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Economic Sanctions and Consumption Inequality in Iran

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Abstract

Economic sanctions impose high costs on the national economy of the sanctioned countries. However, through punished countries, sanctions costs are not evenly distributed among all domestic economic agents. Although the distributional effects of sanctions have been subject of some research, much of the debates on the impacts of sanctions on inequality have mainly focused on income. However, for economists, the distinction between income and consumption could make a significant difference, especially if changes in incomes did not fully transmit to consumption. Our study contributes to this strand of literature by exploiting the concept of “consumption inequality” and empirically examining it in a sanctioned economy. To this end, we constructed a two-step approach of the Factor Augmented Vector Autoregressive Model by developing an index composed of many economic variables to capture the effects of sanctions on the Iranian economy from 1985 to 2019. Our findings indicate that there are time spans during which sanctions have imposed more impacts on the economy. They also display that the effects of sanctions on the Iranian economy were followed by increases in economic inequality, but the consumption inequality increased more relentlessly. Furthermore, income inequality and consumption inequality respond differently to shocks, which emphasizes the importance of the distinction between inequality indices. Our findings indicate that consumption inequality responds to economic shocks and that economic sanctions have significant and continuous effects on consumption inequality in Iranian society.

Keywords: Consumption Inequality, Income Inequality, Sanctions.

JEL Classification: D30, D63, F51.

1. Introduction

Historically, as a long-lasting instrument, primarily after World War II, economic sanctions have been a tool of coercive foreign diplomacy by some states and

international organizations. Global Sanctions Database (GSDB) shows an increase in sanctions from a total of 21 in 1950 to 473 by 2019 (see Kirilakha et al. 2021)¹. Although there is no consensus on their effectiveness (Whang, 2011), economic sanctions can significantly affect the economic situation of sanctioned country. Research indicates that sanctions have adverse effects on sanctioned economies (e.g. Caruso, 2003; Dizaji and van Bergeijk, 2013; Kaempfer and Lowenberg, 2007; Neuenkirch and Neumeier, 2015; Peksen and Son, 2015; Yang et al., 2009) as well as on income equality in the sanctioned countries especially when poor people in the sanctioned country bear most of the costs of sanction policy. Increasing income inequality could harm both the political and the economic stability of the sanctioned country, leaving adverse effects on democracy in the country and bearing humanitarian consequences (Fails, 2012; Knack and Keefer, 1997; Landman and Larizza, 2009; Muller, 1985; Nepal et al., 2011; Neuenkirch and Neumeier, 2016; Solt, 2008).

Mainly drawn on Stolper-Samuelson theorem (1989), the distributional effects of sanctions have been the subject of some research (e.g. Afesorgbor and Mahadevan, 2016; Jeong, 2020). Our study contributes to this strand of literature by exploiting the concept of “consumption inequality” and empirically examining it in a sanctioned economy. There have been many sanctions against Iran imposed by some countries, especially the [United States](#), and international entities with varying degrees in intensity and numbers in time. This feature makes Iran's economy a good case for investigating the economic effects of sanctions including their distributional consequences. Most research on the rising inequality including sanctions impacts on inequality has mainly focused on income. However, for economists, an individual utility function refers to consumption and leisure, so the distinction between income and consumption could make a significant difference, especially if changes in incomes did not fully transmit to consumption, because of temporary changes in incomes or if there was the possibility of borrowing or transfer from the government (Attanasio and Pistaferri, 2016).

Sanctions against Iran have a long history of more than 4 decades, after the 1979 revolution. There have been several sanctions against Iran imposed by some countries, especially the [United States](#), and international entities. Because the sanctions have evolved during the time and don't have the same structure, it is necessary to distinguish them based on their specific features. We can see several

¹. See GSDB website for more information and papers about sanctions at the link <https://www.globalsanctionsdatabase.com/>

periods of sanctions imposed on the Iranian economy, based on their specific features.

Period 1 (1979 to 2005): In this period, sanctions were imposed on the Iranian economy, primarily by the U.S. During that time, other international governments had not imposed any sanctions, so the U.S. sanctions did not impose significant restrictions on the Iranian economy. Furthermore, their impacts on several parts of Iran's economy were not comparable to other phases of sanctions. After seizing the American Embassy in Tehran by revolutionary students, the first sanction was imposed by the US in the form of freezing assets and the trade embargo¹. The sanctions were lifted in January 1981 as part of the [Algiers Accords](#), which was a [negotiated settlement of the hostages' release](#). While the [Iran–Iraq War](#), which began in September 1980, was in progress, United States sanctions prohibited weapon sales and all U.S. assistance to Iran in 1984². In 1995, in response to the [Iranian nuclear program](#) and [Iranian support of organizations](#) (including [Hezbollah](#), [Hamas](#), [Palestine Islamic Jihad](#)), U.S. President, [Bill Clinton](#), issued several [executive orders](#) against Iran³. The [Iran and Libya Sanctions Act](#) (ILSA)⁴ was signed on 5 August 1996 (H.R. 3107, P.L. 104–172)⁵. George Bush's administration also imposed sanctions on Iranian economy in the form of Executive Orders numbers 13224 (2001) and 13382 (2005).

Period 2 (2006 to 2010): During this period, besides the U.S. sanctions, United Nations Security Council imposed several sanctions in the form of resolutions, following the report by the [International Atomic Energy Agency](#) Board of Governors regarding Iran's non-compliance with its safeguards agreement and the Board's finding that Iran's nuclear activities had raised questions within the competency of the Security Council⁶. This wave of sanctions was more severe than the first period because they included the Iranian nuclear-related materials and technology, the Iranian army, freezing assets, Iranian transport systems, and the Iranian financial and banking systems.

1. Executive Order 12170

2. Levs, J. (23 January 2012). A summary of sanctions against Iran. CNN. Archived from the original on 10 May 2018; Retrieved 9 May 2018.

3. Executive Order 12957 of 15 March 1995, banned U.S. investment in Iran's energy sector, and Executive Order 12959 of 6 May 1995, banned U.S. trade with and investment in Iran.

4. ILSA was renamed in 2006 the Iran Sanctions Act (ISA) when the sanctions against Libya were terminated.

5. Katzman, Kenneth (13 June 2013). Iran Sanctions. Federation of American Scientists. Congressional Research Service. Archived (PDF) from the original on 26 July 2013; Retrieved 29 July 2013.

6. Resolution 1969 passed on July 2006, resolution 1737, passed on December 2006, resolution 1747 passed on March 2007, resolution 1803 passed on March 2008, resolution 1835 Passed in September 2008, resolution 1929 passed on June 2010.

Period 3 (2011 to 2014): With this wave of sanctions to isolate Iran from the global economy, many Iranian sectors like the transaction sector were sanctioned by some countries. The main feature of these sanctions was restriction on Iranian oil export and the Iranian financial and banking system.

In this period, the sanctions on the Iranian Economy and Iranian entities became wider. Besides tightening UN and U.S. sanctions, European Unions also added to them for sanctioning the Iranian economy. Barak Obama's administration started a broad sanction campaign against the Iranian Economy (Including the Iranian Central Bank, Iranian petroleum and petrochemical industry, Iranian automobile industry, steel, and many significant sectors), and the UN Security Council levied more sanctions against the Iranian Economy to stop Iranian nuclear enrichment program. European Union also set sanctions which imposed restrictions on cooperation with Iran in foreign trade, financial services, energy sectors and technologies, and banned the provision of insurance and reinsurance by insurers in member states to Iran and Iranian-owned companies. On January 2012, the EU agreed on an oil embargo on Iran, effective from July, and to freeze the assets of Iran's central bank.¹ On March 2012, all Iranian banks identified as institutions in breach of EU sanctions were disconnected from SWIFT, the world's hub of electronic financial transactions.

Period 4 (2015 to 2017): After the third sanction period against the Iranian Economy, Iran and the P5+1 countries (the five permanent members of the United Nations Security Council—China, France, Russia, United Kingdom, United States—plus Germany) engaged in negotiations for an agreement on the Iranian nuclear program. They reached the agreement in Vienna on July 2015, named Joint Comprehensive Plan of Action (JCPOA). Based on JCPOA, UN and EU sanctions against the Iranian economy were removed. US sanctions on the third party to trade with Iranian entities was also removed, although many sanctions of US on Iranian economy were retained. The sanctions were removed with provisions to re-impose the sanctions in case of non-performance by Iran, under the JCPOA. After the agreement was run, many restrictions on the Iranian Economy were removed and it experienced some years of economic growth and an increase in oil and non-oil exports.

Period 5 (2018 up to now): When Donald Trump took the office in the U.S., political pressures on Iran increased to change some articles of JCPOA (freezing the Iranian nuclear program a longer time, and bringing the Iranian missile program

¹. Nasser, L. (12 February 2012). Iran Won't Yield to Pressure, Foreign Minister Says; Nuclear News Awaited. Bloomberg. Archived from the original on 23 December 2014; Retrieved 13 February 2012.

in negotiations), but Iran refused the changes. So, the U.S. re-imposed the sanctions before JCPOA and imposed new sanctions on the Iranian economy and Iranian entities, especially sanctions on Iranian banks, financial sectors, oil exports, steel and petrochemical exports, automobile sector, and so on. After the sanction and restrictions, Iranian oil and non-oil export reduced, and the collaboration of Iranian firms with foreign corporations was interrupted.

To analyze the effects of sanctions on Iranian consumption inequality, we need to use some indices which capture inequality in consumption among Iranian families. In the inequality literature, there are several measures to report consumption inequality. In this study, we have used two indices; Coefficient of variation of consumption (the ratio of the standard deviation of consumption between deciles to their average consumption at a percentage scale) and Palma inequality index which is a ratio of average consumption in the tenth decile to the sum of the average consumption of the first four consumption deciles.

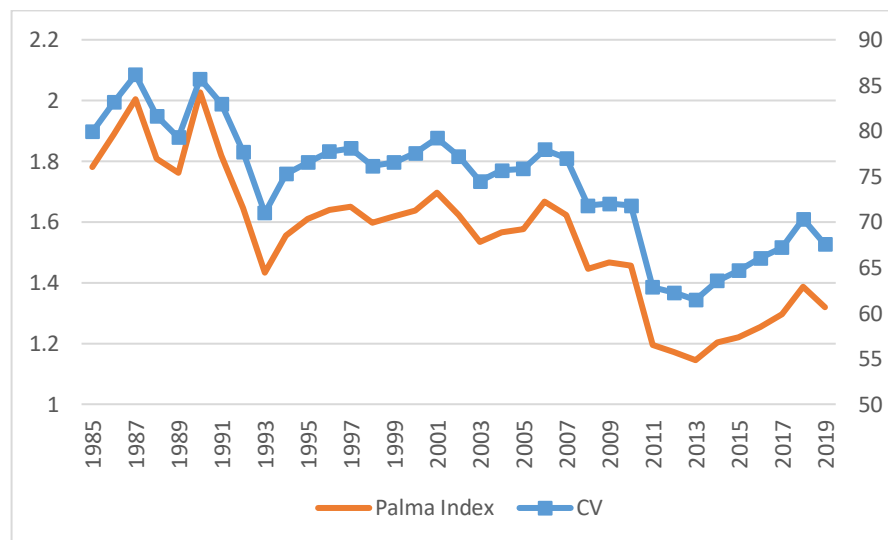


Figure 1. Consumption Inequality Indices among Iranian Family

Source: Research finding.

The figure shows a long-run decreasing trend in consumption inequality, but both indices turned to increasing inequality after 2013. To analyze the effects of sanctions on consumption inequality, we need to construct a model, which explained in section 3.

This article is organized as follows. Section 2 contains the literature review and in section 3 we will describe our empirical strategy. Section 4 contains our empirical results and finally in section 5 we will conclude the paper.

2. Literature Review

In a non-sanctioned economy, economic actors earn a share of domestic output depending on the structural of the economy. However, sanction impose restrictions on the system of the economy and change the income shares of the domestic actors. For example, due to the sanction format, trade sanctions can reduce foreign trade. This situation will change the income distribution to the detriment of economic actors involved in trade sectors.

Some research has indicated that the effects of economic sanctions on the penalized economy might depend on the type of sanctions (or sanctions instrument). The sanction arrangement and its various restriction types could affect income and consumption distribution. (Brooks, 2002; Jeong, 2020). Moreover, the economic structure of the penalized economies has an important role in determining the distributional effects of sanctions on the economy. In an economic structure with one commodity export section and a primitive non-export economy, export restrictions put on by trade sanctions may have great distributional effects to the detriment of modern sectors, however, in a diversified economy with many export products, it may be difficult to predict distributional effects of export restrictions.

In the literature, the potential effect of economic sanctions on income inequality was developed primarily based on the Stolper-Samuelson theorem (e.g. Cooper, 1989; Wang, 1991). According to the Stolper-Samuelson theorem, import restriction sanctions favor the factors that are used intensively in the import-competing sectors, due to the increase in the domestic demand for import-competing goods and services (Stolper and Samuelson, 1941). However, in that case the consumers of imported goods in sanctioned economy are adversely affected, simultaneously the consumers may be offset by benefits delivered in their roles as consumers of exporting goods (Black and Cooper, 1988)). At the same time, factors of production may be allocated in sectors of the economy in such a way that people hit by import sanctions from higher import-competing goods earn benefits from increasing wages in the production of import-competing goods. Moreover, this type of sanctions can decrease the relative price of exporting goods. Overall, Black and Cooper (1988) concluded that making the final effect on the income distribution of the sanctioned economy is not clear. Wang (1991) used the

Harris-Todaro model for agricultural and manufacturing sectors to compare the effects of import and export embargoes on national incomes and found that these two sanction instruments have asymmetrical effects on income distribution.

