-significant nexus with industrial output. This suggests that the interaction effect plays a role in a change from a negative impact to a positive impact, albeit non-significant. This further implies that institutional quality plays a critical role in transmitting the desired economic impact of foreign capital on industrial output in the selected economies. Furthermore, the results hold similar implications for the outcome of the long-run result.

Table 3. Country-Specific ARDL Results

Country	FDI*GOV	FPI*GOV	ODA*GOV	EXR	ECM
Panel A: Short-Run Estimates					
Egypt	0.942519* (0.0000)	-0.360906* (0.0017)	0.053657 (0.2318)	0.012383* (0.0295)	-0.257773* (0.0000)
Ethiopia	-0.218903* (0.0366)	-	0.231218* (0.0231)	0.198258 (0.1190)	-0.195977* (0.0000)
Nigeria	0.157593* (0.0204)	-0.003441 (0.9365)	-0.357787* (0.0329)	-0.375006 (0.1606)	-0.627957* (0.0001)
South Africa	0.381120 (0.1137)	8.125010* (0.0000)	-0.433708 (0.1179)	0.246801 (0.3933)	-0.920847* (0.0014)
Panel B: Long-Run Estimates					
Egypt	0.777010* (0.0091)	-1.400091* (0.0007)	0.208154 (0.2443)	0.048039* (0.0016)	
Ethiopia	-1.116982* (0.0110)	-	1.179823* (0.0069)	1.011641 (0.0643)	
Nigeria	0.250962* (0.0161)	-0.005480 (0.9375)	-0.569763* (0.0007)	-0.597184 (0.0964)	
South Africa	0.413880* (0.0550)	-0.055268 (0.3784)	-0.470988* (0.0537)	0.268015 (0.2799)	

Source: Research finding, using Eview 12.

Note: Values in parentheses represent standard errors; *p < 0.01; **p < 0.05; ***p <0.001 reflect the level of significance, respectively.

For robust analysis, we equally present ARDL results for some country-specific analysis as presented in Table 3. The result shows a mixed nexus among the countries, both in the short and long-run dynamics. It is interesting to note that the significant effect of these interactions appears when considering using single-country analysis. It further reveals that in the interaction of governance quality with foreign direct investment, Egypt, Nigeria, and South Africa show a positive and significant relationship on industrial activities in both the short-run and long-run, except for South Africa’s short-run result, which is insignificant. However, FDI*GOV on the industrial sector of Ethiopia reveals a negative but significant relationship in both the short-run and long-run. These findings across the sampled countries agree with earlier studies on the mediating role of governance quality to foreign investment (Hossain and Rahman, 2017; Igan et al., 2020; Ndiweni and

Bonga-Bonga, 2021). With respect to foreign portfolio investment, it demonstrates negative and significant relationship with industrial growth in Egypt in the short-run and long-run, while that of Nigeria is insignificant in both the short-run and long-run, which agrees with the findings of Agbloyor et al. (2014). For South Africa, it is only positive and significant in the short run, which is in line with the findings of Baharumshah et al. (2017). The negative and insignificant effect in the long run for South Africa could be linked to its susceptibility to externals (Cockeran, 2016). The negative effect of portfolio investment, collaborates to McKinnon and Pill (1997) , is that unrestricted capital inflows have a negative impact on economic activities because the banks face moral hazard when the capital market has moral hazard. Griffin (1970) argued that portfolio investment increases the propensity for consumption, rather than the investment ratio.

5. Conclusion

This study demonstrates the nexus between foreign capital inflows and industrial performance in selected African countries using a non-stationary heterogeneous panel modelling framework to account for both the short and long-run dynamics. For emphasis, we employ the foreign direct investment, foreign portfolio investment, and official development assistance as main predictors and interact these variables with institutional quality to account for the interaction effects with industrial performance. The study conveys that, on average, institutional quality holds a positive impact on industrial output when interacted with foreign capital flow variables, and that the impact appears to be more significant in the long run relative to short-run dynamics. We equally documented the dynamics of the relationship using country-specific analysis and found similar outcomes, exhibiting mixed outcomes across both short and long-run periods. It is evident clear as shown that foreign capital flows perform better in an environment of quality institutions in the selected African countries, with a higher predictive power in the long run. This study suggests that African governments should prioritize and invest in institutional reforms that improve governance, which will enable foreign capital inflows like FDI to more effectively spur industrial performance and output. Beyond broad institutional capacity building, governments also need sector-specific agencies and frameworks regulating and supporting priority industries in order to leverage foreign capital for those sectors.

Statements and Declarations

- Disclaimer: The expressions and outcomes do not represent the position of the CBN but those of the authors.
- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Abbasian, M., Shahraki, A. S., & Tabar, M. H. (2019). The relationship between financial development and international trade in countries selected for Outlook 1404. *Quarterly Journal of the Macro and Strategic Policies*, *7*(27), 396-409. Retrieved from https://doi.org/10.32598/jmsp.7.3.4.

Adams, S., Klobodu, E. K. M., & Lamptey, R. O. (2017). The Effects of Capital Flows on Economic Growth in Senegal. *The Journal of Applied Economic Research, 11*(2), 121–142. Retrieved from https://doi.org/10.1177/0973801016687869.

Adekunle, I. A., Ogunade, A. O., Kalejaiye, T. G., & Balogun, A. M. (2020). Capital Inflows and Industrial Performance in Nigeria: Including the Excluded. *Jurnal Ekonomi & Studi Pembangunan*, *21*(1), 37-52. Retrieved from https://doi.org/10.18196/jesp.21.1.5030.

Agboloyor, E. K., Abor, J. Y., Adjsai, C. K. D., & Yawson, A. (2014). Private capital flows and economic growth in Africa: The role of domestic financial markets. *Journal of International Financial Markets, Institutions and Money*, *30*, 137-152. Retrieved from https://doi.org/10.1016/j.intfin.2014.02.003.

Ahlerup, P., Baskaran, T., & Bigsten, A. (2016). Government Impartiality and Sustained Growth in Sub-Saharan Africa. *World Development*, *83*, 54–69. Retrieved from https://doi.org/10.1016/j.worlddev.2016.03.006.

Baharumshah, A. Z., Slesman, L., & Devadason, E. S. (2017). Types of foreign capital inflows and economic growth: new evidence on the role of financial markets. *Journal of International Development*, *29*(6), 768-789. Retrieved from https://doi.org/10.1002/jid.3093.

Bezić, H., Galović, T., & Mišević, P. (2016). The impact of terrorism on foreign direct investment (FDI) of EU and EEA countries. Proceedings of the Faculty of Economics in Rijeka. *Journal of economic theory and practice/časopis za ekonomsku teoriju i praksu*, *34*(2), 333–362. [In Bosnian]. Retrieved from https://urn.nsk.hr/urn:nbn:hr:192:332919.

Brandl, B., & Traxler, F. (2010). Labour conflicts: A cross-national analysis of economic and institutional determinants, 1971-2002. *European Sociological Review*, *26*(5), 519-540. Retrieved from https://doi.org/10.1093/esr/jcp036.

Cockeran, H. J. (2016). South Africa's macroeconomic resilience to external shocks: A comparison to its BRICS partners. *International Journal of Economics and Finance Studies, 8*(1), 145-160. Retrieved from https://dergipark.org.tr/en/pub/ijefs/issue/26144/275328.

Edo, S. (2018). Private capital inflows and stock market interface in Sub-Saharan Africa. *International Review of Economics, 65*(4), 507-538. Retrieved from https://doi.org/10.1007/s12232-018-0313-z.

Filer, R. K., & Stanišić, D. (2016). The effect of terrorist incidents on capital flows. *Review of Development Economics, 20*(2), 502-513. Retrieved from https://doi.org/10.1111/rode.12171.

Galović, T., Bezić, H., & Mišević, P. (2018). Terrorist activities and capital flows of developed countries. *Economic Journal/Acta Oeconomica, 68*(3), 337-352. Retrieved from https://doi.org/10.1556/032.2018.68.3.2.

Griffin, K. (1970). Foreign capital, domestic savings, and economic development. *Oxford Bulletin of Economics and Statistics, 32*(2), 99-112. Retrieved from https://doi.org/10.1111/j.1468-0084.1970.mp32002002.x.

Griffin, K. (1978). Foreign capital, domestic savings, and economic development. In *International Inequality and National Poverty* (57-80). London: Palgrave Macmillan UK. Retrieved from https://doi.org/10.1007/978-1-349-04069-8_4.

Keji, S. A. (2023). Industrial output growth and foreign direct investment in Nigeria. *Future Business Journal, 9*(58), 1-13. Retrieved from https://doi.org/10.1186/s43093-023-00225-0.

Hossain, M. S., & Rahman, M. Z. (2017). Does governance facilitate foreign direct investment in developing countries? *International Journal of Economics and Financial Issues, 7*(1), 164-177. Retrieved from Retrieved from https://www.econjournals.com/index.php/ijefi/article/view/3370.

Haggard, S. (2004). Institutions and growth in East Asia. *Studies in Comparative International Development, 38*(4), 53-81. Retrieved from https://www.econbiz.de/Record/institutions-and-growth-in-east-asia-haggard-stephan/10002086636.

Markusen, A. (1996). Sticky places in slippery space: A typology of industrial districts. *Economic Geography, 72*(3), 293-313. Retrieved from https://doi.org/10.2307/144402.

Murdipi, R., Baharumshah, A. Z., & Law, S. H. (2023). Portfolio capital flows and economic growth: Do institutional factors matter? *Research in International Business and Finance, 66*, 102019. Retrieved from https://doi.org/10.1016/j.ribaf.2023.102019.

Imoudu, E. C. (2012). The impact of foreign direct investment in Nigeria's economic growth, 1980–2009: Evidence from Johansen's cointegration approach. *International Journal of Business and Social Science, 3*(6), 122-134. Retrieved from https://ijbssnet.com/journals/Vol_3_No_6_Special_Issue_March_2012/16.pdf.

Prasad, E. S., Rogoff, K., Wei, S. -J., & Kose, M. A. (2003). Effects of financial globalization on developing countries: Some empirical evidence. *IMF Occasional Paper, 220*. Retrieved from https://www.imf.org/external/pubs/nft/op/220/.

Sule, A. (2019). External financing and industrial growth in Nigeria. *International Journal of Economics, Business and Management Studies, 6*(1), 180-193. Retrieved from https://doi.org/10.20448/802.61.180.193.

Shahraki, A. S., Panagopoulos, T., Ashari, H. E., & Bazrafshan, O. (2023). Relationship between Indigenous Knowledge Development in Agriculture and the Sustainability of Water Resources. *Sustainability, 15*(7), 5665. Retrieved from https://doi.org/10.3390/su15075665.

Okafor, I. G., Ugochukwu, U. S., & Chijindu, E. H. (2016). Foreign capital inflows and Nigerian economic growth nexus: A Toda-Yamamoto approach. *European Journal of Accounting, Auditing and Finance Research, 4*(3), 16-26. Retrieved from https://eajournals.org/ejaafr/vol-4-issue-3-march-2016-2/foreign-capital-inflows-and-nigerian-economic-growth-nexus-a-toda-yamamoto-approach/.

McKinnon, R. I., & Pill, H. (1997). Credible economic liberalizations and over-borrowing. *American Economic Review, 87*(2), 189-193. Retrieved from https://ideas.repec.org/a/aea/aecrev/v87y1997i2p189-93.

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In S. Strøm (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium* (371-413). Cambridge: Cambridge University Press. Retrieved from https://doi.org/10.1017/CCOL521633230.011.

Prasad, E. S., Rajan, R. G., & Subramanian, A. (2007). Foreign capital and economic growth. *Brookings Papers on Economic Activity, 38*(1), 153-230. Retrieved from https://doi.org/10.1353/eca.2007.0016.

Rakhshani, B., Shahraki, A. S., & Aliahmadi, N. (2021). Cooperative business development problems in the Sistan region villages. *Co-Operation and Agriculture, 10*(38), 211-239. Retrieved from https://doi.org/10.22034/ajcoop.2021.289311.1696.

Okonkwo, O. N. (2016). Foreign portfolio investment and industrial growth in Nigeria (1986–2013). *International Journal of Innovative Finance and Economics Research, 4*(3), 31-38. Retrieved from https://seahipaj.org/journals-ci/sept-2016/IJIFER/full/IJIFER-S-5-2016.pdf.

Kose, M. A., Prasad, E., Rogoff, K., & Wei, S.-J. (2010). Financial globalization and economic policies. In D. Rodrik & M. Rosenzweig (Eds.), *Handbook of Development Economics*, 5 (4283-4359). Retrieved from https://ideas.repec.org/h/eee/devchp/v5y2010icp4283-4359.

Ndiweni, Z. L., & Bonga-Bonga, L. (2021). Capital inflows and economic growth nexus in Sub-Saharan Africa: Evidence on the role of institutions. *MPRA Paper, 107392*, Retrieved from https://mpra.ub.uni-muenchen.de/107392/1/MPRA_paper_107392.pdf.

Shahraki, A. S., Panagopoulos, T., Ashari, H. E., & Bazrafshan, O. (2023). Relationship between Indigenous Knowledge Development in Agriculture and the Sustainability of Water Resources. *Sustainability, 15*(7), 5665. Retrieved from https://doi.org/10.3390/su15075665.

Sule, A. (2020). Institutional quality and economic growth: Evidence from Nigeria. *African Journal of Economic Review, 8*(1), 48-64. Retrieved from https://doi.org/10.22004/ag.econ.301050.

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70*(1), 65-94. Retrieved from https://EconPapers.repec.org/RePEc:oup:qjecon:v70y1956i1p65-94.html.

Pesaran, M. H., & Shin, Y. (1999). An autoregressive distributed-lag modelling approach to cointegration analysis. In S. Strøm (Ed.), *Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium*, *11* (371-413). Cambridge University Press. Retrieved from https://doi.org/10.1017/ccol521633230.011.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5, 2), S71-S102. Retrieved from https://doi.org/10.1086/261725.

Obichukwu, U. I. (2013). The impact of industrial output on the economy of Nigeria, 1980–2010 (Unpublished Project, Caritas University, Enugu State).

Yıldırım, A. (2015). Institutional Structure and International Competitiveness: Turkey as a Case Study (PhD Dissertation, Muğla Sıtkı Koçman University). Retrieved from https://tez.yok.gov.tr/UlusalTezMerkezi/tezDetay.jsp?id=NErrvhRK4TL6qcln0elYVA&no=CDhvotZZ09gKke6Qlh9dRA.

Wang, Q., & Wu, N. (2012). Long-run covariance and its applications in cointegration regression. *Stata Journal*, *12*(3), 515-542. Retrieved from https://doi.org/10.1177/1536867X1201200312.

World Bank. (2003). A user's guide to poverty and social impact analysis. Washington, DC: World Bank. Retrieved from https://searchlibrary.ohchr.org/record/19919.

---------- (2017). World Development Indicators 2017. Washington, DC: World Bank. Retrieved from https://openknowledge.worldbank.org/entities/publication/382524c1-c957-56f8-8b19-ef74d7001e70/full.

---------- (2016). World Development Report 2016: Digital Dividends. Washington, DC: World Bank. Retrieved from https://www.worldbank.org/en/publication/wdr2016.

Cite this article: Sule, A., Liambee Aor, R., Onyeje Doki, N., & Danlami Mohammed, I. (2025). Foreign Capital Flows and Industrial Output in Selected African Countries. *Iranian Economic Review, 29(4)*, 1423-1442.

Iranian Economic Review, 2025, 29(4), 1443-1468
DOI: https://doi.org/10.22059/ier.2023.364965.1007802

RESEARCH PAPER

The Effect of Climate Policy Uncertainty and Financial Globalization Uncertainty on Oil Market Fear: New Insight from QARDL

Ibrahim Farouq[a], Zunaidah Sulong[*, a]

a. Department of Economics, Faculty of Business and Management, Universiti Sultan Zainal Abidin, Terengganu, Malaysia.

* Corresponding author.

Received: 09 September 2023, Revised: 12 October 2023, Accepted: 07 November 2023, Published: 15 December 2025

Publisher: The University of Tehran Press.

Abstract

The oil implied shocks index of Christiane Baumeist is a prominent measure for market fear. This article adopts the oil implied shocks index (OPS) to examine the impact of various uncertainty indicators and economic performance on oil market fear in Nigeria. Our uncertainty proxies acknowledged multiple viewpoints, particularly the climate policy uncertainty (CPU), financial globalization uncertainty (FGU), and economic policy uncertainty (EPU). Based on the Quantile Auto Regressive Distributive Lag model (QARDL), our empirical findings reveal that the impact of CPU, FGU, EPU, and INC on OPS is quantile-based and heterogeneous by virtue of the productivity growth and these uncertainties. Precisely, the CPU has increasingly become an important determinant sparking oil market fear across the quantiles. CPU play an essential role in deepening oil market fear in Nigeria. The Non-linear ARDL results confirmed the positive relationship of all the determinants on OPS. Policy recommendations are discussed accordingly in the last part of the paper.

Keywords: Baumeist, Environmental Policy, Financial Openness, Instability, Quantile.

JEL Classification: E4, E5, F63, F63, F65.

1. Introduction

Oil plays a pivotal role in fostering both economic and financial development, which explains the growing academic and policy interest in oil market dynamics. With the recent expansion of the oil sector's financial activities, market anxiety has become increasingly evident and pervasive. Major global disruptions—such as the 2017–2018 economic downturn and the COVID-19 pandemic—have further amplified uncertainty within the oil industry. To quantify this uncertainty, the Oil

Price Shock (OPS) index, introduced by Christiane Baumeister, a U.S.-based energy economist, is widely employed as a measure of market volatility (Salisu & Gupta, 2020). Historical evidence illustrates that panic levels in the oil sector surged sharply, with volatility increasing from roughly 30% to 90% during the 2008 global financial crisis (Xiao & Liu, 2023). Similarly, the COVID-19 outbreak of 2019 caused widespread disruption across global financial and commodity markets, with OPS levels spiking from around 30% to nearly 160% during the crisis period. Such fluctuations often trigger unpredictable psychological reactions among investors, thereby intensifying market risks (Yaya et al., 2021). Indeed, oil prices collapsed during both the 2008 recession and the COVID-19 pandemic. Given that heightened uncertainty in oil markets adversely affects investment, asset allocation, and risk management—ultimately leading to broader economic instability—this study investigates the effects of climate policy uncertainty, financial globalization uncertainty, economic policy uncertainty, and economic performance on oil market anxiety.

The motivations underlying this research stem from several interconnected factors. Empirical evidence indicates that fluctuations in oil prices are shaped by multiple determinants, including crude oil supply, real GDP, exchange rates, fiscal conditions, and investment behavior (Chatziantoniou et al., 2021; Xiao & Wang, 2021; Wen et al., 2018). The global financial crisis of 2008, which followed the Great Recession, intensified concerns regarding market instability and economic unpredictability. In general, uncertainty tends to suppress investment, consumer spending, and other vital economic activities, thereby exerting adverse effects on financial systems and overall economic performance. It remains a central factor influencing oil price dynamics, as it directly affects the underlying fundamentals of the oil market.

However, accurately measuring uncertainty has proven challenging in empirical analyses. To address this issue, Baker et al. (2016) developed a widely used news-based Economic Policy Uncertainty (EPU) index. Building on this framework, subsequent studies have explored how different forms of uncertainty impact oil price levels and volatility (Qin et al., 2020a; Zhang & Yan, 2020; Liu et al., 2021; Wang et al., 2022). These studies reveal that the effects of uncertainty indicators vary considerably depending on data characteristics and model specifications. Specifically, economic policy uncertainty (EPU) tends to influence oil demand, financial globalization uncertainty (FGU) affects oil financing and investment flows, while climate policy uncertainty (CPU) often alters the supply side of the oil market by influencing corporate and financial decision-making processes.

Despite the growing literature on oil market dynamics, limited attention has been given to the influence of different forms of uncertainty on the oil industry. For instance, Wen et al. (2019) and Huang et al. (2021) focused on assessing and comparing the effects of economic and monetary uncertainty indicators, while Li et al. (2020) and Liang et al. (2020) examined how economic, financial, and geopolitical uncertainties shape oil price behavior. Similarly, Gu et al. (2021) explored the role of macroeconomic factors and regional vulnerabilities in driving oil market fluctuations. Nonetheless, the potential impact of climate-related uncertainty on oil market anxiety remains insufficiently investigated (Guo et al., 2022). Climate change represents one of the most pressing and contentious global socioeconomic challenges (Bartram et al., 2022). The adoption of the Paris Climate Agreement in 2015 further reinforced international commitments to implement stringent policies aimed at reducing greenhouse gas emissions and promoting environmental sustainability.

Consequently, several factors—including unanticipated climate changes, public concern, technological advancement, and evolving economic conditions—have generated significant uncertainty surrounding climate policies. Theoretically, climate policy uncertainty (CPU) can influence the oil market through multiple channels. First, as oil remains the dominant fossil fuel, its consumption substantially contributes to atmospheric carbon dioxide accumulation. To curb these emissions and mitigate the adverse effects of global warming, expanding renewable energy investment and promoting energy-efficient technologies are essential. However, when environmental regulations are vague or inconsistent, critical decisions related to renewable energy development and energy innovation may be delayed or altered, leading to distorted oil demand expectations and heightened market anxiety.

Second, climate-related and transitional risks have profound implications for global investment and trade (Zhang, 2022). In economies undergoing environmental transitions, ambiguous or inconsistent climate policies may intensify uncertainty, thereby amplifying volatility and concern within the oil market. Third, the financial sector also transmits climate-related risks. Insurance companies and institutional investors, in particular, are increasingly exposed to the financial consequences of climate change (Hong et al., 2020; Krueger et al., 2020). Given oil's importance as a financial asset, regulatory and policy-driven climate risks can influence portfolio decisions and asset valuations, further fueling market instability. Therefore, understanding how environmental policy uncertainty interacts with these economic and financial channels is critical to explaining fluctuations in oil market sentiment and volatility.

Previous studies investigating the determinants of oil price fluctuations have predominantly relied on GARCH-type models and observed variance measures. However, such estimations are ex-post in nature, meaning they fail to incorporate expectations or forward-looking market information (Ji and Fan, 2016). In contrast, the Oil Price Volatility Index (OPS), developed by U.S. energy administrators, captures market expectations for 30-day price movements, serving as a forward-looking indicator of volatility. Notably, this index reflects investor sentiment, as heightened fear or uncertainty among market participants tends to influence both their perception of volatility and their trading behavior. Consequently, OPS has become widely recognized as a proxy for oil market anxiety (Baumeister and Hamilton, 2019).

Given these advantages, employing OPS provides deeper insights and stronger economic implications for understanding oil market volatility. In recent years, researchers have increasingly adopted OPS as a preferred measure of oil market fear over traditional volatility indicators (Salisu and Gupta, 2020), extending its application to studies exploring the interlinkages between oil and stock markets (Xiao et al., 2018; Li, 2022). Nevertheless, the relationship between various uncertainty indicators and OPS remains relatively underexplored, highlighting an important gap in the existing literature.

Building on the foregoing discussion, this study examines the influence of Climate Policy Uncertainty (CPU), Economic Policy Uncertainty (EPU), Financial Globalization Uncertainty (FGU), and Income (INC) on Oil Market Panic (OPS) in Nigeria. The global financial and monetary landscape has grown increasingly complex, characterized by frequent disruptions and heightened interdependence among markets, making it difficult to maintain stable investor expectations. Recent empirical works, including those by Xu et al. (2017) and Mitra (2018), have utilized quantile regression techniques to evaluate the varying effects of explanatory factors across different points of the conditional distribution. In line with this approach, the present study employs the Quantile Autoregressive Distributed Lag (QARDL) and Nonlinear Autoregressive Distributed Lag (NARDL) frameworks to capture the potential dynamic and asymmetric impacts of CPU, EPU, and FGU on OPS.

This study contributes to the existing body of literature in three significant ways. First, although the link between uncertainty and oil market volatility has attracted increasing scholarly attention, there is, to the best of our knowledge, no prior study that examines the effects of multiple uncertainty dimensions on oil market anxiety using Nigeria as a case study. The Oil Price Shock (OPS) index provides richer insights than traditional volatility measures derived from historical price data, as it captures market participants' perceptions of fear and behavioral adjustments to external shocks. Hence, applying OPS to assess how oil market anxiety responds to diverse uncertainty sources represents a valuable addition to the literature.

Second, one of the most pressing contemporary concerns relates to the economic implications of climate change. Policymakers, investors, and researchers acknowledge that climate-related risks significantly influence global energy systems, economic structures, and financial markets. Despite this, the relationship between Climate Policy Uncertainty (CPU) and oil market dynamics remains underexplored. Building on Guo et al. (2022), this study extends the discussion by examining how CPU affects oil market anxiety through the OPS channel.

Finally, while prior research has analyzed the effects of individual uncertainty indicators—such as economic, financial, or geopolitical instability (e.g., Wen et al., 2019; Li et al., 2020)—few studies have integrated multiple uncertainty measures within a unified analytical framework. This study advances the literature by simultaneously investigating the combined impacts of CPU, Economic Policy Uncertainty (EPU), and Financial Globalization Uncertainty (FGU) on oil market anxiety using both the Quantile ARDL (QARDL) and Nonlinear ARDL (NARDL) models to capture dynamic and asymmetric effects.

2. Literature Review

A considerable body of research has explored the determinants of oil price fluctuations, emphasizing variables such as supply and demand dynamics, financial indicators, exchange rate movements, and investor behavior. Kilian (2009), for instance, analyzes oil price variations through the lenses of supply and demand, concluding that changes in global oil consumption play a dominant role in driving price shocks. Similarly, Wen et al. (2018) report that exchange rate appreciation exerts a short-term negative influence on oil price movements. Chatziantoniou et al. (2021) find that while both supply and demand factors matter, financial variables exert a stronger impact on oil price volatility. Xiao and Wang (2021) further show that investor attention amplifies negative volatility in the oil market.

In addition to these established factors, uncertainty has emerged as a critical determinant of oil market behavior in recent years. Measuring uncertainty has become central to empirical analysis in this field. Baker et al. (2016) developed a news-based Economic Policy Uncertainty (EPU) index, which has since been widely applied to study the link between uncertainty and macro-financial variables (Dai & Zhu, 2023). Numerous studies confirm that fluctuations in oil prices are strongly connected to broader economic uncertainty. For instance, Wei et al. (2017) demonstrate, using the GARCH-MIDAS model, that EPU indices capture information from both fundamentals and expectations, making them essential predictors of oil market volatility. Similarly, Ji et al. (2018) employ a dynamic copula-based CoVaR approach and find that EPU exerts a moderate influence on oil price returns.

The literature further reveals that the impact of EPU on oil prices is dynamic and context-dependent. Qin et al. (2020a) observe that the relationship alternates between positive and negative over time, with tax- and trade-related uncertainty showing stronger links following policy shifts such as those under the Trump administration. Zhang and Yan (2020) emphasize that EPU effects vary across periods and intensities, particularly during major global events. Lin and Bai (2021) note that EPU originating in oil-exporting nations exerts a stronger upward pressure on oil prices than that in importing nations, while Wang et al. (2022) highlight that different EPU components—especially those related to public debt and exchange rate volatility—display asymmetric predictive power for oil price swings across markets.

A growing body of empirical research has examined the effects of different categories of uncertainty on oil market dynamics. Wen et al. (2019), for example, employ the HAR-RV model and reveal that the Equity Market Volatility (EMV) index provides superior predictive power for realized oil futures volatility compared to the Economic Policy Uncertainty (EPU) index. Similarly, Liang et al. (2020), using a range of forecasting models, explore the relationships among global EPU, U.S. EPU, financial EPU, Geopolitical Risk (GPR), and EMV in relation to oil realized variance, finding that global EPU and EMV play a dominant role in explaining fluctuations in oil market volatility. Li et al. (2020) utilize the GARCH-MIDAS model to evaluate the predictive ability of various news-based uncertainty indicators and demonstrate that EPU, EMV, and U.S. fiscal policy uncertainty significantly improve forecasts of large oil price variations.

In addition, Dutta et al. (2021) find that EMV exerts a pronounced effect on oil market volatility, particularly during periods of heightened uncertainty, and that several EMV-based indicators outperform traditional benchmarks such as the

VIX, EPU, and GPR in forecasting oil price swings. Gu et al. (2021), employing a Vector Autoregression (VAR) framework, also report that EPU exerts a stronger influence on oil market dynamics than geopolitical risk. Furthermore, Huang et al. (2021), using the Time-Varying Parameter VAR (TVP-VAR) model, show that EPU and macroeconomic uncertainty have a more significant impact on commodity prices, including oil, than EMV and the Oil Price Volatility Index (OPS).

Environmental uncertainty has become a growing global concern, attracting considerable scholarly attention in recent years. Hong et al. (2020) describe climate risk as a critical emerging hazard and examine its implications across financial systems. Krueger et al. (2020) further identify environmental risk as a major determinant of investors' portfolio decisions, while Huynh and Xia (2021) note that shifts in environmental risk perceptions can significantly influence corporate bond yields. Javadi and Masum (2021) observe that firms more exposed to climate-related vulnerabilities tend to experience higher bank credit spreads. Similarly, Roncoroni et al. (2021) analyze how environmental transition risks and market structures interact, concluding that stringent climate objectives can coexist with stable economic conditions.

Bartram et al. (2022) argue that ecological policy uncertainty (CPU) leads to varied economic consequences due to corporate regulatory arbitrage, whereas Bouri et al. (2022) find that CPU significantly affects the relative performance of green and brown stocks. In et al. (2022) develop a framework linking energy expenditures with environmental risk, and Ren et al. (2022a) reveal a nonlinear effect of CPU on corporate investment within China's energy sector. Ren et al. (2022b) also report that CPU negatively influences firm-level efficiency in Beijing. Tian et al. (2022), using the Nonlinear ARDL (NARDL) approach, show that CPU asymmetrically impacts the green bond market in the short term, while Zhang and Kong (2022) provide evidence that markets respond negatively to shifts in perceived environmental risks. Dai and Zhang (2023) emphasize that environmental uncertainty substantially increases banks' exposure to financial risks. Despite these advances, Guo et al. (2022) highlight that limited research has examined the effect of climate-related uncertainty on the oil market; their findings, based on a Time-Varying Parameter VAR (TVP-VAR) model, reveal that CPU's influence on oil prices fluctuates between positive and negative over time.

Although interest in the relationship between various forms of uncertainty and the oil market has been increasing, most prior studies have concentrated on examining correlations between uncertainty indicators and oil returns using only historical data. In contrast, the Oil Price Volatility Index (OPS), which is derived from option prices, incorporates both past information and investors' expectations of future market dynamics. Consequently, the OPS is considered a more reliable proxy for oil market uncertainty, as it effectively captures investors' perceptions of risk and the level of anxiety prevailing within the market.

3. Methods and Materials

3.1 Data

Given the constraints in data availability, this study utilizes a monthly time-series dataset for Nigeria spanning from January 1997 to January 2020 (1997M1–2020M1). The measure of oil market anxiety is captured through Oil Price Shocks (OPS), while the explanatory variables include Financial Globalisation Uncertainty (FGU), Climate Policy Uncertainty (CPU), and real GDP, which serves as a proxy for economic performance (INC). The dependent variable is OPS, and the independent variables comprise FGU, CPU, and INC.

The study adopts the environmental policy uncertainty index developed by Gavriilidis (2021), which applies a text-mining approach to quantify economic policy uncertainty using data extracted from leading national newspapers. Specifically, CPU is derived from the frequency of key media articles containing phrases such as climate risk, environmental uncertainty, and greenhouse gases. The monthly CPU index is sourced from policyuncertainty.com.

Additionally, updated data on oil price shocks are obtained from Baumeister's database, as applied in Salisu and Gupta (2020), with original datasets drawn from the U.S. Energy Information Administration (EIA). The Economic Policy Uncertainty (EPU) index is also freely accessible from policyuncertainty.com. The Financial Globalisation Uncertainty (FGU) variable is constructed using the Chinn and Ito (2007) KAOPEN index, incorporating a one-period lag (FGU_{t–1}). Finally, real GDP data representing national income are retrieved from the World Bank's World Development Indicators (WDI) database.