These analyses point to the fact that the economic structure of the sanctioned economy and sanctions instrument have to be included in the analyses because the impact of sanctions could differ depending on sanctioned economy's level of trade openness, its intensity of labor and capital, and its composition of foreign trade. For instance, Black and Cooper (1988) concluded that if domestic exporters use more labor-intensive production processes, the labor force is expected to suffer more from sanctions relative to capital owners. On the other hand, export-oriented sectors of labor-abundant countries intensively use unskilled labor, while import-competing sectors use skilled labor and capital. In labor-scare countries, skilled labor and capital are intensively used by export-oriented sectors, while import-competing sectors demand intensively more unskilled labor. Therefore, free trade is likely to reduce income inequality in labor-abundant countries because unskilled workers earn fewer wages than skilled workers and capital owners, as the reverse is also true in labor-scare countries (Ahlquist and Wibbels, 2012; Chang and Wu, 2016). Unlike the prediction derived from the Stolper-Samuelson Theorem, another strand of research points out that labor-abundant developing countries mainly export intermediate goods, though produced intensively using unskilled labor, for which the technology to produce is still more skilled-labor-intensive in a labor-abundant country. Thus, workers employed in export-oriented sectors are relatively wealthy and skilled in labor-abundant countries. Consequently, international trade may further widen income inequality even in a labor-abundant developing country (e. g. Feenstra and Hanson, 1997; Ha, 2012; Zhu and Trefler, 2005). All these point out that the effects of trade sanctions on income inequality may not be clearly predicted based on the Stolper-Samuelson Theorem and more factors should be included in the analyses, including the type of sanctions instrument and economic structure of the sanctioned economy (for example, factor endowments of the country; Jeong, 2020).

Income Inequality or Consumption Inequality? Which variable should be included in an inequality research, income or consumption? It is a primary question in this section of the study. Most inequality studies have concentrated on income inequality and less on consumption inequality. One reason is the easier availability of data about wages and other earnings of the labor force (Heathcote et al., 2010). Although analyzing income inequality data is practicable, analyzing consumption distribution is a better indicator of family welfare than income distribution because

the utility function in economics tradition is directly related to consumption, so, the joint analysis of consumption and income in an inequality study is more informative. For example, the joint analysis of both variables gives information about the presence of the consumption-smoothing mechanisms. It is important to know households' perception of an income shock as temporary or permanent, so, a single income analysis is not sufficient for an accurate investigation. Large and temporary income shocks have little welfare effects if consumers can smooth income shocks. Moreover, measurement errors in gathering consumption data are less than income data (Gnambs and Kaspar, 2016).

Because of different dynamics in relative prices of goods consumed by different income levels of society, consumption dynamics could be different by income levels, making a significant gap between income inequality and consumption inequality. If consumption distribution at a point in time has a smaller variance relative to income distribution, it shows that changes in consumption are smoother than income changes, so, the distinction between income and consumption will be crucial. The different trends in consumption and incomes could be because of the possibility of saving and borrowing for consumers and also the existence of transfers subsidies from governments. Finally, higher consumption of leisure could partly offset lower consumption of goods when it comes to overall welfare measurement (Attanasio and Pistaferri, 2016).

The main message of modern consumption theories is that risk-averse consumers prefer to have a smooth consumption flow (see the life-cycle hypothesis of Modigliani and Brumberg (1955) and the permanent income hypothesis of Friedman (1957)). Therefore, consumers base their consumption decisions on the permanent part of their income, rather than the current income. So, changes in income distribution will not map exactly onto consumption distribution. The possibility of consumption-smoothing depends highly on availability of tools to consumers, which facilitate the transfer of resources over time, including access to sufficiently developed financial (credit and insurance) markets, the existence of government transfers, and charity and NGOs, especially for low-income classes.

In the following we review the main studies that aim to gauge consumption inequality or consumption distribution and investigate their trends. It should be noted that consumption inequality and consumption distribution are equivalent so we may use the two interchangeably in the text.

One of the most important research issues was to evaluate the trends of consumption and income distribution simultaneously to determine the consumption smoothing condition. Cutler and Katz (1992) were the first to

examine this issue. They proved that the change in the consumption distribution is parallel to the changes in the income distribution. In other words, they indicated that all income shocks were considered as permanent shock by consumers. However, Slesnick (1994), Gottschalk et al. (1994), and Krueger and Perri (2005) showed that consumption inequality grows less and at a slower pace than income inequality. Indeed, they proved that a significant portion of income shocks were both temporary and uninsured.

There is a considerable difference between consumption and income inequality studies if consumers can smooth out transient shocks. In other words, it is recommended to study consumption inequality and income inequality simultaneously only if the consumption smoothing mechanism against transient income shocks is done correctly by consumers. However, some studies (e.g., Attanasio and Steven, 1996; Blundell et al., 2008, Dynarski et al., 1997) have shown that some consumers are not able to smooth the transient shocks because they are heterogeneous. There are some features like different demographic characteristics, wealth levels, various regions and religions that have a considerable impact on the response of consumers.

In recent years, the issue of heterogeneous consumers has been noticed by researchers all over the world. Anderson, Inoue and Rossi (2016) studied the impacts of fiscal policy shocks on consumers, that which differ due to individual characteristics. They found that unexpected fiscal shocks have considerable different impacts on consumers depending on their income and age levels. Moreover, governments' spending policy shocks tend to decrease consumption inequality. De Giorgi and Gambetti (2017) used a factor vector autoregressive model to characterize the cyclical dynamics of the consumption distribution and to investigate the responses of the consumption distribution to technology shocks and various uncertainty shocks. They found that the right-side of the consumption distribution, including educated households, has a larger and quicker response than other parts of the distribution to the shocks. In addition, they showed that shocks reduce consumption inequality. Najarzadeh et al. (2021) examined the consumption responses of different kinds of individuals to macroeconomic fluctuations using the urban Households Income and Expenditure dataset issued by the Statistical Center of Iran and a factor augmented vector autoregressive model. The results demonstrated that a positive oil revenue shock has only a considerable positive effect on the left tail of consumption distribution or the consumption of households with low educational attainments. Moreover, the shocks reduce consumption inequality. Nam et al. (2021) studied the impact of

macroeconomic uncertainty shocks on the household consumption choices. They found that a positive shock to financial, real, and macroeconomic uncertainty indices considerably decrease U.S. households' consumption. Further, they indicated that families that are more uncertain about their future consumption react to economic uncertainty more sensitively. Yang et al. (2021) investigated the impact of social networks on consumption using China Household Finance Survey panel data. They showed that the positive effect of social networks on family's consumption is greater in rural areas and for low-income groups. Furthermore, their results proved that social networks can alleviate the negative effect of exogenous shocks on consumption and play an informal insurance role.

3. Empirical Methodology

To analyze the impacts of economic sanctions on (income or consumption) inequality in Iran, we have constructed a two-step approach. We reckon that sanctions intensity on the Iranian economy is not smooth. In addition, there are time spans in which sanctions have imposed more impacts than other times. To estimate these effects on the Iranian economy, we have constructed an index composed of many economic variables. Sanctions usually impose their effects on the economy in the form of unpleasant changes in economic conditions, so we must construct an index whose changes show the impacts of sanctions on the Iranian economy.

The standard approach to model the effects of sanctions on an economy is the use of dummy variables (including time dummies or dummies for sanctions type). However, the idea of constructing an index for the effects of sanctions on the economy is an alternative to the standard approach. Some recent research has used an index for modeling the effects of sanctions on the sanctioned economy. For example, Dreger et al. (2016) constructed a sanction index for modeling anti-Russian sanctions imposed after the Ukrainian crisis. This index has been expanded in Kholodilin and Netšunajev (2019). Bali and Rapelanoro (2021) constructed another index using sanctions type and time to model the effects of EU sanctions on the Russian economy. Moreover, Li and Li (2022) constructed an index by nighttime lights to analyze the effects of economic sanctions on regional differences in Russia.

Furthermore, some researchers have used indices to model the effects of sanctions on the Iranian economy. Laudati and Pesaran (2021) constructed an index using newspaper coverage to model the effects of sanctions on the Iranian economy. The main weakness of the index is its dependence on the news. Although

at the beginning of the implementation of a sanction the frequency of its news on international publications increases and the index shows more intensity, but with time even if the said sanctions have not changed, they are not at the forefront of the news, so the index may show less intensity. Another point is that this index is based on international newspapers, while a significant part of the domestic news is related to the problems caused by sanctions which can be reflected in the domestic newspapers.

As stated in the theoretical background, the final effects of sanctions on the sanctioned economy is not clear (Black and Cooper (1988)). Also, the impact of sanctions could differ depending on sanctioned economy's level of trade openness, its intensity of labor and capital, and its composition of foreign trade. All of this tell us that modeling the effects of sanctions on the sanctioned economy is so complicated. As stated in the theoretical literature, one of the special features of sanctions is that there is no clear index to measure its intensity. So, using latent variable method in the empirical analysis can be an appropriate approach. Because of the latent variable approach and time series nature of our dataset, we have adopted a FAVAR approach to analysis. Our approach to construct an index of sanctions intensity is based on their effects on the macroeconomic variables. Our idea is that if sanctions have imposed unpleasant impacts on macroeconomic variables, we can observe that the sanctions have some effects on the Iranian economy. Heydari et al. (2021) also constructed a sanction intensity index using factor analysis to analyze the effects of sanctions on employment in Iranian economic sectors.

Following the FAVAR approach initiated by Bernanke et al. (2005), our model is constructed in the form of a small-scale FAVAR model. It should be noted that in comparison to the VAR model, the FAVAR model consists of a two-step approach (by principal component estimation) and thereby enables researchers to add more variables than a simple VAR. It then in the second step includes unobservable and observable variables unitedly in the VAR model. Assuming that F_t and Y_t have the following dynamics,

$$\begin{bmatrix} F_t \\ Y_t \\ I_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \\ I_{t-1} \end{bmatrix} + v_t \quad (1)$$

where Y_t is a $M \times 1$ vector of macroeconomic variables, I_t is an index of inequality (income or consumption inequality), F_t is an unobservable variable which shows economic conditions, $\Phi(L)$ is a conformable lag polynomial of finite order and v_t

is a vector of stochastic shocks. Because F_t is not observable, we need to have an estimation for it to estimate equation (1), hence we have adopted a two-step approach. In the first step, we estimate the unobservable variable, F_t , then we use its estimate in (1). We assume that information about F_t can be extracted from a set of macroeconomic variables, X_t , which is a $N \times 1$ vector of many macroeconomic variables, which could also include elements in Y_t . Indeed, following FAVAR tradition we have the following relation between unobservable F_t and observables in X_t :

$$X_t = \Lambda F_t + e_t \quad (2)$$

where Λ is a $N \times 1$ vector of factor loadings, and e_t is a $N \times 1$ vector of mean zero and uncorrelated error terms. We assume that $N + 1 \gg M + 2$, which means that information set includes large enough variables more than M (number of variables in Y_t) plus 2 (including F_t and I_t). We can interpret (2) as a mechanism which shows relation between unobservable driver of economic conditions (or economic prosperity), F_t , and its projection in observable variables in X_t , like many mirrors in deferent aspects. We can estimate factor loadings in the vector Λ in the form of a factor model, using maximum likelihood method. After that, we can use of an estimate of F_t (which we show it by $\hat{F}_t$) in equation (1) and estimate it using standard methods of estimation of VAR models, like least squares method, by enough lag selection for $\Phi(L)$.

To estimate equations (1) and (2), we should select appropriate variables. Firstly, for the inequality index, I_t , in (1), we used three alternative indices; the Gini coefficient of income inequality (GINI), consumption coefficient of variation (CV), and Palma index of consumption inequality (PALMA). We have three estimation of (1) that are comparable because we have chosen three alternative variables for I_t .

For Y_t , we used inflation rate and GDP per capita based on inequality studies tradition that says inequality increases in lower per capita incomes, and the reverse is true in upper incomes¹. In addition, some studies indicated that inflation affects inequality, but the direction of the effects is not specified and depends on many factors, estimation techniques, and data set attributes. For example, Balcilar et al. (2018) showed a nonlinear relationship between inflation and income inequality in the U.S.. Furthermore, Thalassinou et al. (2012) analyzed the relationship between income inequality and inflation in 13 European countries from 2000 to 2009 and showed that inflation had a positive significant impact on income inequality.

¹. see Kuznets (1955).

To estimate (1), we need to have an estimation of F_t (which we show it by $\hat{F}_t$) which can be done by estimation of the loading factors in (2) (i.e., Λ), by the maximum likelihood method. To estimate loading factors in (2) we should specify an appropriate dataset of the vector X_t . Recall that we have postulated that F_t is non-observable, but it can be traced in variables of the vector X_t , so we need to specify macroeconomic variables which reflect the effects of economic sanctions. Indeed, we can interpret F_t as economic conditions (or economic prosperity) index, and its projection in observable variables in X_t , like many mirrors in different aspects. Table 1 shows the variables in the vector X_t and their abbreviation.

Table 1. Variables in the Vector X_t and Their Abbreviation

EXCHANGE	Percentage change of market exchange rate
CAP	Capital account balance
GDP	GDP growth (in Constant prices)
GDPPER	GDP per capita
INF	Percentage change in Consumer Price Index
NONOIL	Non-oil export (millions of Dollars)
OILINCOME	Oil exports (millions of Dollars)
CPRIVATE	Percentage change in consumption by private sector (in constant prices)
GPRIVATE	Percentage change in consumption by government sector (in Constant prices)
INVESTMENT	Percentage change in fixed capital formation (in constant prices)
DEFLATOR	Percentage change in GDP deflator

Source: Research finding.

Our assumption implied in Table 1 is that the sanctions effects are reflected in the variables of Table 1, so they can be candidates for being included in vector X_t . To select the variables in vector X_t we have also used the results and approaches of previous studies regarding the effects of sanctions on Iran's economy (see e. g. Heydari et al., 2021 for a similar work in this approach). For example, sanctions decrease oil incomes, reduce GDP growth, increase capital outflows, and decrease fixed capital formation.

Our data are in annual frequency and collected from the time series data set of the Central Bank of Iran (Economic Time Series Database, 2021) and the Statistical Center of Iran (HIES¹, 2020). Because we have 3 different inequality indices, we have 3 Vector Autoregression (VAR) models. Our VAR model of the GINI index span from 1969-2019, but VAR models of CV and PALMA are restricted to 1985-2019 because the data of consumption deciles have been

¹. Households Income and Expenditure Survey

published since 1985. Variables in Table 1 also span from 1969 to 2019, so $\hat{F}_t$ also span from 1969 to 2019. It is necessary to say that we have tested the stationarity of all variables using the ADF (augmented dickey fuller) test and the KPSS test and have found that all the variables are integrated of order zero, I (0). To capture the effects of the Iran-Iraq war and also political instabilities of the 1979 revolution, we defined a dummy variable, named WAR, which is 1 between 1979-1988 and 0 otherwise, to include areas of the revolution, seizing the American Embassy in Tehran by revolutionary students (1979), and Iran-Iraq war (1980-1988) in the VAR models.

4. Empirical Results

Firstly, we estimated equation (2) using the maximum likelihood method. Table 2 shows the estimated factor loadings (vector $\hat{\Lambda}$) and model evaluation tests; chi-squared and Bartlet Chi-squared. The null hypothesis of the two tests is that the correlation matrix of the variables in Table 1 is an identity matrix, meaning that there is no relationship between the variables of the vector X_t . In other words, an identity correlation matrix means the variables are unrelated and not ideal for factor analysis. A significant statistical test shows that the correlation matrix is not an identity matrix. Table 2 shows that two test statistics are significant at 95 percent confidence interval, which means there is a meaningful relationship between the variables and the factor loadings, so we can estimate $\hat{F}_t$.

Table 2. Estimates of Factor Loadings of Equation (2)
Method: Maximum of Likelihood

	Loadings		
	F1	Communality	Uniqueness
EXCHANGE	0.125860	0.015841	0.984159
CAP	-0.811230	0.658095	0.341905
GDP	0.071992	0.005183	0.994817
GDPPER	0.909399	0.827006	0.172994
INF	-0.154810	0.023966	0.976034
NONOIL	0.822703	0.676841	0.323159
OILINCOME	0.900826	0.811487	0.188513
CPRIVATE	-0.006071	3.69E-05	0.999963
GPRIVATE	-0.028167	0.000793	0.999207
INVESTMENT	-0.077230	0.005965	0.994035
DEFLATOR	-0.181374	0.032897	0.967103
Chi-square			
	statistic	Bartlett chi-square	

Test Statistics	148.9405	129.7024
Probability	0.0000	0.0000
Parameters	22	
Degrees-of-freedom	44	

Source: Research finding.

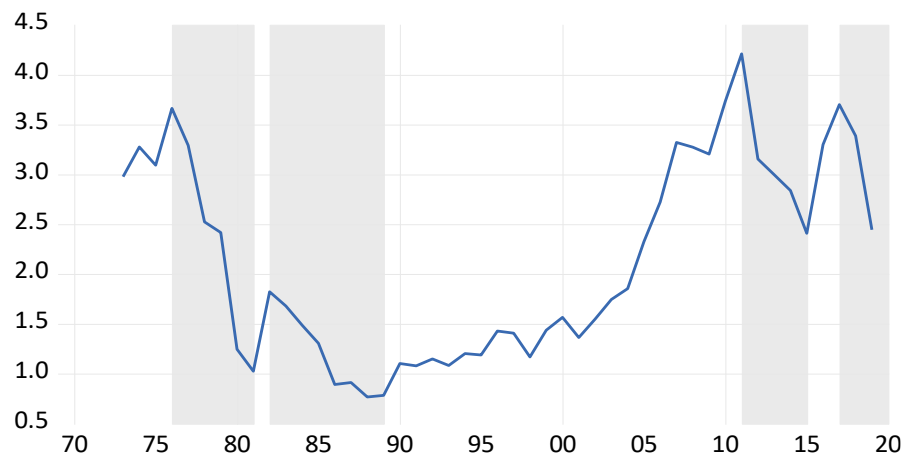


Figure 2. Estimated Index of Economic Condition ($\hat{F}_t$) Based on Table 2

Source: Research finding.

Figure 2 shows the estimated $\hat{F}_t$ based on the factor loadings in Table 2. There are four distinct periods of significant falling of the index; a) 1976-1981 is the period of political inconstancy (including the 1979 revolution and the beginning of the war between Iran and Iraq), b) 1982-1988 includes events of the war up to acceptance of the UN resolution number 598 by Iran and end of the war, c) 2011-2015 which is the era of the intense Iranian economic sanctions by the UN, EU and US (oil embargo, sanctions against Iranian Central Bank and financial sanctions) which ended with JCPOA, and d) 2017-2019 which is the era of the maximum pressure campaign of Trump's administration against the Iranian economy. The figure shows that sanctions and political instabilities could change the direction of $\hat{F}_t$, so we can interpret it as an economic condition index or an economic prosperity index. In other words, bad political events and economic sanctions can reflect their effects as turning the direction of $\hat{F}_t$ to lasting descends as long as the effects endure. Furthermore, we can use of $\hat{F}_t$ as an acceptable estimate of the economic condition and its ongoing descends as the signs of a bad political environment, mainly because of economic sanctions (in the case of the Iranian recent decades of economic history).

By estimating equation (2), we can estimate equation (1) using the standard method of least squares ¹. Before estimating the VAR models, it is necessary to test the stationarity of the variables and to determine their lag lengths. Based on the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test, we cannot reject the null hypothesis of stationarity for the study variables at 5 percent type I error (Table 3). We have also determined lag orders by information criteria (Akaike information criteria and Swartz Bayesian information criteria). To ensure that the lag orders are appropriate, we have tested the hypothesis of no serial correlation in all the VARs' residuals. We would change the lag orders in the VAR model until the rejection of the no serial correlation hypothesis (Table 4).

Table 3. KPSS Unit Root Test of the Variables of the Three VAR Models

Variable	KPSS Test Statistics	Test Results
F	0.307018*	Stationary
GDPPIR	0.23359*	Stationary
GINI	0.134693*	Stationary
INF	0.314439*	Stationary
PALMA	0.064436*	Stationary
CV	0.078267*	Stationary

Source: Research finding.

Note: * Denotes significant at 95 percent level.

Table 4. Serial correlation Test of 3 VAR residuals

Var with CV as Inequality index (CV VAR)			
Lag	LR stat	df	Prob.
1	21.43681	16	0.1623
2	18.09661	16	0.3183
3	16.52256	16	0.4171
4	13.34631	16	0.6473
Var with GINI as Inequality index (GINI VAR)			
Lag	LR stat	df	Prob.
1	26.53404	16	0.0470
2	12.46881	16	0.7111
3	10.04337	16	0.8644
4	16.20753	16	0.4386
Var with PALMA as Inequality index (PALMA VAR)			
Lag	LR stat	df	Prob.
1	22.59451	16	0.1250

¹. Variables are in logarithmic form.

2	17.33560	16	0.3642
3	16.37736	16	0.4269
4	11.34324	16	0.7878

Source: Research finding.

Note: Null hypothesis: No serial correlation at lag h.

Besides implementing LM tests of serial correlation, we have tested the normality of the residuals by the Jarque-Bera chi-squared test. The idea is that if the VARs are well specified, their residuals will behave approximately stochastically with no significant skewness and excess kurtosis relative to the normal distribution. The results show no significant deviation from the normal hypothesis in the three VAR residuals (Table 4).

Table 5. Test of Normality in VAR Residuals

VAR Residual	Jarque-Bera	df	Prob.
CV VAR	7.668560	8	0.4665
GINI VAR	13.52926	8	0.0949
PALMA VAR	3.205043	8	0.9208

Source: Research finding.

Figure 3 shows responses of the inequality indices of the three VAR models to one standard deviation innovation to shocks. To identify the shocks, we have followed the approach by Pesaran and Shin's (1998) Generalized Impulses, which is insensitive to the ordering of the variables in the VARs. As various panels of the figure show, responses of CV and PALMA indicators as alternative indices of consumption inequality are alike. However, GINI responses to the shocks of different variables are unlike them.

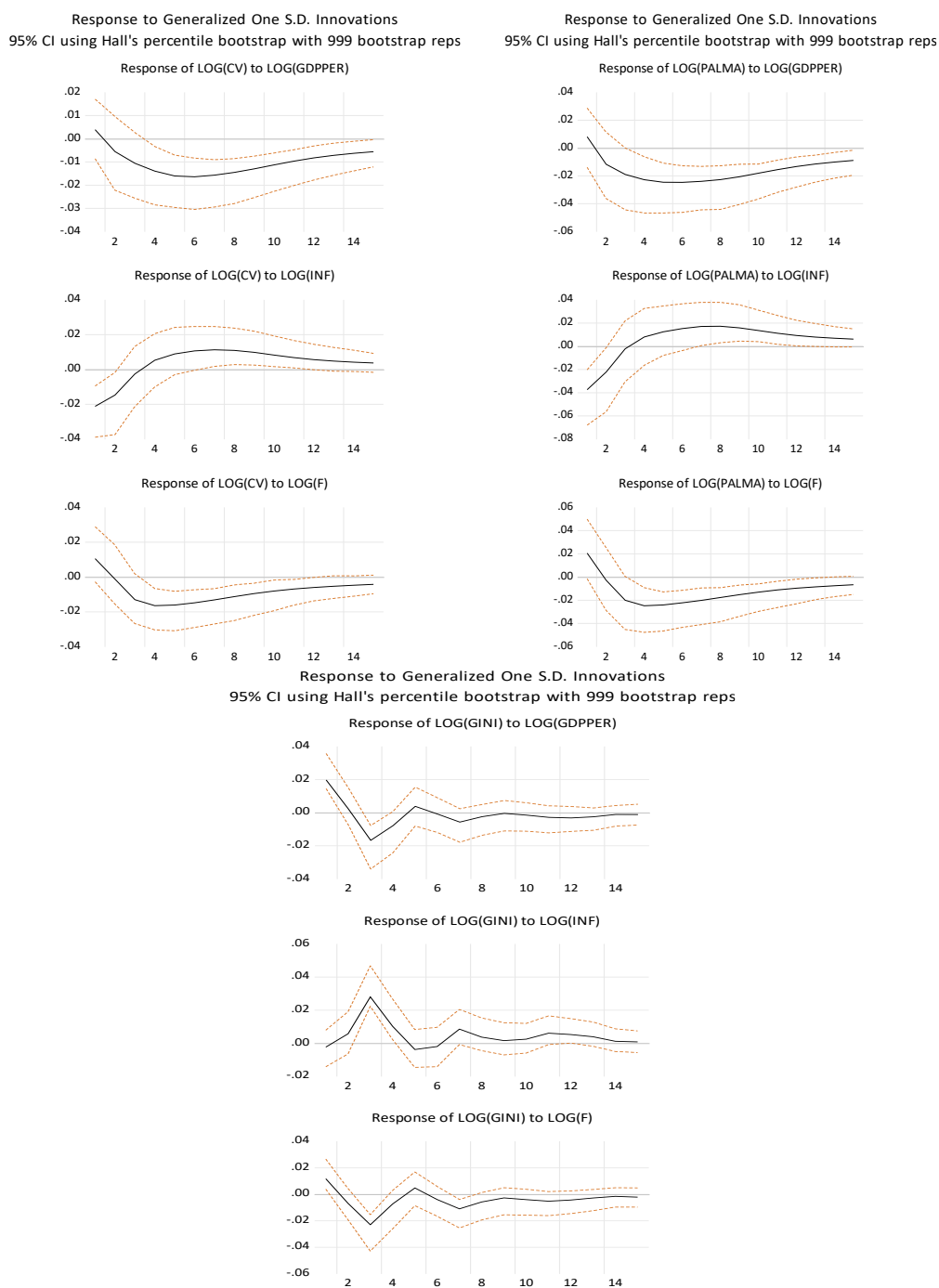


Figure 3. Response Functions of Inequality Indices to One Standard Deviation Innovation to Variables

Source: Research finding.