Table 1 presents the descriptive statistics for all variables, where OPS denotes oil market fear, FGU represents financial globalisation uncertainty, CPU refers to climate policy uncertainty, EPU stands for economic policy uncertainty, and INC captures economic performance. The Jarque–Bera (JB) statistic is employed to test for data normality under the null hypothesis that each series follows a normal distribution. The results indicate that the null hypothesis is rejected for all variables, suggesting that the data deviate from normality. Given this non-normal distribution, the application of traditional linear models could lead to biased or inefficient estimates. Consequently, the study employs advanced econometric techniques—specifically the Quantile ARDL (QARDL) and Nonlinear ARDL (NARDL) models—which account for asymmetries and distributional heterogeneity. These methods allow for a more comprehensive assessment of the relationships across the entire conditional distribution, capturing both lower and upper tail dynamics of the data and ensuring more robust and reliable results.

Table 1. Descriptive Summary

Variables	Mean	Standard deviation	Skewness	Kurtosis	Jarque-Bera
$lnOPS_t$	3.743	0.525	-0.995	6.134	18.341*
					(0.000)
$lnFGU_t$	7.521	1.389	-0.279	2.726	5.437**
					(0.073)
$lnCPU_t$	1.692	0.890	-0.915	4.041	6.315
					(0.000)
$lnEPU_t$	6.361	2.102	-3.329	5.218	27.375
					(0.000)
$lnINC_t$	6.309	1.357	0.457	2.831	31.803
					(0.000)

Source: Policy Uncertainty (2023); Energy Information Administration (2023); Chinn and Ito (2007) and World Development Indicators (2023).
Note: * shows statistical significance at 1 percent level, while ** signifies the 5 percent significance level.

3.2 Model Specification

Several studies have identified factors such as oil production activity, real GDP, exchange rates, financial indicators, and investor behavior as key determinants influencing volatility and anxiety in the oil market (Chatziantoniou et al., 2021; Xiao and Wang, 2021). However, only a limited number of studies have explicitly examined the role of uncertainty in shaping oil market anxiety. As highlighted earlier, different types of uncertainty can exert either positive or negative effects on oil market dynamics, given their capacity to influence the fundamental structure and expectations within the energy sector. Moreover, empirical evidence underscores that macroeconomic and financial performance remain significant determinants of oil market stability (Kilian and Vigfusson, 2011). In line with the existing literature, this study proposes a conceptual framework that integrates various dimensions of uncertainty—economic, financial, and climate-related—alongside macroeconomic performance indicators to better explain the drivers of oil market anxiety.

$$lnOPS_t = f(lnCPU_t, lnEPU_t, lnFGU_t, lnINC_t) \tag{1}$$

OPS indicates oil market fair, CPU indicates climate policy uncertainty, EPU shows economic policy uncertainty and INC shows economic performance.

Moreover, all variables are used with the natural logarithm. Finally, f denotes the functional representation. The specification in equation (1) is transformed into the econometric specification showing stochastic error term as presented below:

$$lnOPS_t = \beta_0 + \beta_1 lnCPU_t + \beta_2 lnEPU_t + \beta_3 lnFGU_t + \beta_4 lnINC_t + \varepsilon_t \quad (2)$$

Other notations are described earlier; ϵt is the stochastic error term which includes other determinants not taken into account in our study.

3.3 Quantile ARDL

The quantile approach has become one of the most commonly used models for assessing the association between economic parameters. In addition, we contribute to the existing research by adopting Cho et al. (2016)'s Quantile ARDL model. This model is an improved variant of the ARDL approach that examines the short- and long-run effects of the parameters that provide explanation across several quantiles of the explained variable. There are several options for the QARDL model. First, it explores the short and long-run effects of the explained variable over different quantiles. Second, it is applicable with a small sample size. Finally, it can be used when the variables possess an interaction order of 0 I (0) or one I (1) (Bhutto and Chang, 2019). In contrast to the ARDL and NARDL frameworks, this method has a limitation: we cannot use the QARDL method if the variables have a degree of integration as I (2). In summary, we can't use this model if the variables evolve into stationary after the second differencing. As such, before employing the QARDL together with ARDL models, we use the ADF and KPSS analyses to assess the level of integration across all variables. When the order of integration is defined, we use the QARDL model proposed by Cho et al. (2016). Following Xiao and Liu (2023), we describe our model in a quantile-based approach of the QARDL model in the framework presented by Cho et al. (2016) as:

$$\begin{aligned} QOPS_t = a(r) &+ \sum_{i=1}^{n1} b_i\,(r)\Delta lnCPU_{t-i} + \sum_{i=0}^{n2} c_i\,(r)\Delta lnEPU_{t-i} \\ &+ \sum_{i=0}^{n3} d_i\,(r)\Delta lnFGU_{t-i} + \sum_{i=0}^{n4} e_i\,(r)\Delta lnINC_{t-i} + e_t(r) \end{aligned} \quad (3)$$

where $e_t(\tau) = OPS_{t-i} - QOPS_t \left(\substack{r \\ \delta_{t-1}}\right)$ and $0 > \tau < 1$ indicates each quantile where its values can be shown as below: τ ∈ {0.05 to 0.95}. The QARDL is specified as:

$$QOPS_t = a + \gamma lnOPS_{t-1} + \beta_{cpu} lnCPU_{t-1} + \beta_{epu} lnEPU_{t-1} + \beta_{fgu} lnFGU_{t-1} + \beta_{inc} INC_{t-1} + \sum_{i=1}^{p} b_i\,(r)\Delta lnCPU_{t-i} + \sum_{i=0}^{q} c_i\,(r)\Delta lnEPU_{t-i} + \sum_{i=0}^{r} d_i\,(r)\Delta lnFGU_{t-i} + \sum_{i=0}^{s} e_i\,(r)\Delta lnINC_{t-i} + e_t(\tau) \tag{4}$$

The QARDL-ECM form of the above generalized formulae (Equation 9) can be shown below:

$$QOPS_t = a(r) + \gamma(r)(lnOPS_{t-1} - \beta_{cpu}(r) lnCPU_{t-1} - \beta_{epu}(r) lnEPU_{t-1} - \beta_{fgu}(r) lnFGU_{t-1} - \beta_{inc}(r) INC_{t-1}) + \sum_{i=1}^{p} b_i\,(r)\Delta lnCPU_{t-i} + \sum_{i=0}^{q} c_i\,(r)\Delta lnEPU_{t-i} + \sum_{i=0}^{r} d_i\,(r)\Delta lnFGU_{t-i} + \sum_{i=0}^{s} e_i\,(r)\Delta lnINC_{t-i} + e_t(r) \tag{5}$$

The long-run determinants for CPU, EPU, FGU and INC are specified as $\beta_{cpu} = -\frac{\beta_{cpu}}{p}$, $\beta_{epu} = -\frac{\beta_{epu}}{p}$, $\beta_{fgu} = -\frac{\beta_{fgu}}{p}$, $\beta_{inc} = -\frac{\beta_{inc}}{p}$.

Notably, the ECM element *w* has to be significant with negative coefficient. Also, to examine the estimation result of CPU, EPU, FGU and INC on the oil market fear, we apply the Wald test to estimate the null hypothesis shown below:

$$H_0: w * (0.05) = w * (0.1) = w * (0.2) = \cdots = w * (0.95) \tag{6}$$

The alternate hypothesis is:

$$H_0: xi \neq \frac{j}{w(i)} \neq w(j) \tag{7}$$

Table 2. Stationary Estimates

Variables	KPSS (At Level) lm-stat [C-value]	KPSS (At First Diff.) lm-stat [C-value]	ADF (At Level) t-stat [p-value]	ADF (At First Diff.) [p-value]
OPSt	0.52* (0.739)	0.18* (0.739)	-6.98* (0.000)	-11.84* (0.000)
FGUt	0.47* (0.739)	0.09* (0.739)	-0.83 (0.792)	-9.57* (0.000)
CPUt	1.26 (0.739)	0.31* (0.739)	-4.02* (0.001)	-10.28* (0.000)
EPUt	1.42 (0.739)	0.28* (0.739)	-2.31 (0.162)	-11.67* (0.000)
INCt	1.39 (0.739)	0.07* (0.739)	-1.83 (0.372)	-6.03* (0.000)

Source: Policy Uncertainty (2023); Energy Information Administration (2023); Chinn and Ito (2007), and World Development Indicators (2023).
Note: * shows statistical significance at 1 percent level, while ** signifies the 5 percent significance level.

Table 2 above checks the stationarity of the variables using KPSS and ADF test statistics at the level and first difference. ***,** and * indicate that rejection of the null hypothesis at 10%, 5%, and 1% significance levels, respectively.

3.4 Non-Linear ARDL

Furthermore, the NARDL model is used in this work to uncover the asymmetric relationship between CPU, EPU, FGU, INC, and the oil market fair. It is noteworthy to understand that one of the advantages of NARDL is that is a more robust and popular approach due to its flexibility, which means that it can be used irrespective of the nature of variables, i.e., I(0), I(1), or a mixture of both. However, it cannot be applied if the order of integration is above I(1) (like I(2) process as this will nullify the entire model (Biyase and Naidoo, 2023; Khanday et al., 2024; Jakada et al., 2023; Sehrawat, 2021; Vasichenko et al., 2020, and many others). Uncertainty about financial globalisation, economic policy uncertainty, climate policy uncertainty, and income level all have an essential role to play in oil price shocks. Shin et al. (2014) proposed the following nonlinear equation for constructing the nonlinear ARDL:

$$\begin{aligned}\Delta OPS_t = \omega_1 &+ \sum_{j=1}^{no} \omega_{2j} \Delta FGU^+ + \sum_{j=1}^{np} \omega_{3j} \Delta FGU^- t - j \\ &+ \sum_{j=1}^{nq} \omega_{4j} \Delta CPU^+ t - j + \sum_{j=1}^{nr} \omega_{5j} \Delta CPU^- t - j \\ &+ \sum_{j=1}^{ns} \omega_{6j} \Delta EPU_{t-j} + \sum_{j=1}^{nu} \omega_{7j} \Delta INC_{t-j} + \gamma_1 OPS_{t-1} \\ &+ \gamma_2 FGU^+{}_{t-1} + \gamma_3 FGU^-{}_{t-1} + \gamma_4 CPU^+{}_{t-1} \\ &+ \gamma_5 CPU^-{}_{t-1} + \gamma_6 EPU_{t-1} + \gamma_7 INC_{t-1} + \mu_t \end{aligned} \tag{8}$$

Notably, c1 to c7 denote the long-run coefficients, while the changes in the variables capture the short-run dynamics. Furthermore, the bounds testing procedure is employed to examine the existence of a long-term relationship among the variables within the framework of the Nonlinear Autoregressive Distributed Lag (NARDL) model presented in Equation (9). The bounds testing approach, developed by Pesaran et al. (2001), is designed to assess cointegration among variables regardless of whether they are integrated of order zero or one. The NARDL model also accounts for the asymmetric effects arising from positive and negative variations in the explanatory variables, thereby allowing a more comprehensive understanding of their differential impacts.

3.5 Diagnostic Tests

It is important to note that several diagnostic tests were conducted to evaluate the adequacy and reliability of the estimated models. The Ramsey RESET test was employed to verify the correctness of the model specification, while the serial correlation test was used to check for the absence of autocorrelation in the residuals. Additionally, the adjusted R-squared statistic was computed to assess the overall goodness of fit of the models. The outcomes of these diagnostic evaluations are reported alongside the cointegration test results in Table 3.

3.6 The ARDL Bounds Tests for Cointegration

The outcomes of the cointegration bounds test are presented in Table 3. The computed F-statistic, valued at 17.127 and significant at the 5% level, exceeds the upper critical bound, thereby confirming the presence of a long-run equilibrium relationship among climate policy uncertainty, economic policy uncertainty, financial globalisation uncertainty, economic performance, and oil market fear.

Table 3. Bound Test Results

Function	*F*-statistics QARDL		*F*-*statistics* NARDL	
$F_{lnOPS}(lnCPU_t, lnEPU_t, lnFGU_t, lnINC_t)$	17.127		12.425	
C value bounds				
Level of significance	I(0)	I(1)	I(0)	I(1)
At 10%	2.02	3.09	2.84	3.10
At 5%	2.56	3.49	3.73	3.61
At 1%	3.29	4.37	4.02	5.52
Diagnostic test				
R^2	0.518		0.610	
Adj-R^2	0.502		0.521	
F statistic	7.531		8.24	
Prob (F statistic)	0.000		0.000	
LM	1.153		1.55	
ECM	-0.435**		-0.571*	
$Wald_{LR}$	5.85*		6.233*	
$Wald_{SR}$	0.562*		0.583**	

Source: Policy Uncertainty (2023); Energy Information Administration (2023); Chinn and Ito (2007) and World Development Indicators (2023).

Note: * shows statistical significance at 1 percent level, while ** signifies the 5 percent significance level.

4. Results and Discussion

This study examines how financial globalisation uncertainty, economic policy uncertainty, climate policy uncertainty, and economic performance influence different quantiles of Nigeria's oil market anxiety. It extends the existing literature by comparing results from the Quantile Autoregressive Distributed Lag (QARDL) model (Cho et al., 2016) with those from the Nonlinear Autoregressive Distributed Lag (NARDL) framework. The QARDL model's main advantage lies in its ability to capture heterogeneous effects across various quantiles of the dependent variable, providing a more nuanced understanding of the relationships. However, one limitation of the QARDL approach is that it cannot be applied when any variable is stationary at the second difference. To ensure model validity, this study employs both Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests to determine the stationarity properties of the variables. As shown previously in Table 1, the ADF results reveal that all variables are stationary either at level or at first difference, while the KPSS test confirms stationarity at I(0) or

I(1). These findings satisfy the preconditions for applying both models. The results of the bound cointegration tests, presented in Table 3, further confirm the existence of long-run relationships among the studied variables under both the QARDL and NARDL frameworks.

Table 4 presents the results of the Quantile ARDL (QARDL) model, covering quantiles ranging from Q0.05 to Q0.95, which represent the lower and upper ends of the oil market fear distribution, respectively. The findings reveal that at the 5th quantile, shocks originating from climate policy uncertainty (CPU), financial globalization uncertainty (FGU), and economic policy uncertainty (EPU) account for approximately 85%, 50%, and 9% of the variations in oil market fear, while economic performance (INC) explains about 17% in the long run. At this stage, CPU exerts the greatest influence on oil market fear compared to other variables. Similarly, in the 10th quantile, CPU continues to have a stronger impact than FGU, EPU, and INC, contributing roughly 74% of the observed variation. Across the 20th to 80th quantiles, CPU consistently demonstrates the most significant explanatory power, accounting for about 74%, 71%, 66%, 64%, 61%, 70%, 73%, and 63% of the variation in oil market fear, respectively. However, in the 90th and 95th upper quantiles, FGU emerges as the dominant factor influencing oil market fear. Overall, the short-run outcomes across quantiles show a consistent pattern with the long-run estimates.

In particular, an increase in economic policy uncertainty (EPU) often exerts a direct negative effect on real economic activity by discouraging investment and consumption, which subsequently reduces oil demand and heightens market volatility. Consequently, surges in EPU tend to amplify fear within the oil market, as investors and traders anticipate a decline in oil demand and potential price drops resulting from such shocks. However, the influence of EPU on oil market anxiety is not constant—it fluctuates over time and becomes especially pronounced during major crises that trigger economic downturns, such as the 2018 financial crisis or the recent COVID-19 pandemic. This suggests that market participants exhibit heightened sensitivity to EPU shocks during periods of economic instability.

The relationship between financial globalization uncertainty (FGU) and oil market anxiety is shaped not only by economic fundamentals but also by the financial nature of the oil sector. Due to this close connection, fluctuations in global financial conditions often heighten market apprehension, making FGU a key determinant of oil market fear over time. Accordingly, FGU consistently exhibits a positive and significant impact on oil market volatility and investor sentiment. Conversely, economic performance (as measured by INC) shows a negative relationship with oil market anxiety. This inverse link suggests that as Nigeria—an oil-producing and oil-dependent nation—experiences stronger economic activity, market participants become less apprehensive about potential oil price shocks because increased domestic demand provides a stabilizing effect. Moreover, Nigeria's ongoing efforts to diversify its economy aim to mitigate this dependence on oil revenues, thereby reducing the broader economic and psychological vulnerabilities associated with oil market fluctuations.

Our findings indicate that climate policy uncertainty (CPU) is one of the strongest drivers of oil market anxiety. Broadly, CPU influences oil market behavior through several interconnected channels. First, a significant share of global carbon dioxide emissions stems from oil consumption, directly linking the sector to climate change. To mitigate these adverse effects, governments must implement energy restructuring, improve efficiency, and regulate fossil fuel use. However, the design and enforcement of such policies often involve considerable uncertainty (Nodari, 2014). When policy directions are unclear or inconsistent, oil market participants face difficulty in predicting future demand patterns. This uncertainty amplifies their anxiety, as fluctuating climate regulations introduce additional risks into investment decisions and market expectations.

Second, climate change often amplifies both physical and transition risks, which can negatively impact firms and broader economic stability (In et al., 2022; Zhang, 2022). When policy measures to mitigate global warming are uncertain or poorly defined, these risks remain inadequately managed, heightening economic volatility and intensifying anxiety within the oil market. Furthermore, climate-related risks also influence real economic activity and financial markets. Krueger et al. (2020) emphasize that institutional investors increasingly consider climate shocks in their decision-making, while Zhang (2022) finds that climate risks exert a negative effect on stock valuations. Given the deep financial integration of the oil market, such risks quickly transmit through investment channels, linking fluctuations in financial sentiment with oil price instability. Consequently, uncertainty surrounding climate policies can magnify market apprehension and volatility. Overall, the empirical evidence underscores the importance of understanding how climate policy uncertainty shapes oil market anxiety across different quantiles and market conditions.

Our findings can be further extended by exploring the underlying factors driving the rise in climate policy uncertainty and the broader apprehension surrounding climate-related risks. One major catalyst is the frequency of significant global climate policy events, such as the Paris Climate Change Conference held on December 12, 2015. The conference brought together nearly 200 parties that endorsed the Paris Agreement, committing to reduce greenhouse gas emissions and limit global temperature increases. The Agreement officially came into force in November 2016, marking a landmark step in international climate governance. However, the subsequent withdrawal of the United States from the Agreement in June 2017 heightened global uncertainty regarding the stability and enforcement of climate policies. As Battiston et al. (2021) note, the period following the Paris Agreement saw increased involvement of the financial sector in climate-related discussions, with monetary and regulatory authorities recognizing climate change as an emerging systemic financial risk.

Diaz-Rainey et al. (2021) report that both the ratification of the Paris Agreement and the subsequent announcement of the United States' withdrawal had a markedly negative impact on the fossil fuel industry. These developments contributed to a sharp rise in climate policy uncertainty, which in turn fueled volatility across economic and financial markets—intensifying anxiety within the oil sector. Additionally, government initiatives aimed at transitioning toward greener, low-carbon economies have raised public awareness of environmental risks and climate-related threats. Fahmy (2022), using the Google Search Index, finds that since the adoption of the Paris Agreement, investor attention to climate-related issues has grown significantly. This heightened public concern over climate risks likely magnified the positive relationship between climate policy uncertainty and oil market fear in the post-2016 period.

The NARDL estimation results presented in Table 5 distinguish between the positive and negative components of climate policy uncertainty (CPU) and financial globalization uncertainty (FGU). The findings indicate that both increases and decreases in these variables exhibit positive estimated coefficients. Specifically, a 1% rise in CPU leads to a 3% increase in oil market anxiety in the short run and a 14% increase in the long run. Conversely, a 1% decline in CPU results in a 3% reduction in oil market fear in the short term and an 11% decrease in the long term.

Regarding FGU, the positive shock is statistically positive but insignificant in the short run, while in the long run, it becomes statistically significant with a coefficient of 0.71. The negative shock of FGU, however, is statistically positive and significant, suggesting that a 1% decrease in FGU reduces oil market fear by 14% in the short run and 24% in the long run.

Overall, the NARDL results reinforce the findings of the QNARDL model, confirming positive associations between FGU, CPU, EPU, and INC in explaining oil market anxiety. Nevertheless, the asymmetry evident in the NARDL results highlights that FGU's short-run effects are insignificant, whereas long-run effects are substantial. These findings imply that variations in CPU and FGU exert asymmetric influences on Nigeria's oil market fear over both short- and long-term horizons.

Table 4. QARDL Results

Quantiles	Constant	ECM	Long-run estimates				Short-run estimates				
$[r]$	$a[r]$	p^*	$\beta CPU[r]$	$\beta EPU[r]$	$\beta FGU[r]$	$\beta INC[r]$	$w1[r]$	$k0[r]$	$d0[r]$	$y0[r]$	$h0[r]$
Q_5	0.017* (0.005)	0.019* (0.004)	0.850* (0.0817)	0.094** (0.041)	0.503* (0.048)	0.171* (0.038)	0.149 (0.834)	0.691** (0.323)	0.108* (0.041)	0.424* (0.031)	0.1701* (0.067)
Q_{10}	0.014 (0.005)	-0.061* (0.013)	0.740* (0.078)	0.088** (0.045)	0.5168* (0.045)	0.177* (0.036)	0.177** (0.075)	0.438* (0.034)	0.138* (0.051)	0.219* (0.059)	0.127* (0.021)
Q_{20}	0.042* (0.013)	0.034** (0.013)	0.714* (0.079)	0.089** (0.044)	0.482* (0.043)	0.181* (0.036)	0.210* (0.042)	0.243* (0.059)	0.165* (0.058)	0.411* (0.038)	0.108* (0.024)
Q_{30}	0.027** (0.011)	0.020** (0.009)	0.662* (0.078)	0.165** (0.082)	0.519* (0.042)	0.169* (0.032)	0.164* (0.041)	0.331* (0.065)	0.167* (0.019)	0.331* (0.051)	0.944* (0.196)
Q_{40}	0.018** (0.008)	0.019** (0.009)	0.649* (0.079)	0.255** (0.129)	0.561* (0.041)	0.157* (0.029)	0.143* (0.037)	0.317* (0.087)	0.184* (0.019)	0.222* (0.054)	0.753* (0.129)
Q_{50}	0.009 (0.012)	0.026** (0.013)	0.611* (0.080)	0.014** (0.052)	0.566* (0.056)	0.184* (0.027)	0.108* (0.038)	0.154* (0.048)	0.177* (0.019)	0.169* (0.053)	0.612* (0.109)
Q_{60}	0.015 (0.008)	0.015** (0.007)	0.703* (0.089)	0.275 (0.857)	0.336* (0.103)	0.189* (0.026)	0.906** (0.474)	0.188* (0.042)	0.142* (0.023)	0.119** (0.055)	0.690* (0.107)
Q_{70}	0.014 (0.008)	0.017** (0.008)	0.738* (0.075)	0.291* (0.106)	0.282* (0.084)	0.218* (0.028)	0.199* (0.093)	0.148* (0.043)	0.100* (0.023)	0.122 (0.070)	0.689* (0.105)
Q_{80}	0.311* (0.118)	0.346* (0.110)	0.629* (0.098)	0.416* (0.079)	0.152 (0.096)	0.218* (0.037)	0.211* (0.089)	0.124 (0.069)	0.075* (0.023)	0.193** (0.095)	0.790* (0.143)
Q_{90}	0.165 (0.185)	0.285** (0.125)	0.081** (0.041)	0.342** (0.170)	0.441* (0.064)	0.155** (0.095)	0.201* (0.073)	0.112* (0.046)	0.047 (0.025)	0.266* (0.097)	0.813* (0.176)
Q_{95}	0.189* (0.036)	0.209* (0.097)	0.129* (0.234)	0.187* (0.028)	0.425* (0.138)	0.309** (0.133)	0.580* (0.161)	0.786* (0.126)	0.708* (0.123)	0.747* (0.128)	0.800* (0.142)

Note: * Shows statistical significance at the 1 percent level, while ** signifies the 5 percent significance level.
Source: Policy Uncertainty (2023); Energy Information Administration (2023); Chinn and Ito (2007), and World Development Indicators (2023).

Table 5. NARDL Results

Variable	Short-run	SE	t-statistic
ΔCPU^{+}	0.038**	0.018	2.13
ΔCPU^{-}	0.036**	0.015	2.415
ΔFGU^{+}	0.007	0.028	0.259
ΔFGU^{-}	0.149**	0.058	2.541
ΔEPU	0.292*	0.060	4.851
ΔINC	0.104	0.061	1.711
$ECT(-1)$	-0.567*	0.104	-5.466
Variable	**Long-run**	**SE**	**t-statistic**
C	0.108*	0.041	2.605
CPU^{+}	0.144**	0.058	2.506
CPU^{-}	0.115*	0.028	4.076
FGU^{+}	0.710*	0.063	11.362
FGU^{-}	0.239**	0.111	2.147
EPU	0.037**	0.017	2.209
INC	0.679	0.372	1.828

Note: * Shows statistical significance at the 1 percent level, while ** signifies the 5 percent significance level.
Source: Policy Uncertainty (2023); Energy Information Administration (2023); Chinn and Ito (2007), and World Development Indicators (2023).

5. Conclusion

In recent times, amid heightened global uncertainties, anxiety in the oil market has intensified, accompanied by significant fluctuations in oil prices. This study employs the oil price shocks (OPS) index to analyze how economic policy uncertainty (EPU), climate policy uncertainty (CPU), financial globalization uncertainty (FGU), and economic performance (INC) influence oil market fear in Nigeria. Recognizing that the relationships between these variables and OPS may vary across quantiles, the study primarily adopts the Quantile ARDL (QARDL) model for empirical analysis. Additionally, the Nonlinear ARDL (NARDL) model is applied to test for potential asymmetric effects between CPU and FGU on OPS.

The empirical results reveal that CPU, FGU, EPU, and INC exert quantile-dependent impacts on oil market anxiety. The QARDL findings underscore the dominant role of climate policy uncertainty in shaping Nigeria's oil market fear across most quantiles, except at the upper quantile, where financial globalization uncertainty becomes more influential. Furthermore, the NARDL results confirm the positive associations observed in the QARDL estimations, reinforcing the presence of asymmetric relationships among the variables and their collective influence on oil market fear in Nigeria.

High levels of fear and uncertainty in the oil market negatively affect trade, investment, and effective risk management. The findings of this study provide essential insights for addressing the current volatility in the oil sector. Specifically, climate-related instability—alongside economic, financial, and performance-related uncertainties—can intensify market anxiety, particularly within the framework of the Paris Agreement. To mitigate oil market volatility stemming from climate policy uncertainty, policymakers should accelerate the shift toward cleaner and more sustainable energy systems. Likewise, investors are encouraged to diversify their portfolios by incorporating renewable energy investments.

Furthermore, governments and investors must recognize that climate, economic, and financial uncertainties influence oil market behavior in distinct ways, requiring targeted and context-specific responses. During crises such as pandemics, both authorities and market participants should remain vigilant to these overlapping sources of uncertainty, as they can significantly heighten investor apprehension. Policymakers can stabilize demand and prevent sharp price declines by implementing economic stimulus measures and strengthening transparency and market regulations. At the same time, investors may need to hedge against risks through alternative financial instruments or temporarily reduce their exposure to the oil sector to safeguard their assets.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors have no conflicts of interest to declare that are relevant to the content of this article.
- Data Availability Statement: Data from this study are available upon request.

References

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics, 131*(4), 1593-1636. Retrieved from https://www.aeaweb.org/conference/2014/retrieve.php?pdfid=1116.

Bartram, S. M., Hou, K., & Kim, S. (2022). Real Effects of Climate Policy: Financial Constraints and Spillovers. *Journal of Financial Economics, 143*(2), 668-696. Retrieved from https://www.sciencedirect.com/science/article/pii/S0304405X21002853.

Baumeister, C., & Hamilton, J. D. (2019). Structural Interpretation of Vector Autoregressions with Incomplete Identification: Revisiting the Role of Oil Supply and Demand Shocks. *American Economic Review, 109*(5), 1873-1910. Retrieved from https://www.nber.org/system/files/working_papers/w24167/w24167.pdf .

Biyase, M., & Naidoo, Y. (2023). The Symmetric and Asymmetric Effect of Remittances on Financial Development: Evidence from South Africa. *International Journal of Financial Studies, 11*(1), 26. Retrieved from https://www.mdpi.com/2227-7072/11/1/26.

Bouoiyour, J., Selmi, R., Hammoudeh, S., & Wohar, M. E. (2019). What are the Categories of Geopolitical Risks that Could Drive Oil Prices Higher? Acts or Threats? *Energy Economics*, *84*, 104523. Retrieved from https://www.academia.edu/download/115117995/j.eneco.2019.10452320240521-1-go182t.pdf.

Bouri, E., Iqbal, N., & Klein, T. (2022). Climate Policy Uncertainty and the Price Dynamics of Green and Brown Energy Stocks. *Finance Research Letters*, *47*, 102740. Retrieved from https://www.sciencedirect.com/science/article/pii/S1544612322000629.

Chatziantoniou, I., Filippidis, M., Filis, G., & Gabauer, D. (2021). A Closer Look into the Global Determinants of Oil Price Volatility. *Energy Economics, 95*, 105092. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988320304321.

Chinn, M. D., & Ito, H. (2007). Current Account Balances, Financial Development and Institutions: Assaying the World "Saving Glut". *Journal of International Money and Finance, 26*(4), 546-569. Retrieved from https://www.nber.org/system/files/working_papers/w11761/w11761.pdf .

Dai, Z., & Zhu, H. (2023). Dynamic Risk Spillover among Crude Oil, Economic Policy Uncertainty, and Chinese Financial Sectors. *International Review of Economics & Finance, 83,* 421-450. Retrieved from https://www.sciencedirect.com/science/article/pii/S1059056022002374.

De Schryder, S., & Peersman, G. (2013). The US Dollar Exchange Rate and the Demand for Oil. Retrieved from https://journals.sagepub.com/doi/pdf/10.5547/01956574.37.1.ssch.

Diaz-Rainey, I., Gehricke, S. A., Roberts, H., & Zhang, R. (2021). Trump vs. Paris: The Impact of Climate Policy on US Listed Oil and Gas Firm Returns and Volatility. *International Review of Financial Analysis*, *76*, 101746. Retrieved from https://www.sciencedirect.com/science/article/pii/S1057521921000880.

Dutta, A., Bouri, E., & Noor, M. H. (2021). Climate Bond, Stock, Gold, and Oil Markets: Dynamic Correlations and Hedging Analyses during the COVID-19 Outbreak. *Resources Policy, 74*, 102265. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301420721002762.

Fahmy, H. (2022). The Rise in Investors' Awareness of Climate Risks after the Paris Agreement and the Clean Energy-Oil-Technology Prices Nexus. *Energy Economics, 106*, 105738. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988321005855.

Gu, X., Zhu, Z., & Yu, M. (2021). The Macro Effects of GPR and EPU Indexes over the Global Oil Market—Are the Two Types of Uncertainty Shock Alike? *Energy Economics, 100*, 105394. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988321002930.

Guo, Y., Ma, F., Li, H., & Lai, X. (2022). Oil Price Volatility Predictability Based on Global Economic Conditions. *International Review of Financial Analysis, 82*, 102195. Retrieved from https://www.sciencedirect.com/science/article/pii/S1057521922001569.

Hong, C., Zhang, Q., Zhang, Y., Davis, S. J., Zhang, X., Tong, D., Guan, D., Liu, Z., & He, K. (2020). Weakening Aerosol Direct Radiative Effects Mitigate Climate Penalty on Chinese Air Quality. *Nature Climate Change, 10*(9), 845-850. Retrieved from https://drive.google.com/file/d/129xMuRBl0rzCF3JfSSaNmMxUuqxTvG6q/view.

In, S. Y., Weyant, J. P., & Manav, B. (2022). Pricing Climate-Related Risks of Energy Investments. *Renewable and Sustainable Energy Reviews, 154*, 111881. Retrieved from https://www.sciencedirect.com/science/article/pii/S1364032121011485.

Cho, J. W., Choi, J. H., Kim, T., & Kim, W. (2016). Flight-to-quality and Correlation between Currency and Stock Returns. *Journal of Banking & Finance*, *62*, 191-212. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=2024638.

Jakada, A. H., Ibrahim, B. A., Danmaraya, I. A., Fagge, A. M., & Yola, A. T. (2023). Asymmetric Effect of Crude Oil Price on the Quality of Environment in Nigeria: An Application of Non-Linear ARDL. *Caspian Journal of Environmental Sciences*, *21*(3), 493-507. Retrieved from https://www.researchgate.net/.

Javadi, S., & Masum, A. A. (2021). The Impact of Climate Change on the Cost of Bank Loans. *Journal of Corporate Finance*, *69*, 102019. Retrieved from https://www.sciencedirect.com/science/article/pii/S0929119921001401.

Ji, Q., Geng, J. B., & Tiwari, A. K. (2018). Information Spillovers and Connectedness Networks in the Oil and Gas Markets. *Energy Economics, 75*, 71-84. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988318303116.