All the responses are significant in 95 percent confidence intervals. The figure shows that an increase in GDP per capita will smoothly decrease consumption inequality in Iran. Unlike consumption inequality, the response of income inequality (GINI) to an increase in GDP per capita is variable. The Response of consumption inequality to inflationary shocks is negative in the initial years, but it is reverse in subsequent years. It confirms that inflationary shocks in the medium to long run increases consumption inequality. Like the response of income inequality, the response of the income Gini index to inflationary shocks is variable and differs from that of consumption inequality indices, but overall, it shows that inflationary shocks will increase income inequality.

To better compare the impacts of sanctions on income and consumption inequality, Figure 4 indicates the three responses of inequality indices to one standard deviation innovation to economic conditions ($\hat{F}$). Remember that sanctions ruin economic conditions, so an increase in the level of sanctions causes a decrease in the economic condition index. In other words, sanctions have a negative relationship with the economic condition index, $\hat{F}$, as their effects reflect on dimensions of $\hat{F}$. Figures 3 and 4 show that all responses are significant in a 95 percent confidence interval, so we can say that improvement of economic conditions, as expected, has a meaningful impact on income and consumption inequality. Responses of consumption inequality to an economic condition shock are smooth. Moreover, it confirms that better economic conditions lead to more consumption equality in the Iranian economy. The response of income inequality is more variable, but it is in general in the same direction. Therefore, we can say that the effects of sanctions on the Iranian economy were followed by increases in economic inequality, but the effects on consumption inequality are smoother.

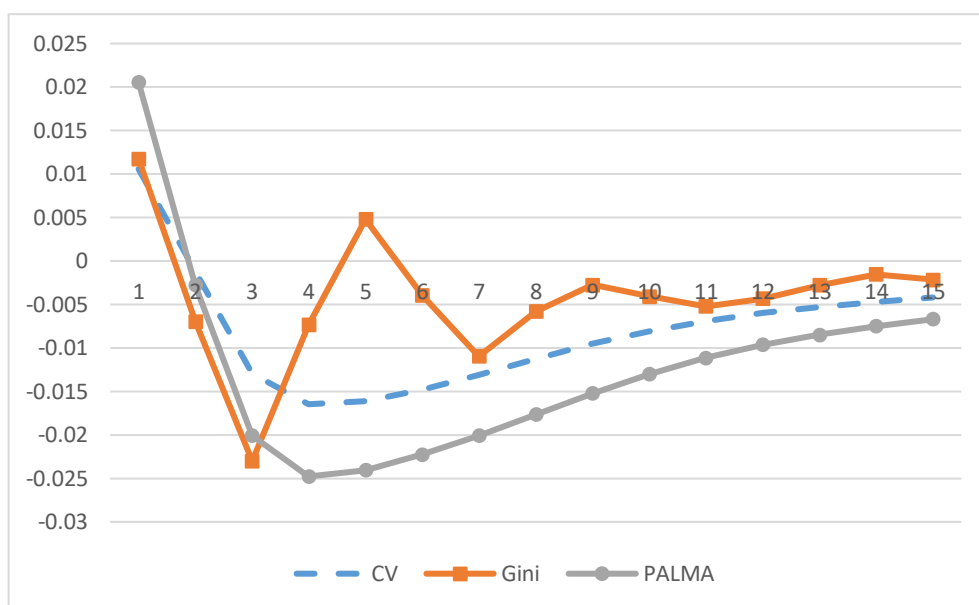


Figure 4. Responses of Inequality Indices to One Standard Deviation Innovation to Economic Conditions ($\hat{F}$)

Source: Research finding.

Table 6 contains variance decompositions of the three inequality variables. As results show, the economic condition index explains a significant share of the variances of three inequality variables between 5 to 10 years. This finding indicates that sanctions have a prominent share of inequality in the Iranian economy.

Table 6. Variance Decompositions of the three VAR Models

Part 1: Variance decomposition of log (CV)					
Period	S.E.	LOG(CV)	LOG(GDPPER)	LOG(INF)	LOG(F)
1	0.041634	100.0000	0.000000	0.000000	0.000000
		(0.00000)	(0.00000)	(0.00000)	(0.00000)
5	0.060773	74.06496	17.74482	1.134690	7.055535
		(14.7906)	(12.4026)	(7.72886)	(11.7123)
10	0.069286	59.31539	33.78670	1.252384	5.645529
		(15.1241)	(15.0854)	(9.27983)	(12.1595)
15	0.071378	56.12535	37.20484	1.318026	5.351781
		(16.1375)	(16.4928)	(9.98865)	(12.8090)
Cholesky Ordering: LOG(CV) LOG(GDPPER) LOG(INF) LOG(F)					
Standard Errors: Monte Carlo (100 repetitions)					
Part 1: Variance decomposition of log (Gini)					
Period	S.E.	LOG(GINI)	LOG(GDPPER)	LOG(INF)	LOG(F)
1	0.041105	100.0000	0.000000	0.000000	0.000000

		(0.00000)	(0.00000)	(0.00000)	(0.00000)
5	0.058171	61.35757	11.66795	19.64710	7.327377
		(12.0801)	(8.07393)	(8.73604)	(7.02286)
10	0.062138	56.07439	12.32102	18.97392	12.63068
		(13.1555)	(9.13862)	(9.57058)	(7.31689)
15	0.063341	54.71167	13.02868	19.64367	12.61599
		(13.9369)	(10.0792)	(10.4581)	(7.78195)

Cholesky Ordering: LOG(GINI) LOG(GDPPER) LOG(INF) LOG(F)

Standard Errors: Monte Carlo (100 repetitions)

Part 1: Variance decomposition of log (Palma)					
Period	S.E.	LOG(PALMA)	LOG(GDPPER)	LOG(INF)	LOG(F)
1	0.067499	100.0000	0.000000	0.000000	0.000000
		(0.00000)	(0.00000)	(0.00000)	(0.00000)
5	0.096950	74.17515	19.83141	0.728844	5.264599
		(14.2647)	(13.3700)	(6.34649)	(8.56859)
10	0.109845	60.50891	34.29082	0.913233	4.287038
		(15.5793)	(16.0907)	(5.88849)	(8.87341)
15	0.113294	57.28542	37.63906	1.001675	4.073846
		(16.7486)	(17.5962)	(6.14833)	(9.90416)

Cholesky Ordering: LOG(PALMA) LOG(GDPPER) LOG(INF) LOG(F)

Standard Errors: Monte Carlo (100 repetitions)

Source: Research finding.

The difference in responses of income inequality and consumption inequality to shocks shows that selection of the inequality indexes among various variables such as income, consumption, and wages is a crucial step in the inequality analysis. As explained in the theoretical background, there is more emphasis on consumption because it better reflects consumer's utilities than income. Therefore, differences in the response of income inequality relative to consumption inequality show that there is a different mechanism between income and consumption. The information problems of income indices, the existence of consumption smoothing behavior, different dynamics in relative prices of goods consumed by different income levels of society, the possibility of saving and borrowing for consumers, the existence of transfers from governments, and higher consumption of leisure are possible explanations for different trends in income and consumption responses to an economic shock. We have shown that consumption inequality responded to economic shocks, and economic sanctions have a meaningful impact on consumption inequality in Iranian society.

Drawn on the literature of the consumption theory and following the life-cycle hypothesis of Modigliani and Brumberg (1955) and the Permanent Income

Hypothesis of Friedman (1957), we recognize that risk-averse consumers prefer to have a smooth consumption flow. Therefore, consumers base their consumption decisions on the permanent part of their income, rather than the current income. Thus, changes in income distribution will not map exactly onto consumption distribution. Our results confirm the idea that the responses of consumption inequality to the shocks in economic volatilities are smoother than income inequality.

Our results showed that the sanctions do not have similar effects on the Iranian economy, as Figure 2 shows, which confirms that the structure of sanctions against Iran was not the same over time. As it was said in the theoretical part of the paper, the sanction arrangement and its various restriction types could affect income and consumption distribution (Brooks, 2002; Jeong, 2020). So, our results support the idea and show that the sanctions of the Obama administration and the maximum pressure campaign of Trump have had effects on the Iranian economy, as they turned the economic conditions index (see Figure 2). In general, we can conclude that the sanctions of the 2010s have had significant distributional impacts on Iranian society and have hit the poor people more than the rich people.

5. Conclusion

This paper aimed to model the effects of economic sanctions on economic inequality. We constructed an index of economic conditions that could reveal information about economic sanctions and other events that degrade economic prosperity. Our idea was that the sanction trend as a variable is not visible and measurable in statistics, but its economic impacts can be measured. The results showed that in the Iranian economy, economic sanctions (especially recent sanctions by the US, EU, and UN) have had effects on economic prosperity. Our results showed that inflationary shocks have had impacts on consumption equality in the Iranian economy. Furthermore, we can say that the effects of sanctions on the Iranian economy were followed by increasing in economic inequality, but the consumption inequality increased more obviously. The results showed that improvement of economic conditions, as expected, will have significant effects on income and consumption inequality, but responses of consumption inequality to shocks to economic condition is smooth and, in general, our findings indicate that better economic conditions are followed by more consumption equality in Iranian economy. The response of income inequality is more variable, but, overall, it is in the same direction. The difference in responses of income inequality and consumption inequality to shocks shows that it is important to focus on inequality

index. We have indicated that consumption inequality significantly responds to inflationary shocks and per-capita income shocks. Also, economic sanctions have had significant and continuous impacts on consumption inequality in Iranian society.

Our results support the idea and show that the sanctions of the Obama administration and the maximum pressure campaign of Trump have had effects on the Iranian economy. Therefore, we can conclude that the sanctions of the 2010s have had significant distributional effects on Iranian society and have hit the poor people more than the rich people.

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Upper Bounds of Stock Portfolio Investment Risk Using Value at Risk (Case Study: Indonesian Blue-Chip Stocks in 2022)

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Abstract

In recent years, stocks become the most preferred asset by Indonesian investors. Besides offering large profits, stock investment also has a risk factor that can occur at any time. One way to minimize risk is to form a stock portfolio. This paper aims to measure the upper bounds of the portfolio loss risk formed by several single assets that are mutually dependent. The upper bound value is chosen because the exact value of portfolio loss risk is difficult to obtained by Convolution or Panjer Recursion methods. The main analysis of this research is formed the upper bounds of stock portfolio investment risk using VaR with Cornish Fisher Expansion approach by utilized comonotonicity and convex order properties. The portofolio contains of 3 single asset (ARTO.JK, ITMG.JK, and MIKA.JK) which collected from IDX Indonesia from 10/25/21 to 10/21/22. The novelty of this research is combined comonotonicity and convex order properties with VaR-CFE to get upper bounds of portolio risk prediction. The result show that at 95% significance level and 1-day holding period, the upper bounds of VaR-CFE prediction for the portfolio is -0.1394. The social impact of this research can be a benchmark to get accurate risk prediction of their portfolio asset.

Keywords: Comonotonicity, Convex Order, Portfolio, Risk, Value at Risk-Cornis Fisher Expansion.

JEL Classification: G11, G32.

1. Introduction

Investment, as economic activities of Indonesian having various backgrounds (Fernandez et al., 2020), has been chosen to meet their needs and prepare for a

better life in the future (Maruddani and Trimono, 2021). According to (Ridha and Budi, 2020), apart from being able to improve people's living standards, investment activities can also encourage national economic growth by increasing the GDP value. Murti and Sahara (2019) stated that countries with a favorable investment climate tend to have better economic growth than countries with a stagnant investment climate.

Financial assets traded on the IDX Indonesia including stocks, options, futures, mutual funds, and bonds (Tarno et al., 2020). According to the Indonesian Securities Custodian (KSEI), during 2017-2022, there was a significant increase in the number of official investors registered with IDX Indonesia (KSEI Indonesia., 2022a). In 2017, the number of registered investors was 1,000,289 (KSEI Indonesia, 2017), then in November 2022, it rise to 10,000,628 (KSEI, Indonesia, 2022b), or increased by 999.77%. This trend shows the increasing public interest to invest in financial assets. Stocks are the assets most in demand by investors. As of November 2022, 4,323,643 of 10,000,628 investors in IDX Indonesia were stock investors (KSEI Indonesia., 2017).

In order to improve the performance of each company and provide a reference for potential investors, IDX Indonesia releases a list of stocks of those categorized as blue-chip. According to (Maruddani and Trimono, 2021), blue-chip stocks are the most recommended stocks for investors because they provide stable profits. Jagati (2019) suggested that beginner and middle-class investors with investment funds between IDR 10 million and 100 million choose blue chip stocks, as they have a stable performance and high selling power. Thus, if investors want to resell their own stocks, finding potential buyers will not be difficult.

According to Murata and Hamori (2021), stock investment also has a risk factor for losses that can occur at any time apart from offering large and relatively fast profits. In stock trading activities, stock prices often experience fluctuations caused by various factors. Therefore, investors must choose the right investment strategy to maximize profit with the possible minimum risk (Avramov et al., 2013). One way to minimize risk in stock investment is to diversify. The diversification process involves forming an efficient stock portfolio with minimum risk. According to Radović, Radukić and Njegomir (2018), an efficient portfolio can produce optimal profit levels with the lowest loss risk.

However, the formation of a portfolio is only to minimize risk, not to eliminate it (Zanfelicce and Rabechini Jr, 2021). Consequently, investors need to know the estimated limit value of losses that may occur to maintain investment stability and prevent investments from bankruptcy. Meanwhile, according to

(Trimono et al., 2019), predicting the loss risk can be done using the VaR. VaR predicts an asset's maximum loss value under normal market conditions at a certain confidence level and period. In measuring portfolio risk using VaR, the distribution function of the portfolio is needed (Tarno et al., 2022a). However, it is difficult to determine the joint distribution function of two independent random variables (Jakobsons et al., 2016). Therefore, an alternative to calculating the estimated risk value of a stock portfolio in which its single assets are not mutually exclusive is calculating the upper bound of the portfolio risk value without using the joint distribution function (Xing and Li, 2018). Furthermore, the value of the upper bound for the loss risk obtained can be used as a reference by investors to prepare actions and strategies that must be taken if one day the risk occurs (ARAI, 2017).

The aim of this study was to establish an upper bound on the loss risk in a blue-chip stock portfolio at IDX Indonesia with the single stocks making up the portfolio that is not mutually dependent (mutually dependent). The upper bound model was developed by utilizing the komonotonic and convex order characteristics of the single stock returns that make up the portfolio. There were two novelties offered in this study. The first was using the VaR with Cornish Fisher Expansion (CFE) approach to calculate the value of the upper bound of losses on a stock portfolio. In previous research on determining VaR as the upper bounds of portfolio risk (i.e., Bernard et al., 2017; Ansari and Rüschenclorf, 2020), there was no explanation of the construction of the VaR model using the CFE approach. The next novelty was the involvement of three mutually dependent single assets with a negative correlation as portfolio constituent variables. Some previous research on this topic used two variables for the numerical simulation; these studies include Jakobson et al. (2015) and Maggioni and Pflug (2019).

2. Literature review

In determining the upper bound of loss risk for the IDX Indonesia blue chip stock investment portfolio, this study referred to several relevant similar studies to obtain optimal research results. Several previous studies related to risk analysis of stock investment portfolios include; Hadiyoso, Firdaus and Sasongko (2016) used the single index model to develop an optimal portfolio of 43 Islamic stocks at IDX. In a numerical simulation, using historical price data from /05/12/11 to 07/04/14, the result showed that the most significant proportion of the portfolio is MKPI.JK with value of 11.32%, while the smallest one is KOIN.JK (0.05%). The stock that have a large proportion of the formation of the portfolio (more than 5%) primarily stocks from the trade, property, and basic chemical industry sectors. However, an analysis

of the loss risk was not available, considering that the risk was also an essential indicator in the portfolio. Thus, it needed to be further studied.

Sumaji, Hsu and Salim (2017) analyzed market risk values using VaR on nine manufacturing company stocks listed on IDX LQ-45. The result showed that the stock portfolio was formed based on the Markowitz method without regard to the independence between stocks. The analysis showed that the VaR model with the variance-covariance approach is the best model for measuring the maximum potential loss of a manufacturing stock portfolio. Salsabila and Hasnawati (2018) investigated the value of portfolio risk in the Indonesian Companies Listed on the LQ45 Index for the 2013–2016 period. They constructed the portfolio based on the Markowitz method without examining the dependencies of every single asset making up the portfolio. Then, the portfolio formed was used as a reference for predicting the value of the loss risk.

Next, Pasaribu (2019) explored the amount of loss risk in a portfolio composed of liquid stocks on the Indonesian stock market. However, this study did not specifically explain the procedure for compiling a stock portfolio; they used a portfolio determined in another study and then analyzed the value of the loss risk using VaR. Juniar et al. (2020) formation of an optimal portfolio with the Markowitz model and analyzed the loss risk based on VaR for 10 Sharia stocks in the Jakarta Islamic Index. In this study, there was no dependency test on each stock, so there was no conclusion about whether single asset were mutually dependent or mutually independent. Loss risk analysis of Portfolio formation was carried out using VaR-MCS. The results showed that for a single asset, at a 99% confidence level and a one-day holding period, the most significant loss occurred in ADRO.JK, which was -7.24%. VaR MCS predicted a loss of -4.32% in the stock portfolio with the same confidence level and holding period. The result suggested that the portfolio can minimize the value of the loss risk.

KSEI Indonesia. (2022b) reported that banking stocks are among the most in demand by investors. Referring to this fact, Sholikhah, Sudarto and Shaferi, (2020) analyzed banking stocks by forming a portfolio to minimize the loss risk. Based on the stock price of 10 banks in Indonesia in March - July 2020, the MVEP method resulted that stocks with the highest proportion were BBNI.JK (20.23%) and stocks with the lowest proportion were BBHI.JK (1.32%). This study did not include the process of preparing a portfolio, so it was likely that the results obtained needed to be more accurate. Research related to Indonesian banking stocks was also conducted by Irsan, Priscilla and Siswanto (2022). They particularly examined the risk value using the VAR model with a historical simulation and variance-

covariance approach. The portfolio weight was determined using the MVEP Method. The drawback of this study was not to test the dependence on three banking stock prices that were the research sample. The results showed that in the 95% confidence level and holding period of one day, the results of the prediction of losses by holding variance-covariance and historical simulation were -0.02790 and 0.01978.

According to Embrechts et al. (2013), to measure the loss risk in a stock portfolio, a distribution function of portfolio return is needed, where the distribution function of portfolio return is a joint distribution function of single asset return. If the return price of a single asset is mutually independent, then determining the distribution function of portfolio returns is easy to determine (Bernard et al., 2018). Nevertheless, the distribution function of portfolio returns will require more work to determine if single-asset returns are mutually dependent (Bignozzi et al., 2015). To solve this problem, Pucetti (2013) proposed an alternative to calculating the upper bound of portfolio loss risk without using the portfolio distribution function. Chen et al. (2022) guaranteed that the upper bound obtained will always be more significant or at least the same as the actual loss risk.

Based on previous research, this research predicted the loss risk in a stock portfolio composed of 3 stock assets that were not mutually exclusive. The risk measure used was Value-at-Risk (VaR) with the Cornish Fisher Expansion (CFE) approach. The stocks used in this study were three blue chip stocks at IDX Indonesia, which were not mutually exclusive with negative correlation values. This proposition was based on the findings of Achudume and Ugbebor (2021). They suggested that a portfolio will be optimal if every single asset composed of it is negatively correlated so that if one stock suffers a loss, other stocks can still cover the loss.

3. Data and Methods

3.1 Data Description

In this study, an analysis of the upper bound of VaR on the stock portfolio used the stock data of Blue-chip companies at IDX Indonesia in 2022, which were Jago Bank (ARTO.JK), Indo Tambangraya Megah (IMTG.JK), and Mitra Keluarga Karyasehat (MIKA.JK). They were selected following the concept of forming a portfolio put forward by (Tarno et al., 2020) and (Tarno et al., 2022b) that the main objective of forming a portfolio was to optimize the return value by reducing the loss risk to as small as possible. In achieving the goal, the portfolio's single asset returns had to be negatively correlated. So, one day, one of the assets suffered a

loss. In that case, there was still a significant possibility that the other asset would record a profit.

3.2 Convex-order

Convex order is one of the methods used to compare two random variables with identical and finite expected values. The following is the convex-order definition for a single random variable, according to (Lu et al., 2018).

Definition 1. [Convex-order] Let X_1 and X_2 be two random variables, and g is a convex function such that the values $E[g(X_1)]$ and $E[g(X_2)]$ are defined. X_1 is said to be smaller than X_2 in convex-order ($X_1 \leq_{co} X_2$) if $E[g(X_1)] \leq E[g(X_2)]$.

According to Florea et al. (2015), Convex-orders are closely related to stop-loss orders; this can be seen from a bi-implicated relationship between the two. The definition of stop-loss-order for two single random variables, according to Bouhadjer et al. (2016), is as follows:

Definition 2. Suppose there are two random variables, X_1 and X_2 . X_1 is said to be smaller than X_2 in the stop-loss-order ($X_1 \leq_{sl} X_2$) if for every constant K holds:

$$E[(X_1 - K)_+] \leq E[(X_2 - K)_+] \text{ and } E[X_1] = E[X_2] \quad (1)$$

Referring to Jain and Gupta (2018), apart from the bi-implication relationship, several relationships between convex orders and stop-loss orders are as follows: (i) if $X_1 \leq_{co} X_2$, then $E[X_1] = E[X_2]$; (ii) If $X_1 \leq_{co} X_2$ then $X_1 \leq_{sl} X_2$; (iii) $X_1 \leq_{sl} X_2$ then $X_1 \leq_{co} X_2$.

3.3 Commonotonic Random Variables

Suppose we have a set X which contains some N random variables, namely, $X_1, X_2, \dots, X_N$. A is a commonotonic set if one of the following equivalent statements is fulfilled (Gao and Zhao, 2017): (1) X has commonotonic-support. A commonotonic set $A \subset \mathbb{R}^N$ is called commonotonic-support of X if $P[X \in A] = 1$. (2) For every $x = (x_1, x_2, \dots, x_n)$, then $F_X(x) = \min \{F_{X_1}(x_1), F_{X_2}(x_2), \dots, F_{X_n}(x_n)\}$ (3) For random variable $U \sim \text{Uniform}(0,1)$, valid X similar in distribution to $(F_{X_1}^{-1}(U), F_{X_2}^{-1}(U), \dots, F_{X_N}^{-1}(U))$; (4) There is a random variable Z and an undecreasing function φ_i such that X is similar in distribution to $(\varphi_1(Z), \varphi_2(Z), \dots, \varphi_N(Z))$.

According to Kumar and Srinivasan (2014), one of the characteristics of the random variable is having a distribution function that plays a vital role in predicting risk values. Suppose X is a single random variable with the $F_X(\cdot)$ distribution function. Based on Cheung and Vanduffel (2013), for each random variable X , there is X^C which is the Commonotonic Random Variable of X , and there is φ which is a non-degenerate function, and random variable Z so that X^C is similar in the distribution of $F_X^{-1}(U)$. As U is distributed Uniformly (0,1), in the end, the values of $F_X^{-1}(U)$ are the values of the random variable X itself. As a result, X is similar in distribution to X^C , and the distribution function of X^C is the same as the distribution function X , namely $F_X(\cdot)$ (Ortega-Jiménez et al., 2021).

The Upper Bound in Convex-Order for Stock Portfolio

According to Jakobsons and Vanduffel (2015), a convex-order bound applies for each random variable X , which is a single asset return, and S_N , which is a portfolio return of N stock assets. Furthermore, the upper bound in the convex order will be a reference for measuring the bound of the loss risk for the S_N portfolio. For $X_1, X_2, \dots, X_N$, which are returns from some N stocks, S_N is obtained through the following equation (R. Zhou and Palomar, 2021):

$$S_N = X_1 + X_2 + \dots + X_N \quad (2)$$

Bernard et al. (2017) state that the upper bounds in the convex-order sequence for X and S_N are X^C and S_N^C . X^C is the commonotonic random variable of X , while S_N^C is the commonotonic random variable of S_N . So, mathematically, it can be written as:

$$S_N \leq_{co} S_N^C \quad (3)$$

Inequality (3) implies S_N^C also being the upper bound of the stop-loss order for S_N , so it can be written as follows:

$$S_N \leq_{sl} S_N^C \quad (4)$$

According to Haugh et al. (2015), since every X_i is guaranteed to have X_i^C as a boundary in the convex-order, then S_N^C can be obtained by adding up each X_i^C value, namely:

$$S_N^C = X_1^C + X_2^C + \dots + X_N^C \quad (5)$$

Then, the inverse distribution function for from S_N^C at point $\alpha \in (0,1)$, i.e. $F_{S_N^C}^{-1}(\alpha)$ is given by the following theorem:

Theorem 1. (Sun X. et al., 2018) inverse distribution function for from S_N^C at point $\alpha \in (0,1)$, defined as:

$$F_{S_N^C}^{-1}(\alpha) = \sum_{i=1}^n F_{X_i}^{-1}(\alpha) \quad (6)$$

The Upper Bound of VaR on the Stock Portfolio

In stock portfolios, a risk measure can be used to predict the loss risk that might occur in the future (Zhou et al., 2018). In this study, the risk measure used is VaR-CFE. Theoretically, VaR is the maximum risk value that can still be tolerated at a confidence level of $1-\alpha$, $\alpha \in (0,1)$ with a specific holding period. Suppose S_3 is a random variable representing the portfolio return of 3 stocks, VaR for S_3 at a confidence level of $(1 - \alpha)$ is defined as (Alshamali et al., 2021):

$$VaR_{1-\alpha}(S_3) = F_{S_3}^{-1}(\alpha) \quad (7)$$

that is, $F_{S_3}^{-1}(\cdot)$ is the inverse of the distribution function of $F_{S_3}(\cdot)$.