Khanday, I. N., Tarique, M., Wani, I. U., & Dar, M. H. (2024). Poverty and Financial Development: An Asymmetric and Nonlinear ARDL Analysis for India. *Journal of Economic Studies*, *51*(4), 764-782. Retrieved from https://www.researchgate.net/.

Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review, 99*(3), 1053-1069. Retrieved from https://www.jstor.org/stable/pdf/25592494.pdf.

Krueger, P., Sautner, Z., & Starks, L. T. (2020). The Importance of Climate Risks for Institutional Investors. *The Review of Financial Studies, 33*(3), 1067-1111. Retrieved from https://www.jstor.org/stable/pdf/48574180.

Li, Y., Huang, J., Gao, W., & Zhang, H. (2021). Analyzing the Time-Frequency Connectedness among Oil, Gold Prices, and BRICS Geopolitical Risks. *Resources Policy, 73*, 102134. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301420721001483.

Liang, C., Wei, Y., Li, X., Zhang, X., & Zhang, Y. (2020). Uncertainty and Crude Oil Market Volatility: New Evidence. *Applied Economics, 52*(27), 2945-2959. Retrieved from https://www.researchgate.net/.

Lin, B., & Bai, R. (2021). Oil Prices and Economic Policy Uncertainty: Evidence from Global, Oil Importers, and Exporters' Perspectives. *Research in International Business and Finance, 56*, 101357. Retrieved from https://www.sciencedirect.com/science/article/pii/S027553192030965X.

Liu, Z., Tang, Y. M., Chau, K. Y., Chien, F., Iqbal, W., & Sadiq, M. (2021). Incorporating Strategic Petroleum Reserve and Welfare Losses: A Way Forward for the Policy Development of Crude Oil Resources in South Asia. *Resources Policy, 74*, 102309. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301420721003196.

Mei, D., Ma, F., Liao, Y., & Wang, L. (2020). Geopolitical Risk Uncertainty and Oil Future Volatility: Evidence from MIDAS Models. *Energy Economics*, *86*, 104624. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988319304219.

Mitra, S. K. (2018). An Analysis Of Brand Value And Its Determinants Using Quantile Regression. *Academy of Marketing Studies Journal, 22*(3), 1-9.

Anjum, N., Ghumro, N. H., & Husain, B. (2017). Asymmetric Impact of Exchange Rate Changes on Stock Prices: Empirical Evidence from Germany. *International Journal of Economics and Financial Research, 3*(11), 240-245. Retrieved from https://ideas.repec.org/a/arp/ijefrr/2017p240-245.html.

Bhutto, N. A., & Chang, B. H. (2019). The Effect of the Global Financial Crisis on the Asymmetric Relationship between Exchange Rate and Stock Prices. *High Frequency, 2*(3–4), 175-183. Retrieved from https://onlinelibrary.wiley.com/doi/pdfdirect/10.1002/hf2.10033.

Nodari, G. (2014). Financial Regulation Policy Uncertainty and Credit Spreads in the US. *Journal of Macroeconomics, 41*, 122-132. Retrieved from https://www.sciencedirect.com/science/article/pii/S0164070414000743.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, *16*(3), 289-326. Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1002/jae.616.

Qin, M., Zhang, Y. C., & Su, C. W. (2020). The Essential Role of Pandemics: A Fresh Insight into the Oil Market. *Energy Research Letters, 1*(1), 1-20. Retrieved from https://erl.scholasticahq.com/article/13166-the-essential-role-of-pandemics-a-fresh-insight-into-the-oil-market.

Ren, J., Yang, J., Zhang, Y., Xiao, X., Xia, J. C., Li, X., & Wang, S. (2022). Exploring Thermal Comfort of Urban Buildings Based on Local Climate Zones. *Journal of Cleaner Production, 340,* 130744. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652622003833.

Ren, X., Zhang, X., Yan, C., & Gozgor, G. (2022). Climate Policy Uncertainty and Firm-Level Total Factor Productivity: Evidence from China. *Energy Economics, 113,* 106209. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988322003577.

Roncoroni, A., Battiston, S., Escobar-Farfán, L. O., & Martinez-Jaramillo, S. (2021). Climate Risk and Financial Stability in the Network of Banks and Investment Funds. *Journal of Financial Stability, 54*, 100870. Retrieved from https://www.sciencedirect.com/science/article/pii/S1572308921000309.

Sehrawat, M. (2021). Modelling the Nexus between Human Capital, Income Inequality, and Energy Demand in India: New Evidence from Asymmetric and Non-Linear Analysis. *Environmental Science and Pollution Research, 28*, 3632-3643. Retrieved from https://link.springer.com/article/10.1007/s11356-020-10733-z.

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring Economic Policy Uncertainty. *The Quarterly Journal of Economics*, *131*(4), 1593-1636. Retrieved from https://www.aeaweb.org/conference/2014/retrieve.php?pdfid=1116.

Salisu, A. A., Gupta, R., Bouri, E., & Ji, Q. (2020). The Role of Global Economic Conditions in Forecasting Gold Market Volatility: Evidence from a GARCH-MIDAS Approach. *Research in International Business and Finance, 54*, 101308. Retrieved from https://www.sciencedirect.com/science/article/pii/S0275531920307273.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling Asymmetric Cointegration And Dynamic Multipliers in a Nonlinear ARDL Framework. In *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications* (281-314). New York: Springer. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=1807745.

Tian, H., Long, S., & Li, Z. (2022). Asymmetric Effects of Climate Policy Uncertainty, Infectious Diseases-Related Uncertainty, Crude Oil Volatility, and Geopolitical Risks on Green Bond Prices. *Finance Research Letters, 48*, 103008. Retrieved from https://www.sciencedirect.com/science/article/pii/S1544612322002501.

Vasichenko, K., Khan, I., & Wang, Z. (2020). Symmetric and Asymmetric Effect of Energy Consumption and CO2 Intensity on Environmental Quality: Using Nonlinear and Asymmetric Approach. *Environmental Science and Pollution Research, 27*, 32809-32819. Retrieved from https://link.springer.com/article/10.1007/s11356-020-09263-5.

Wang, Q., Yang, X., & Li, R. (2022). The Impact of the COVID-19 Pandemic on the Energy Market–A Comparative Relationship between Oil and Coal. *Energy Strategy Reviews, 39*, 100761. Retrieved from https://www.sciencedirect.com/science/article/pii/S2211467X21001450.

Wei, Y., Liu, J., Lai, X., & Hu, Y. (2017). Which Determinant Is the Most Informative in Forecasting Crude Oil Market Volatility: Fundamental, Speculation, or Uncertainty? *Energy Economics, 68*, 141-150. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988317303195.

Wen, Y., Wang, Y., Zhao, K., Chong, D., Huang, W., Hao, G., & Mo, S. (2018). The Engineering, Economic, and Environmental Performance of Terminal Blend Rubberized Asphalt Binders with Wax-Based Warm Mix Additives. *Journal of Cleaner Production, 184*, 985-1001. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652618306607.

Xiao, J., & Liu, H. (2023). The time-varying Impact of Uncertainty on Oil Market Fear: Does Climate Policy Uncertainty Matter? *Resources Policy, 82*, 103533. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301420723002441.

Xiao, J., & Wang, Y. (2021). Investor Attention and Oil Market Volatility: Does Economic Policy Uncertainty Matter? *Energy Economics, 97*, 105180. Retrieved from https://www.sciencedirect.com/science/article/pii/S0140988321000852.

Xu, R., Xu, L., & Xu, B. (2017). Assessing CO2 Emissions in China's Iron and Steel Industry: Evidence from a Quantile Regression Approach. *Journal of Cleaner Production, 152*, 259-270. Retrieved from https://www.sciencedirect.com/science/article/pii/S0959652617305930.

Yaya, O. S., Gil-Alana, L. A., Adekoya, O. B., & Vo, X. V. (2021). How Fearful are Commodities and US Stocks in Response to Global Fear? Persistence and Cointegration Analyses. *Resources Policy, 74*, 102273. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301420721002841.

Zhang, D., & Kong, Q. (2022). Credit Policy, Uncertainty, and Firm R&D Investment: A Quasi-Natural Experiment Based on the Green Credit Guidelines. *Pacific-Basin Finance Journal*, *73*, 101751. Retrieved from https://www.sciencedirect.com/science/article/pii/S0927538X22000464.

Zhang, Y. J., & Yan, X. X. (2020). The Impact of US Economic Policy Uncertainty on WTI Crude Oil Returns in Different Time and Frequency Domains. *International Review of Economics & Finance*, *69*, 750-768. Retrieved from https://www.sciencedirect.com/science/article/pii/S1059056020300708.

Zhang, Y., He, M., Wang, Y., & Liang, C. (2022). Global Economic Policy Uncertainty Aligned: An Informative Predictor for Crude Oil Market Volatility. *International Journal of Forecasting*, *39*(3), 1318-1332. Retrieved from https://www.sciencedirect.com/science/article/pii/S0169207022001005.

Cite this article: Farouq, I., & Sulong, Z. (2025). The Effect of Climate Policy Uncertainty and Financial Globalization Uncertainty on Oil Market Fear: New Insight from QARDL. *Iranian Economic Review*, *29*(4), 1443-1468.

Iranian Economic Review, 2025, 29(4), 1469-1496
DOI: https://doi.org/10.22059/ier.2024.361041.1007747

RESEARCH PAPER

Total Factor Productivity Contributions and Its Drivers: Endogenous Growth Accounting Approach

Elaheh Farivar Tanha[a], **Mehdi Fathabadi**[a,*], **Mahmood Mahmoodzadeh**[a], **Masood Soufimajidpour**[a]

a. Department of Economics, Fi.C., Islamic Azad University, Firoozkooh, Iran.
* Corresponding author.

Received: 19 August 2023, Revised: 22 April 2024, Accepted: 16 May 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

This paper applies the endogenous growth accounting Approach to measure total factor productivity (TFP) and its Contributions in 121 four-digit ISIC code manufacturing industries between 2003 and 2019. The basic problem of most researchers is that they use the theory of exogenous growth to account for. This study uses the endogenous growth theory and the induced innovation theory to justify the utilization of varying coefficient production functions and decomposes total factor productivity into two parts: input-embedded and input-free productivities. Input-free productivity is divided into technical efficiency change and technological progress, while input-embedded productivity depends on the inputs used in the production function (labor and capital). Findings show that the average value-added growth is % 6.7%. The average ratio of input-embedded productivity in the industry's growth is about 21.8%. The contribution of capital-embedded productivity is -6.7% and the contribution of labor-embedded productivity is 28.5%. Therefore, technology is more manifest in labor. The IFP-free productivity ratio is 1.4%, which is due to two factors: technical efficiency change and technological progress.

Keywords: Endogenous Growth Theory, Growth Accounting, Iran's Manufacturing Industries, Total Factor Productivity.

JEL Classifications: D24, O14, O47.

1. Introduction

Solow's standard growth accounting approach (1956) considers two factors: the contribution of changes in classical production inputs (labor force and capital stock), and the residual. Solow's residual is the portion of an economy's output growth that cannot be attributed to the accumulation of capital and labor. It is not explained by changes in production inputs, and it is usually measured by the increase in total factor productivity (TFP), which also represents technological progress. Therefore, growth accounting seeks to answer the question of whether the production growth of an economy is due to changes in available production inputs and technology. Growth accounting is a popular tool to measure the contribution of different economic drivers to economic growth through their impact on TFP growth (Akcigit et al., 2021). However, there are two problems with the standard growth accounting method. First, the fixed coefficients assumption in the standard production function, along with the exogenous growth theory, fails to capture the changing input-output relation across countries and over time. This contradicts the endogenous growth theory of Romer (1986) and Lucas (1988) as well as the induced innovation theory proposed by Hicks (1963). Some studies use the time-varying contribution of input costs as the time-varying coefficients of inputs, which rely on the assumption of constant returns to scale that may not be valid at the macro-level in endogenous growth theory, as shown in Barro (1999) (Kumbhakar et al., 2000). Second, standard growth accounting can only estimate the overall effect of a growth driver on economic growth, but is incapable of identifying the pathways or channels through which the growth drivers affect economic growth because all the possible routes are mixed in TFP measured by a Solow residual (Hac et al., 2021).

Lack of identification and partition of the overall effects is sometimes problematic. For example, suppose a country has a constraint in its public R&D budget, a question that is raised: where should we invest and how much should we invest in each field to promote economic growth? This is an important issue in the real world and requires comparing the effects of R&D on economic growth through different channels, which are unable to be fulfilled by the standard growth accounting approach (Heyets et al., 2019). By using endogenous growth and induced innovation theory, a production function is defined by variable coefficients in this paper that allows a varying coefficient production function to reflect the quality change of inputs without the restriction of constant returns to scale. Then, Total factor productivity (TFP) is decomposed into input-embedded productivity and input-free productivity. Accordingly, the second source of economic growth in standard growth accounting (the growth in TFP) can be further separated into growth in various input-embedded productivities and input-free productivity. Therefore, new growth accounting can evaluate various channels through which the growth drivers affect economic growth, including their effects on input quantity, input quality, and input-free productivity, which is unidentified in standard growth accounting. A recurring question among economists is: What is the source of a country's economic growth? Researchers use a variety of methods to answer this question. One simple and useful method is growth accounting (Ghosh et al., 2021). The contribution of this article is threefold. First, this study uses the endogenous growth theory and the induced innovation theory to justify the utilization of varying coefficient production functions. Second, this study decomposes total factor productivity (TFP) into input-embedded and input-free productivities. Third, this paper tends to generalize the traditional neoclassical growth accounting methodology to investigate various channels through which growth drivers affect economic growth. To do so, this paper applies the new model to investigate economic growth in 121 four-digit ISIC code manufacturing industries from 2003 to 2019.

The remainder of the paper is structured as follows. The next Section addresses the review of the related literature. The third Section establishes the new growth accounting model. In the succeeding Section, a data description is provided. Next, the empirical results are presented, and in the final Section conclusion and discussion.

2. Literature Review

2.1 Theoretical Framework

Barro and Sala-i-Martin (2004) suggest that, despite the significant importance of the economic growth rate, its drivers remain one of the biggest mysteries in economics. Adam Smith believed that specialization and the division of labor were the engines of economic growth. Classical economists like Malthus and Ricardo thought that limited natural resources were the main constraint on growth opportunities. During the 20th century, economists shifted focus toward investment in physical capital and infrastructure. However, in the 1950s, economists like Solow (1956; 1957) examined economic growth more seriously. Solow proposed that technology, capital stock, and labor were the key drivers of a nation's economic growth, testing his theory with U.S. data. Researchers applied his theory in various countries. Generally, three approaches are used to evaluate economic growth: the theoretical approach, which uses economic growth theories to explain contributing factors; the steady-state approach, focusing on stable economic growth; and the growth accounting approach, which measures the contributions of various factors to economic growth. The first approach can't precisely quantify individual contributions; the second is mainly for developed countries. The third approach, however, can quantify the contributions of different factors to economic growth.

2.2 Difference from Previous Studies

Many studies have investigated the factors driving economic growth and total factor productivity (TFP). Haouas et al. (2024), using an accounting framework, found that Algeria's economic growth performance has been weak and modest for decades. This is largely due to labor growth, with weak capital accumulation and significant losses in TFP growth. Zhang et al. (2023) showed that a 1% decrease in external technology dependence could lead to a 1% increase in TFP in China. They also found that the impact of external technology dependence on TFP is stronger in technology-intensive industries compared to other sectors. Herzer (2022) found that increases in domestic R&D expenditure positively impact the level and growth rate of TFP, as predicted by semi-endogenous growth theory. However, this effect is more pronounced in middle-income countries than in low-income ones. Herzer also showed that domestic R&D has a significantly greater effect on TFP in developing countries compared to international R&D spillovers. Rawat and Sharma (2021) revealed that technical change and efficiency improvement are key drivers of TFP growth in India. Albanese et al. (2021) indicated that, on average, local TFP appears to be relatively unresponsive to EU programs.

Jia et al. (2020) demonstrated that manufacturing TFP growth contributes directly to economic growth and indirectly through capital and labor input growth. In contrast, similar direct and indirect effects were not observed for non-manufacturing TFP growth. Bandyopadhyay et al. (2019) calibrated their model to the US economy and found that misallocation and its negative effects on TFP and GDP can be significant.

Most studies on economic growth accounting rely on exogenous models, but they fall short because they can't analyze total productivity growth, treating it as exogenous and using the Solow residual approximation. This article employs an endogenous approach to account for the economic growth of Iran's manufacturing industries, presenting two significant advantages over traditional methods. First, it rejects the assumption of constant returns to scale, allowing for the possibility of increasing returns. Second, it elucidates the nature of productivity growth and its driving factors, addressing a common flaw in earlier studies that often underestimated the share of productivity growth. Standard growth accounting only estimates the overall impact of a growth stimulus on economic growth without identifying the specific pathways or mechanisms through which these stimuli operate. This article's approach aims to fill that gap.

2.3 Standard Growth Accounting in the Form of Exogenous Growth Theory

Growth accounting is a common technique for measuring the contribution of factors of production to economic growth. It was first introduced in the form of the exogenous growth theory by Solow (1956; 1957) and Swan (1956). Subsequently, many researchers used this method in their studies (Jorgenson and Stiroh, 2000; Jones, 2002; Bai and Zhang, 2010). A classic production function with Cobb–Douglas formation is frequently used by many scholars in several growth-accounting studies (Gallup and Sachs, 2000; Miller, 2002; Deininger and Jin, 2005; Hammond and Thompson, 2008; Pope and LaFrance, 2013; Shee and Stefanou, 2015; Sheng et al., 2019). This production function is;

$$\mathrm{y_{it}} = \mathrm{a_{it}} + \beta \mathrm{k_{it}} + (1-\beta)\mathrm{l_{it}} \tag{1}$$

where $\mathrm{y_{it}}$ is the production, $\mathrm{a_{it}}$ is the TFP or technology level, $\mathrm{k_{it}}$ is the capital stock, and $\mathrm{l_{it}}$ is the labor. Therefore, production growth is as follows;

$$\dot{\mathrm{y}}_{\mathrm{it}} = \dot{\mathrm{a}}_{\mathrm{it}} + \beta \dot{\mathrm{k}}_{\mathrm{it}} + (1-\beta)\dot{\mathrm{l}}_{\mathrm{it}} \tag{2}$$

According to Equation (2), production growth is driven by the expansion of classical production factors and the improvement in productivity of all production factors. Therefore, the contribution of capital and labor to economic growth is equivalent to $\frac{\beta \dot{\mathrm{k}}_{\mathrm{it}}}{\dot{\mathrm{y}}_{\mathrm{it}}}$ and $\frac{(1-\beta)\dot{l}_{\mathrm{it}}}{\dot{\mathrm{y}}_{\mathrm{it}}}$, respectively. And, $\frac{\dot{\mathrm{a}}_{\mathrm{it}}}{\dot{\mathrm{y}}_{\mathrm{it}}}$ is a TFP contribution. TFP, in the long term, is often regarded as the major driving force of economic growth; however, it is a Solow residual that measures the portion of output not explained by the amount of inputs used in production (Sickles 2005; Jin et al. 2002; Deininger and Jin 2005).

2.4 New Standard Growth Accounting in the form of Exogenous Growth Theory

The framework of endogenous growth theory of input elasticity in time and specific to each company is affected by variables such as R&D investment, which is as follows;

$$y_{it} = a_{it} + \beta_{it}k_{it} + \theta_{it}l_{it} \tag{3}$$

where $\beta_{it} = f_1(W_{it})$ and $\theta_{it} = f_2(W_{it})$ and W_{it} are drivers of growth as R&D that affect input elasticity. Assuming that there is a linear relation between growth drivers and the input elasticity, Equation (3) is rewritten as follows;

$$y_{it} = \alpha_0 + \lambda W_{it} + (\beta_0 + \gamma W_{it})k_{it} + (\theta_0 + \rho W_{it})l_{it} \tag{4}$$

where α_0 , β_0 , and θ_0 are the level of TFP, capital elasticity, and labor elasticity when W = 0, respectively. Also, λ, γ, and ρ measure the effects of W on TFP, capital elasticity, and labor elasticity, respectively. In the production function, k_{it}

and l_{it} measure the quantity of the inputs, whereas the input elasticities to some extent can be regarded as the quality of the inputs. A greater input elasticity can increase output for a given amount of input.

The endogenous growth theory introduces spillovers on inputs, whereas the induced innovation theory introduces invention on inputs, but both can result in a better quality of the inputs, and therefore, more output is given fixed inputs. The theory of induced innovation emphasizes the differences in resource endowment and input prices across countries, and this can change the shape of the production function over time. As one of the growth drivers, International trade, though, can change resource allocation and input prices, and therefore affect input elasticity and productivity. Structural transformation, which refers to the reallocation of economic activity across agricultural sectors, industry, and services, is another growth driver (Herrendorf et al., 2014). In most cases, industry and services are more productive than agriculture. So, countries can improve their aggregated TFP by increasing their contribution to their non-agricultural sector. Above all, as each sector has its production technologies and therefore sector-specific input elasticity, structural transformation can also affect input elasticity. Accordingly, improving the contribution to a specific sector can make the total input elasticity of the economy closer to the input elasticity of that sector. Country-level input elasticities are not constant because the ratio of the three sectors varies across countries, and structural transformation happens all the time (Herrendorf et al., 2014). Supposing Equation (4) is the true data-generating process, we assume constant input elasticities. So, Equation (4) can be rewritten as:

$$\begin{aligned} y_{it} = \alpha_0 + \lambda W_{it} + \left[(\beta_0 - \hat{\beta}) + \gamma W_{it})\right] k_{it} + \\ \left[(\theta_0 - \hat{\theta}) + \rho W_{it})\right] l_{it} + \hat{\beta} k_{it} + \hat{\theta} l_{it} \end{aligned} \tag{5}$$

where $\hat{\beta}$ and $\hat{\theta}$ are estimates of capital and labor elasticities derived by the classic production function with Cobb–Douglas formation. Then, the measured TFP is:

$$\begin{aligned} T\hat{F}P_{it} &= \alpha_0 + \lambda W_{it} + \left[(\beta_0 - \hat{\beta}) + \gamma W_{it})\right] k_{it} \\ &\quad + \left[(\theta_0 - \hat{\theta}) + \rho W_{it})\right] l_{it} \\ &= \alpha_0 + \left(\beta_0 - \hat{\beta}\right) k_{it} + (\theta_0 - \hat{\theta}) l_{it} \\ &\quad + [\lambda + \gamma k_{it} + \rho l_{it})]\, W_{it} \end{aligned} \tag{6}$$

When the main purpose is to estimate the overall effects of Z on output, standard growth accounting is sufficient and appropriate, as the impacts of Z on productivity and input elasticities (i.e., λ, γ, and ρ), in the end, all contribute to the output. Furthermore, as TFP was defined earlier in this paper, it is reasonable to contribute all the residuals along with the quantity and quality of inputs into TFP. This new method measures the effects of growth drivers on the elasticity of inputs along with their effect on productivity. In general, the new growth accounting aims not only to decompose the economic growth into changes in input values and total factor productivity but also to decompose TFP growth into input-embedded productivities (labor-embedded and capital-embedded) independent of inputs or input-free. It is worth mentioning that the growth of additional input productivity refers to the increase in productivity due to the improvement of the quality of inputs. Therefore, new growth accounting can identify and measure the pathways or channels through which the growth drivers affect economic growth.

3. Methods and Materials

The weakness of standard growth accounting is the constant assumption of input elasticity. To overcome this shortcoming, the varying coefficient model is proposed by Hastie and Tibshirani (1993) in the form;

$$y = x_1 z_1(\phi_1) + \cdots + x_K z_K(\phi_K) + \varepsilon \tag{7}$$

where the coefficients of the non-parametric function are of threshold variables ϕ_K. On the other hand, the stochastic frontier model, which was proposed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977) and has been widely used by many researchers (Jin et al., 2002; Wang et al., 2016; Yang et al., 2016), has the following form;

$$y_{it} = f(X_{it}; \beta) + \nu_{it} - u_{it} \tag{8}$$

where $f(X_{it}; \beta)$, in this stochastic frontier model, represents the maximum production with the available inputs in each period, and hence it measures the optimal relationship between inputs and production over time. Also, ν_{it} is the regression error term, and $-u_{it}$ is the technical inefficiency. In other words, technical efficiency is calculated as $TE_{it} = exp(-u_{it})$. Regarding the model with variable coefficients and the stochastic frontier model, the stochastic frontier model with variable coefficients is defined as follows;

$$y_{it} = \psi_0(\phi_{it}) + \sum_{k=1}^{p} \psi_k(\phi_{it}) x_{it}^k + \nu_{it} - u_{it} \tag{9}$$

where $\beta_{it}^k = \psi_k(\phi_{it})$ is a function to estimate the varying elasticity of the production input. The intercept, $\psi_0(\phi_{it})$ is also assumed to be a nonparametric function of the threshold variables to measure the effects of growth drivers on output through input-free productivity. Research and development (R&D) is the most important threshold variable as an economic growth driver, which also explains technological progress. The degree of openness of the economy or trade-to-GDP ratio can be the second growth driver considered as a threshold variable. On the other hand, the free exchange of outputs can improve input-free productivity growth, as comparative advantages can play a positive role in economic growth even with constraints in the input endowment. Thus, trade may affect economic growth through its effect on both input-embedded productivity (input elasticity) and input-free productivity. Structural transformation is the third economic driver. Even without technological progress, an economy can increase its economic growth by moving more resources from less productive to more productive sections. After estimating the coefficients, production growth can be decomposed by the following form;

$$\Delta y_{it} = \sum_{k=1}^{p} \left(\beta_{it}^{k}\, x_{it}^{k} - \beta_{i,t-1}^{k}\, x_{i,t-1}^{k}\right) + \Delta IFP_{it} + \Delta v_{it} \tag{10}$$

where $\Delta IFP_{it} = \psi_0(\phi_{it}) - u_{it}$ measures the input-free productivity growth for period *i* at time t. Also, to decompose productivity related to inputs, $\beta_{it}^{k}\, x_{it}^{k} - \beta_{i,t-1}^{k}\, x_{i,t-1}^{k}$, both sides of equation (10) are divided by Δy_{it}Thus, new growth accounting is achieved *as* follows;

$$1 = \underbrace{\sum_{k=1}^{p}\left[\frac{\Delta x_{it}^{k}(\beta_{it}^{k}+\beta_{i,t-1}^{k})}{2\Delta y_{it}}\right]}_{input\ quantity} + \underbrace{\underbrace{\sum_{k=1}^{p}\left[\frac{\Delta \beta_{it}^{k}(x_{it}^{k}+x_{i,t-1}^{k})}{2\Delta y_{it}}\right]}_{\text{input−embedded productivity}} + \underbrace{\frac{\Delta IFP_{it}}{\Delta y_{it}}}_{\text{input−free productivity}}}_{\text{total factor productivity}} + \underbrace{\frac{\Delta v_{it}}{\Delta y_{it}}}_{\text{residual}} \tag{11}$$

where the four parts on the right-hand side of Equation (11) are the contributions of changes in input quantities, input-embedded productivity, input-free productivity, and residuals, respectively. For comparison, the standard growth accounting model has the following form;

$$1 = \underbrace{\sum_{k=1}^{p}\left[\frac{\beta_{it}^{k}\, \Delta x_{it}^{k}}{\Delta y_{it}}\right]}_{\text{input quantity}} + \underbrace{\frac{\Delta TFP_{it}}{\Delta y_{it}}}_{TFP} + \underbrace{\frac{\Delta v_{it}}{\Delta y_{it}}}_{residual} \tag{12}$$

where β_{it}^{k} in Equation (12) is the conventional coefficient of the input that is fixed across sections and over time. The growth drivers may affect the level of output through the first three parts on the right-hand side of the above equation. These drivers may affect (input elasticity) β_{it}^{k} and ΔIFP_{it}, the input-free productivity of Equations (13) and (14):

$$\Delta IFP_{it} = \alpha + \delta_1 \mathrm{R\&D_{it}} + \delta_2 \mathrm{trade_{it}} + \delta_3 \mathrm{structure_{it}} + \epsilon \quad (13)$$

$$\beta_{it}^{k} = \alpha^{k} + \eta_1^{k} R\&D_{it} + \eta_2^{k} trade_{it} + \eta_3^{k} structure_{it} + \upsilon^{k} \quad (14)$$

Equations (13) and (14) are for section *i* at time *t* and are derived from Equation (9). The estimation results of the parameters δ and η can measure the effects of the growth drivers.

Table 1. Descriptive Statistics

Variable	Indicator	Unit of measurement	Mean		St. deviation		Maximum		Minimum	
			Growth	Level	Growth	Level	Growth	Level	Growth	Level
Production	Value added (y)	Billion rials (Constant in 2011)	0.79	67	36.7	148.2	238.6	1232.8	-276.4	0.07
Inputs	Capital stock (k)	Billion rials (Constant in 2011)	-0.41	147.2	36.5	325.8	232.7	2947.2	-271.3	0.15
	Employment (L)	Thousands of people	2.1	12.88	22.4	17.2	175.2	111.4	-225.2	0.078
Growth drivers	Research and development (R&D)	R&D-to-output ratio	-0.04	0.002	0.96	0.006	10.92	0.15	-8.83	0.00
	Trade openness	Trade-to-production ratio	0.002	0.17	0.94	0.32	8.22	4.34	-5.73	0.00
	Structural changes	Capital stock to employment ratio	-2.5	9.3	28.7	9.9	221.2	135.2	-215.3	0.88

Source: Iran Statistical Center & Research finding.

This paper uses the data of 121 ISIC four-digit code manufacturing industries (with 10 employees or more) in Iran from 2003 to 2019. The variables used include the number of employees, capital stock, and added value. The capital stock data is estimated by the "perpetual inventory method (PIM)".

Added value and capital stock have been adjusted with the producer price index of the industrial sector. In this paper, to measure research and development, the R&D ratio to industrial-added value is used. The ratio of trade to industrial-added value is used to measure the economy's openness, and the capital stock ratio to employment is used as an approximation for structural changes.

4. Results and Discussion

In the first step, the varying coefficient stochastic frontier employed is used. To do this, the technical inefficiency term $-u_{it}$ is ignored, and, then, the model is estimated using the parametric estimation method proposed by Hsiao (2014). In this method, the coefficients of explanatory variables change both in time and between sections as follows:

$$y_{it} = \sum_{k=1}^{K}(\bar{\beta}_k + \alpha_{ki} + \lambda_{kt})x_{kit} + \nu_{it}; \quad i = 1, \dots, N; \; t = 1, \dots, T \tag{15}$$

To estimate with the fixed effects method in this model, the parameters α_k and λ_k are considered constant as $\bar{\beta}$. After estimating Equation (15), the coefficients of explanatory variables are calculated. The estimation of this step is done using the Stata software version 17.

In the second step, the contribution of production inputs (labor and capital) and input-embedded productivity to economic growth is calculated using the estimation results of the variable coefficients in the first step. The estimations are derived using Excel software. In the third step, the goal is to estimate the technical efficiency (TE) which is one of the components of input-free productivity (IFP). Input-free productivity consists of technical inefficiency ($-u_{it}$) and technological progress $\psi_0(\phi_{it})$. As a result, after estimating Equation (15), the residuals ν_{it} are extracted. Then, the technical inefficiency term $-u_{it}$ is isolated from the residual using the “Error Components Frontier” (ECF) method proposed by Battese and Coelli (1992).

The fourth step is the estimation of technological progress $\psi_0(\phi_{it})$ which is another component of input-free productivity (IFP). To estimate technological progress, the panel data model with non-parametric time-varying coefficients of Li et al. (2011) is used. So, Equation (9) is estimated ignoring the technical inefficiency term $-u_{it}$ and then the trend function $\psi_0(\phi_{it})$ and the coefficients function are estimated using the "Non-parametric local linear method". Results of the trend function show technological progress in the factory industry. In the fifth step, the role of input-free productivity (IFP), the contribution of total productivity of production factors (TFP), and the contribution of residuals from the economic growth of manufacturing industries are calculated. To calculate the contribution of IFP, first, using the results of the third and fourth steps, technical efficiency and technological progress are collected, input-free productivity is obtained and by dividing it by production growth, the contribution of IFP is obtained. Then, by adding the contribution of IFP and the contribution of input-embedded productivity to economic growth, the TFP contribution to economic growth is obtained. Finally, by calculating other contributions, the contribution of the residue is measured.

4.1 Manufacturing Industries' Value-added Growth Accounting

Estimating the stochastic frontier model with varying coefficients (Equation10) Variable elasticities in time and among industries were obtained for capital stock and labor force (Figure1). The figure shows that the elasticity of the labor decreased from 2003 to 2013, and subsequently increased. The figure on the left also shows the capital stock elasticity. It can be seen that the capital stock elasticity has been increasing until 2011 and after that, it has remained almost steady.

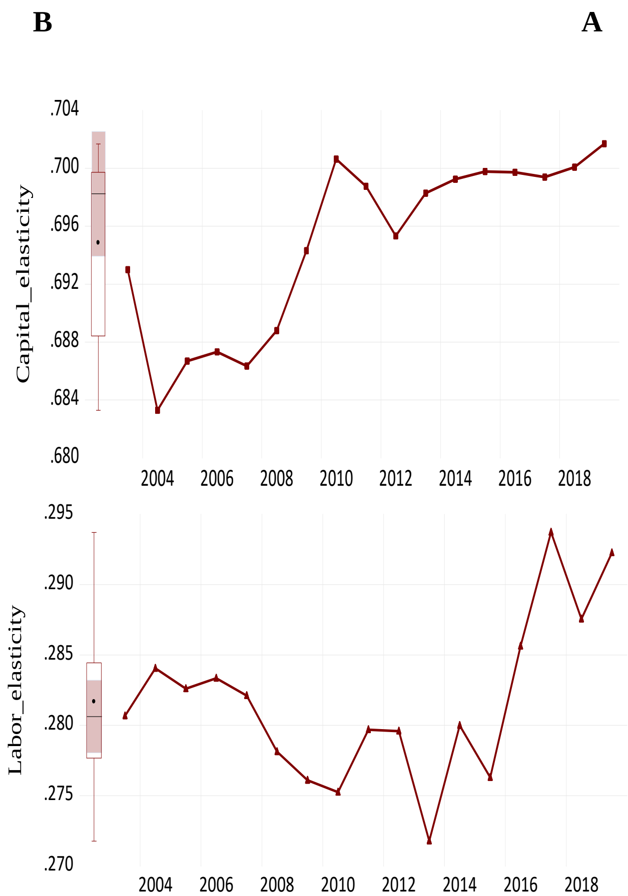


Figure 1. Labor Force and Capital Stock Trends in Iran's Manufacturing Industries, 2003-2019

Source: Research finding.

The return to scale has changed slightly until 2013. It seems that the return to scale has decreased until 2012 and then increased and reached a constant return to scale (Figure 2).

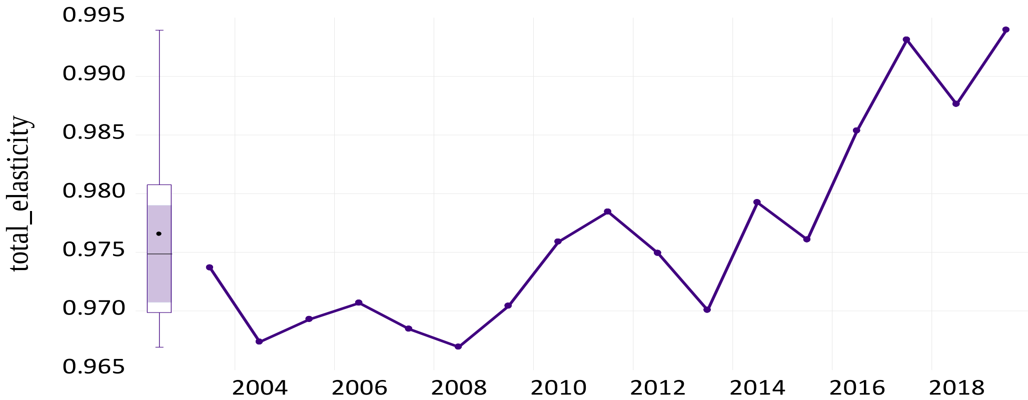


Figure 2. The Return To Scale Trend In Iran's Manufacturing Industries, 2003-2019
Source: Research finding.

By combining the estimation results of the stochastic frontier model with varying coefficients and the estimation of technical efficiency with the Boundary Element Method (BEM), classic TFP growth is decomposed into input-free productivity growth and input-embedded productivity growth. Input-free productivity growth includes two components: technical efficiency changes and technological progress. IFP growth was negative from 2003 to 2006, and it improved from 2007-2016 and growing by about 3% in 2016, and then started to decline again.

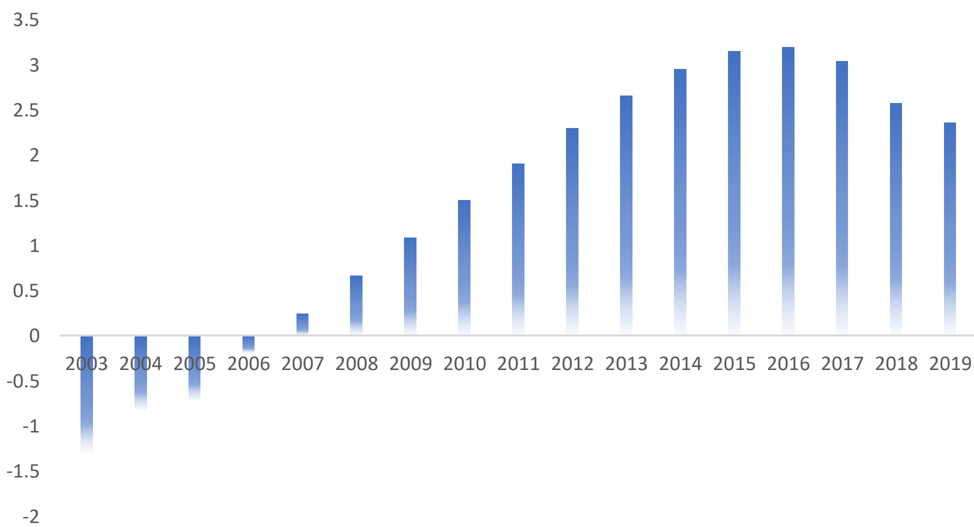


Figure 3. Input-Free Productivity Trend in Iran's Manufacturing Industries, 2003-2019
Source: Research finding.

Figure 3 shows the growth of labor, capital, and production elasticity along with the growth of technical efficiency and technological progress of Iran's manufacturing industries from 2003 to 2019. The average capital stock growth in this period is 5.4%; which is the highest growth in 2016 (%32.7) and the lowest in 2011 (%-19.1). The growth of labor has been stable and has grown by 3.7% annually on average. The labor has experienced negative growth in just 4 years. The elasticities of capital and labor stock experience fluctuating trends.

In 2004 and 2005, the elasticity of capital stock declined most sharply to -1.4%, while the elasticity of labor showed a positive growth of 1.2% in the same year. This happened again in 2016 and 2017, but the opposite was observed in other years as well. It seems that labor and capital have replaced each other in the process of production. Of course, these two inputs have changed in the same direction over the years. The average annual growth rates of elasticity of capital and labor are -0.03% and 0.27%, respectively. Technical efficiency (TE) is an important measure to evaluate the firm's performance. When maximum production efficiency is achieved, the unit uses almost all the available input, and production efficiency will be at 100 while the minimum will be 0. The average technical efficiency of Iran's manufacturing industries is 78.7%, which is 21.3% away from the efficient frontier. At the leading edge, the level of efficiency has gradually increased and reached 93.8% in 2019. Technological progress has also increased slowly annually and has grown by an average of 0.3%.

Table 2. The Growth of the Number of Inputs, the Elasticity of Labor and Capital, the Growth of Technical Efficiency and the Technological Progress in Iran's Manufacturing Industries, 2003-2019

Year	Capital stock		Labor		Technical efficiency		Technological progress growth
	Elasticity growth	Quantity growth	Elasticity growth	Quantity growth	Growth	Quantity	
2003	0.2	32.7	-1.5	12.4	-1.3	73.1	-0.04
2004	-1.4	17.4	1.2	1.4	-0.8	72.3	-0.03
2005	-1.4	4.1	1.2	0.1	0.0	72.3	0.0
2006	0.1	11.3	0.3	2.1	-0.9	71.4	0.0
2007	-0.1	20.7	-0.4	13.9	0.1	71.5	0.15
2008	0.4	1.2	-1.4	6.7	0.4	71.9	0.25
2009	0.8	2.0	-0.7	4.0	0.7	72.7	0.34
2010	0.9	-1.9	-0.3	4.3	1.1	73.8	0.41
2011	-0.3	-19.1	0.6	2.9	1.4	75.2	0.47
2012	-0.5	-1.9	-0.04	-4.6	1.8	77	0.52
2013	0.4	-0.5	-2.8	9.3	2.1	79.1	0.56
2014	0.1	1.9	3.1	2.2	2.4	81.4	0.58
2015	0.1	22.8	-1.3	11.8	2.6	84.0	0.58
2016	-0.01	10.2	3.4	-0.2	2.6	86.7	0.55
2017	-0.05	3.1	2.9	-0.7	2.6	89.2	0.44
2018	0.1	-11.5	-2.1	-6.0	2.4	91.7	0.16
2019	0.2	-1.0	1.7	4.0	2.1	93.8	0.24
Average	-0.03	5.4	0.27	3.7	1.1	78.7	0.3

Source: Research finding.

Note: It should be noted that this study was conducted for 121 manufacturing industries in Iran during the period from 2003 to 2019, and the numbers presented in the table are the average of these 121 industries for each year; the average for all these years is also provided in the last row of the table. Additionally, summaries of this data are displayed in Figures 1 to 3.

Table 3. Economic Growth Accounting of 121 Manufacturing Industries in Iran, 2003-2019; %

Year (1)	Production growth (2)	New growth accounting						Standard growth accounting		
		Input quantity contribution		Total factor productivity contribution			Residual	Factors contribution		
		Capital	Labor	Capital-embedded productivity	Labor-embedded productivity	Input-free productivity		Capital	Labor	TFP
2003	33.9	84.2	8.9	-1.1	3.6	-0.6	5.0	66.9	10.3	22.8
2004	8.7	138.1	4.5	-9.5	44.9	-60.7	-17.3	137.1	4.5	41.6
2005	6.8	41.7	0.6	-10.6	57.8	-78.6	89.1	41.6	0.6	57.8
2006	12.8	60.5	4.6	-1.5	6.8	2.7	26.9	60.5	4.6	34.9
2007	18	62.5	-6.0	-1.2	4.2	1.9	38.6	79.0	21.8	0.7
2008	0.3	65.2	-4.0	-4.7	18.3	-5.5	30.7	258.5	583.2	741.7
2009	6.5	2.3	52.8	21.6	-49.7	48.3	24.7	20.9	17.0	62.1
2010	3.4	92.8	12.6	-9.8	3.4	-14.4	14.5	-30.2	27.1	103.1
2011	-17.7	75.5	-4.5	-10.7	-29.9	5.7	64.0	75.4	-4.5	29.2
2012	-5.5	108.5	-12.6	30.9	-1.1	-16.6	-9.1	24.3	23.2	52.5
2013	-4.2	41.5	-9.7	-29.5	79.0	-12.3	31.0	8.3	-59.6	151.3
2014	10.7	19.7	7.2	23.1	59.0	2.9	-12.0	12.2	5.9	81.9
2015	19.4	67.5	17.3	-6.8	6.6	-0.4	15.8	82.6	16.7	0.9
2016	19.9	35.7	-0.3	16.1	56.3	-0.1	-7.6	35.7	-0.3	64.6
2017	10.6	20.7	-1.8	28.6	88.1	-1.7	-33.9	20.7	-1.8	81.1
2018	-15.8	50.8	10.9	-10.8	29.9	-1.7	20.9	50.8	10.8	38.4
2019	5.1	-13.9	23.0	46.1	106.2	16.9	-78.2	-13.9	23.2	90.7
Average	6.7	56.1	6.1	4.1	28.5	-6.7	12.0	54.7	40.1	5.2

Source: Research finding.

Table 3 shows Iran's manufacturing Industries' value-added growth, which is estimated based on both standard growth accounting and new growth accounting approaches, which differ in TFP. Total factor productivity (TFP) in the new growth accounting approach is decomposed into input-embedded productivity (labor and capital) and input-free productivity. Input-free productivity is divided into technical efficiency change and technological progress, while input-embedded productivity depends on the inputs used in the production function (labor and capital). Findings obtained from applying a new growth accounting approach show that the average contribution of inputs to growth (ignoring technology) is %62.2. The contribution of capital and labor are 1.56% and 1.6%, respectively. The ratio of these inputs in standard growth accounting is 94.8%. The average value-added growth is %6.7.

As mentioned earlier, technology increases the quality of inputs. Therefore, part of the ratio of inputs to growth is due to the quality of inputs. The input quality change, which is also referred to as productivity, is one of the components of the productivity of all factors. The findings show that the average ratio of input-embedded productivity in the growth of industries is about 21.8%. The contribution of capital-embedded productivity is -6.7% and the contribution of labor-embedded productivity is 28.5%. Therefore, technology is more manifested in labor. The IFP-free productivity ratio is 1.4%, which is due to two factors; technical efficiency change and technological progress.

4.2 Input-free Productivity Growth and Input Elasticity Drivers

The new growth accounting can identify and quantify the pathways or channels through which the growth drivers affect production growth. In this section, the effect of growth drivers including research and development (R&D), trade, and structural transformation on input-free productivity growth and elasticity of inputs were estimated.

All three growth drivers have a statistically significant positive influence on labor force elasticity. In terms of the capital elasticity model, R & D and Structural transformation are both positive, whereas the impact of trade drivers is negative. Therefore, it can be said that the growth drivers have increased the return to scale efficiency in Iran's manufacturing industries. Figure 2 shows that the return to scale has improved relatively over time. The drivers cause an increase in the input quality (capital and labor), capital services, and production labor, which is manifested in the production process. The contribution of input crystallization productivity to production growth is about 22.8%, which also shows the positive impact of factors affecting input elasticity in manufacturing industries.

Table 4. The Estimation of the Effects of Growth Drivers on The Input Elasticity and Input-Free Productivity Growth

Variables	Capital elasticity	Labor elasticity	Input-free productivity
R & D	0.0003* (0.00014)	0.0003** (0.00016)	0.0001 (0.0003)
Trade	-0.0002* (0.00008)	0.0002* (0.00011)	-0.0004** (0.00018)
Structural transformation	0.006*** (0.0001)	0.003*** (0.0002)	0.017*** (0.0003)
intercept	0.66*** (0.001)	0.26*** (0.001)	-0.097*** (0.0002)
$\bar{R}^2$	0.97	0.96	0.72
F-statistic	353.8***	286.2***	10.02***
Hausman Test	27.8***	59.1***	811.5***
Estimation Method	F.E	F.E	F.E
Number of observations	1713	1713	1713

Source: Research finding.
Note: *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Standard errors are in parentheses.

In the input-free productivity model, research and development R&D has a significant negative impact on IFP. Trade has a statistically significant negative impact at the 10% level on IFP whereas structural transformation has a significant positive impact at the 1% level on IFP. The coefficient of this indicator shows that by increasing this ratio, input-free productivity increases. In fact, by increasing this ratio, the quantity of capital stock ratio to labor increases in the production process. That is, using new capital (such as machinery and equipment) in the production process. Input-free productivity components (technical efficiency and technological progress) provide the basis for improvement.

4.3 Robustness of the Estimations

In this section, we check the robustness of the results of the model in Equations (13) and (14). Ordinary least squares estimators are sensitive to the presence of observations that lie outside the norm for the regression model of interest. The sensitivity of conventional regression methods to these outlier observations can result in coefficient estimates that do not accurately reflect the underlying statistical relationship. We use the M-estimation method which was introduced by

Huber (1973). M-estimation addresses dependent variable outliers where the value of the dependent variable differs markedly from the regression model norm (large residuals).

Table 5. Robust Estimation of Growth Drivers' Effects on the Input Elasticity and Input-Free Productivity Growth

Variables	Capital elasticity	Labor elasticity	Input-free productivity
R & D	0.002*** (0.0004)	0.003*** (0.0005)	0.001*** (0.0002)
Trade	0.003*** (0.0002)	0.002*** (0.0003)	-0.0005*** (0.0001)
Structural transformation	0.009*** (0.0005)	0.005*** (0.0006)	0.01*** (0.0003)
intercept	0.66*** (0.004)	0.28*** (0.001)	-0.07*** (0.003)
R-squared	0.19	0.1	0.44
Rw-squared	0.28	0.14	0.51
Rn-squared	503.3***	213.3***	1454.4***
Estimation Method	M-estimation	M-estimation	M-estimation
Number of observations	1713	1713	1713

Source: Research finding.

Note: *** indicates significance at the 1% level; Standard errors are in parentheses.

Economic growth is not a natural occurrence; it's driven by market forces, various economic factors, and shifts in macroeconomic policies. One of the paper's findings is the negative contribution of capital stock productivity, likely due to the depreciation of capital stock in manufacturing industries and insufficient new investments to compensate for this depreciation. This scenario can lead to diminishing or even negative returns. Another key finding is the relatively high contribution of labor productivity to the economic growth of Iran's manufacturing industries. This could be linked to the accumulation of human capital. Human capital spillovers have been validated by Acemoglu and Angrist (2000). However, the observed lack of spillovers at the macro level contradicts micro-level data, where individual-level wage payments are seen as investments in human capital.

Another finding is the role of research and development (R&D) in total factor productivity (TFP) growth. The paper's results indicate that total factor productivity significantly impacts the economic growth of Iran's manufacturing industries. Empirical evidence suggests that R&D undeniably improves productivity and enhances economic growth at the industry or firm level. The evidence also shows that R&D spillovers can be considerable, indicating that the social return on R&D spending may exceed private returns. Other studies have found that the rate of return on R&D for some companies ranges between 20 and 30 percent. If this estimate is accurate, it suggests that Iran's manufacturing industries allocate far fewer resources to R&D than they should.

Technological advancement is another key driver of productivity and economic growth in Iran's manufacturing industries. Due to the law of diminishing returns, a country cannot maintain long-term growth solely by accumulating more capital or labor. Therefore, the primary driver for long-term growth must be technological progress. Evidence shows a positive relationship between past TFP and future economic growth in developed economies. This indicates that countries where growth was driven by TFP before a crisis tend to experience higher post-crisis growth. Meanwhile, the relationship between post-crisis economic growth and the share of capital stock or labor force in economic growth is negative. This suggests that countries whose growth is primarily driven by capital or labor accumulation may struggle, especially during economic downturns.

Based on the results, physical capital accumulation emerged as the most significant driver of value-added growth. On average, it contributes approximately 56% to the total value added, with a peak of over 80% in some years. This finding underscores the pivotal role that physical capital plays in generating value in industries. Technological advancements have also improved capital efficiency, leading to an additional 4.1% increase in the capital share. Consequently, the total share of capital rises to around 60%. In traditional calculations, the capital share is about 55%, which is not substantially different from the new method.

The average labor share is approximately 6%, which represents the net contribution of labor to value-added growth without the influence of technology on labor productivity. This indicates the basic contribution from labor, exclusive of any technological enhancements. Given this, we can infer that technology plays a significant role in boosting labor productivity. The combined effect of technology and labor is estimated to be around 28.5%, bringing the total share of labor and technology to 34.5%. In comparison, the labor share calculated through traditional growth accounting methods is about 40%. This difference suggests that conventional methods might overestimate the contribution of the labor force. By accounting for technology's impact on labor productivity, these newer calculations provide a more accurate depiction of the factors driving value-added growth.

In the traditional framework, the share of total productivity—often considered a proxy for technology—is about 5.2 percent. However, this approach leaves the source or nature of this growth unclear. By contrast, the new method provides a more detailed understanding of technology's role, demonstrating that it primarily improves labor productivity. In this approach, technology is seen as embedded within the labor force, aiding in their productivity. It also contributes to capital efficiency, though to a lesser extent. Notably, the neutral technology effect is negative. This distinction suggests that the new method better explains how technology contributes to value-added growth. It primarily does so by enhancing labor productivity, while also providing a slight boost to capital productivity through increased capital services. Therefore, the traditional method may undervalue the role of technology by focusing on a generalized estimate of total productivity without accounting for these nuanced impacts on labor and capital.

The impact of technology on the productivity of capital and labor is often uneven, with capital productivity facing greater fluctuations, especially in economies like Iran's, which have been subjected to international sanctions. These sanctions make it difficult to import advanced technology, leading to rapid obsolescence of capital equipment and diminishing capital returns. The inability to repair or replace outdated machinery reduces capital's production capacity, thus negatively impacting its productivity. Although this also affects labor productivity, the labor force tends to be more resilient. This resilience stems from the adaptability of human resources; workers can maintain or even improve productivity by enhancing their skills and utilizing medium- or low-cost technologies. In contrast, capital often relies on high-end technology, which is largely inaccessible due to sanctions. The labor force's broader range of skills and adaptability contribute to this resilience, even though specialized skills may face greater challenges. Ultimately, Iran's economy, in the face of sanctions, experiences a greater impact on capital productivity, while the labor force demonstrates a capacity to endure and adapt.

Research and development (R&D), structural changes, and trade are all significant drivers of labor-augmented technology, capital-augmented technology, and neutral technology. R&D provides the foundation for technological innovation, while trade enables the flow of technology and expertise across borders, giving industries the resources they need for modernization. Structural changes, including shifts in economic frameworks and capital deepening, can further contribute to improved productivity by fostering more efficient processes and systems. Capital per capita, a key factor in growth theories, can catalyze economic development by enabling a shift from labor-intensive to capital-intensive industries. This transition generally leads to higher productivity, as it provides the workforce with advanced tools and machinery, enhancing efficiency and output.

By increasing capital per capita, economies not only make better technology available to their workforce but also create a context in which labor can be used more effectively, supporting broader economic growth.

5. Conclusion

This paper aims to answer the question of how technology contributes and what role it plays in the production of manufacturing industries. There are two approaches to answering this question: Using standard growth accounting or new growth accounting. Using endogenous growth theory and the induced innovation theory with the benefit of the stochastic frontier model with varying coefficients allowed changing the quality of inputs in the growth accounting method. The growth accounting method outperforms standard growth accounting because it enables us to monitor the importance of technology through which the technology affects growth from two paths of impact on inputs (labor-embedded and capital-embedded) and input-free productivity. New growth accounting is adopted to study the economic growth of Iran's manufacturing industries using a balanced panel of 121 ISIC four-digit code manufacturing industries from 2003 to 2019. Results show that, on the one hand, labor is being replaced by capital in the production process, which is consistent with the induced innovation theory.

On the other hand, there is an increasing trend of returns to scale, which is consistent with the endogenous growth theory. The decomposition of the value-added growth showed that inputs (capital and labor) still play a dominant role. However, part of their contribution to the growth of added value is due to the presence of technology. The findings showed that technology has been manifested more in the productivity of manpower, and work-augmenting technology has made an important contribution to the growth of the added value of Iran's manufacturing industries. The contribution of capital-augmenting technology to the production process is trivial. Also, the results showed that the conventional growth accounting method has an estimation error in estimating TFP contribution. The new growth accounting method showed that technology impacts the input productivity (capital and labor) and it plays an important role in input-free productivity.

The average technical efficiency of Iran's manufacturing industries is 78.7%, which is 21.3% away from the efficient frontier. However, the level of efficiency has gradually increased, and technological progress has also grown by an average of 0.3%. In the second part, the effect of economic growth drivers on the input elasticity and input-free productivity was estimated using the fixed effects method. The results showed that growth drivers like research and development, trade, and structural transformation have a significant positive impact on labor elasticity. In terms of the capital elasticity model, research and development and structural transformation have a positive and significant impact on capital elasticity, whereas trade has a significant negative influence on capital elasticity. This means that growth drivers have increased the labor quality and capital in the production process.

Considering the results, it is recommended to establish and expand research and development (R&D) units within Iran's manufacturing industries to accelerate the process of attracting researchers, innovators, and technological advancements. Additionally, to maximize the spillover effects of R&D from technologically advanced countries and adapt them to local conditions, efforts should be made to harness these technologies, which could significantly boost production in the manufacturing industries. Furthermore, it is suggested to provide efficient support to companies in the manufacturing industry for productivity improvement or technological modernization.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Acemoglu, D., & Angrist, J. (2000). How large are Human-Capital Externalities? Evidence from Compulsory Schooling Laws. *NBER Macroeconomics Annual*, *15*, 9-59. Retrieved from https://www.journals.uchicago.edu/doi/pdf/10.1086/654403.

Aigner, D., Lovell, C. K., & Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*, *6*(1), 21-37. Retrieved from https://doi.org/10.1016/0304-4076(77)90052-5.

Akcigit, U., & Ates, S. T. (2021). Ten Facts on Declining Business Dynamism and Lessons from Endogenous Growth Theory. *American Economic Journal: Macroeconomics*, *13*(1), 257-98. Retrieved from https://www.aeaweb.org/articles/pdf/doi/10.1257/mac.20180449.

Albanese, G., de Blasio, G., & Locatelli, A. (2021). Does EU Regional Policy Promote Local TFP Growth? Evidence from the Italian Mezzogiorno. *Papers in Regional Science*, *100*(2), 327-349. Retrieved from https://doi.org/10.1111/pirs.12574.

Bai, Y., & Zhang, J. (2010). Solving the Feldstein–Horioka Puzzle with Financial Frictions. *Econometrica, 78*(2), 603-632. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=1525495.

Bandyopadhyay, D., King, I., & Tang, X. (2019). Human Capital Misallocation, Redistributive Policies, and TFP. *Journal of Macroeconomics*, *60*, 309-324. Retrieved from https://espace.library.uq.edu.au/view/UQ:0d445e5/UQ0d445e5_OA.pdf.

Barro, R. J. (1999). Notes on Growth Accounting. *Journal of Economic Growth*, *4*(2), 119-137. Retrieved from https://www.nber.org/system/files/working_papers/w6654/w6654.pdf.

Barro, R., & Sala-i-Martin, X. (2004). *Economic Growth* (2nd Ed.). Cambridge, MA: The MIT Press.

Battese, G. E., & Coelli, T. J. (1992). Frontier Production Functions, Technical Efficiency, and Panel Data: with Application to Paddy Farmers in India. *Journal of Productivity Analysis*, *3*(1), 153-169. Retrieved from https://www.academia.edu/download/50157079/download.pdf.

Deininger, K., & Jin, S. (2005). The Potential of Land Rental Markets in the Process of Economic Development: Evidence from China. *Journal of Development Economics*, *78*(1), 241-270. Retrieved from https://doi.org/10.1016/j.jdeveco.2004.08.002.

Gallup, J. L., & Sachs, J. D. (2000). Agriculture, Climate, And Technology: Why are the Tropics Falling Behind? *American Journal of Agricultural Economics*, *82*(3), 731-737. Retrieved from http://earthinstitute.columbia.edu/sitefiles/file/about/director/pubs/AmerJournAgrEcon0800.pdf.

Ghosh, T., & Parab, P. M. (2021). Assessing India's Productivity Trends and Endogenous Growth: New Evidence from Technology, Human Capital, and Foreign Direct Investment. *Economic Modelling*, *97*, 182-195. Retrieved from http://www.igidr.ac.in/pdf/publication/WP-2021-004.pdf.

Hac, L. D., & Nguyen Ngoc, T. (2021). Evaluating Endogenous Growth. *Journal of Contemporary Issues in Business and Government*, *27*(2), 1966-1975. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=3812409.

Hammond, G. W., & Thompson, E. C. (2008). Determinants of Income Growth in Metropolitan and Nonmetropolitan Labor Markets. *American Journal of Agricultural Economics*, *90*(3), 783-793. Retrieved from https://www.jstor.org/stable/20492328.

Haouas, A., Ochi, A., & Labidi, M. A. (2024). Sources of Algeria's Economic Growth, 1979–2019: Augmented Growth Accounting Framework and Growth Regression Method. *Regional Science Policy & Practice*, *16*(3), 1-19. Retrieved from https://www.sciencedirect.com/science/article/pii/S1757780224001501.

Hastie, T., & Tibshirani, R. (1993). Varying-coefficient Models. *Journal of the Royal Statistical Society: Series B (Methodological)*, *55*(4), 757-779. Retrieved from https://www.jstor.org/stable/2345993.

Herrendorf, B., Rogerson, R., & Valentinyi, A. (2014). Growth and Structural Transformation. *Handbook of Economic Growth*, *2*, 855-941. Retrieved from https://www.nber.org/system/files/working_papers/w18996/w18996.pdf.

Herzer, D. (2022). The Impact of Domestic and Foreign R&D on TFP in Developing Countries. *World Development*, *151*, 1-20. Retrieved from https://doi.org/10.1016/j.worlddev.2021.105754.

Heyets, V., Skrypnychenko, M., & Shumska, S. (2019). Population Aging and Economic Dynamics in Ukraine: Models of Endogenous Growth Theory and Empirical Estimates of Current Challenges. *7th International Conference on Modeling, Development and Strategic Management of Economic Systems*, 283-288. Kyiv: Atlantis Press. Retrieved from https://www.atlantis-press.com/article/125919230.pdf.

Hicks, J. (1963). *The Theory of Wages*. Berlin: Springer.

Hsiao, C. (2014). *Analysis of Panel Data*. Cambridge: Cambridge University Press.

Huber, P. J. (1973). Robust Regression: Asymptotics, Conjectures, and Monte Carlo. *The Annals of Statistics*, *1*(5), 799-821. Retrieved from https://www.jstor.org/stable/2958283.

Jia, F., Ma, X., Xu, X., & Xie, L. (2020). The Differential Role of Manufacturing and Non-Manufacturing TFP Growth in Economic Growth. *Structural Change and Economic Dynamics*, *52*, 174-183. Retrieved from https://doi.org/10.1016/j.strueco.2019.10.006.

Jin, S., Huang, J., Hu, R., & Rozelle, S. (2002). The Creation and Spread of Technology and Total Factor Productivity in China's Agriculture. *American Journal of Agricultural Economics*, *84*(4), 916-930. Retrieved from https://www.jstor.org/stable/1244735.

Jones, C. I. (2002). Sources of US Economic Growth in a World of Ideas. *American Economic Review*, *92*(1), 220-239. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=72188.

Jorgenson, D. W., & Stiroh, K. J. (2000). US Economic Growth at the Industry Level. *American Economic Review*, *90*(2), 161-167. Retrieved from https://www.jstor.org/stable/117212.

Kumbhakar, S. C., Denny, M., & Fuss, M. (2000). Estimation and Decomposition of Productivity Change When Production is not Efficient: A Panel Data Approach. *Econometric Reviews*, *19*(4), 312-320. Retrieved from https://doi.org/10.1080/07474930008800481.

Li, D., Chen, J., & Gao, J. (2011). Non-parametric Time-Varying Coefficient Panel Data Models With Fixed Effects. *The Econometrics Journal*, *14*(3), 387-408. Retrieved from https://www.jstor.org/stable/23116938.

Lucas Jr, R. E. (1988). On the Mechanics Of Economic Development. *Journal of Monetary Economics*, *22*(1), 3-42. Retrieved from https://doi.org/10.1016/0304-3932(88)90168-7.

Meeusen, W., & van Den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review*, *18*(2), 435-444. Retrieved from https://doi.org/10.2307/2525757.

Miller, D. J. (2002). Entropy-based Methods of Modeling Stochastic Production Efficiency. *American Journal of Agricultural Economics*, *84*(5), 1264-1270. Retrieved from https://www.jstor.org/stable/1245057.

Pope, R. D., & LaFrance, J. T. (2013). Robust Error Specification in a Production System. *American Journal of Agricultural Economics*, *95*(3), 669-684. https://www.jstor.org/stable/24475963.

Rawat, P. S., & Sharma, S. (2021). TFP Growth, Technical Efficiency, and Catch-Up Dynamics: Evidence from Indian Manufacturing. *Economic Modelling*, *103*, 1-44. Retrieved from https://doi.org/10.1016/j.econmod.2021.105622.

Romer, P. M. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy*, *94*(5), 1002-1037. Retrieved from https://www.jstor.org/stable/1833190.

Shee, A., & Stefanou, S. E. (2015). Endogeneity Corrected Stochastic Production Frontier and Technical Efficiency. *American Journal of Agricultural Economics*, *97*(3), 939-952. Retrieved from https://www.jstor.org/stable/24477087.

Sheng, Y., Ding, J., & Huang, J. (2019). The Relationship between Farm Size and Productivity in Agriculture: Evidence from Maize Production in Northern China. *American Journal of Agricultural Economics*, *101*(3), 790-806. Retrieved from https://www.jstor.org/stable/48601965.