According to Feng, Wächter and Staum (2015), to predict the value of $VaR_{1-\alpha}(S_3)$, a distribution function $F_{S_3}(\cdot)$ and an inverse distribution function $F_{S_3}^{-1}(\cdot)$ are needed. If X_1 , X_2 and X_3 are single asset returns that makeup mutually independent portfolio returns, then $F_{S_3}(\cdot)$ is relatively easy to determine using the Convolution or Panjer Recursion method (Cooper et al., 2021). However, if X_1 , X_2 and X_3 are mutually dependent, $F_{S_3}(\cdot)$ and $F_{S_3}^{-1}(\cdot)$ become difficult to determine. As a result, the VaR model cannot be constructed, and we cannot estimate the loss risk. To overcome this problem, (Hanbali et al., 2022) introduced another alternative to predict the loss risk, namely by determining the upper bound value for $VaR_{1-\alpha}(S_3)$. The upper bound of $VaR_{1-\alpha}(S_3)$ is given by the following theorem:

Theorem 2. (Dhaene et al., 2014) for every random variable Y and Z , apply:

$$Y \leq_{sl} Z \Leftrightarrow VaR_{1-\alpha}(Y) \leq VaR_{1-\alpha}(Z) \quad (8)$$

which applies to every $\alpha \in (0,1)$.

In previous section, it has been explained that for each S_3 , one can construct S_3^C , a commonotonic random variable of S_3 , as well as an upper bound for S_3 in convex orders and stop-loss orders. Therefore, based on Theorem 2, it is obtained

$$VaR_{1-\alpha}(S_3) \leq VaR_{1-\alpha}(S_3^c) \quad (9)$$

So, the upper bound of portfolio loss risk is the VaR value of S_3^c . Then, the $VaR_{1-\alpha}(S_3^c)$ construct is determined based on the following theorem:

Teorema 3. (Cheung et al., 2017) Consider $X_1, X_2, \dots, X_N$ as commonotonic random variable, and suppose:

$$S_N^c = X_1^c + X_2^c + \dots + X_N^c \quad (10)$$

Then for every $\alpha \in (0,1)$, the additive properties of VaR apply, namely:

$$VaR_{1-\alpha}(S_N^c) = VaR_{1-\alpha}(X_1) + VaR_{1-\alpha}(X_2) + \dots + VaR_{1-\alpha}(X_N) \quad (11)$$

For a portfolio composed of 3 single assets, the predicted value of losses using the VaR method at a confidence level of $1-\alpha$ will not be greater than the sum of $VaR_{1-\alpha}(X_1)$, $VaR_{1-\alpha}(X_2)$, and $VaR_{1-\alpha}(X_3)$. Alternatively, if written in the equation is as follows:

$$VaR_{1-\alpha}(S_3) \leq VaR_{1-\alpha}(X_1) + VaR_{1-\alpha}(X_2) + VaR_{1-\alpha}(X_3) \quad (12)$$

Cornish Fisher Expansion (CFE) Approach on VaR Method

Amédée-Manesme et al. (2019) argue that if stock returns do not precisely follow the normal distribution (skewness = 0 and kurtosis = 3), then the results of calculating VaR with the HS, VC, and MCS approaches will be inefficient. To overcome this problem, the CFE method can be used as an alternative to calculating VaR. CFE tends to provide a larger estimate of the VaR value. However, the VaR estimate will be smaller, especially if the data return has a positive slope. Specifically, ECF considers skewness and kurtosis values in VaR calculations (Christoph et al., 2020).

By using the CFE approach, the α -th used for VaR measurements is expanded by the following formula (Rastegar and Amzajerdi, 2019)

$$CFE = q_\alpha + \frac{((q_\alpha)^2 - 1)S(X)}{6} + \frac{((q_\alpha)^3 - 3q_\alpha)\psi(X)}{24} - \frac{(2(q_\alpha)^3 - 5q_\alpha)S^2(X)}{36} \quad (13)$$

If the kurtosis value is less than 3, then the CFE formula is as follows:

$$CFE = q_\alpha + \frac{((q_\alpha)^2 - 1)S(X)}{6} + \frac{((q_\alpha)^3 - 3q_\alpha)K(X)}{24} - \frac{(2(q_\alpha)^3 - 5q_\alpha)S^2(X)}{36} \quad (14)$$

where, CFE is the Cornish-Fisher expansion value; q_α is the α -the quantile of Standard Normal distribution; $S(X)$ is the skewness of stock returns; $K(X)$ is the kurtosis of stock returns; $\psi(X)$ is the difference in excess kurtosis values. If the

initial investment value is V_0 and the holding period is t , then the VaR formula with the CFE approach at $(1 - \alpha)$ confidence level can be calculated as (Westgaard et al., 2020):

$$VaR_{\alpha}^{CFE}(X) = -V_0 \times (\mu - CFE \sigma) \times \sqrt{T} \quad (15)$$

with, μ is stock return mean, and σ is stock volatility.

Risk Prediction Accuracy with Backtesting Test

The concept of accuracy testing in the backtesting method calculates the violation ratio (Zhang and Nadarajah, 2018). In the period K_{E+1} to period K_U (length of the test window), the violation is symbolized by η_k , which is worth 1 if there is a violation and 0 if there is no violation in period k . R_t is the return in period k , and Adj-Esk is the value of Adj-ES in period k . The number of violations is symbolized by v_j with $j = \{0, 1\}$, where v_1 is the number of η_k which is worth 1 (the number of days the violation occurred), and v_0 is the number that is worth 0 (the number of days without a violation).

$$v_1 = \sum_{k=K_{E+1}}^K \eta_k \text{ and } v_0 = K_U - v_1 \quad (16)$$

The violation ratio (VR) is calculated by comparing v_1 with the expected number of violations. Where m_0 is the probability of the estimated violation, then

$$VR = \frac{v_1}{m_0 \times K_U} \quad (17)$$

If $VR = 1$ or $VR < 1$ then the risk prediction is accurate, meanwhile if $VR > 1$ then the risk prediction isn't accurate.

4. Result and Discussion

The historical stock price data that became the sample was from 10/25/21 to 10/21/22. So, with each variable, there will be 246 data. The following is a descriptive statistical value of historical stock price:

Table 1. Descriptive Statistics of Daily Historical Stock Price

	Mean	St. dev	Min	Max	Skewness	Kurtosis
ARTO.JK	12208.90	3846.02	4680	19000	-0.05798	-1.38039
ITMG.JK	29913.16	7947.07	19100	44175	0.31826	-1.22953
MIKA.JK	2481.88	234.61	2090	3050	0.08202	-1.22934

Soruce: Research finding.

Referring to the standard deviation value, the stock with the highest deviation from the average value was ITMG.JK. Meanwhile, the stock with the most homogeneous value and the lowest deviation was MIKA.JK. Similarly, based on the skewness value, the ITMG.JK and MIKA.JK stock price data tended to converge at a value smaller than the average because the two stocks had a positive skewness value. For ARTO.JK, the negative skewness value meant that the stock price data converged during the observation period at a value greater than the average. The kurtosis of all assets was less than 0. This state suggested that the distribution curve was flatter than a normal curve with the same mean and standard deviation. During the observation period, the three stocks experienced various price fluctuations. To find out the fluctuation pattern, we present a time series plot in the following figure:



Figure 1. Time Series Plots of Daily Historical Stock Price at Observation Period

Soruce: Research finding.

During the observation period, the stocks price experiencing the most significant price decline were Arto.JK. At the beginning of the period (10/25/21), the stock price was at the IDR 14,925 level; this value dropped to IDR 5.425 in the final recording period. Referring to Detik Finance, the main factor causing this decline was an increase in the benchmark interest rate issued by Bank Indonesia (Finance Detik, 2022). Unlike Arto.JK, two other stocks price experienced a significant increase. For MIKA.JK, the highest increase occurred around March - May 2022. As for ITMG.JK, the increase occurred more slowly from the beginning to the end of the recording period.

We need historical return values to construct the VaR model on upper-bound portfolio loss risk prediction. The return value is obtained in this study using the Log return method. Suppose there are P_t and P_{t-1} , which are stock prices in periods t and $t-1$, then the return value for period t can be obtained through the following equation:

$$R_t = \ln \left(\frac{P_t}{P_{t-1}} \right) \quad (16)$$

Descriptive statistical values for each single asset return are presented in the following table:

Table 2. Descriptive Statistics of Daily Historical Return

	Mean	St. dev	Min	Max	Skewness	Kurtosis
ARTO.JK	-0.00415	0.03888	-0.07201	0.18055	0.75772	2.11977
ITMG.JK	0.00231	0.02798	-0.07235	0.11790	0.41569	1.49769
MIKA.JK	0.00104	0.02289	-0.07134	0.07232	-0.00222	1.51736

Soruce: Research finding.

During the observation period, the stock that provided the most considerable average daily profit was ITMG.JK, which was engaged in coal mining. Coal was one of the largest mining commodities exported by Indonesia, and its price tended to increase during the observation period. The increased price was due to plans to lift the ban on coal imported from Australia, increase the capacity of coal rail transport, and improve logistics conditions because the weather was back to normal (Kompas, 2021). Furthermore, the stock with the lowest average return was ARTO.JK (-0.415%). This condition showed the value of the losses recorded by ARTO.JK during the observation period was more significant than the value of the profits received. The fall in digital bank stocks, such as ARTO.JK., was caused by expensive valuations compared to other big banks. Then, the average profitability of digital bank issuers was still relatively small. The highest profit values were recorded during the observation period by ARTO.JK, ITMG.JK, and MIKA.JK was 18.055%, 11.790%, and 7.23%, respectively. Referring to the Skewness value, ARTO.JK and ITMG.JK returns tended to center on a value that was smaller than the average; this was because the skewness of both was positive.

In determining the upper bound of the portfolio loss risk, the first procedure was to determine the portfolio model used. Because our goal was to determine the upper bound of the portfolio loss risk in general, the portfolio model we choose was the general model, namely:

$$S_{3,t} = R_{1,t} + R_{2,t} + R_{3,t} \quad (17)$$

with, $S_{3,t}$ is the portfolio return in period t . $R_{1,t}$, $R_{2,t}$, and $R_{3,t}$ respectively were the stock returns of ARTO.JK, ITMG.JK, and MIKA.JK in period t . Furthermore, before carrying out the correlation test, we performed a normality test for every asset return. The purpose of the normality test was related to selecting the best

correlation test method to be used. If every asset return was normally distributed, the best correlation test method was Pearson correlation, otherwise, we could use the Spearman method (Aghnitama et al., 2021). By using $\alpha = 5\%$, the normality test results using the Kolmogorov-Smirnov test are as follows:

Table 3. Normality Test of Daily Historical Return

	KS value	Sig	Decision
ARTO.JK	0.978	0.294	The data are normally distributed
ITMG.JK	1.207	0.109	The data are normally distributed
MIKA.JK	1.004	0.265	The data are normally distributed

Soruce: Research finding.

Table 3 shows that the value of each single asset return is $\text{sig} > \alpha$; therefore, we concluded that daily historical returns were normal. Since the data were normally distributed, the correlation test method chosen was Pearson's correlation. The Pearson correlation method calculates the correlation value based on the product moment of each data value on the corresponding variable. The statistical test values for the Pearson correlation test are given in the following table:

Table 4. Pearson Correlation Test Statistical Test Scores

	ARTO.JK	ITMG.JK	MIKA.JK
ARTO.JK	$r = 1$	$r = -0.133$ $\text{sig} = 0.037$	$r = -0.126$ $\text{sig} = -0.049$
ITMG.JK	$r = -0.133$ $\text{sig} = 0.037$	$r = 1$	$r = -0.163$ $\text{sig} = 0.011$
MIKA.JK	$r = -0.126$ $\text{sig} = 0.049$	$r = -0.163$ $\text{sig} = 0.011$	$r = 1$

Soruce: Research finding.

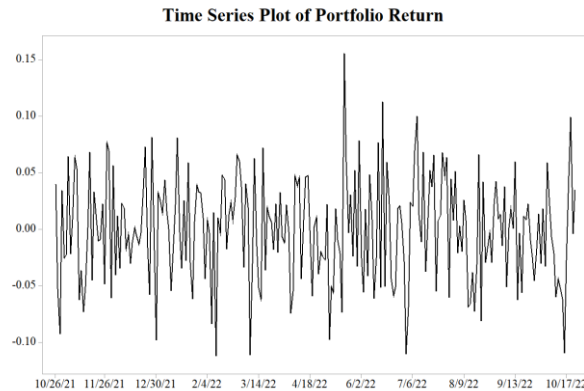
Table 4 shows a significant negative correlation between the three stock returns; therefore, the stock portfolio formed was ideal based on the rules for compiling a portfolio according to (Hersugondo et al., 2022). Before determining the upper bound for S_3 , we present the value of descriptive statistics for S_3 to obtain characteristics and descriptive information before we determined the upper bound of losses using VaR.

Table 5. Descriptive Statistics of Portfolio Return

	Mean	St. dev	Min	Max	Skewness	Kurtosis
Portfolio Return	0.08279	0.04578	-0.11208	0.15504	0.03070	-0.08684

Soruce: Research finding.

Table 5 exhibits that the formation of a portfolio can produce an average positive return and suggests that during the observation period, the profits obtained by investors were worth more than the losses received. The most significant loss value received on portfolio investment was -0.11208. However, this loss's value was smaller than the maximum profit value of 15,504%. In other words, the maximum profit earned could still cover the losses incurred. The distribution of portfolio return data tended to be centered on values below the average; this condition referred to skewness with a positive value. Furthermore, the most centered data distribution was in the value interval 0.03421 – 0.07882, with a frequency of 50 data. Furthermore, the time series plot of stock return is given in the following figure:

**Figure 3.** Time Series Plots of Daily Portfolio Return at Observation Period

Soruce: Research finding.