Sickles, R. C. (2005). Panel Estimators and the Identification of Firm-Specific Efficiency Levels in Parametric, Semiparametric, and Nonparametric Settings. *Journal of Econometrics*, *126*(2), 305-334. Retrieved from https://doi.org/10.1016/j.jeconom.2004.05.004.

Solow, R. M. (1957). Technical Change and the Aggregate Production Function. *The Review of Economics and Statistics*, *39*(3), 312-320. Retrieved from https://doi.org/10.2307/1926047.

Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, *70*(1), 65-94. Retrieved from https://doi.org/10.2307/1884513.

Swan, T. W. (1956). Economic Growth and Capital Accumulation. *Economic Record*, *32*(2), 334-361. Retrieved from https://doi.org/10.1111/j.1475-4932.1956.tb00434.x.

Wang, X., Yamauchi, F., & Huang, J. (2016). Rising Wages, Mechanization, and the Substitution Between Capital and Labor: Evidence from Small Scale Farm System in China. *Agricultural Economics*, *47*(3), 309-317. Retrieved from https://doi.org/10.1111/agec.12231.

Yang, J., Wang, H., Jin, S., Chen, K., Riedinger, J., & Peng, C. (2016). Migration, Local Off-Farm Employment, and Agricultural Production Efficiency: Evidence from China. *Journal of Productivity Analysis*, *45*(3), 247-259. Retrieved from https://papers.ssrn.com/sol3/Delivery.cfm?abstractid=2420562.

Zhang, C., Yao, Y., & Zhou, H. (2023). External Technology Dependence and Manufacturing TFP: Evidence from China. *Research in International Business and Finance*, *64*, 1-20. Retrieved from https://doi.org/10.1016/j.ribaf.2023.101885.

Cite this article: Farivar Tanha, E., Fathabadi, M., Mahmoodzadeh, M., & Soufimajidpour, M. (2025). Total Factor Productivity Contributions and Its Drivers: Endogenous Growth Accounting Approach. *Iranian Economic Review*, *29*(4), 1469-1496.

Iranian Economic Review, 2025, 29(4), 1497-1525
DOI: https://doi.org/10.22059/ier.2024.369080.1007874

RESEARCH PAPER

Unlocking Growth: The Impact of Human Development and the Creative Economy on Economic Prosperity and Poverty Reduction in Indonesia

Rizkiawan[*,a], Siti Amalia Amalia[a], Muhammad Saleh Mire[a]
a. Archipelago College of Economics, Mulawarman University, Kalimantan, Indonesia.
* Corresponding author.

Received: 17 December 2023, Revised: 21 March 2024, Accepted: 12 April 2024, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract
This study examines the relationship between human development, the creative economy, economic development, and poverty structure in Indonesia. The primary objective is to explore how human development and the creative economy influence economic growth and poverty reduction. Using path analysis, this research investigates the direct and indirect effects of human development and the creative economy on economic development and poverty structure, focusing on variables such as education, health, income distribution, and employment opportunities. The results show that human development significantly enhances economic development, which, in turn, helps reduce poverty. Additionally, the creative economy contributes positively to economic growth, but its impact on poverty reduction has been limited due to uneven regional development. The study also reveals that economic development mediates the relationship between both human development and the creative economy with poverty structure. These findings emphasize the need for integrated policies that promote both human and economic development, ensuring equitable distribution of growth benefits. The implications of this research suggest that targeted investments in education, infrastructure, and support for creative industries, especially in underserved regions, are essential for fostering inclusive economic growth and reducing poverty in Indonesia. By strengthening human capital and creative sectors, Indonesia can achieve sustainable development and improve living standards across its diverse population.
Keywords: Destitution, Innovative, Progress, Prosperity, Wealth.
JEL Classification: O1, O4, O15.

1. Introduction

Human development is a crucial aspect of any nation’s growth, encompassing a wide range of factors that influence an individual's quality of life (Dellyana et al., 2023). It is generally defined as the process by which people enhance their knowledge, skills, and capabilities, which ultimately leads to improvements in living standards. The key pillars of human development include access to quality education, healthcare, economic opportunities, and the ability to participate in decisions that affect one’s life (Susanti and Silvia, 2024). At the global level, human development has been recognized as essential for ensuring economic competitiveness and social stability (Purwadi and Satria, 2024). For any country, including Indonesia, human development serves as the foundation for economic growth, social mobility, and the eradication of poverty. As countries advance, human development is vital for empowering citizens, improving their well-being, and ensuring equitable access to resources (Ramadhan and Satria, 2025).

Human development is inherently interconnected with economic development. As noted by Mahrinasari and Pratama (2024), economic progress relies heavily on the quality of human capital. A country’s economy cannot thrive without a healthy, educated, and skilled workforce. At the same time, for individuals to achieve their full potential, the economy must offer sufficient opportunities in terms of jobs, wages, and social services (Fadilla et al., 2024). Therefore, there is a symbiotic relationship between human development and economic growth: each supports the other, creating a cycle that propels a nation forward. If a country invests in human development, it directly strengthens its economic growth by cultivating a workforce capable of driving innovation, increasing productivity, and sustaining social stability (Dima and Nalle, 2025).

The relationship between human development and economic growth has been fraught with challenges. Despite steady improvements in some key indicators, such as life expectancy and literacy rates, significant disparities remain across different regions (Goh et al., 2024). The country's economic progress has not been equally distributed, with much of the growth concentrated in urban centers like Jakarta, Bali, and Yogyakarta, while rural areas continue to struggle with underdevelopment. The Human Development Index (HDI) in Indonesia reflects this uneven development (Qudsi and Ashar, 2025). While urban areas have access to better healthcare, education, and employment opportunities, rural populations often face barriers to achieving the same quality of life, leaving them at a disadvantage in terms of social mobility and economic opportunity (Yuslin, 2024).

The gap between urban and rural areas in Indonesia is one of the most pressing issues in human development. According to the World Bank (2021), rural populations in Indonesia experience higher levels of poverty, lower educational attainment, and reduced access to quality healthcare. This urban-rural divide exacerbates the inequality within the country, making it more difficult for people in remote areas to improve their living standards (Asmara et al., 2024). The lack of infrastructure, including poor transportation networks, limited access to digital technologies, and inadequate public services, further hinders the development of rural regions. As a result, many rural communities are trapped in cycles of poverty, unable to access the resources and opportunities that could help them break free (Rizkiawan et al., 2024).

Inequality is not just limited to geographic regions but is also exacerbated by the growing income gap between the rich and the poor. According to Indonesia's Statistics Bureau (BPS, 2020), a significant portion of the population remains under the poverty line, with a substantial disparity in wealth distribution. While the country's economic growth has led to the emergence of a burgeoning middle class, it has also left a large portion of the population behind. This inequality means that while some Indonesians enjoy rising living standards, others are left to face the harsh realities of poverty (Fahmi, 2016). Access to essential services such as healthcare and education becomes more difficult for the economically disadvantaged, reinforcing the socio-economic divide.

Economic growth, as a measure of national development, can be seen in various indicators, such as gross domestic product (GDP) and income levels (Purwono, 2021). However, it is essential to understand that economic growth alone does not necessarily translate into improved living conditions for all citizens. In Indonesia, despite positive GDP growth rates, many regions continue to experience stagnation in terms of human development (Komariyah, 2023). This disparity highlights the need for a more inclusive approach to economic development, one that integrates human development into the growth agenda (M. Ramadhan, 2025). Economic growth must be accompanied by targeted efforts to improve education, healthcare, and employment opportunities for all citizens, especially those in rural and underserved areas (Hali, 2025).

Indonesia's economic strategy has traditionally relied on its natural resources, such as oil, gas, and agriculture, as primary drivers of growth. However, with the global economy becoming increasingly reliant on technology and innovation, the country must diversify its economic base (Gahari, 2024). This is where the creative economy comes in as a potential driver of sustainable development. The creative economy encompasses a wide range of industries, including art, fashion, music, design, film, and digital media (Dairoby, 2024). These industries not only offer opportunities for economic growth but also have the potential to foster cultural expression, innovation, and social cohesion. The growth of the creative economy in Indonesia has the potential to create jobs, promote entrepreneurship, and improve regional economies, especially in areas that have been left behind by traditional industries.

Indonesia's creative economy has experienced significant growth, contributing to both the country's GDP and its cultural influence globally. According to the Indonesian Ministry of Creative Economy (2020), the creative industries contributed 7.44% to the country's GDP in 2019, with the sector growing at a rate of 10.5% annually. This sector has become an important source of economic growth, especially in urban areas such as Jakarta, Yogyakarta, and Bali. The creative economy offers a platform for young entrepreneurs to innovate and create new products and services that resonate with both local and global markets. Moreover, the creative economy is seen as a sustainable driver of growth because it taps into Indonesia's rich cultural heritage, transforming it into valuable economic assets (Chollisni et al., 2022).

Despite the promising growth of the creative economy, its development has been uneven across the country (Digdowiseiso, 2023). The concentration of creative industries in urban areas has resulted in a significant disparity between regions. While cities like Jakarta and Yogyakarta have seen a flourishing creative economy, other regions such as Papua, Kalimantan, and parts of Sulawesi have not been able to fully leverage their creative potential (Arianto and Cahyono, 2025). This uneven distribution of creative industries further deepens the gap between urban and rural areas. In these underserved regions, the lack of infrastructure, limited access to markets, and inadequate support for entrepreneurship hinder the growth of the creative economy (Putra, 2024). Additionally, there is a shortage of skilled labor in many creative sectors, which prevents businesses from scaling up and creating more job opportunities (Burhanudin, 2023).

The lack of government support and inadequate infrastructure in non-urban regions are some of the key factors limiting the growth of the creative economy outside of major cities (Nasution et al., 2025). While the government has made efforts to promote the creative economy through initiatives such as the Indonesian Creative Economy Agency (Bekraf), these efforts have largely been focused on urban areas (Murtadi and Hadi, 2024). Small businesses in the creative sector often struggle to access financing, markets, and the digital tools necessary to expand their reach. The absence of policies that provide incentives for creative entrepreneurs, such as tax relief, low-interest loans, and digital infrastructure, has made it difficult for businesses to thrive in these regions. Consequently, the full potential of the creative economy to contribute to poverty reduction and human development remains untapped (Widodo, 2023).

Poverty in Indonesia is not merely an issue of income but also a result of limited access to resources and opportunities. This multidimensional problem encompasses economic, social, and cultural aspects (Soegiarso, 2022). Many of Indonesia's poor live in rural and remote areas where they have limited access to education, healthcare, and employment opportunities. Poverty in Indonesia is closely linked to the lack of quality human resources, which is a barrier to achieving sustainable economic development (Permana, 2024). As the country continues to grapple with poverty, investing in human development is critical to reducing inequality and improving the living standards of the population. High-quality human resources are essential for driving economic growth and addressing the complex challenges associated with poverty (Burhanudin, 2023).

To address these challenges, Indonesia needs to adopt a more inclusive approach to development, one that focuses on building human capital in underdeveloped regions and fostering the growth of the creative economy (Hutama, 2024). This requires significant investments in education and healthcare, as well as the creation of policies that support entrepreneurship, especially in the creative industries (Rahayu, 2025a). By improving human development in these areas, Indonesia can create new economic opportunities, reduce poverty, and promote social mobility. The creative economy has the potential to bridge the gap between urban and rural areas, providing new avenues for growth and development in underserved regions (Iman and Wahyudi, 2023).

Addressing the inequality in access to education and skills development is essential for fostering inclusive growth. The creative economy provides an opportunity to do this by creating jobs in sectors such as design, digital media, and arts (Hayat and Sulaiman, 2023). However, for this potential to be fully realized, the government must provide the necessary support to foster the growth of creative industries in rural and underdeveloped areas. This includes improving access to digital tools, investing in education and training programs, and providing financial support to creative entrepreneurs (Fadli, 2024). Only by addressing these issues can Indonesia ensure that the benefits of the creative economy reach all corners of the country and contribute to reducing poverty and inequality (Hayat and Sulaiman, 2023).

Indonesia has made significant progress in human development, but there remain substantial gaps, particularly between urban and rural areas. The creative economy offers a unique opportunity to address these disparities by providing new sources of income, employment, and cultural expression. However, for the creative economy to thrive in underserved regions, the government must invest in infrastructure, education, and policies that support creative businesses. By integrating human development with economic growth, Indonesia can harness the potential of the creative economy to create a more equitable and sustainable future for all its citizens. Through these efforts, the country can unlock the full potential of its human resources, fostering a more inclusive and prosperous society.

2. Literature Review

2.1 Economic Development

Economic development is a continuous and dynamic process, reflecting the progress that a nation makes over time. Unlike static economic conditions, economic development represents a forward-looking transformation that aims to achieve more than just increases in output. At its core, it is about improving the standard of living and well-being of the population (Dellyana et al., 2023). This progress is typically measured through the growth of real income, which encompasses both the total national income and the distribution of that income across the population. The relationship between economic growth and development is fundamentally rooted in two key factors: national income and population (Susanti and Silvia, 2024). The per capita income, or national income divided by the population, serves as an indicator of the average income of individuals in a country, offering insights into the economic prosperity of a nation (Purwadi and Satria, 2024).

The concept of economic development is often framed within different models that emphasize various aspects of growth. Ramadhan and Satria, 2025) identified four key development models: the growth-oriented development model, the job creation model, the poverty elimination model, and the basic needs-oriented model. Each model has distinct goals, but all share the ultimate aim of improving the quality of life, enhancing goods and services, creating decent jobs with fair wages, and ensuring that all households achieve a minimum standard of living (Dima and Nalle, 2025). In essence, economic development is not just about enhancing the wealth of a few but ensuring that the benefits of growth are widely distributed and contribute to the improvement of living standards for all (Goh et al., 2024).

2.2 Poverty Structure

Poverty is a multifaceted issue that is deeply embedded in the structural dynamics of society (Yuslin, 2024). According to structuralist theories, poverty is not merely a result of individual failings or market forces but is instead shaped by larger structural factors, such as economic policies, industrialization, and spatial inequality (Qudsi and Ashar, 2025). Structural factors often dictate the level of exposure different communities have to economic opportunities, which in turn affects their risk of poverty. Asmara et al. (2024) emphasized that economic development plays a crucial role in reducing poverty, particularly through urbanization and improved access to education and health services. Their research highlighted how China's rapid economic growth and urbanization have led to a dramatic decline in poverty over recent decades (Rizkiawan et al., 2024).

While economic development is often seen as a necessary condition for poverty reduction, it is not always a sufficient one (Fahmi, 2016). Economic growth must be inclusive and accompanied by policies that address the underlying causes of poverty, such as limited access to resources, unequal income distribution, and inadequate social services (Purwono, 2021). Moreover, the spatial distribution of poverty, with many impoverished communities concentrated in rural or remote areas, further complicates efforts to eliminate poverty. As such, a comprehensive approach that addresses both the economic and social dimensions of poverty is needed to achieve sustainable development (Hali, 2025).

2.3 Human Development

Human development is a broader concept that transcends traditional economic measures and focuses on improving the overall well-being of individuals. According to Gahari (2024), the Human Development Index (HDI) is a widely used tool to measure human development achievements across regions and time. HDI takes into account three key dimensions: life expectancy (health), educational attainment (knowledge), and income (standard of living). By considering these factors, HDI provides a composite index that offers a more holistic view of human development, beyond just economic indicators (Dairoby, 2024).

Human capital plays a critical role in driving economic growth. (Digdowiseiso, 2023) noted that investment in human capital, such as education, training, and health, leads to higher productivity and a better standard of living. As the economy improves, there is an increased focus on human capital development, as people become more inclined to invest in their education, skills, and health (Arianto and Cahyono, 2025). This creates a virtuous cycle where human development leads to economic growth, which in turn provides more resources for further human development. Moreover, technological innovation, which is essential for productivity growth, is also heavily reliant on a skilled and educated workforce. In this way, human development and economic development are deeply intertwined, each supporting and enhancing the other (Putra, 2024).

2.4 Creative Economy

The concept of the creative economy emerged in the late 20th century, as new forms of economic activities began to prioritize creativity, innovation, and cultural expression. John Howkins, in his book "The Creative Economy: How People Make Money," introduced the idea that the creative economy involves economic activities focused on the generation of ideas rather than routine and repetitive tasks (Nasution et al., 2025). Howkins argued that creativity is a key driver of economic progress and that societies that prioritize creativity and innovation are better positioned to succeed in the modern global economy. This view has been widely adopted, particularly in countries looking to diversify their economies and move beyond traditional industries (Murtadi and Hadi, 2024).

The creative economy has become an increasingly important driver of growth. The sector includes industries such as art, design, music, film, fashion, and digital media (Soegiarso, 2022). The growth of the creative economy in Indonesia reflects the country's rich cultural heritage and its growing capacity to produce innovative and globally competitive products. According to Sari and Sukma (2023), the creative economy can be divided into 14 sectors, including advertising, architecture, arts, crafts, design, fashion, video, film, music, performing arts, publishing, and digital services like interactive games and software development. These sectors not only contribute to economic growth but also serve as vehicles for cultural expression and social cohesion (Iman and Wahyudi, 2023).

Despite the rapid growth of the creative economy in major urban centers, there remains a significant gap in terms of development across different regions. The creative economy in Indonesia is largely concentrated in cities like Jakarta, Yogyakarta, and Bali, while other areas, particularly in Eastern Indonesia, struggle to tap into this potential (Hayat and Sulaiman, 2023). The lack of infrastructure, skilled labor, and government support in these regions limits the growth of creative industries. Moreover, small and medium-sized enterprises (SMEs) in the creative sector often face challenges in terms of market access, financing, and digital infrastructure. This has led to uneven development in the creative economy, with certain regions reaping the benefits while others remain underdeveloped (Fadli, 2024).

2.5 Relationships between Variables

The relationship between human development and economic growth is well established in the literature. Nasution et al. (2025) highlighted that education is one of the most important investments for economic development. An educated population is more likely to be productive, innovative, and capable of contributing to the economy. Furthermore, individuals with higher levels of education tend to earn higher incomes, which in turn boosts the overall economy. As the economy grows, there is more investment in education and skill development, which creates a feedback loop that drives further growth (Sari and Sukma, 2023).

Human development is closely linked to poverty reduction. According to Klasen in Qudsi and Ashar (2025), increasing access to essential assets, particularly human capital through education, is one of the most effective ways to reduce poverty. Their research found that the average length of schooling negatively correlated with the number of people living in poverty, indicating that investment in education can significantly reduce poverty rates (Dima and Nalle, 2025).

The creative economy also has a significant impact on economic development. Dellyana et al. (2023) argued that the creative economy is central to the development of local economies, particularly in underdeveloped regions. By fostering innovation and creativity, the creative economy can create jobs, attract investment, and improve local infrastructure. This has been demonstrated in various parts of the world, where creative industries have revitalized economically disadvantaged regions and provided new avenues for economic growth (Hayat and Sulaiman, 2023).

The relationship between the creative economy and poverty reduction is complex but promising. According to Purwadi and Satria (2024) the growth of micro, small, and medium-sized enterprises (MSMEs) is often closely tied to poverty. While MSMEs can be a source of income for the poor, their growth is often driven by the availability of demand in local markets. In many developing countries, including Indonesia, MSMEs have played a crucial role in reducing poverty by providing employment and economic opportunities. However, the effectiveness of MSMEs in poverty reduction depends on the availability of infrastructure, market access, and financial support from the government and private sectors (Ramadhan and Satria, 2025).

Economic development and poverty reduction are closely interconnected. Ramadhan and Satria (2025) emphasized that economic growth should not just be measured by increases in GDP but should also take into account the distribution of income and its effects on the quality of life. Economic development, therefore, should focus not just on increasing wealth but on ensuring that the benefits of growth are shared widely across society. This approach requires policies that address inequality and provide opportunities for all segments of the population to improve their living standards.

3. Methods and Materials

The data analysis in this study follows the path analysis method, a powerful statistical technique used to examine the relationships between multiple endogenous and exogenous variables simultaneously. As outlined in the conceptual framework, this method is particularly well-suited for testing complex models that include several variables that may influence one another in various ways. Path analysis provides a clear and structured way to model these relationships by breaking down the process into smaller, more manageable steps, enabling researchers to evaluate the direct and indirect effects of different factors.

In the present study, the exogenous variables include human development (X1) and the creative economy (X2), while the endogenous variables are economic development (Y1) and poverty structure (Y2). The use of path analysis allows us to test the impact of both human development and the creative economy on economic development and poverty reduction, all while taking into account the interdependencies among these factors.

3.1 Exogenous Variables

The first exogenous variable, human development (X1), is measured using three indicators: expected length of schooling (X1.1), average length of schooling (X1.2), and life expectancy (X1.3). Human development is considered a fundamental aspect of national progress because it encapsulates both the education system and the overall health of the population. The indicators chosen reflect key areas in human development that are likely to have significant impacts on the broader economic landscape. Specifically, the expected length of schooling (X1.1) reflects the future opportunities available to the population, while the average length of schooling (X1.2) indicates the level of education currently attained. Life expectancy (X1.3) is a direct measure of the health outcomes within a population, which influences not only the productivity of individuals but also their ability to contribute effectively to the economy.

The second exogenous variable, the creative economy (X2), is also assessed through several indicators: gross regional domestic product (X2.1), exports (X2.2), the number of foreign tourists (X2.3), and the number of micro, small, and medium enterprises (X2.4). The creative economy is a critical factor in modern economies, especially for countries like Indonesia, where there is a rich cultural heritage and a growing market for creative goods and services. Gross regional domestic product (X2.1) serves as a general measure of the economic output generated within a specific region, which is influenced by creative industries. Exports (X2.2) capture the global reach of creative products, which can stimulate economic growth and raise national income. The number of foreign tourists (X2.3) reflects the attractiveness of Indonesia's creative offerings, such as cultural tourism, arts, and entertainment, which further enhance economic prosperity. Lastly, the number of micro, small, and medium enterprises (X2.4) is an important indicator of the vibrancy and accessibility of the creative economy, particularly in terms of job creation and the empowerment of local communities.

3.2 Endogenous Variables

On the endogenous side, economic development (Y1) is represented by two indicators: per capita income (Y1.1) and economic growth (Y1.2). Economic development is a broader term that incorporates changes in both the level and distribution of income within a country. Per capita income (Y1.1) is a key indicator used to measure the average income of individuals in the country, which reflects the overall standard of living. Economic growth (Y1.2) is measured by the increase in GDP or the expansion of economic activity, which provides insight into the general health of the economy. Both indicators are crucial for understanding how well the country is progressing and whether the benefits of growth are being shared equitably across the population.

The second endogenous variable, poverty structure (Y2), includes five indicators that help provide a comprehensive view of poverty in the country: poor population growth (Y2.1), population size (Y2.2), poverty severity index (Y2.3), poverty depth index (Y2.4), and income distribution (Y2.5). These indicators allow for a nuanced understanding of poverty by considering both the extent of poverty (through population growth and poverty indices) and its intensity (through severity and depth indicators). Understanding poverty in terms of these dimensions is crucial for identifying specific areas of vulnerability within the population and creating targeted policies that address both the causes and consequences of poverty.

3.3 Mathematical Model and Pathways

Based on the conceptual framework and the use of path analysis, the relationships between the variables can be modeled mathematically. The first structural equation represents the relationship between economic development (Y_1) and the exogenous variables, human development (X_1) and creative economy (X_2):

$$Y_1 = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \epsilon_1$$

In this equation, Y_1(economic development) is a function of X_1(human development) and X_2(creative economy). The coefficients α_1 and α_2 represent the direct effects of human development and the creative economy on economic development, while $\epsilon_1$is the error term, capturing all unmeasured factors affecting economic development.

The second structural equation describes the relationship between poverty structure (Y_2), the exogenous variables, and the endogenous variable economic development (Y_1):

$$Y_2 = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_7 Y_1 + \epsilon_2$$

This equation indicates that poverty structure (Y_2) is influenced not only by human development (X_1) and the creative economy (X_2) but also by economic development (Y_1). The inclusion of Y_1as an explanatory variable in this equation suggests that economic development can have an indirect effect on poverty, improving conditions and reducing poverty levels as the economy grows. The coefficient $\alpha_7$represents the strength of this indirect relationship, and ϵ_2 again captures the error term for the poverty structure model.

3.4 Software and Analysis

For the analysis of these structural equations, the study utilizes Warp Partial Least Squares (PLS), a powerful tool for estimating complex relationships between variables. Warp PLS is particularly suitable for path analysis, as it is capable of handling multiple endogenous and exogenous variables simultaneously. This software allows for the testing of the model's fit and the significance of the pathways between variables, providing valuable insights into the direct and indirect effects of human development, the creative economy, and economic development on poverty structure.

4. Results and Discussion

According to Hair et al. (2014: 92), *Outer loading* is a value that explains the relationship (correlation) between an indicator and its latent variables. The higher the *outer loading*, the closer the relationship between an indicator and its latent variables. Outer loading values of 0.4 - 0.7 are acceptable, while *outer loading* < 0.3 is permanently eliminated from the analysis process. In general, *outer loading* values of 0.4 - 0.7 can be considered for elimination, which increases the value of *composite reliability* or *average variance*. The following are the results of several indicators of Human Development, Creative Economy, Human Development, and Poverty Structure, which are as follows:

	X1	X2	Y1	Y2	Type (as defined)	SE	P value
X1.1	(0.883)	-0.085	0.081	0.220	Formative	0.046	<0.001
X1.2	(0.816)	0.018	0.004	-0.322	Formative	0.046	<0.001
X1.3	(0.606)	0.099	-0.122	0.114	Formative	0.047	<0.001
X2.1	0.055	(0.932)	-0.104	0.033	Formative	0.045	<0.001
X2.2	0.015	(0.808)	-0.321	-0.299	Formative	0.046	<0.001
X2.3	-0.435	(0.248)	0.470	0.034	Formative	0.050	<0.001
X2.4	0.075	(0.601)	0.398	0.336	Formative	0.048	<0.001
Y1.1	0.323	0.321	(0.669)	-0.412	Formative	0.047	<0.001
Y1.2	-0.323	-0.321	(0.669)	0.412	Formative	0.047	<0.001
Y2.1	-0.007	0.009	-0.019	(0.983)	Formative	0.045	<0.001
Y2.2	0.158	0.435	-0.387	(-0.183)	Formative	0.050	<0.001
Y2.3	0.030	0.054	-0.060	(0.977)	Formative	0.045	<0.001
Y2.4	0.007	0.019	0.007	(0.965)	Formative	0.045	<0.001

Figure 1. PLS Wrap Calculation Result: First Outer Loading
Source: Research finding.

It is known from the interpretation above that several indicators do not meet the requirements, namely the number of foreign tourists (X 2.3) and the number of residents ($Y_{2.2}$). Based on the *outer loading* results, it is retested for some qualified indicators, while unqualified indicators cannot be maintained or eliminated.

	X1	X2	Y1	Y2	Type (as defined)	SE	P value
X1.1	(0.883)	-0.082	0.074	0.217	Formative	0.046	<0.001
X1.2	(0.816)	0.009	0.081	-0.286	Formative	0.046	<0.001
X1.3	(0.606)	0.107	-0.216	0.068	Formative	0.047	<0.001
X2.1	0.002	(0.940)	-0.032	0.046	Formative	0.045	<0.001
X2.2	-0.037	(0.831)	-0.242	-0.271	Formative	0.046	<0.001
X2.4	0.050	(0.583)	0.396	0.312	Formative	0.048	<0.001
Y1.1	0.335	0.330	(0.669)	-0.426	Formative	0.047	<0.001
Y1.2	-0.335	-0.330	(0.669)	0.426	Formative	0.047	<0.001
Y2.1	-0.013	-0.017	-0.002	(0.983)	Formative	0.045	<0.001
Y2.3	0.014	0.026	-0.025	(0.981)	Formative	0.045	<0.001
Y2.4	-0.001	-0.009	0.027	(0.967)	Formative	0.045	<0.001

Figure 2. PLS Wrap Calculation Result: Second Outer Loading
Source: Research finding.

So, it can be concluded from the results of the interpretation above that all indicators of the variables of the construct of human development (X_1), creative economy (X_2), economic development (Y_1), and poverty structure (Y_2), are known to all get *an outer loading* value of > 0.4, which means that all indicators are maintained in the following analysis process.

According to Hair et al. (2014: 103), *Average* variance extracted (AVE) is a value (on average) that describes how much a latent variable or construct can explain the *variance* of its indicators. The higher the AVE, the better a latent variable or construct explains the *variance* of its indicators. An AVE value of >

0.5 means that a latent variable or construct has absorbed information from its indicators by more than 50%. The following is the result of the *average variance extracted* (AVE):

	X1	X2	Y1	Y2
R-squared			0.163	0.376
Adj. R-squared			0.159	0.371
Composite reliab.	0.817	0.836	0.618	0.984
Cronbach's alpha	0.661	0.698	-0.237	0.976
Avg. var. extrac.	0.604	0.638	0.447	0.954
Full collin. VIF	1.116	1.183	1.385	1.504
Q-squared			0.168	0.379
Min	-4.812	-2.277	-6.857	-2.169
Max	2.195	2.459	2.539	2.536
Median	0.092	0.015	0.090	-0.007
Mode	0.139	0.000	-2.055	-0.537
Skewness	-0.975	0.164	-1.251	0.225
Exc. kurtosis	1.815	-0.331	7.473	-0.514
Unimodal-RS	Yes	Yes	Yes	Yes
Unimodal-KMV	Yes	Yes	Yes	Yes
Normal-JB	No	Yes	No	No
Normal-RJB	No	Yes	No	No
Histogram	View	View	View	View

Figure 3. PLS Wrap Calculation Result: Average Variance Extracted (AVE)
Source: Research finding.

So, it can be concluded based on the above interpretation that the latent variables of human development (X_1), creative economy (X_2), and poverty structure (Y_2) have absorbed variance from each indicator > 50 percent. At the same time, the latent variable of economic development (Y_1) has absorbed *variance* from each indicator < 50 percent.

	X1	X2	Y1	Y2
R-squared			0.163	0.376
Adj. R-squared			0.159	0.371
Composite reliab.	0.817	0.836	0.618	0.984
Cronbach's alpha	0.661	0.698	-0.237	0.976
Avg. var. extrac.	0.604	0.638	0.447	0.954
Full collin. VIF	1.116	1.183	1.385	1.504
Q-squared			0.168	0.379
Min	-4.812	-2.277	-6.857	-2.169
Max	2.195	2.459	2.539	2.536
Median	0.092	0.015	0.090	-0.007
Mode	0.139	0.000	-2.055	-0.537
Skewness	-0.975	0.164	-1.251	0.225
Exc. kurtosis	1.815	-0.331	7.473	-0.514
Unimodal-RS	Yes	Yes	Yes	Yes
Unimodal-KMV	Yes	Yes	Yes	Yes
Normal-JB	No	Yes	No	No
Normal-RJB	No	Yes	No	No
Histogram	View	View	View	View

Figure 4. PLS Wrap Calculation Result: Composite Reliability
Source: Research finding.

Therefore, it can be concluded based on the above interpretation that the latent variables of human development, creative economy, economic development, and poverty structure are known to have composite reliability values of all> 0.6.

According to Hair et al. (2014: 104-105), discriminant validity tests the extent to which a construct completely differs from another construct. As for determining the validity of discrimination through a cross-loading approach. Compare the outer loading value of an indicator against its latent variable and the *outer loading* value of the indicator against other latent variables. In this approach, the outer loading value of an indicator against its latent variable must be greater than the *outer loading* value of the indicator against other latent variables. In this approach, test whether an indicator is better at testing its latent variable than other latent variables. In other words, it tests whether any indicators are swapped. The following are the results of testing the validity of cross-loading discriminants, which are as follows:

	X1	X2	Y1	Y2
X1.1	(0.883)	0.006	0.141	-0.093
X1.2	(0.816)	0.238	0.388	-0.497
X1.3	(0.606)	0.108	0.015	-0.098
X2.1	0.120	(0.940)	0.257	-0.295
X2.2	0.126	(0.831)	0.188	-0.403
X2.4	0.107	(0.583)	0.297	-0.167
Y1.1	0.507	0.546	(0.669)	-0.703
Y1.2	-0.175	-0.147	(0.669)	0.028
Y2.1	-0.312	-0.380	-0.511	(0.983)
Y2.3	-0.283	-0.343	-0.500	(0.981)
Y2.4	-0.290	-0.363	-0.467	(0.967)

Figure 5. PLS Wrap Calculation Result: Cross-Loading Discriminant Validity
Source: Research finding.

So, it can be concluded, based on the interpretation above, that the *loading* value between each indicator variable and its latent variable is higher when compared to other latent variables.