Figure 3 shows that the portfolio return is stationary during the observation period. It means there are no extreme jumps in value or outlier data. The highest profit value was recorded on 05/19/22, while the biggest loss occurred on 02/12/22. The previous chapter explained that the upper bound for portfolio losses using the VaR risk measure was the sum of the VaR values of each single asset return. The advantage of this method was that we did not need to construct a portfolio return distribution function, so the processing steps became efficient. Theoretically, the results obtained are guaranteed to be accurate.

The Upper Bound of Portfolio Loss Risk Using VaR with Cornish-Fisher Expansion (CFE)

For example, P_3 is a portfolio composed of ARTO.JK, ITMG.JK, and MIKA.JK stocks and S_3 is a portfolio return. In the t -period, the upper bound of the VaR of $P_{3,t}$ at each confidence level $(1 - \alpha)$ and the holding period w is obtained using the following formula:

$$VaR_{(1-\alpha),w}^{CFE}(S_3) = VaR_{(1-\alpha),w}^{CFE}(R_1) + VaR_{(1-\alpha),w}^{CFE}(R_2) + VaR_{(1-\alpha),w}^{CFE}(R_3) \quad (18)$$

with $VaR_{(1-\alpha),w}^{CFE}(R_1)$, $VaR_{(1-\alpha),w}^{CFE}(R_2)$, and $VaR_{(1-\alpha),w}^{CFE}(R_3)$ respectively the VaR value of ARTO.JK, ITMG.JK, and MIKA.JK. $VaR_{(1-\alpha),w}^{CFE}(S_3)$ would be the upper bound value of the VaR portfolio P_3 . The following parameters will be used to calculate the upper bound of VaR using the CFE approach:

Table 6. VaR-CFE Parameters for ARTO.JK, ITMG.JK, and MIKA.JK

Parameters		Value		
		ARTO.JK	ITMG.JK	MIKA.JK
Excess kurtosis		0	0	0
Sig level (1- α)		95% & 99%	95% & 99%	95% & 99%
Cornish-Fisher Expansion value (CFE Value)	$\alpha = 1\%$	-2.868	-2.713	-2.711
	$\alpha = 5\%$	-1.619	-1.632	-1.378
Holding period (day)		1, 3, and 5	1, 3, and 5	1, 3, and 5

Soruce: Research finding.

Since the observation period ended on 10/21/22, this date was the reference in determining risk predictions for the following periods. By using equation (23), the VaR- CFE value for a single asset at several confidence levels and holding periods is as follows:

Tabel 7. VaR- CFE for a Single Asset at 95% Confidence Level

	Holding period		
	1 day	3 days	5 days
ARTO.JK	-0.0588	-0.1018	-0.1315
ITMG.JK	-0.0480	-0.0831	-0.1073
MIKA.JK	-0.0326	-0.0564	-0.0729

Soruce: Research finding.

At the 95% confidence level, the single asset with the most significant loss risk was ARTO.JK, during the 1-day holding period, the VaR- CFE prediction was -0.0588, meaning that the value of the loss risk that would occur for one period after 10/21/22 was 5.88 % of the total funds invested. If an investor had IDR 100 million in funds, then within one day after that, the maximum possible loss that the investor would experience was IDR 5.88 million. Then, for a holding period of 3 and 5 days, the predicted loss of VaR- CFE for ARTO.JK was 10.18% and 13.15%, respectively. Furthermore, the single asset with the smallest loss was MIKA.JK. This company engaged in the health sector had a predicted loss of 3.26% for a 1-day holding period. Then, for the 3 and 5-day holding periods, the predicted loss risk was 5.64% and 7.29%. Furthermore, VaR- CFE predictions for the 99% confidence level can be seen in the following table:

Tabel 8. VaR- CFE for a Single Asset at 99% Confidence Level

	Holding period		
	1 day	3 days	5 days
ARTO.JK	-0.1074	-0.1860	-0.2401
ITMG.JK	-0.0782	-0.1355	-0.1749
MIKA.JK	-0.0631	-0.1093	-0.1411

Soruce: Research finding.

At the 99% confidence level, the stock with the highest loss prediction value and the slightest loss value was the same as at the 95% confidence level. ARTO.JK was the stock with the highest prediction of loss, and MIKA.JK was the stock with the minor prediction of loss. After obtaining the loss risk value of a single asset, then we used these results to obtain the upper bound of the VaR-ECF value for a stock portfolio made up of 3 single assets. The upper bound of the VaR-ECF portfolio was obtained by adding up the value of the loss risk of a single asset at the corresponding confidence level and holding period. The following are the upper bound of the portfolio VaR-ECF value at the 95% and 99% confidence levels:

Tabel 9. The Upper bound of Portfolio Loss Risk Using VaR- CFE

Confidence level	Holding period		
	1 day	3 days	5 days
95%	-0.1394	-0.2414	-0.3116
99%	-0.2487	-0.4307	-0.5560

Soruce: Research finding.

Table 9 shows that, at a 95% confidence level and 1 day holding period, the value of the loss investors received from the P_3 portfolio for the next period from 10/21/22 would not exceed 13.94%. For a 99% confidence level, the upper bound value obtained was 24.87%. As a validation, we constructed a P_3 loss prediction value to ensure that at the appropriate level of confidence, the predicted loss risk value did not exceed the upper bound value. For the 95% and 99% confidence levels, the VaR-ECF values for the stock portfolio were -0.0731 and -0.1112. This predicted value was smaller than the upper bound value, so the upper bound value obtained was valid for measuring the value of the loss risk in the stock portfolio.

Backtesting Test

In the risk prediction, the risk prediction results could be interpreted as an estimate of the losses that would occur; in other words, the risk value that would occur in these stocks was around the predicted value obtained. Since after calculating the upper bound of VaR, backtesting was carried out; thus, before making predictions, we first determined the estimation window (K_E) and test window (K_U). The lengths of both were set equal to the in-sample and out-sample periods. For more details, the distribution of the estimation window and the test window can be seen in Table 10.

Table 10. The Distribution of the Estimation Window and Test Window

Estimation Window		Test Window
k	$k + K_E - 1$	Adj-ES ($k + K_E$)
1 (10/25/21)	08/27/22	Upper bound of VaR for 08/29/22
2 (10/26/21)	(08/29/22)	Upper bound of VaR for 08/30/22
3 (10/27/21)	(08/30/22)	Upper bound of VaR for 08/31/22
...	...	...
39 (8/29/22)	(10/19/22)	Upper bound of VaR for 10/20/22
40 (8/30/22)	(10/20/22)	Upper bound of VaR for 10/21/22

Soruce: Research finding.

At the 95% significance level ($\alpha = 5\%$) and one day holding period, the results of the prediction of the risk of loss in the test window are as follows:

Table 11. The Upper Bound of VaR-CFE at Test Window Periods

Period	Actual Portfolio Return	Upper bound of VaR
08/29/22	-0.02992	-0.17401
08/30/22	0.02174	-0.16181
08/31/22	0.04209	-0.16412
...	...	...
10/20/22	-0.00439	-0.16321
10/21/22	0.03465	-0.1394

Soruce: Research finding.

The main concept of the backtesting test is to measure the value of the Violation Ratio, calculated based on the values of m_0 and η . The calculation of the Adj-ES violation ratio at the 95% confidence level was simulated on several values of estimated violation probability, namely 0.1%, 0.5%, 1%, 2%, 3%, 4% and 5%. With the help of software R 3.3.2, the obtained value of the ratio of violations is as follows:

Table 12. Violation Ratio Value on Several m_0 Value

m_0	Violation Ratio	m_0	Violation Ratio
0.1%	0.002	2%	0.01
0.5%	0.003	3%	0
1%	0.007	5%	0

Soruce: Research finding.

In estimating the upper bound of loss risk using VaR on stock portfolio with a 95% confidence level, the VaR could provide accurate prediction results for each violation probability VR value < 1 . The value of VaR could be interpreted as predicting losses in the corresponding period. Then, the predicted upper bound of VaR-CFE was applied to the following 16 periods after 10/21/22.

Table 13. The Predicted Upper Bound of VaR-CFE

Period	Predict	Period	Predict
10/22/22	-0.1421	10/30/22	-0.1566
10/23/22	-0.1467	10/31/22	-0.1533
10/24/22	-0.1527	11/1/22	-0.1520
10/25/22	-0.1522	11/2/22	-0.1713
10/26/22	-0.1387	11/3/22	-0.1515
10/27/22	-0.1417	11/4/22	-0.1454
10/28/22	-0.1442	11/5/22	-0.1662
10/29/22	-0.1412	11/6/22	-0.1398

Soruce: Research finding.

The highest estimated loss occurred on 11/2/22, which was -0.1713. Thus, investors needed to prepare a good risk management strategy so that the losses did not have a destructive impact on the investment being carried out. During this period, investors were not advised to sell their assets on the Indonesia Stock Exchange because when there was a significant loss, the asset price decreases, increasing the loss if investors sell their assets.

5. Conclusion

Based on the analysis in section 4, we conclude that the three single assets we have chosen to compile the portfolio follow the optimal portfolio rule because the correlation between single assets is negative. Based on the comotonic properties, the portfolio loss risk ceiling is equal to the sum of the loss values of every single asset. In this study, the loss risk is measured using the VaR-CFE model. The stock with the highest loss value for a single asset is ARTO.JK. At the 95% confidence level and one day holding period, the predicted value of ARTO.JK's stock price loss for the period after 10/21/22 is -0.0588. Furthermore, the single asset with the smallest predicted loss value is MIKA.JK operates in the health sector. For a 95% confidence level and a one-day holding period, the loss risk for this stock is -0.0326. Finally, the upper bound for portfolio loss risk at the 95% confidence level is -0.1394. After validation, the results show that the VaR-ECF value of the stock portfolio at the 95% confidence level and one-day holding period is -0.0731; this value is proven to be lower than the upper bound predicted value.

Statements and Declarations

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- Conflict of interest: The authors declare that there is no conflict of interest.

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The Performance Evaluation of Tejarat Internet Bank Services (AHP and Eisenhower Matrix Methods)¹

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Abstract

Online banking is becoming a popular choice for many clients who value convenience and efficiency. However, it is also important to evaluate how well internet banks perform in terms of client satisfaction. The aim of this study is to measure the performance of Tejarat internet bank services, one of the largest Iranian banks that offers online banking services to its clients. We used two methods: The Importance-Performance Matrix and the analytical Hierarchy Process. The Importance-Performance Matrix helped us rank the identified factors according to their importance and urgency for improving the bank's performance. The analytical hierarchy process helped us compare and weigh the relative importance of various criteria and sub-criteria that affect the bank's performance. We collected data from a sample of 169 Tejarat online financial services users through a questionnaire survey. Our results showed that the bank's performance was influenced by five factors: efficiency, ease of use, security, speed, and support. We also found that security and ease of use were the most critical and urgent factors that required immediate attention from the bank. Therefore, we recommend that Tejarat internet bank services focus on enhancing security and ease of use as their top priorities to improve their performance. We also suggest that they improve the quality of service in the client support section by being more responsive and fast. These insights are not only beneficial for Tejarat Internet Bank Services but also for other banks that want to improve their performance in the online banking sector.

Keywords: AHP, Client Satisfaction, E-Commerce, Importance-Performance Matrix Analysis (IPMA), Internet Banking.

JEL Classification: G41, M29, M19.

1. Introduction

One of the most widely used digital banking services in the financial sector right now is internet banking (Almaiah et al., 2022; Namahoot and Laohavichien, 2018).

¹. The present article has been extracted from the thesis titled 'Evaluation of Internet Bank Indicators Using AHP Methods and Eisenhower Matrix (Case Study: TEJARAT Bank)'. The thesis was conducted under the supervision of Majid Afsharirad.

As more people use the internet and mobile devices, internet banking has become a handy and effective way for clients to handle their money (Namahoot and Laohavichien, 2018). Internet banking also offers banks a low-cost and scalable way to serve many clients. Due to the COVID-19 epidemic, banks were supposed more than ever to deliver a seamless and secure online banking experience. This article examines the factors that influence client satisfaction in internet banking and gives practical advice for banks that want to improve their internet banking services.

The banking sector has undergone tremendous changes from the traditional era to the modern age. Therefore, a study has been conducted to understand the client's preference for digital banking. This study (Alsmadi et al., 2022) also examines the various factors that affect digital banking, the challenges faced by digital banking, and the different modes of digital payment used by clients. However, despite the growing importance of internet banking, there is a notable research gap in the literature concerning the comprehensive evaluation of performance indicators and the application of decision-making methods like the Analytic Hierarchy Process (AHP) to improve internet banking services in the context of the evolving banking industry. This study aims to fill this gap by delving into the application of AHP in evaluating the performance of internet banking services, identifying critical indicators, and providing insights to enhance client satisfaction and loyalty, especially in the face of intensified competition within the banking sector (Abbasi et al., 2020). To overcome this challenge, many banks have started using analytical methods to evaluate the performance of their internet banking services (Kaur et al., 2021; Seçme et al., 2009). The analytic hierarchy process (AHP) is one such method that has gained popularity in the banking industry (Shamshur and Weill, 2019; Xi and Li, 2022). AHP is a technique that assists decision-makers in prioritizing and ranking multiple criteria based on their relative importance. By applying AHP, banks can identify the most critical performance indicators of internet banking services and allocate resources in the best way possible. However, the growing competition in the banking industry has made it essential for banks to evaluate the performance of their internet banking services to ensure client satisfaction and loyalty (Abbasi et al., 2020). Evaluating internet banking performance is a complicated task that involves the assessment of multiple performance indicators such as security, support, ease of use, speed, and efficiency (Hu and Liao, 2011).