The *r-squared* value is a value that expresses how much the free variable can explain the *variance* of the non-free variable. The following are the results of the coefficient of determination (*r-squared*) test, which are as follows:

	X1	X2	Y1	Y2
R-squared			0.163	0.376
Adj. R-squared			0.159	0.371
Composite reliab.	0.817	0.836	0.618	0.984
Cronbach's alpha	0.661	0.698	-0.237	0.976
Avg. var. extrac.	0.604	0.638	0.447	0.954
Full collin. VIF	1.116	1.183	1.385	1.504
Q-squared			0.168	0.379
Min	-4.812	-2.277	-6.857	-2.169
Max	2.195	2.459	2.539	2.536
Median	0.092	0.015	0.090	-0.007
Mode	0.139	0.000	-2.055	-0.537
Skewness	-0.975	0.164	-1.251	0.225
Exc. kurtosis	1.815	-0.331	7.473	-0.514
Unimodal-RS	Yes	Yes	Yes	Yes
Unimodal-KMV	Yes	Yes	Yes	Yes
Normal-JB	No	Yes	No	No
Normal-RJB	No	Yes	No	No
Histogram	View	View	View	View

Figure 6. PLS Wrap Calculation Result: Coefficient of Determination (r-squared)
Source: Research finding.

Based on Figure 6, the results of the coefficient of determination (*r-squared*) of several latent variables are as follows:

1. The *r-squared* value of the latent variable of economic development (Y_1) is 0.163, meaning that the latent variable of human development (X_1) and creative economy (X_2) can explain the *variance* of the latent variable of economic development (Y_1) of 16.3 percent.
2. The *r-squared* value of the latent variable of poverty structure (Y_2) is 0.376, meaning that the latent variables of human development (X_1), creative economy (X_2), and economic development (Y_1) can explain the *variance* of the latent variable of poverty structure (Y_2) of 37.6 percent.

Path coefficients

	X1	X2	Y1	Y2
X1				
X2				
Y1	0.249	0.292		
Y2	-0.206	-0.207	-0.428	

P values

	X1	X2	Y1	Y2
X1				
X2				
Y1	<0.001	<0.001		
Y2	<0.001	<0.001	<0.001	

Figure 7. PLS Wrap Calculation Results: Direct Effect Significance Test
Source: Research finding.

Based on Figure 7, the results of the direct *effect* significance test are as follows:

1. The value of *the path coefficients* of human development (X_1) to economic development (Y_1) of 0.249 is positive, meaning that human development (X_1) has a positive effect on economic development (Y_1). It is known that the *p-values* < 0.001, which means < 0.05, it can be concluded that human development (X_1) has a positive and significant effect on economic development (Y_1) (Hypothesis Accepted).
2. The value of *the path coefficients* of the creative economy (X_2) to economic development (Y_1) of 0.292 is positive, meaning that the creative economy (X_2) has a positive effect on economic development (Y_1). It is known that the *p-values* < 0.001, which means < 0.05, it can be concluded that the creative economy (X_2) has a positive and significant effect on economic development (Y_1) (Hypothesis Accepted).
3. The value of *the path coefficients* of human development (X_1) to the poverty structure (Y_2) of -0.206 is negative, meaning that human development (X_1) negatively affects the structure of poverty (Y_2). It is known that the *p-values* < 0.001, which means < 0.05, it can be concluded that human development (X_1) has a negative and significant effect on the structure of poverty (Y_2) (Hypothesis Rejected).
4. The value of the *path coefficients* of the creative economy (X_2) to the poverty structure (Y_2) of – 0.207 is negative, which means that the creative economy (X_2) hurts the poverty structure (Y_2). It is known that the *p-values* < 0.001, which means < 0.05, it can be concluded that the creative economy (X_2) has a negative and significant effect on the poverty structure (Y_2) (Hypothesis Accepted).
5. The value of the *path coefficient* of economic development (Y_1) to the poverty structure (Y_2) of -0.428 is negative, meaning that economic development (Y_1) negatively affects the poverty structure (Y_2). It is known that the *p-values* < 0.001, which means < 0.05, it can be concluded that economic development (Y_1) has a negative and significant effect on the structure of poverty (Y_2) (Hypothesis Accepted).

WarpPLS 7.0 - Indirect and total effects (table view)

Close Help

---------------- Indirect and total effects (table view) ----------------

****

* Indirect and total effects *

****

Indirect effects for paths with 2 segments

	X1	X2	Y1	Y2
X1				
X2				
Y1				
Y2	-0.107	-0.125		

Number of paths with 2 segments

	X1	X2	Y1	Y2
X1				
X2				
Y1				
Y2	1	1		

P values of indirect effects for paths with 2 segments

	X1	X2	Y1	Y2
X1				
X2				
Y1				
Y2	0.002	<0.001		

Figure 8. PLS Wrap Calculation Results: Mediation Testing (Indirect Effect)
Source: Research finding.

Based on figure 8 of the mediation test (*indirect effect*) is as follows:

1. The indirect effect of human development (X_1) on the structure of poverty (Y_2) through economic development (Y_1) is -0.107. It is known that the p-values<0.002, which means 0.05. This means that economic development (Y_1) has a significant influence in mediating the relationship between human development (X_1) and poverty structure (Y_2). In other words, human development (X_1) indirectly has a significant effect on the structure of poverty (Y_2) through economic development (Y_1).
2. The indirect influence of the creative economy (X_2) on the poverty structure (Y_2) through economic development (Y_1) is – 0.125. The *p-value* < 0.001, which means 0.05. This means that economic development (Y_1) has a significant influence in mediating the relationship between the creative economy (X_2) and the poverty structure (Y_2). In other words, the creative economy (X_2) indirectly has a significant effect on the structure of poverty (Y_2) through economic development (Y_1).

Kock's overall model fit test (2021:78-29) states as follows:

1. Model fit testing is not essential if a study only intends or aims to be limited to hypothesis testing.
2. If you want to check the suitability of the model to the data, several indicators can be used, such as average *path coefficient* (APC), average r-squared (ARS), average *adjusted R-squared* (AARS), average *block variance inflation factor* (AVIF), *average full collinearity VIF* (AFVIF), and *Tenenhaus* GoF (GoF)

```
General project information
----------------------------------------------------------

Version of WarpPLS used: 7.0
License holder: Trial license (3 months)
Type of license: Trial license (3 months)
License start date: 06-Jul-2023
License end date: 04-Oct-2023
Project path (directory): C:\Users\DELL\Downloads\WRP PLS\
Project file: DS.prj
Last changed: 06-Jul-2023 11:46:50
Last saved: Never (needs to be saved)
Raw data path (directory): C:\Users\DELL\Downloads\
Raw data file: DATA ANALISIS WRAP PLS SETELAH LN FIX UPDATE.xls


Model fit and quality indices
----------------------------------------------------------

Average path coefficient (APC)=0.276, P<0.001
Average R-squared (ARS)=0.270, P<0.001
Average adjusted R-squared (AARS)=0.265, P<0.001
Average block VIF (AVIF)=1.072, acceptable if <= 5, ideally <= 3.3
Average full collinearity VIF (AFVIF)=1.297, acceptable if <= 5, ideally <= 3.3
Tenenhaus GoF (GoF)=0.422, small >= 0.1, medium >= 0.25, large >= 0.36
Sympson's paradox ratio (SPR)=1.000, acceptable if >= 0.7, ideally = 1
R-squared contribution ratio (RSCR)=1.000, acceptable if >= 0.9, ideally = 1
Statistical suppression ratio (SSR)=1.000, acceptable if >= 0.7
Nonlinear bivariate causality direction ratio (NLBCDR)=1.000, acceptable if >= 0.7
```

Figure 9. PLS Wrap Calculation Result: Model Fit Testing (Global Model Fit)
Source: Research finding.

Based on Figure 9 of the model fit test (*global model fit*), which is as follows:

1- Based on *the average path coefficient* (APC) indicator, it is known that the APC value is 0.276 with *a p-value* of < 0.001, which means 0.05. This means that the *average path coefficient* (APC) indicator of model fit testing has been met.

2- Based on the *average r-squared* (ARS) indicator, it is known that the ARS value is 0.270 with *a p-value* of < 0.001, which means < 0.05. This means the *average r-squared* indicator (ARS) of model fit testing is fit.

3- Based on the *average adjusted R-squared* (AARS) indicator, it is known that the AARS value is 0.265, with *a p-value* of < 0.001, which means < 0.05. This means that the *average adjusted R-squared* (AARS) indicator of model fit testing has been fitted.

4- Based on *the average block variance inflation factor* (AVIF) indicator, it is known that the AVIF value is 1.072, with *an ideal* value of <= 3.3, which means <= 5. This means that the model fit test has been fitted.

5- Based on the *average full collinearity VIF* (AFVIF) indicator, it is known that the AFVIF value is 1,297 with *an ideal* <= 3.3 value, which means <= 5. This means that the model fit test has been fitted.

6- Based on the *Tenenhaus* GoF (GoF) indicator, it is known that the GoF value is 0.422. This means that the model fit test is included in the *large* group.

This summary is the overall result of both exogenous and endogenous variables. The following is a summary of the calculation results of PLS Wrap version 7 made in the table version, which is as follows:

Table 1. A Summary of Hypothesis Test Results

Influence of Variables	Coefisies ß	*P-value*	Conclusion
X 1 to Y_1	0.246	0.001	Positive and Significant
X_2 to Y_1	0.292	0.001	Positive and Significant
X_1 to Y_2	- 0.206	0.001	Negative and Significant
X 2 to Y_2	- 0.207	0.001	Negative and Significant
Y_1 to Y_2	- 0.428	0.001	Negative and Significant
Y_1 mediates X_1 against Y_2	- 0.107	0.002	Negative and Significant
Y_1 mediates X_2 against Y_2	- 0.125	0.001	Negative and Significant

Source: Research finding.

4.1 Human Development for Economic Development in Indonesia

The analysis of human development in the context of economic development in Indonesia reveals a significant and positive relationship between the two. This means that improvements in human development, such as better education, healthcare, and skill acquisition, directly contribute to the economic growth of regions across Indonesia (Qudsi and Ashar, 2025). Human development is recognized as an essential pillar for accelerating economic growth, particularly in emerging economies like Indonesia, where human capital plays a crucial role in determining the pace of economic transformation (Asmara et al., 2024). As human development improves, it helps to create a more productive, educated, and healthier workforce, which ultimately drives economic development by increasing productivity, enhancing innovation, and fostering a more competitive economy (Rizkiawan et al., 2024).

The new growth theory provides a valuable framework for understanding the importance of human development in promoting economic growth (Fahmi, 2016). According to the theory, both physical and human capital are critical for long-term economic growth, with human capital playing a particularly significant role in developing nations. Human capital refers to the knowledge, skills, and abilities that individuals acquire, typically through education, training, and experience (Purwono, 2021). In the case of Indonesia, the development of human capital is crucial for its economic advancement, as it can lead to a more skilled and productive workforce capable of adopting new technologies and driving growth in various sectors (Komariyah, 2023). Moreover, public policies that focus on investing in human capital are fundamental to fostering productivity growth, which serves as a key engine for long-term economic development. Education, as an integral component of human capital, directly influences a nation's ability to absorb modern technology and enhance production capacity, thereby facilitating sustained economic development (Hali, 2025).

In Indonesia, where education and skill levels vary widely across regions, the government has a critical role in fostering human capital development (Gahari, 2024). Education not only equips individuals with the necessary skills to participate in the job market but also enhances their ability to adapt to technological advancements, which are essential for improving productivity and economic output (Dairoby, 2024). As regions invest in the development of their human capital, they simultaneously create opportunities for economic growth. In essence, human development is not just about improving the quality of life for individuals but also about ensuring that the economy as a whole benefits from a more skilled, educated, and capable workforce (Permana, 2024).

4.2 Creative Economy for Economic Development in Indonesia

The analysis results show a clear and significant positive relationship between the creative economy and economic development in Indonesia. This signifies that the creative economy, which encompasses industries such as arts, design, fashion, film, music, and digital media, can make substantial contributions to the country's economic growth (Dairoby, 2024). The creative economy is increasingly seen as a driver of economic progress, as it provides both direct and indirect opportunities for job creation, income generation, and export opportunities. As Indonesia continues to develop its creative sectors, it is positioned to tap into the growing global demand for creative products and services, further enhancing its economic competitiveness (Arianto and Cahyono, 2025).

In his influential book *The Creative Economy: How People Make Money From Ideas*, John Howkins highlighted the transformative potential of the creative economy, noting that it involves more than just the production of goods and services it centers on the generation of ideas (Putra, 2024). Creative industries are characterized by innovation, originality, and the ability to add value to both local and global markets. In Indonesia, the creative economy has proven to be a significant income generator, contributing to the country's GDP and creating numerous employment opportunities (Nasution et al., 2025). Artists, designers, filmmakers, musicians, and other creatives are essential contributors to this dynamic sector. The growth of the creative economy in Indonesia not only helps diversify the economy but also fosters cultural exchange, enhances global visibility, and drives social development (Murtadi and Hadi, 2024).

The expansion of the creative economy in Indonesia can be seen in the increasing number of small businesses and entrepreneurs that are emerging within the sector. These businesses, whether in fashion, digital media, or tourism, provide jobs for a wide range of workers with varying skill levels and educational backgrounds (Soegiarso, 2022). By nurturing creativity and innovation, the creative economy also encourages entrepreneurship, which is essential for regional economic growth. In addition to providing new business opportunities, the creative economy fosters economic diversification by introducing new industries and revenue streams, particularly in regions that are underserved by traditional industries (Soegiarso, 2022).

As countries increasingly recognize the importance of the creative economy, Indonesia has the opportunity to capitalize on its diverse cultural assets (Iman and

Wahyudi, 2023). The unique blend of Indonesian traditions, arts, and modern innovation offers immense potential for growth within creative sectors such as tourism, crafts, and design. With targeted government support and investments in infrastructure, education, and technology, Indonesia can further unlock the potential of its creative industries, driving sustainable economic development and creating jobs across the nation (Hayat and Sulaiman, 2023).

4.3 Human Development on the Structure of Poverty in Indonesia

The results of the study indicate that human development has a negative and significant effect on the structure of poverty in Indonesia (Dellyana et al., 2023). This relationship highlights the importance of improving access to quality education, healthcare, and other essential services as a means of alleviating poverty. In particular, education is seen as one of the most effective tools for breaking the cycle of poverty (Susanti and Silvia, 2024). By acquiring skills and knowledge, individuals are better equipped to enter the labor market and secure higher-paying jobs. Education provides individuals with the opportunity to improve their standard of living, which ultimately contributes to reducing poverty at both the individual and societal levels (Purwadi and Satria, 2024).

Dima and Nalle (2025) emphasized that education is a key mechanism for lifting people out of poverty. He argued that for individuals to secure well-paying jobs and improve their income, they must first have access to quality education. However, in many developing countries, including Indonesia, access to higher education remains limited for the poor (Yuslin, 2024). The financial barriers to education, such as tuition fees, transportation costs, and the lack of access to quality schools, often prevent low-income families from pursuing higher levels of education (Qudsi and Ashar, 2025). This creates a cycle where the poor remain uneducated, limiting their ability to access better job opportunities and improving their overall standard of living (Rizkiawan et al., 2024).

Moreover, education plays a fundamental role in the broader development agenda, as it enhances a country’s ability to absorb modern technology and create sustainable economic growth. In Indonesia, improving access to quality education and skill development is crucial to reducing poverty (Rizkiawan et al., 2024). As human development improves, individuals are better positioned to escape poverty, thereby reducing the proportion of the population living below the poverty line. The government's focus on expanding education opportunities and improving healthcare can contribute to long-term poverty reduction, particularly in underdeveloped regions where poverty is most prevalent (Hali, 2025).

4.4 Creative Economy on the Structure of Poverty in Indonesia

The study also highlights an important finding regarding the relationship between the creative economy and poverty structure in Indonesia. While the creative economy certainly holds promise in generating jobs and creating wealth, its impact on poverty reduction has been limited (Arianto and Cahyono, 2025). This limitation arises from the uneven distribution of benefits across different segments of the population. While the creative economy can offer a wide array of employment opportunities, particularly in sectors like art, fashion, digital media, and design, these opportunities are not equally accessible to everyone, especially in rural or underserved areas (Dairoby, 2024). One of the key barriers to accessing the creative economy is the higher level of education, skills, and capital required to participate in many of its sectors. For instance, art and design industries often demand a certain level of formal education or specialized training, which may be out of reach for individuals in poverty or those living in remote regions with limited access to quality education (Nasution et al., 2025).

The creative economy's potential to reduce poverty is also constrained by the unequal distribution of resources and opportunities across regions. Urban centers like Jakarta, Bali, and Yogyakarta have seen significant growth in creative industries, benefiting from better access to infrastructure, markets, and networks. In contrast, rural areas face challenges in accessing the necessary resources to foster a thriving creative economy (Nasution et al., 2025). Despite the sector's potential to contribute to inclusive growth, the unequal access to resources and opportunities prevents the creative economy from reaching its full poverty-reducing potential (Soegiarso, 2022).

To ensure that the creative economy has a more significant and widespread impact on poverty reduction, targeted policies and initiatives are needed. The government must play a proactive role in creating an enabling environment for creative entrepreneurs, particularly in underserved regions (Iman and Wahyudi, 2023). This can be achieved by focusing on increasing access to training and skills development programs, which would equip individuals with the necessary expertise to participate in the creative economy. Additionally, greater investment in infrastructure such as digital connectivity, transportation, and local creative hubs can help reduce the barriers to entry for entrepreneurs in rural areas (Iman and Wahyudi, 2023). Providing easier access to funding, through microloans or government-backed programs, would also allow creative businesses to grow and create more jobs. Finally, fostering partnerships between local governments, educational institutions, and the private sector can ensure that creative industries have the support they need to thrive (Hayat and Sulaiman, 2023). By implementing these measures, Indonesia can unlock the full potential of the creative economy, ensuring that its benefits are more equitably shared and contribute to reducing poverty across the nation (Fadli, 2024).

4.5 Economic Development on the Structure of Poverty in Indonesia

The results of this study clearly demonstrate that economic development has a significant and negative effect on Indonesia's poverty structure, highlighting the crucial role that sustained economic development plays in poverty reduction

(Adriansyah and Prastika, 2023). As the economy grows, it creates new opportunities in various sectors, which can, in theory, reduce poverty levels (Sari and Sukma, 2023). Increased economic activity can lead to more job creation, improved access to essential services, and a higher standard of living for the population at large (Dima and Nalle, 2025). However, this effect is contingent on how equitably the benefits of economic growth are distributed across different regions and social groups. When economic benefits are shared broadly, poverty tends to decrease, as more individuals are able to access the opportunities generated by growth (Hayat and Sulaiman, 2023).

However, the analysis also sheds light on a significant challenge facing Indonesia: uneven economic development across the country. While some regions have experienced rapid economic growth, others have remained relatively stagnant, which exacerbates regional disparities (Permana, 2024). This uneven development can lead to widening income gaps, where only a small proportion of the population in certain areas benefits from economic progress, while the majority remains trapped in poverty. Such disparities between regions not only hinder the overall reduction in poverty but also contribute to a deepening of socio-economic inequalities. In some regions, economic growth has not been inclusive, and large sections of the population are left without access to the opportunities that growth provides. This situation highlights the importance of ensuring that the benefits of economic development are distributed more equally, so that no region or group is left behind.

Economic inequality remains one of the most pressing challenges to achieving sustainable development in Indonesia. As Kuncoro (2000) notes, economic development should not only focus on increasing Gross Regional Domestic Product (GDP), but also on how the growth is distributed among the population (Arianto and Cahyono, 2025). Simply increasing GDP without addressing the disparities in wealth and income can lead to growing social divisions and reinforce existing poverty structures. To address this, Indonesia needs to adopt inclusive policies that prioritize the equitable distribution of wealth. These policies should focus on improving access to education, healthcare, and social services, particularly for the poorest and most marginalized communities (Arianto and Cahyono, 2025). By ensuring that the benefits of economic growth reach all sectors of society, Indonesia can reduce inequality and create a more sustainable, inclusive economy. If growth continues to leave certain segments of the population behind, it will only perpetuate cycles of poverty and inequality, undermining long-term social and economic stability. Therefore, a comprehensive approach that tackles both economic growth and income distribution is essential for reducing poverty and promoting a fairer society in Indonesia (Arianto and Cahyono, 2025).

4.6 Economic Development Mediates the Relationship between Human Development and Indonesia's Poverty Structure

The mediation role of economic development in the relationship between human development and poverty reduction is a critical finding in this study (Chollisni et al., 2022). The results indicate that improvements in human development particularly in education, skills, and healthcare directly contribute to economic development, which then plays a key role in alleviating poverty. As human development enhances the quality of education and equips individuals with the necessary skills to enter the labor market, it fosters a more productive and competitive workforce. This, in turn, leads to higher economic growth (Purwono, 2021). As the economy grows, the creation of more job opportunities becomes a natural outcome, providing individuals with the means to escape poverty and improve their quality of life. The study highlights the importance of human development as a foundational element for driving economic growth and reducing poverty.

This mediation effect emphasizes the need for a coordinated approach to human and economic development policies. For human development to have a lasting impact on economic progress, investments in education, healthcare, and skill development must be coupled with policies that promote economic growth (Asmara et al., 2024). Governments and other key stakeholders must create an environment that not only supports human capital development but also ensures that such development is effectively channeled into productive economic activities (Hali, 2025; Asmara et al., 2024). By strengthening human capital through education and skills training, governments can facilitate the creation of high-value industries and jobs that drive sustainable growth, ultimately benefiting the entire population, particularly the most vulnerable groups (Fahmi, 2016).

In Indonesia, this integrated approach is particularly important given the country’s diverse socio-economic landscape. While some regions are experiencing rapid economic growth, others remain significantly underdeveloped. For economic growth to be truly inclusive, policies must focus on ensuring that the benefits of development reach all areas of the country, especially rural and marginalized communities (Rizkiawan et al., 2024). By aligning human development with economic development strategies, Indonesia can foster a more equitable distribution of wealth and opportunities. Strengthening human capital will not only stimulate economic growth but also ensure that the fruits of growth are shared more equally, thereby reducing poverty and promoting long-term social stability (Fahmi, 2016).

4.7 Economic Development Mediates Creative Economy's Relationship to Indonesia's Poverty Structure

Economic development plays a crucial mediating role in the relationship between the creative economy and poverty reduction in Indonesia (Dellyana et al., 2023).

While the creative economy holds significant potential to generate jobs and stimulate economic growth, its impact on poverty alleviation can only be realized if it is supported by sustained economic development (A. Ramadhan and Satria, 2025). As the creative economy grows, it creates new business opportunities and employment avenues for marginalized communities, but this potential remains largely untapped in regions that lack sufficient economic infrastructure and access to resources (A. Ramadhan and Satria, 2025). Economic development provides the necessary environment through investments in infrastructure, education, and technology that allows the creative economy to thrive. Without such a foundation, the creative sectors cannot reach their full potential, limiting their ability to reduce poverty and contribute to the overall economic prosperity of the country (A. Ramadhan and Satria, 2025).

To maximize the impact of the creative economy on poverty reduction, strategic government policies are essential (Fourqoniah et al., 2024). These policies should focus on improving access to resources for creative entrepreneurs, particularly in underserved regions (Fadilla et al., 2024). Many creative businesses face barriers to financing, technology, and market access, which prevent them from scaling and reaching broader audiences. The government must implement policies that provide financial support, such as grants and low-interest loans, and invest in digital infrastructure to enable creative industries to expand beyond local markets (Dima and Nalle, 2025). By enhancing market access and creating an enabling environment, the government can help creative businesses grow, generate more employment, and ultimately improve the welfare of individuals, particularly those in marginalized communities (Fadilla et al., 2024).

The development of human capital is crucial for the success of the creative economy in reducing poverty. Education and skill development in creative fields are necessary to equip the workforce with the expertise required for the sector’s growth (A. Ramadhan and Satria, 2025). By investing in creative education and training programs, particularly in rural and underserved areas, the government can ensure that individuals have the skills needed to thrive in the creative industries (Dellyana et al., 2023). Additionally, partnerships between educational institutions and creative businesses can help align training programs with industry needs, ensuring that graduates are well-prepared to enter the workforce. Through these efforts, the creative economy can become a key driver of inclusive economic development, offering new opportunities for individuals across Indonesia to escape poverty and improve their livelihoods (Susanti and Silvia, 2024).

5. Conclusion

The significant role of human development and the creative economy in driving economic growth and reducing poverty in Indonesia, with economic development serving as a crucial mediator between these factors. The findings underscore the importance of inclusive policies that enhance human capital and support the growth of creative industries, especially in underdeveloped regions, to ensure equitable economic development. For future research, it is recommended to explore the specific regional variations in the impact of the creative economy, considering the diverse challenges and opportunities across Indonesia. The implications of this research suggest that policy-makers should focus on creating an enabling environment for creative entrepreneurship and invest in education and infrastructure to foster sustainable and inclusive economic growth.

References

Adriansyah, M. A., & Prastika, N. D. (2023). We are Team: Effectiveness of Team Building Training to Improve Cohesiveness. *International Journal of Professional Business Review*, *8*(5), 85. Retrieved from https://doi.org/10.26668/businessreview/2023.v8i5.1898.

Arianto, E., & Cahyono, H. (2025). The effect of human development index and unemployment on poverty in Indonesia from 2018 to 2023. *International Journal of Financial, Accounting, and Management*, *8*(2), 76–88. Retrieved from https://doi.org/10.62017/finance.v2i4.83.

Asmara, G., Asmara, G. D., & Saleh, R. (2024). The effect of economic growth on the human development index in Indonesia. *Journal of Economics Research and Social Sciences*, *8*(2), 267–276. Retrieved from https://doi.org/10.18196/jerss.v8i2.22627.

Burhanudin, B. (2023). Contribution of the creative economy sector to economic growth and labor absorption in Pangkalpinang, Indonesia. *ICTMT Journal*, *8*(2), 239–252. Retrieved from https://doi.org/10.23969/jrie.v4i3.148.

Chollisni, A., Syahrani, S., Dewi, S., Utama, A., & Anas, M. (2022). The concept of creative economy development in post-COVID-19 pandemic Indonesia: Strategy and public policy management study. *Linguistics and Culture Review*, *6*(4), 312–329. Retrieved from https://doi.org/10.21744/lingcure.v6nS1.2065.

Dairoby, A. (2024). Efforts to improve Indonesia's creative economy through policy innovation and entrepreneurship. *ProIROFONIC Journal*, *8*(2), 104–118. Retrieved from https://doi.org/10.29210/020232227.

Dellyana, A., Susanti, D., & Silvia, H. (2023). Digital innovative governance of the Indonesian creative economy. *Sustainability*, *15*(23), 162–173. Retrieved from https://doi.org/10.3390/su152316234.

Digdowiseiso, K. (2023). The development of the creative economy in Indonesia's post-pandemic development. *Journal IICET*, *5*(1), 45–59. Retrieved from https://doi.org/10.29210/020232227.

Dima, E., & Nalle, F. (2025). Economic growth dynamics in Kupang City: The role of poverty, human development index, and inflation. *International Journal of Financial, Accounting, and Management*, *7*(1), 43–60. Retrieved from https://doi.org/10.35912/ijfam.v7i1.2712.

Fadilla, M., Hariyanti, D., & Putri, F. (2024). Contribution of creative economy and tourism to inclusive economic development in Indonesia. *Jurnal Riset Ilmu Ekonomi*, *4*(3), 181–198. Retrieved from https://doi.org/10.23969/jrie.v4i3.148.

Fadli, K. (2024). Creative economy as a catalyst for sustainable economic growth in Indonesia. *Journal of Economic and Social Policy*, *11*(2), 213–229. Retrieved from https://doi.org/10.23969/jrie.v4i3.148.

Fahmi, F. (2016). The location of creative industries in a developing country: Indonesia case. *ScienceDirect*, *1*(4), 1–13. Retrieved from https://doi.org/10.1177/0042098015620529.

Fourqoniah, F., Prakasa, Y., & Bharata, W. (2024). Understanding Intellectual Capital in MSMEs Knowledge Management: Bibliometric Analysis and Systematic Literature Review. *In GMPI Conference Series*, 25–33. Retrieved from https://doi.org/10.53889/gmpics.v3.418.

Gahari, R. (2024). The impact of foreign investment, human development index, labor, and poverty levels on economic growth in Indonesia. *Journal of Economic and Financial Studies*, *10*(1), 85–100. Retrieved from https://doi.org/10.53088/jerps.v4i2.1034.

Goh, L., Trinugroho, I., Law, S., & Rusdi, D. (2024). Institutional quality, FDI inflows, human capital development, and poverty: a case of Indonesia. *International Journal of Social Economics*, *51*(11), 1450–1467. Retrieved from https://doi.org/10.1108/IJSE-09-2023-0733?urlappend=%3Futm_source%3Dresearchgate.net%26medium%3Darticle.

Hali, A. (2025). The role of creative economy in national development and its impact on poverty reduction. *Indonesian Research Journal on Education*, *13*(1), 34–48. Retrieved from https://doi.org/10.21776/ub.JIAE.009.02.4

Hayat, R., & Sulaiman, R. (2023). Economic growth and poverty alleviation in Indonesia: An integrated approach using creative economy metrics. *Southeast Asian Economic Development Review*, *5*(1), 88–103. Retrieved from https://doi.org/10.29210/020231783.

Hutama, S. (2024). Creative industries and poverty reduction in Indonesia: The impact of the digital economy. *International Journal of Sustainable Development*, *19*(2), 82–98. Retrieved from https://doi.org/10.2991/978-2-494069-77-0_19.

Iman, D., & Wahyudi, A. (2023). The economic role of creative industries in developing countries: Indonesia's perspective. *World Development Economics Journal*, *15*(2), 233–249. Retrieved from https://doi.org/10.52783/cana.v32.4575.

Komariyah, S. (2023). Impact of poverty, economic growth, and information and communication technology on human development in Indonesia. *Jurnal Perbanas*, *23*(2), 112–130. Retrieved from https://doi.org/10.14414/jebav.v26i1.2939.

Mahrinasari, T., & Pratama, I. (2024). Local wisdom and the government's role in strengthening the creative economy and sustainable competitive advantage. *Heliyon*, *1*(1), 1–13. Retrieved from https://doi.org/10.1016/j.heliyon.2024.e31133.

Murtadi, M., & Hadi, S. (2024). Measuring creative economy in Indonesia: Issues and challenges in data collection. *ResearchGate*, *1*(1), 1–13.

Nasution, L., Sari, R., & Harianto, A. (2025). The influence of human development index on economic growth, unemployment, and poverty reduction in Bener Meriah Regency: A path analysis approach. *ICEEGLOF Proceedings*, *7*(2), 215–227. Retrieved from https://proceeding.pancabudi.ac.id/index.php/ICEEGLOF/article/view/409.

Permana, R. (2024). Creative economy and poverty alleviation in rural Indonesia: A new strategic approach. *ProIROFONIC Journal*, *9*(3), 77–88. Retrieved from https://doi.org/10.54373/ifijeb.v4i5.2189.

Purwadi, W., & Satria, M. (2024). Mapping of creative economy commodities sourced from local wisdom. *PJLSS Journal*, *22*(2), 77–89.

Purwono, R. (2021). Poverty dynamics in Indonesia: Empirical evidence from the island of Sumatra. *ScienceDirect*, *1*(1), 1–14. Retrieved from https://doi.org/10.57239/PJLSS-2024-22.2.00773.

Putra, T. (2024). Human development and its relation to poverty in developing countries: An Indonesian case. *IJAFIBS Journal*, *6*(1), 34–48.

Qudsi, H., & Ashar, K. (2025). An analysis of the effect of economic growth, education, and health on poverty in East Java Province during the 2018-2023 period. *JDESS (Journal of Development Economics & Social Studies)*, *1*(1), 11–29.

Rahayu, E. (2025). Human development and the creative economy in the context of poverty alleviation in Indonesia: A review. *Economic Journal of Southeast Asia*, *13*(1), 118–132. Retrieved from https://doi.org/10.21776/jdess.2025.04.1.19.

Ramadhan, A., & Satria, M. (2025). The role of human development quality and investment in promoting sustainable economic growth in Indonesia. Retrieved from *JDESS Journal*, *1*(1), 1–12.

Ramadhan, M. (2025). The role of human development quality and investment in reducing poverty in Indonesia. Retrieved from *Journal of Economic Development Studies*, *1*(1), 1–13.

Rizkiawan, R., Sites, A., Hasid, Z., & Mired, M. (2024). The influence of human development and creative economy on economic development and poverty structure in Indonesia. *Iranian Economic Review*, *1*(1), 1–13. Retrieved from https://doi.org/10.22059/ier.2024.369080.1007874.

Sari, N., & Sukma, R. (2023). The relationship between human development index and economic growth in Southeast Asia: The role of creative industries in Indonesia. *Journal of Asia Pacific Business Innovation*, *12*(1), 210–223. Retrieved from https://doi.org/10.18196/jerss.v8i2.22627.

Soegiarso, B. (2022). Economic growth, poverty alleviation, and Indonesia's creative economy sector: A comprehensive analysis. *Asian Economic Policy Review*, *10*(4), 301–314. Retrieved from https://doi.org/10.20525/ijrbs.v12i6.2833.

Susanti, D., & Silvia, H. (2024). Integrating creative economy in the national sustainable development plan. *YUME: Journal of Management*, *7*(3), 1655–1664. Retrieved from https://doi.org/10.2298/SPAT231219004M.

Widodo, W. (2023). Indonesian creative economy performance in 2015–2020: Government policy impact. *Journal of Economic and Business Analysis*, *6*(1), 155–173. Retrieved from https://doi.org/10.26618/jeb.v20i1.11152.

Yuslin, H. (2024). Creative industry development as a local economic development effort. *Journal of Islamic Economics Lariba*, *7*(1), 67–76. Retrieved from https://doi.org/10.1016/j.sbspro.2016.05.370.

Cite this article: Rizkiawan, Amalia, S. A., & Mire, M. S. (2025). Unlocking Growth: The Impact of Human Development and the Creative Economy on Economic Prosperity and Poverty Reduction in Indonesia. *Iranian Economic Review, 29*(4), 1497-1525.

Iranian Economic Review, 2025, 29(4), 1526-1552
DOI: https://doi.org/10.22059/ier.2025.400115.1008285

RESEARCH PAPER

Exchange Rate and Inflation in Iran: Cause or Consequence

Teymur Rahmani[*,a], **Mehdi Darabi**[a], **Hossein Mohammad Khanlou**[a]

a. Faculty of Economics, University of Tehran, Tehran, Iran.
* Corresponding author.

Received: 05 August 2025, Revised: 20 October 2025, Accepted: 23 November 2025, Published: 15 December 2025
Publisher: The University of Tehran Press.

Abstract

The present study addresses a contentious issue within the theoretical and empirical discourse on exchange rate and inflation. While the monetary theory posits that the long-term drivers of exchange rate appreciation and the general price level are the growth of broad money, influenced by fiscal dominance, some researchers argue that the exchange rate serves as the cause of price level changes and even broad money growth. Others contend that, although the long-term determinant of inflation is broad money growth, exchange rate shocks play a significant role in inflationary surges. This study focuses on examining whether what may be interpreted as semi-exogenous exchange rate shocks are the drivers of inflationary surges. To this end, the impact of the deviation of the exchange rate from its filtered value, and also from its value derived from a revised monetary theory, is estimated as an exogenous exchange rate shock on the deviation of inflation from its filtered value. Empirical results for the period 1984–2023 indicate that the deviation of the exchange rate from its filtered value has a significant effect on the deviation of inflation from its filtered value, whereas the deviation of the exchange rate from the value based on the revised monetary theory does not exhibit a significant impact. Consequently, these findings cast doubt on the notion that exogenous exchange rate deviations are the primary drivers of inflationary surges in Iran.

Keywords: Exchange Rate, Inflation, Inflationary Surges, Monetary Model, Oil Rents.
JEL Classification: E31, E52, F31.

1. Introduction

The Iranian economy has undergone a significant shift toward high and double-digit inflation since approximately 1971, experiencing one of the most persistent high-inflation episodes globally. Over this period, only six years have recorded single-digit inflation, three of which were near 9 percent. Notably, there has been no sustained indication of inflation declining over time. As many economists have emphasized, the dynamics of inflation are far too complex to identify, predict, or control with certainty. Inflation has persisted across periods of abundant oil revenues and times of restricted oil income, though it has proven more challenging to manage during the latter. A key observation is that, since 1971, broad money growth has remained consistently high, significantly exceeding real economic growth. Moreover, trend extraction methods reveal that inflation exhibits an upward trend independent of the method of filtering, mirroring the upward trajectory of broad money growth. However, the relationship between broad money growth and inflation is not a straightforward process wherein the central bank determines money supply growth, which then stimulates aggregate demand through conventional channels, subsequently driving up prices. Instead, a substantial portion of broad money growth stems from what is termed fiscal dominance, or more precisely in the Iranian context, "Generalized Fiscal Dominance". This dominance manifests as heightened demand for goods and services, compelling the central bank—within the prevailing political economy—to accommodate this demand, ultimately validating price increases.

This study focuses not on a detailed exposition of inflation dynamics across various periods but on the relationship between exchange rate and inflation. It should be insisted that this study is not about the determinants of inflation, is not about the long run behavior of inflation, and is not about exchange rate pass-through. The study somehow tests the contention that exchange rate surges are the main determinant of deviation of inflation from its trend. Among some Iranian economists, there exists a claim that not only do exchange rate surges contribute to inflationary episodes, but also the entirety of inflation may be attributed to exchange rate increases. Occasionally, conspiracy theories emerge, suggesting that governments deliberately raise exchange rate—or at least acquiesce to such increases—to benefit specific interest groups, thereby shaping inflation. While no economic theory or proposition regarding the exchange rate-inflation nexus is flawless, some models are deemed more plausible, necessitating continuous refinement. Nevertheless, the accumulation of data and detailed trend analysis can provide analysts with a degree of confidence that, in Iran, a singular underlying force—generalized fiscal dominance—drives both inflation and exchange rate appreciation, ultimately reflected in high broad money growth, although this issue is not addressed here. However, researchers may arrive at divergent conclusions depending on the period studied and statistical methods employed, particularly if influenced by preconceived judgments.

Focusing on the underlying force behind both inflation and exchange rate movements in the long run allows for a relatively preferred analytical framework. The simple narrative is that generalized fiscal dominance generates demand for goods and services far exceeding the economy's productive capacity or real growth. As Iran's economy relies on natural resource rents, these rents have enabled policymakers to maintain inflation well below the gap between broad money growth and economic growth at times, misleading some analysts into underestimating the role of money growth in driving inflation. This reliance on resource rents has cast doubt on the validity of monetary theory for both inflation and exchange rate, particularly in the short term, though its relevance holds in the long run. During periods when exogenous factors—such as declining oil prices or sanctions—curtail access to these rents, exchange rate and inflationary surges emerge, leading many analysts to conclude that exchange rate shocks significantly influence or even primarily cause inflationary spikes. Yet, restricted access to resource rents facilitates price corrections for goods, services, and exchange rate based on their fundamental drivers. Given the asset-like nature of currency and the absence of price stickiness, exchange rate surges occur more rapidly and precede inflationary jumps, prompting econometric studies to suggest that exchange rate shocks cause inflationary surges.

This study endeavors to provide an analysis grounded in monetary theory, accounting for Iran's resource-rent-based economy, to explain the formation and realization of inflation. It also derives an exchange rate based on the monetary model, using deviations of the unofficial market exchange rate from this model-derived rate as an exogenous exchange rate shock. The impact of this shock on deviations of inflation from its trend is then empirically examined. The second section reviews theoretical analyses of inflation and briefly surveys empirical literature. The third section discusses the theoretical determination of exchange rates, focusing on the inflation-exchange rate nexus. The fourth section analyzes Iranian economic data, while the fifth presents empirical estimation and analysis. The study concludes with a summary and findings. Given that the primary aim is to clarify the exchange rate-inflation relationship, the paper is rooted in existing theoretical literature without intending to advance new theory.

2. Review of Theoretical Analysis of Inflation

It is a fundamental principle that no price increases spontaneously, regardless of whether the market structure is competitive or monopolistic. In competitive markets, the forces of supply and demand—beyond the control of any single buyer or seller and reflected in shifts of supply and demand curves—underlie price increases. In monopolistic structures, a monopolist adjusts prices based on cost-benefit considerations, provided there are changes in demand or cost structures. If inflation represents the average growth rate of goods and services prices, and if, during periods of inflation—especially high inflation—nearly all prices rise simultaneously and this trend persists over time, while random shifts in supply, demand, or firm costs leading to sustained price increases across all goods and services are highly improbable, it can be inferred that an identifiable phenomenon drives these concurrent structural changes in demand and supply. Macroeconomic theory has approached this issue from the outset of inflation's emergence as a topic with this perspective.

In identifying this overarching factor behind rising goods and services prices, economic analysis—both theoretical and data-driven—has demonstrated that no general price increase can occur or persist without being accompanied by the growth of monetary variables, such as broad money. This conclusion holds irrespective of the causal role assigned to any specific variable. Consider a scenario where consumers decide to increase their expenditures, a key component of aggregate demand, thereby pressuring prices, without any other changes, including monetary variable growth. The persistence of such behavior would imply lower savings and future welfare, rendering sustained price increases impossible. Similarly, if firms boost investment—another component of aggregate demand—pressuring goods and services prices without altering other variables, including monetary ones, the absence of increased savings would raise interest rates, reducing net investment returns and halting this behavior. Moreover, if the demand for goods and services spurred by this investment fails to materialize, it diminishes investment returns, further obstructing continued investment and price pressure. Suppose government spending, another aggregate demand component, rises, increasing demand and prices without changes in other variables, including monetary ones. This would necessitate financing the deficit, pushing up interest rates and curbing other demand components, thus preventing sustained demand growth from government spending and subsequent inflation. Finally, if net exports—the last aggregate demand component—increase, driving demand and price pressures without altering other variables, including monetary ones, the likelihood of sustained net export growth is low. Persistent net export increases would lead to balance-of-payments surpluses, pressuring the exchange rate to depreciate and raising the relative price of domestic goods, which would undermine further net export growth. Thus, no mechanism for sustained aggregate demand growth capable of driving prolonged price increases exists without accompanying monetary variables growth.

Turning to the supply side and production cost increases, consider a wage hike pressuring goods and services prices without changes in other variables, including monetary ones. Such increases would lead to layoffs, gradually swelling unemployment and creating a significant barrier to further wage demands, rendering sustained price growth unfeasible. This is why Davidson and Weintraub (1973) post-Keynesian cost-push analysis—the most coherent framework for cost-driven inflation—only permits price increases from wage hikes when accompanied by monetary variables growth. Now, imagine a key input price, such as oil, rises, increasing production costs and pressuring prices without changes in other variables, including monetary ones. While sustaining this for decades is implausible, even if possible, production methods would adapt, finding substitutes and preventing continuous oil price increases, thus halting inflation from this source—though this is largely irrelevant to Iran's economy. Evidently, exogenous production cost changes, while capable of causing inflationary shocks and playing a significant short-term role in explaining inflation, cannot sustain price increases or inflation over time. In Iran, where wage increases in the formal sector do not lead to unemployment, this is because wages typically respond to inflation rather than initiate it, and subsidized bank loans and other production factors—essentially monetary variables growth—facilitate this.

Based on the above, various factors can temporarily pressure goods and services prices and act as inflation drivers, but none of those mentioned can sustain this capacity over long periods, especially beyond five decades. Moreover, it is highly improbable—or, in statistical terms, nearly impossible—for a country to face a sequence of these events without monetary variables growth, enabling persistent inflation. Even repeated such episodes, eroding the purchasing power of monetary variables, would negate this possibility. Thus, a proposition for inflation emerges: "Sustained inflation is only possible if accompanied by monetary variables growth, even if the initial price increase is not driven by such growth." This perspective explains why mainstream macroeconomic texts, when examining long-run (steady-state) behavior, attribute price growth or inflation to money supply growth (in Iran, broad money growth), requiring little further discussion (e.g., Kurlat, 2020; Walsh, 2017). Attributing inflation to money supply growth may serve as a simplification, avoiding details, implying that only with money supply growth can price increases and inflation persist beyond a transient nature. This view does not suggest that money supply changes are entirely exogenous or fully controlled by monetary policymakers. The fiscal dominance literature (e.g., Sargent & Wallace, 1981), originally developed for advanced economies like the U.S. rather than developing ones, highlights how money supply growth becomes endogenously inevitable. Similarly, the fiscal theory of price level determination, (see for example Cochrane (2023) and Woodford (1995, 1998)), does not imply that inflation can occur or persist without money supply growth; rather, it explains price levels and inflation as contingent on the government budget constraint alongside money market equilibrium conditions. Consequently, no economic analysis asserts that sustained price increases are possible without money supply growth.

Excluding temporary inflation fluctuations, which may stem from various factors including supply-side shocks—irrelevant to Iran's persistent inflation problem—we can address the dominant theory explaining inflation in Iran, offering a theoretical framework not unique to the country. This dominant theory, known in macroeconomic literature as fiscal dominance, is better termed generalized fiscal dominance for Iran. This concept is consistent with monetary explanations of inflation, rooted in modern macroeconomic theory, and aligns with empirical data.

What does the generalized fiscal dominance mean? Its simplest and most recognized form occurs when the government runs a budget deficit, financed through bank borrowing, ultimately from the central bank. Another manifestation involves government-owned companies and institutions, whose revenues and expenditures are not reflected in the public budget, incurring deficits financed via bank borrowing and the central bank. A further example is when the government mandates banks to provide low-cost loans for support programs unrelated to the public budget. Additionally, generalized fiscal dominance occurs when banks or credit institutions, technically insolvent under accounting principles or commercial law, are prevented from bankruptcy, necessitating money creation to sustain operations. In essence, any direct or indirect government authorization of expenditure reliant on money creation constitutes generalized fiscal dominance. Such spending directives pressure goods and services prices and the exchange rate, naturally driving price increases. Given Iran's reliance on natural resource rents and foreign exchange earnings unlinked to goods and services production, these revenues have enabled exchange rate stabilization and mitigated severe price pressures during abundant periods, though even then, inflation persisted. Reliance on resource rent-derived foreign exchange activates a mechanism pressuring the fundamental exchange rate, rendering long-term control of the exchange rate and inflation via these revenues unfeasible. This mechanism first weakens the tradable sector, heightening import reliance to manage inflation. For instance, if $40 billion initially sufficed for relative exchange rate control, progressively larger sums become necessary, which is unsustainable. Second, it boosts the non-tradable sector, leading to sharp price increases, exemplified by the significant rise in housing prices. Stabilizing the exchange rate and rising domestic housing costs make property purchases abroad relatively cheaper for Iranians, accelerating capital flight—evident in the widespread migration to California in the 1970s and Canada in the 2000s. This capital outflow further pressures the exchange rate, increasing the foreign exchange needed for control, which is naturally unattainable. Once a fundamental force for exchange rate appreciation emerges, any disruption in exports or foreign exchange earnings undermines exchange rate and inflation control. Given the currency's asset-like nature and lack of price stickiness in liquid asset markets, it responds rapidly, triggering exchange rate surges. With diminished capacity to control inflation through foreign exchange, prices of goods and services—especially in the tradable sector—begin to rise. Due to price stickiness in some goods and services, inflation lags behind exchange rate surges, leading to the perception that exchange rate jumps cause inflationary spikes. However, the core issue is that reduced foreign exchange earnings eliminate the ability to sustain price control, prompting price adjustments toward fundamental levels. The tradable sector's quicker response to exchange rate surges stems from this dynamic. Rahmani et al (2023) demonstrate that exchange rate surges increase inflationary inequality, largely due to significant food price rises—key tradable goods with a high share in lower-income deciles' consumption baskets—highlighting this phenomenon.

It should be noted that the causal relationship between inflation and exchange rates, both originating from a common source, does not negate the well-established exchange rate pass-through (ERPT) effect in the literature. ERPT remains relevant whether inflationary forces or exchange rate changes are deemed the fundamental driver. In other words, ERPT focuses on the statistical relationship between exchange rate changes and inflation, not on theoretically tracing the cause of exchange rate shifts. Numerous studies on ERPT and inflation exist, requiring no comprehensive review. For instance, Ha et al. (2020) examined ERPT's impact on consumer prices, emphasizing the source of exchange rate changes across 50 countries, finding that monetary policy shocks exhibit stronger pass-through than other domestic shocks. They also noted that ERPT is lower in countries with credible floating exchange rate and inflation-targeting regimes, suggesting that shock nature must be considered—a statistical take on ERPT. Similarly, Kwon and Shin (2023) explored the nonlinear ERPT using survey-based inflation expectations in Korea under varying monetary policy credibility, finding stronger short-term pass-through in less credible regimes, implying that monetary policy credibility is crucial for controlling inflation and price stability amid exchange rate changes. This study focuses on pass-through intensity, not the underlying cause of exchange rate shifts. Falckadouro (2024), focusing on Canada—a commodity-exporting economy—identified a contrasting ERPT effect. While standard analysis suggests exchange rate appreciation increases domestic prices, Falckadourofound that positive commodity demand shocks appreciate the domestic currency, reducing the exchange rate, yet this demand surge pressures goods and services prices. The study concludes that ERPT depends on shock origin and economic structure. Nasir et al. (2020), using monthly data from 1999–2018 for the Czech Republic—the first developing country to adopt inflation targeting—analyzed ERPT's impact on inflation expectations, showing its significant influence, though expectations are heavily shaped by past and current inflation, suggesting adaptive expectations. This study, despite considering other factors, underscores ERPT's role, focusing on statistical relationships. Anderl and Caporale (2023) investigated nonlinear ERPT in five inflation-targeting and three non-targeting countries from 1993–2021 using monthly data, finding stronger pass-through in nonlinear models and during high future inflation expectations, concluding that anchoring expectations via monetary policy reduces ERPT.

In Iran, numerous studies have explored the inflation-exchange rate nexus, including ERPT. For example, Ebrahimi and Madanizadeh (2016) examined ERPT in Iran over the time period 1992–2014, estimating it at 30–40 percent, finding that trade openness increases ERPT while reduced inflation and exchange rate volatility decrease it, affirming monetary policy's role in inflation control. Barakchian et al. (2021) analyzed the causal relationship between exchange rates and the consumer price index from 1991–2020, showing that during currency crises, exchange rates significantly drive price dynamics in both short and long terms, with causality from exchange rates to prices confirmed. They also noted weakened ERPT during oil revenue booms, with surges re-emerging during exchange rate shocks. Sadat Hoseyni et al. (2018) found ERPT depends on the inflationary environment, using quarterly data from 1988–2015 and a smooth transition regression model, concluding that pass-through to import price indices is higher in high-inflation regimes.

In summary, empirical studies yield varied results on the inflation-exchange rate relationship, with most focusing on ERPT—a statistical linkage. A notable number of studies highlight the importance of monetary policy and its credibility in determining ERPT magnitude.

3. Empirical Evidence on the Monetary Model of Exchange Rate

This section examines the impact of oil rents on Iran's commodity and asset markets, as well as those of other oil-exporting countries. The objective is to empirically demonstrate how oil rents mitigate the inflationary effects of money supply growth. To achieve this, based on the monetary theory of exchange rates, the variables of inflation and money supply growth are analyzed within the framework of the purchasing power parity (PPP) exchange rate and the monetary model of exchange rate determination. The primary rationale for this approach is the critical role of the exchange rate channel in the relationship between money supply growth and inflation, as natural resource rents from oil exports influence inflation through their effect on exchange rates and, consequently, imports.

3.1 Monetary Theory and Exchange Rates

This section examines the long-term relationship among exchange rates, the general price level, and broad money in Iran, drawing comparisons with other oil-exporting countries. To better understand the interplay of these three nominal variables, it is essential to first align them using the "exchange rate determination" literature. For this purpose, the relative Purchasing Power Parity (PPP) relationship is employed to compare the trend of the general price level with that of the exchange rate, while the monetary model of exchange rate determination is used to align the trend of broad money with the exchange rate.

Following the post-World War I reevaluation of national currencies to restore the gold standard, Cassel (1921; 1922) proposed PPP as a practical solution (Rogoff, 1996). This study adopts the relative PPP framework, utilizing the Consumer Price Index (CPI) as the price index (P), as depicted in Equation (1).

$$E_t = \frac{P_t/P_0}{P_t^*/P_0^*}E_0 = \frac{CPI_t/CPI_0}{CPI_t^*/CPI_0^*}E_0 \tag{1}$$

Here, E_t represents the exchange rate, with the asterisk (*) denoting the foreign country (the United States) and the subscript 0 indicating base-year values. Equation (1) suggests that the gross growth of the exchange rate relative to the base year equals the ratio of gross price level growth in the domestic country to that in the foreign country. In a monetary context, PPP is considered an equilibrium relationship, though it was initially treated as a behavioral one in early empirical applications.

The monetary model of exchange rate determination extends the PPP framework. It treats PPP as an equilibrium condition, positing that both inflation and exchange rate growth result from excess money supply growth over output growth domestically relative to abroad. If broad money growth and output growth proxy for aggregate demand and supply growth, respectively, the monetary model attributes exchange rate and inflation growth to excess aggregate demand over aggregate supply. Simply put, as shown in Equation (2), the monetary model replaces CPI in Equation (1) with the ratio M⁄Y (broad money to real GDP).

$$E_t = E_0 \times \left(\frac{M_t/Y_t}{M_t^*/Y_t^*}\right) \Big/ \left(\frac{M_0/Y_0}{M_0^*/Y_0^*}\right) \qquad (2)$$

Equation (2) represents the baseline monetary model (see Mark, 1995; Mark and Sul, 2001; Rapach and Wohar, 2002), derived from Lucas (1982) general equilibrium models and Obstfeld and Rogoff (1995) frameworks (Rapach and Wohar, 2002). This equation is used to analyze the long-term relationship between exchange rates, broad money, and output. Empirical literature supports the reliability of the PPP relationship over long horizons, particularly in high-inflation countries where prices adjust more rapidly, shortening the long-run period (Caves et al., 2007). Darabi et al. (2024), in an empirical study of 153 countries (excluding those without World Bank data) from 1980 to 2021, confirmed the high accuracy of both PPP and the baseline monetary model.

3.2 Trends in Exchange Rates, PPP-Based Exchange Rates, and Monetary Model Exchange Rates in Iran

As previously noted, this study examines the long-term trends of exchange rates, the general price level, and broad money by converting the latter two into exchange rate equivalents using the PPP relationship and the monetary model. Accordingly, the PPP-based exchange rate trend represents the general price level trend, while the monetary model exchange rate trend reflects the broad money trend (net of output).

From 1984 to 2000, real oil prices remained stable. As shown in **Error! Reference source not found.**, the real value of Iran's oil exports during this period stabilized at approximately $35 billion. The Figure 1 illustrates that all three trends—exchange rate, PPP-based exchange rate, and monetary model exchange rate—align closely. This convergence indicates that the growth trends of exchange rates, inflation, and broad money are proportionate. Figure 2 reveals that this pattern is not unique to Iran, having been observed in 26 major oil-exporting countries. With the global oil price surge in the 2000s, the real value of oil exports rose, peaking in 2011 before declining in 2012. During this period, divergence emerged among the three exchange rate measures. Broad money growth significantly outpaced inflation, which in turn exceeded exchange rate growth. If broad money growth proxies aggregate demand growth, this suggests that, despite excess aggregate demand over supply (averaging about 20%), exchange rates and price levels did not grow proportionately. This discrepancy arose because excess demand was met through oil revenue-driven imports. The concept of rent is used here, as oil revenue growth resulted from global price increases rather than value-added from labor or capital (see World Bank (2010)). Figure 2 indicates that other oil-exporting countries experienced similar patterns, with divergence intensifying in the 2000s, corresponding to Iran's 1980s.

As depicted in Figures 1 and Figure 2, following the oil export decline, the three trends converged again. The monetary model exchange rate remaining above the other two reflects the persistent rise in real oil export values since the 1990s. The divergence during 2014–2017, however, was not solely due to oil rents; high real deposit interest rates also contributed significantly to this gap (Rogoff, 1996), cites interest rate changes as a factor disrupting PPP relationships.

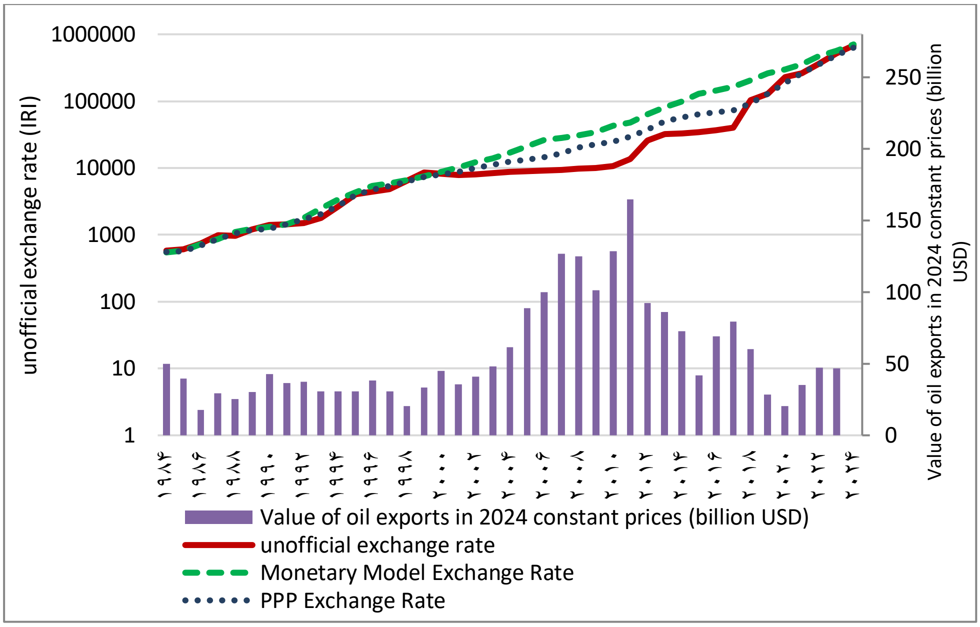


Figure 1. Annual Trends of Unofficial Exchange Rate, Monetary Model Exchange Rate, PPP-Based Exchange Rate, and Real Value of Oil Exports in Iran
Source: Research finding.

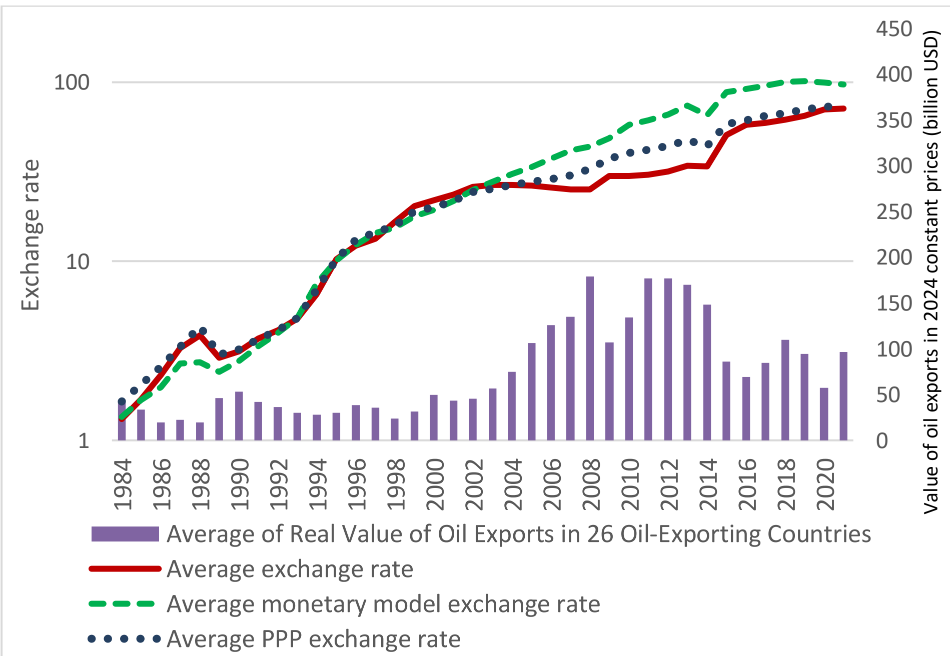


Figure 2. Annual Trends of Average Exchange Rate, Average Monetary Model Exchange Rate, Average PPP-Based Exchange Rate, and Average Real Value of Oil Exports in 26 Oil-Exporting Countries (1984–2021). A weighted geometric mean is applied, with each country's share based on production volume. 1971 is selected as the base year.

Source: Research finding.

Divergence between the exchange rate and PPP-based exchange rate reflects a change in the real exchange rate level, with literature attributing this to shifts in the terms of trade (TOT) due to changes in real oil export values (Amano and Van Norden, 1998a; 1998b; Caves et al., 2007). As shown in Figure 3, Iran's real exchange rate trend inversely mirrors the real value of oil exports. The disconnection between these trends during 2014–2017 resulted from high real deposit interest rates.

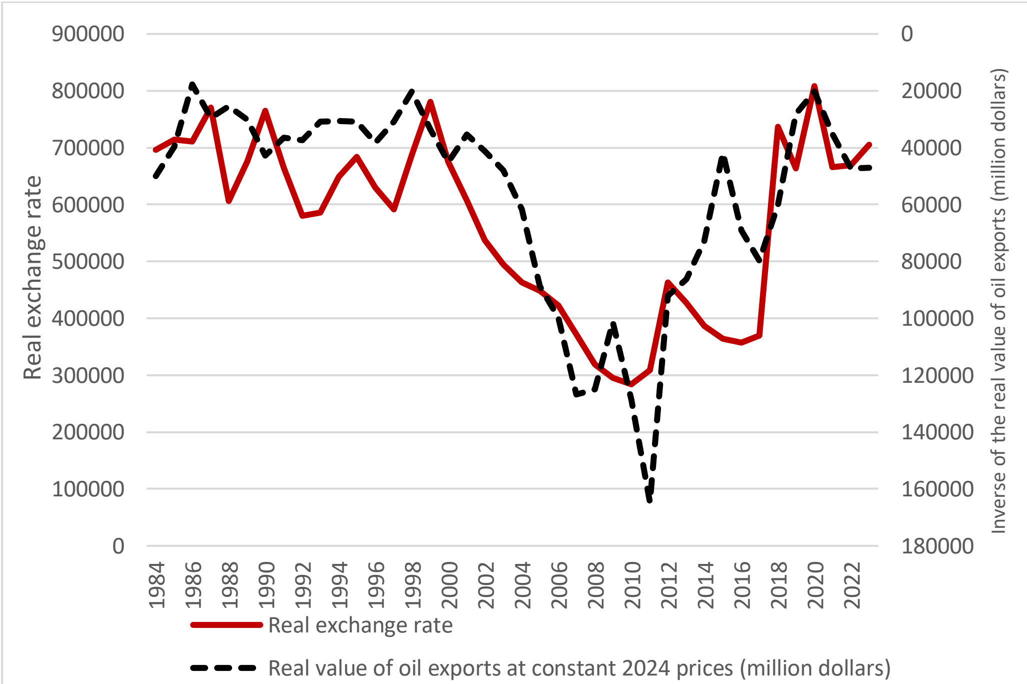


Figure 3. Real Exchange Rate at Constant 2024 Prices and Inverse of Real Value of Oil Exports at Constant 2024 Prices. The real exchange rate is calculated as: $\boldsymbol{Real\ Exchange\ Rate_t = Nomianl\ Exchange\ Rate_t \times \frac{CPI_t^{us}}{CPI_t^{IR}} \times \frac{CPI_{2024}^{IR}}{CPI_{2024}^{US}}}$.

Source: Research finding.

3.3 Revised Monetary Model Incorporating Oil Rents

A key limitation of the monetary model of exchange rate determination is its failure to account for oil rents and supply shocks related to oil. Oil rents exert a stronger influence than other natural or non-natural rents—typically distributed more evenly across countries—due to their highly uneven distribution and wide price volatility. Consequently, Darabi et al. (2024) revised the monetary model in Equation (2). Figure 4 illustrates the trends of the unofficial exchange rate, monetary model exchange rate, revised monetary model exchange rate, and real oil export values for Iran, suggesting that the revised model substantially addresses the explanatory shortcomings of the original monetary model. Figure 5 presents similar findings for other oil-exporting countries. The disconnection between the monetary model exchange rate and the unofficial exchange rate during 2014–2016 is attributable to high real deposit interest rates. As Darabi et al. (2024) demonstrates, the exchange rate maintains a significant long-term relationship with the right-hand side of Equation (2) (baseline monetary model), oil rents, and interest rates. Thus, exchange rate surges, particularly in 2012, 2018, and 2020, stem from fundamental factors—broad money, output, interest rates, and oil exports—and the monetary model, as a structural framework based on economic fundamentals, effectively explains these dynamics.

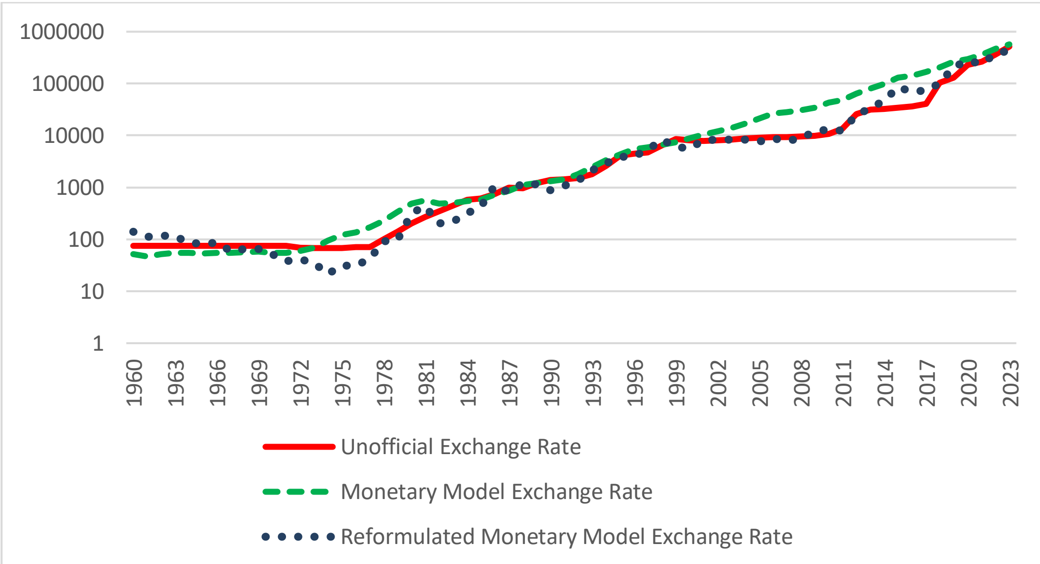


Figure 4. Unofficial Exchange Rate, Monetary Model Exchange Rate, and Reformulated Monetary Model Exchange Rate in Iran, 1960–2023.
Source: Darabi et al. (2024).

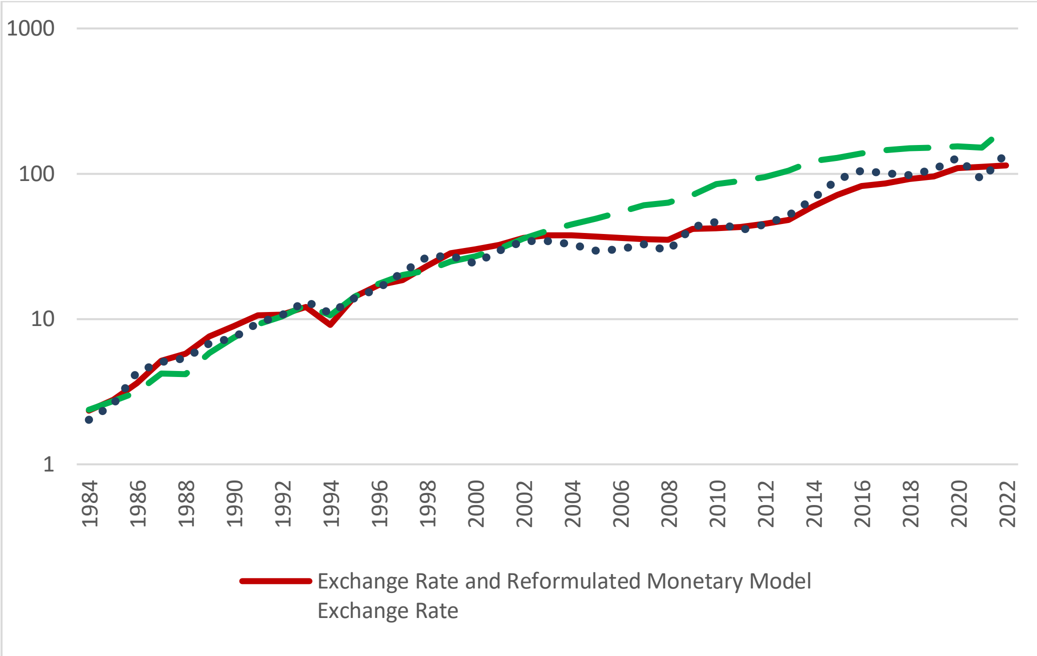


Figure 5. Average of Exchange Rate and Reformulated Monetary Model Exchange Rate in 26 Oil-Exporting Countries, 1984–2022
Source: Darabi et al. (2024)

4. Data Analysis of Iran's Economy Based on Theoretical Foundations

As demonstrated in the previous section, the monetary model of exchange rate determination, particularly in its reformulated form, effectively explains the behavior of the informal market exchange rate in Iran. Therefore, this section does not focus on the determinants of the exchange rate but rather aims to show that, in the long run, inflation in Iran is predominantly driven by sustained high money supply growth far exceeding real economic growth. This high money supply growth is influenced by the generalized fiscal dominance of the government, as discussed earlier. Accordingly, this section analyzes data trends to provide the basis for the model estimation in the subsequent section.

Figure 6 illustrates the difference between the growth rate of money supply and the growth rate of gross domestic product (GM2-GGDPF) alongside the inflation rate (INF) over the extended period of 1960–2025. According to the monetary theory, assuming a constant velocity of money, it is expected that, in the long run, the difference between money supply growth and GDP growth should equate to the inflation rate.

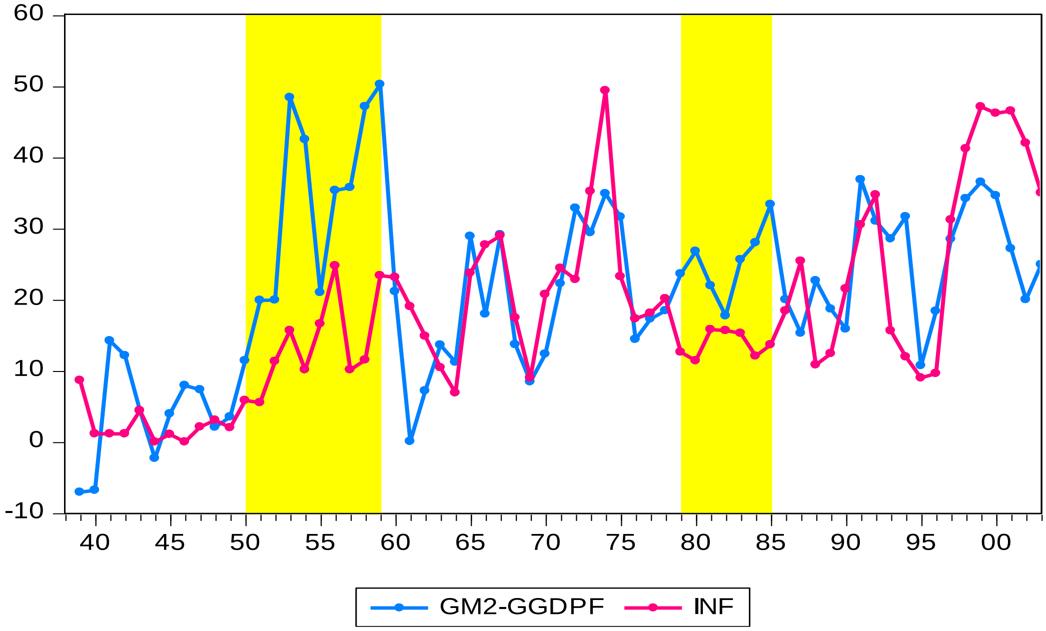


Figure 6. Relationship between the Difference in Money Supply and Economic Growth and Inflation, 1960–2025
Source: Research finding.

As observed in Figure 6, several key findings emerge:

- There is a positive correlation between the difference in money supply growth and economic growth and inflation, with a simple correlation coefficient of 0.53.
- The relationship between the difference in money supply growth and economic growth and inflation is not one-to-one, with deviations occurring in certain periods.
- In only two periods has the difference between money supply growth and economic growth significantly and persistently exceeded the inflation rate. Both periods (the 1970s and parts of the 2000s) coincided with sharp increases in natural resource rents driven by rising real oil prices, with the effect being more pronounced in the 1970s, leading to a larger gap between money supply growth minus economic growth and inflation.
- Even during periods of abundant natural resource rents used to control inflation, sustained high money supply growth eventually exerts inflationary pressure.
- Only in one period, starting from 2018, has the inflation rate significantly exceeded the difference between money supply growth and economic growth for a considerable duration. This period corresponds to a sharp decline in natural resource rents and the increased cost of utilizing these rents for inflation control.

Rahmani et al. (2025) demonstrate that natural resource rents explain why the deviation between the difference in money supply growth and economic growth and inflation is sometimes amplified or mitigated. Figure 6 is consistent with this finding. It can be inferred from Figure 6 that in periods without abundant natural resource rents, such as most of the 1980s and 1990s, the monetary theory adequately explains inflation. However, in the 1970s and parts of the 2000s, the use of natural resource rents to control inflation rendered the monetary theory less reliable, a phenomenon explained by Rahmani et al. (2025).

In summary, it can be argued that the monetary theory, coupled with the concept of generalized fiscal dominance, provides a robust explanation for long-term inflation in Iran. Consequently, this study does not focus on explaining long-term inflation. Given that numerous researchers, including Jalali-Naeini et al. (2024) and Rahmani et al. (2023), have concluded that exchange rate jumps are a key driver of inflationary shocks, this study considers money supply growth as a long-term factor and exchange rate fluctuations as a significant driver of short-term inflationary spikes. The primary objective is to clarify whether exchange rate jumps are an exogenous factor in driving inflationary spikes.

To further investigate whether inflationary spikes, often associated with exchange rate jumps, reflect causality from exchange rate movements to inflation or primarily represent adjustments of both to prior money supply growth, a brief analysis of the historical trends of inflation and exchange rate growth is presented in Figure 7. As clearly shown in Figure 7, Iran's economy shifted toward high inflation from the early 1970s. Notably, despite a relatively stable exchange rate, the inflation rate rose from 6% in 1971 to 25% in 1977 (highlighted in yellow in Figure 7). Thus, high money supply growth manifests its inflationary impact even in the absence of exchange rate changes, though not to its full extent. Similarly, in the 2000s, despite efforts to stabilize the exchange rate, expansionary government policies that fueled money supply growth led to inflation rising from 12% in 2005 to 25% in 2008 (highlighted in yellow in Figure 7). Subsequently, extensive foreign exchange injections and imports temporarily curbed inflation.

In the 1980s, while negative supply shocks (e.g., reduced aggregate supply) partially explained inflationary pressures, sustained money supply growth exerted its inflationary impact rapidly, without delay, due to limited import capacity for inflation control. One exchange rate jump often cited as a cause of inflationary spikes occurred in the early 1990s. However, a closer examination of post-war developments reveals that expansionary policies were the primary driver. Highly expansionary post-war policies, initially masked by improved expectations, the recovery of firms' production, and reliance on imports, delayed their inflationary impact until the early 1990s. During this period, no significant negative supply shock occurred to justify attributing the exchange rate jump to external factors; rather, it was primarily the delayed effect of money supply growth on the balance of payments.

Another exchange rate jump, frequently cited as a cause of inflationary spikes, occurred in the early 2010s. A more plausible interpretation is that sustained high money supply growth in the 2000s, combined with reliance on oil revenues (natural resource rents) to control both exchange rate and inflation, created underlying pressure for exchange rate appreciation. This is evidenced by the increased volume of central bank interventions to stabilize the exchange rate. The exchange rate jump and the inflationary spike reflected the diminished capacity to use natural resource rents to control both, with the exchange rate reacting more quickly due to its lack of stickiness, thus being perceived as the cause of the inflationary spike.

The subsequent exchange rate jumps cited as causes of inflationary spikes occurred repeatedly after 2018. These require careful analysis. The 2018 exchange rate jump and its fluctuations into parts of 2019 represent an adjustment of the exchange rate to fundamental factors, with sanctions accelerating the timing. From mid-2013 to late 2017, first due to reduced inflation expectations and later due to the banking crisis and Ponzi-game banking practices, real interest rates rose to unprecedented levels, leading to a recession in asset and goods prices while sustaining high money supply growth. Consequently, inflation and asset price growth were delayed, accumulating significant inflationary pressure alongside high real interest rates. Additionally, reliance on improved oil revenues (natural resource rents) helped stabilize the exchange rate and inflation. Thus, the sharp 2018 exchange rate jump lacks a non-monetary and exogenous explanation as a cause of the inflationary spike. Post-2018, money supply growth intensified beyond its long-term trend, and alongside political developments acting as temporary halts or triggers for exchange rate changes, it explains much of the exchange rate jumps. Therefore, exogenous exchange rate jumps play a limited role. It should also be noted that reduced natural resource rents, their increased cost of use, rising inflation expectations, and higher money velocity partially explain these exchange rate jumps. However, reduced money supply growth since mid-2021 has limited subsequent exchange rate jumps compared to 2018, despite more severe political shocks.

The overall analysis suggests that, in addition to long-term inflation in Iran being explained by monetary factors driven by generalized fiscal dominance, inflationary spikes are also largely explained by these factors. While the role of exogenous exchange rate jumps in driving inflationary spikes is not entirely dismissed, careful examination indicates that exchange rate jumps unrelated to the fundamental factor of money supply growth play a minimal role in explaining inflationary spikes. This issue will be empirically examined in the next section.

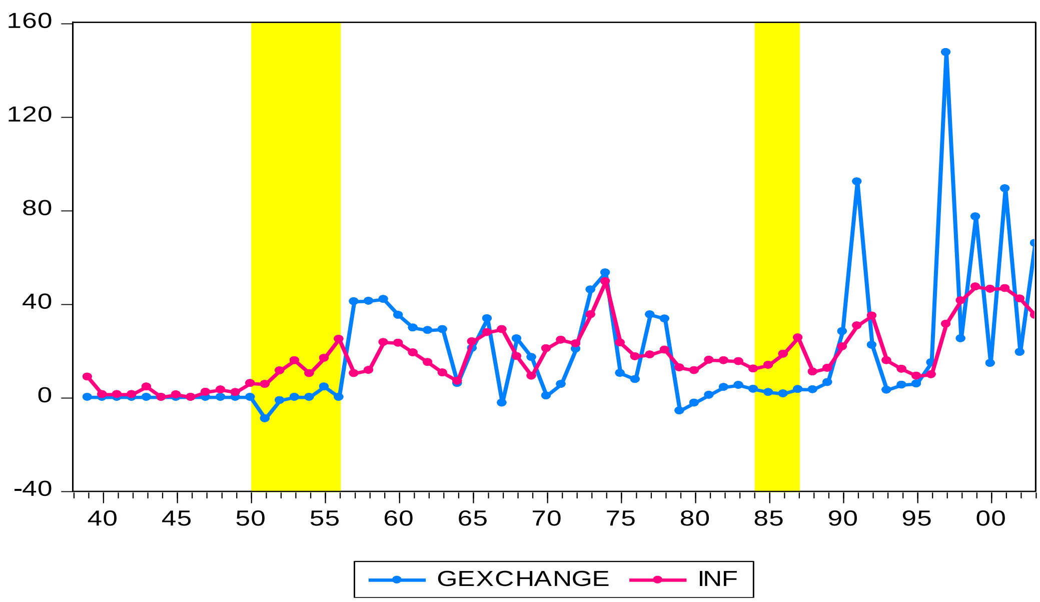


Figure 7. Percentage Change in Exchange Rate (GEXCHANGE) and Inflation Rate (INF), 1960–2025

Source: Research finding.

5. Empirical Finding

In this section, the effect of deviations in the exchange rate from its long-term trend on deviations in the inflation rate is examined to determine whether exchange rate jumps can explain inflationary fluctuations. Unlike an approach based on estimating an inflation model using fundamental factors, this study adopts an alternative method to assess the relationship between the deviations in the exchange rate and inflation.

In this method, two definitions of exchange rate deviations are considered. In the first definition, based on filtering, exchange rate deviations are calculated as the difference between the informal market exchange rate and the trend extracted using the Hodrick-Prescott (HP) filter. Under this definition, without considering the fundamental factors affecting the exchange rate and relying solely on historical data, a smoothed trend for the exchange rate is estimated, and any deviation from this trend is regarded as an exchange rate deviation or shock.

In the second definition, based on a theoretical framework, instead of using the HP filter, the exchange rate is derived from the reformulated monetary model proposed by Darabi (2023). In this approach, the difference between the informal market exchange rate and the exchange rate calculated from the reformulated monetary model is considered the deviation from the trend. The advantage of this definition over the first is that it incorporates the determinants of the exchange rate in estimating its trend, with the residual difference between the theoretical trend and the market exchange rate interpreted as exogenous exchange rate shocks.

Similarly, the inflation rate trend is extracted using the HP filter, and the difference between the actual inflation rate and this trend is considered the deviation of the inflation rate from its long-term trend. Subsequently, deviations in the inflation rate from its long-term trend are estimated separately: once based on the first definition of exchange rate deviations using Equation (3) and once based on the second definition using Equation (4). The results are then interpreted and compared. The study covers the period from 1984 to 2023 and is based on annual data. The choice of the 1984–2023 period is due to the relative stability of the exchange rate as a result of the exchange rate regime and high oil revenues before this time period. Exchange rate and inflation data are sourced from the Central Bank of the Islamic Republic of Iran's statistics and data.

$$(\pi_t - \pi_t^{HP}) = \alpha_0 + \alpha_1 (LFX_t - LFX_t^{HP}) + u_t \quad (3)$$

$$(\pi_t - \pi_t^{HP}) = \beta_0 + \beta_1 (LFX_t - LFXM_t^{*}) + u_t \quad (4)$$

where u_t is a white noise error term. In these equations, $(\pi_t - \pi_t^{HP})$ represents the deviation of the inflation rate from its trend extracted using the HP filter, $(LFX_t - LFX_t^{HP})$ denotes the deviation of the informal market exchange rate from its smoothed trend using the HP filter, and $(LFX_t - LFXM_t^{*})$ represents the deviation of the informal market exchange rate from the exchange rate calculated based on the reformulated monetary model.

Estimating Equations (3) and (4) using the ordinary least squares (OLS) method requires that the data be stationary to avoid spurious regression and ensure the model and estimated coefficients are reliable. Table 1 presents the results of the stationarity tests for the variables.

Table 1. Results of the ADF Unit Root Test

Variable	Symbol	Specification	ADF Test
Deviation of the inflation rate from the long-term trend	$(\pi_t - \pi_t^{HP})$	With intercept	I(0)
Deviation of exchange rate from long-term trend	$(LFX_t - LFX_t^{HP})$	With intercept	I(0)
Deviation of exchange rate from monetary model rate	$(LFX_t - LFXM_t^{*})$	With intercept	I(0)

Source: Research finding.

As shown in Table 1, all three variables used in the estimation are stationary, allowing the application of the OLS model. However, initial estimation results indicated that the model residuals exhibited serial correlation, following a first-order autoregressive process, AR(1).

To address this issue, the feasible generalized least squares (FGLS) method was employed. In this method, an AR(1) model for u_t is estimated first, yielding the autocorrelation coefficient $\hat{\rho}$. All variables are then adjusted based on $\hat{\rho}$, and the model coefficients are re-estimated.

Several approaches exist for implementing this method. Given the limited number of observations and to avoid reducing the sample size, the Prais-Winsten estimation method was used (see Wooldridge, 2016).

Table 2. FGLS Model Results – Equation (3)

Response Variable: Deviation of Inflation Rate from Long-Term Trend		
	Coefficient	p-value
Intercept	-0.002	0.833
Deviation of exchange rate from long-term trend	0.173	0.004
$\hat{\rho}$	0.436	
R^2	0.20	
Regression F-test	9.291	0.004
Durbin-Watson	1.641	
Jarque-Bera	1.349	0.509
Breusch-Pagan	0.081	0.777

Source: Research finding.

As shown in Table 2, deviations in the exchange rate from its filtered trend have a positive and statistically significant effect on inflationary deviations. In other words, when focusing solely on data and calculating the long-term trend using the filter-based method, exchange rate jumps relative to their long-term trend significantly impact inflation rate jumps, consistent with findings by many researchers who attribute inflation jumps to exchange rate jumps. Approximately 20% of inflation rate deviations are explained by these exchange rate deviations. The F-statistic also indicates the regression's significance. Additionally, comparing the Durbin-Watson statistic with the values calculated by Savin and White (1977) for a regression with one explanatory variable and 40 observations confirms that positive residual autocorrelation has been addressed. The Breusch-Pagan test further confirms the homoscedasticity of residuals.

Table 3. FGLS Model Results – Equation (4)

Response Variable: Deviation of Inflation Rate from HP Trend		
	Coefficient	p-value
Intercept	-0.001	0.913
Deviation of exchange rate from monetary model rate	0.013	0.738
$\hat{\rho}$	0.410	
R^2	0.00	
Regression F-test	0.113	0.738
Durbin-Watson	1.571	
Jarque-Bera	1.661	
Breusch-Pagan	0.201	0.654

Source: Research finding.

In contrast to the previous regression, when the theoretical framework is used to calculate exchange rate deviations instead of the filter-based method, Table 3 shows that exchange rate deviations have no significant effect on inflation rate deviations from their long-term trend. In other words, these deviations are not substantial enough to explain changes in the inflation rate, with explanatory power over the 40-year period being nearly zero. Nevertheless, the Durbin-Watson statistic and the Breusch-Pagan test confirm the absence of serial correlation and homoscedasticity of residuals, respectively.

Comparing the results of Tables 2 and 3 suggests that, while exchange rate changes have a significant impact on inflation rate deviations based on data alone, the monetary model incorporating natural resource rents effectively explains exchange rate changes. In other words, after accounting for this model, residual exchange rate changes are not substantial enough to be considered the primary driver of inflation jumps. This finding leads to the conclusion that fiscal dominance, manifested through money supply growth, plays a dominant and decisive role in shaping both exchange rate and inflation dynamics in both the short and the long term.

6. Conclusion and Policy Implications

Rather than focusing on explaining inflation in the short or long term, this study empirically investigates whether exchange rate jumps are the dominant driver of inflationary spikes in Iran. To address this question, a theoretical analysis is first provided to demonstrate that, in the long run, generalized fiscal dominance, manifested through sustained high money supply growth in Iran since the early 1970s, is the primary driver of inflation. This study does not aim to empirically test this long-term relationship. The key finding of this analysis is that, in the long run, sustained increases in the general price level and inflation are not possible without growth in monetary aggregates, particularly broad money supply growth.

Next, the study demonstrates that the Purchasing Power Parity (PPP) and monetary models provide a robust explanation for long-term exchange rate movements across a large sample of countries. For the Iranian economy, the trend of the unofficial exchange rate and the exchange rate expected from the monetary model are analyzed, revealing why, in certain periods, the unofficial exchange rate has been significantly lower than the monetary model's predicted rate. Additionally, a reformulated monetary model is employed to show that when natural resource rents (oil revenues) are incorporated, the reformulated monetary model effectively explains variations in the unofficial exchange rate.

Subsequently, an analysis of the historical trends of inflation and its fundamental long-term driver (the difference between money supply growth and economic growth) in Iran is presented. This analysis demonstrates that high money supply growth provides a convincing explanation for Iran's long-term inflation. However, it is noted that in periods when inflation is lower than what money supply growth would suggest, the abundance of natural resource rents enables the temporary control of inflation by leveraging external value-added. Nevertheless, even during periods of abundant natural resource rents or oil revenues used for inflation control, sustained high money supply growth gradually exerts its inflationary pressure.

The study further examines historical trends in exchange rate growth and inflation to establish two key points: first, inflation has persisted even during periods of exchange rate stability; second, periods of exchange rate jumps, often cited as the cause of inflationary spikes, reflect the manifestation of the fundamental driver of both exchange rate increases and inflation. Consequently, exogenous exchange rate jumps unrelated to sustained high money supply growth have not played a significant role in Iran's inflationary spikes, though this claim is made with some caution.

In the empirical section to test our hypothesis that exogenous exchange rate shocks are not the original driver of inflation spikes, the study investigates whether exogenous exchange rate jumps have a significant effect on inflationary spikes. Based on data from 1984 to 2023, it is shown that when the effect of deviations of the unofficial exchange rate from its filtered trend is estimated on inflation rate deviations, the effect is statistically significant. This confirms that, statistically, exchange rate jumps have caused inflationary spikes. However, when the effect of deviations of the unofficial exchange rate from its fundamental value, based on the reformulated monetary model, is estimated on inflation rate deviations, the effect is not significant. This implies that exogenous exchange rate jumps, based on theoretical analysis, have not had a significant role in Iran's inflationary spikes or, at the very least, suggests that the causal effect of exchange rate jumps on inflation may have been overstated.

Statements and Declarations

- Funding: This work does not receive any funding.
- Conflict of interest: The authors declare that there is no conflict of interest.

References

Amano, R. A., & Van Norden, S. (1998a). Exchange rates and oil prices. *Review of International Economics*, *6*(4), 683–694. Retrieved from https://doi.org/10.1111/1467-9396.00136.

Amano, R. A., & Van Norden, S. (1998b). Oil prices and the rise and fall of the US real exchange rate. *Journal of International Money and Finance*, *17*(2), 299–316. Retrieved from https://doi.org/10.1016/S0261-5606(98)00004-7.

Anderl, C., & Caporale, G. M. (2023). Nonlinearities in the exchange rate pass-through: The role of inflation expectations. *International Economics*, *173*, 86–101. Retrieved from https://doi.org/10.1016/j.inteco.2022.10.003.

Barakchian, S., Barkish, A., & Valizadeh, M. (2021). Exchange rate pass-through in Iran: Exchange rate effects on the consumer price index. *Journal of Economic Research and Policies*, *28*(96), 33–64. Retrieved from http://qjerp.ir/article-1-2796-en.html.

Cassel, G. (1921). *The World's Monetary Problems*. Constable and Company Limited. Retrieved from https://catalog.hathitrust.org/Record/001126345.

Cassel, G. (1922). *Money and foreign exchange after 1914*. Retrieved from https://doi.org/10.1111/j.2397-2335.1923.tb00886.x.

Caves, R. E., Frankel, J. A., & Jones, R. W. (2007). *World Trade and Payments: An Introduction* (Trans. by A. Hashemi, 10th Ed.). Stockholm: E Upplagan.

Cochrane, J. (2023). *The fiscal theory of the price level*. Retrieved from https://doi.org/10.2307/j.ctv2sbm8kh.

Darabi, M., Rahmani, T., & Hemmati, A. (2024). *Exchange Rate in Oil-Exporting Countries and its Relationship with the Oil Rents, with Emphasis on*. Tehran: University of Tehran Publication.

Davidson, P., & Weintraub, S. (1973). Money as cause and effect. *The Economic Journal*, *83*(332), 1117–1132. Retrieved from https://doi.org/10.2307/2230844.

Ebrahimi, S., & Madanizadeh, S. A. (2016). Changes in Exchange Rate Pass-Through in Iran. *Applied Economic Studies in Iran*, *5*(18), 147–170. Retrieved from https://aes.basu.ac.ir/article_1498.html.

Flaccadoro, M. (2024). Exchange rate pass-through in small, open, commodity exporting countries: Lessons from Cnada. Journal of International Economics, 148, 103885. Retrieved from https://doi.org/10.1016/j.jinteco.2024.103885.

Ha, J., Stocker, M. M., & Yilmazkuday, H. (2020). Inflation and exchange rate pass-through. *Journal of International Money and Finance*, *105*, 102187. Retrieved from https://doi.org/10.1016/j.jimonfin.2020.102187.

Jalali-Naeini, S. A., Seighalani, S. and Sadeghzadeh, M. (2024). Dynamics of Monetary Aggregates, the Exchange Rate and their Relationship with Inflation in Iran. *Economic and Planning Research*, *28*(4), 3-42. Retrieved from http://eprj.ir/article-1-2269-en.html.

Kurlat, P. (2020). A Course in Modern Macroeconomics. Retrieved from https://cir.nii.ac.jp/crid/1971712334789333632.

Kwon, J., & Shin, W. (2023). Nonlinear exchange rate pass-through and monetary policy credibility: Evidence from Korea. *Economics Letters*, *230*, 111234. Retrieved from https://doi.org/10.1016/j.econlet.2023.111234.

Lucas, R. E. (1982). Interest rates and currency prices in a two country world. *Journal of Monetary Economics*, *10*, 335–359. Retrieved from https://doi.org/10.1016/0304-3932(82)90032-0.

Mark, N. C. (1995). Exchange rates and fundamentals: Evidence on long-horizon predictability. *American Economic Review*, *85*(1), 201–218. Retrieved from https://www.jstor.org/stable/2118004.

Mark, N. C., & Sul, D. (2001). Nominal exchange rates and monetary fundamentals: Evidence from a small post-Bretton Woods panel. *Journal of International Economics*, *53*, 29–52. Retrieved from https://doi.org/10.1016/S0022-1996(00)00052-0.

Nasir, M. A., Huynh, T. L. D., & Vo, X. V. (2020). Exchange rate pass-through & management of inflation expectations in a small open inflation targeting economy. *International Review of Economics and Finance*, *69*, 178-188. Retrieved from https://doi.org/10.1016/j.iref.2020.04.010.

Obstfeld, M., & Rogoff, K. S. (1995). Exchange rate dynamics redux. *Journal of Political Economy*, *103*(3), 624–660. Retrieved from https://doi.org/10.1086/261997.

Rahmani, T., & Darabi, M. (2023). Currency shocks, broad money growth, and inflation. *The 30th Annual Conference on Monetary and Exchange Rate Policies*.

Rahmani, T., Darabi, M., & Kumar, H. (2025). Oil rents and the dual gap in Iran's goods and asset markets: A theoretical framework for improving rial governance. *The 32th Annual Conference on Monetary and Exchange Rate Policies*. Retrieved from http://jme.mbri.ac.ir/article-1-712-en.html.

Rahmani, T., Dreger, C., Azarbayejani, A., & Madani Zadeh, S. A. (2023). Analyzing the effect of exchange rate shocks on inflation inequality. *Journal of Money and Economy*, *18*(4), 441-455. Retrieved from http://jme.mbri.ac.ir/article-1-664-en.html.

Rapach, D. E., & Wohar, M. E. (2002). Testing the monetary model of exchange rate determination: New evidence from a century of data. *Journal of International Economics*, *58*(2), 359–385. Retrieved from https://doi.org/10.1016/S0022-1996(01)00170-2.

Rogoff, K. S. (1996). The purchasing power parity puzzle. *Journal of Economic Literature*, *34*(2), 647–668. Retrieved from https://www.jstor.org/stable/2729217.

Sadat Hoseyni, N., Asgharpur, H., & Haghighat, J. (2018). Effect of Exchange Rate Pass-through on Import Price Index: Smooth Transition Regression Approach. *Journal of Economic Research*, *53*(2), 57–75. Retrieved from https://jte.ut.ac.ir/article_65938.html.

Sargent, T. J., & Wallace, N. (1981). Some unpleasant monetarist arithmetic. *Federal Reserve Bank of Minneapolis Quarterly Review*, *5*(3), 1–17. Retrieved from https://doi.org/10.21034/qr.531.

Savin, N. E., & White, K. J. (1977). The Durbin-Watson test for serial correlation with extreme sample sizes or many regressors. *Econometrica: Journal of the Econometric Society*, 1989–1996. Retrieved from https://doi.org/10.2307/1914122.

Walsh, C. E. (2017). *Monetary Theory and Policy*. Cambridge, MA: MIT Press.

Woodford, M. (1995). Price-level determinacy without control of a monetary aggregate. *Carnegie-Rochester Conference Series on Public Policy*, *43*, 1–46. Retrieved from https://doi.org/10.1016/0167-2231(95)90033-0.

Woodford, M. (1998). Control of the public debt: a requirement for price stability? *The Debt Burden and Its Consequences for Monetary Policy: Proceedings of a Conference Held by the International Economic Association at the Deutsche Bundesbank, Frankfurt, Germany*, 117–158. Retrieved from https://doi.org/10.1007/978-1-349-26077-5_5.

World Bank. (2010). The Changing Wealth of Nations. In *The changing wealth of nations: measuring sustainable development in the new millennium*. The World Bank. Retrieved from https://doi.org/10.1596/978-0-8213-8488-6.

Cite this article: Rahmani, T., Darabi, M., & Mohammad Khanlou, H. (2026). Exchange Rate and Inflation in Iran: Cause or Consequence. *Iranian Economic Review, 29*(4), 1526-1552.