1.1 Internet Banking Performance Indicators

Internet banking has become a critical component of the banking industry, providing clients with a convenient and accessible means of managing their finances (Almaiah et al., 2022; Namahoot and Laohavichien, 2018). To ensure the success of internet banking services, banks must evaluate their performance based on various indicators, such as security, support, ease of use, speed, and efficiency. Evaluating internet banking performance is a difficult task that requires the evaluation of multiple performance indicators such as security, support, ease of use, speed, and efficiency.

1.1.1 Security

Security is a vital factor in internet banking services, as clients need to trust that their personal and financial information is safe (Nazaritehrani and Mashali, 2020). Security has become a crucial factor in encouraging the use of internet banking, which has seen a huge increase in usage. Banks and financial institutions must ensure that their internet banking systems are secure and reliable to gain the trust and confidence of their clients. Sensitive client data security necessitates a thorough strategy that addresses a number of issues, including authentication and access control, data privacy and protection, encryption, secure communication, and defense against fraud and cyberattacks. A secure internet banking system is essential to reducing the risks of unauthorized access, identity theft, data breaches, phishing attacks, and other types of cyber threats. In aiming to promote the widespread use of internet banking services, security in the adoption of internet banking is crucial.

1.1.2 Support

Support is another key indicator of internet banking services, as clients may face technical issues or need assistance with their transactions (Anouze and Alamro, 2020). Banks must provide prompt and effective client support, such as online chat or phone support, to address client questions and concerns. Because internet banking uses technology and can be challenging for certain users, it is important for financial institutions to offer enough support to guide users through the process and help them with any challenges they might run into. Depending on the client's level of technological knowledge and the unique features of the internet banking system, several levels of support may be needed.

1.1.3 Ease of Use

Clients are more likely to adopt and stick with internet banking services if they find them easy to use (Ezzi, 2014). The design of the web application, the availability of services, and the website navigation all affect how simple it is to use the internet banking system. These are significant components that affect how clients view and employ internet banking services.

1.1.4 Speed

Speed is another important indicator of internet banking services, as clients expect their transactions to be processed quickly (Nazaritehrani and Mashali, 2020). For instance, countries that have superior digital infrastructure, such as smartphones and high-speed internet access, generally have higher adoption rates for internet banking. Likewise, banks with simple and straightforward digital banking interfaces might draw more clients than those with complicated and challenging platforms. Mobile computing is a computing paradigm designed for workers who travel outside the boundaries of their organizations or for any other people traveling outside their homes (Salehnia et al., 2014).

1.1.5 Efficiency

Efficiency is the final indicator of internet banking services, representing the overall performance of the platform in terms of transaction processing times, availability, and reliability (Chen et al., 2019). By decreasing the number of physical branches and workers needed to serve clients, online banking can assist banks in lowering operational costs. Banks may be able to manage transactions and accounts electronically, without having to physically interact with clients, with the help of a comprehensive internet banking system.

This article's objective is to evaluate the performance of online banking services by employing the AHP methods and the Eisenhower Matrix in this situation. As a case study, the study uses Tejarat Bank, one of Iran's large corporations. The goal of the study is to determine the most vital online banking performance indicators for Tejarat Bank and to offer suggestions for how to enhance the effectiveness of its internet banking services. The findings from this research may be helpful for financial firms and decision-makers who want to raise the standard of internet banking services and increase client loyalty and satisfaction. The rest of the paper is structured as follows. Section 2 provides the literature review, and in Section 3, the research methodology is explained. Section 4 illustrates the data collection methods, and in Section 5, the empirical findings are

presented. Finally, the conclusion and policy implications of the paper are stated in Section 6.

2. Literature Review

Internet banking has become more common in recent years due to its convenience and accessibility. Many studies have examined the relationship between internet banking and client satisfaction, highlighting the importance of a positive client experience in achieving client satisfaction. Overall, several more studies have looked at the connection between internet banking and client satisfaction, emphasizing the significance of a satisfying client experience. Tang et al. (2024) empirically analyzed the driver role of emerging technologies and new industry trends on bank diversity and liquidity. Finally, they consider the heterogeneous impact of Fintech on banks. We debate the role of bank characteristics (size and ownership structure) and the financial crisis triggered by the COVID-19 outbreak. The sudden outbreak and rapid spread of COVID-19 in late 2019 triggered huge financial upheavals. The Chinese government imposed a series of quarantine measures to control the spread of the virus. These restrictions cause a severe shock to the development of the real economy. Our research examines how Fintech affects bank diversification and liquidity policies in the context of economic turmoil by focusing on a rare COVID-19 epidemic shock. The findings provide further evidence on the interplay between Fintech and the banking sector during the epidemic. Elshaer et al. (2024) social commerce witnessed significant growth due to increasing numbers of consumers choosing online channels as their preferred means of shopping. Consumer attitude and trust are key factors influencing customers purchase decision of buying products and services marketed through online platforms such as social commerce. A positive consumer attitude towards a brand or product can lead to greater level of perceived trust and, hence, increase the likelihood of purchasing. Further, a negative consumer attitude or low trust may deter individuals from purchasing, even if they are interested in the product. This study aims at investigating the mediating role of customers attitude and perceived trust on the relationship the relationship between social commerce and buying intention post-COVID-19 pandemic. Adaptability can enhance client satisfaction by enhancing client engagement. Banks can use client data analysis to better understand their needs and tailor solutions to each individual client, increasing client satisfaction. Also, banks may provide better client care thanks to internet banking. Banks can quickly respond to client concerns by implementing chat bots or virtual assistants, enhancing the entire client experience (Hsu and Lin,

2023). Ultimately, the studies pointed to the need for a satisfying client experience to obtain client satisfaction in internet banking. Client satisfaction and loyalty can be significantly affected by elements like ease of use, security, and client service, which ultimately affect how well-performing banks with online banking services perform financially. The COVID-19 outbreak hastened the uptake of online banking services, making it more crucial than ever for banks to give their clients a safe and straightforward experience (Almaiah et al., 2022; Sasono et al., 2021). Technology has become an increasingly critical success factor in modern day banking like many other aspects of human life; driving competition, process, operation and customer service delivery and satisfaction (Soyebo and Olaiya, 2022). On the other hand, with the increase in the activities of banks, the emergence of new competitors in the industry, and the increase in the complexity of economic variables and society's needs, the importance of defining goals and developing new banking programs has increased (Amiri et al., 2023).

Client satisfaction has significantly decreased as a result of the introduction of internet banking. Clients are now accustomed to the ease of online account access as mobile and internet-based banking become more common. There are several issues with using mobile devices as resource providers, including unstable wireless connections, limited energy capacity, and frequent location changes (Samani and Bashi, 2020). Clients are more satisfied as a result of this accessibility because they can make transactions and participate in banking activities at their leisure without having to go to a physical branch. According to surveys, clients who communicate with their banks through digital means are more satisfied than those who use traditional channels (Szopiński, 2016). Online banking enables clients to manage their accounts, pay bills, transfer money, and perform other banking functions without leaving their homes, resulting in a more enjoyable experience for many clients. Moreover, internet banking empowers banks to offer clients individualized services. Faster response times and more efficient service can help increase client satisfaction levels. A study by Al-Masaeed et al. (2022) examined the factors that contribute to client satisfaction in internet banking. The study found that factors such as website design, ease of use, security, and client service all had a significant impact on client satisfaction. Another study by Salehnia et al. (2014) explored the relationship between internet banking and client loyalty. The study found that a positive client experience, including ease of use, security, and responsiveness, was a significant driver of client loyalty in internet banking. Soyebó and Olaiya (2022) show that emerging technology variables such as Web Payment, Mobile Money operators, Automated Teller Machine and Point

of Sale terminals have positive long run relationships with bank performance in Nigeria.

Banks can use AHP method and the Eisenhower matrix to assess their internet banking services and decide how to distribute resources based on the data (Liu et al., 2007; Yazdani et al., 2017). This article surveys the current research on internet banking and client satisfaction, showing how these methods can help enhance internet banking services (Hsu and Lin, 2023). We will examine previous studies on internet banking indicators in the next sections.

Table 1. Literature Review of Security KPIs in Internet Banking

KPI	Definition	References
Confidentiality	Protecting customers' personal and financial information from unauthorized access or disclosure	(Fox et al., 2021; Gull et al., 2022)
Integrity	Ensuring the accuracy and completeness of customers' transactions and information	(Fox et al., 2021; Gull et al., 2022)
Availability	Ensuring that customers can access their accounts and perform transactions whenever they need to	(Fox et al., 2021; Gull et al., 2022)
Authentication	Verifying the identity of customers to prevent fraud and unauthorized access	(Fox et al., 2021; Gull et al., 2022)

Table 2. Literature Review of Support KPIs in Internet Banking

KPI	Definition	References
Responsiveness	Timely and effective response to customers' inquiries and issues	(Fan et al., 2018; Meyer-Waarden et al., 2023)
Competence	Adequate knowledge and skills of customer service representatives to resolve customers' issues	(Fan et al., 2018; Meyer-Waarden et al., 2023)
Empathy	Ability to understand and address customers' emotional needs and concerns	(Fan et al., 2018; Meyer-Waarden et al., 2023)

Table 3. Literature Review of Ease of Use KPIs in Internet Banking

KPI	Definition	References
User interface	The design and layout of internet banking platform	(Bach et al., 2018; Hewa et al., 2021)
Navigation	The ease with which customers can find and access the desired features and services	(Bach et al., 2018; Hewa et al., 2021)
Transaction process	The simplicity and intuitiveness of the process for performing transactions	(Bach et al., 2018; Hewa et al., 2021)

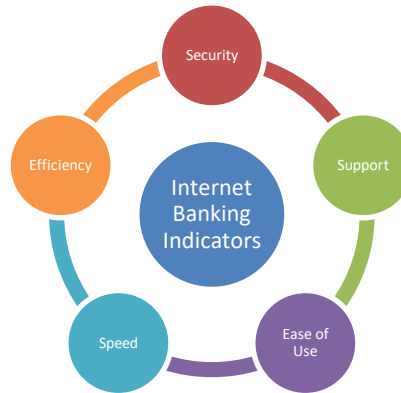


Figure 1. Conceptual Model

Source: Research finding.

Table 4. Literature Review of Speed & Efficiency KPIs in Internet Banking

KPI	Definition	References
Response time	The time it takes for the internet banking platform to respond to customers' requests	(George, 2018)
Processing time	The time it takes for the internet banking platform to process customers' transactions	(Almaiah et al., 2022; Fan et al., 2018)
Transaction cost	The cost to customers for using internet banking services compared to traditional banking channels	(Szopiński, 2016)

The present study focuses on evaluating internet banking indicators with a specific emphasis on privacy, speed, support, ease of use, and efficiency within the context of internet banking services. In this section, we bridge the nexus between our literature review and the development of our conceptual model, providing a clear link between the empirical model's construction and the insights gleaned from prior research.

Consumers' perception of security and privacy risk is a significant factor influencing their use of internet banking (Lin, 2020). It underscores the significance of robust data protection mechanisms to build user trust and satisfaction. In our conceptual model, we position "privacy" at the forefront, acknowledging its pivotal role in influencing user perception and behavior in the realm of online banking services. Lin and Wang (2020) conducted a study titled 'Examining the Factors Affecting Intention to Adopt Internet Banking: Employing the DEMATEL-ANP-SEM Approach' Banks that design their online platforms to

be easy to operate and improve transaction speed can enhance customer satisfaction and increase the likelihood of continued use. We incorporate "speed" as a distinct indicator in our conceptual hierarchy, recognizing its contribution to customer satisfaction and efficient online transactions.

Customers often seek help and support when using internet banking service. This can include assistance with understanding the functions of internet banking, creating logins, and navigating the online platform (Naeem and Ozuem, 2021). We integrate "support" into our hierarchical model, understanding its significance in addressing user concerns and queries promptly. The user interface of a banking app or website should be intuitive and easy to navigate, allowing users to find what they're looking for and perform tasks without difficulty (Fox et al., 2021). In our conceptual model, we allocate a specific category to "ease of use," aligning with research that highlights its influence on user adoption and retention. Banks hope that internet banking will help them maintain profitable growth by enabling them to automate work, reduce costs, and retain customers simultaneously. E-commerce, when properly integrated into existing banking operations, can lead to substantial cost savings and higher profitability (Taherabady et al., 2010). Within our conceptual model, we emphasize "efficiency" as a critical determinant, reflecting its implications for streamlined operations and customer satisfaction. The integration of these indicators into our hierarchical model draws from a synthesis of existing literature. It reflects our commitment to grounding our empirical model in well-established research findings, providing a foundation for the subsequent methodology and analysis sections.

3. Methodology of Research

In this article, two approaches have been used to evaluate the internet bank indices: the Analytic Hierarchy Process(AHP) and the Eisenhower matrix.

3.1 AHP

Internet banking customers can use Analytic Hierarchy Process (AHP) to make better decisions about their financial transactions. AHP is a decision-making method that allows users to rank and choose different options based on a set of criteria(Saaty, 1988). Helping consumers choose the best investment opportunities based on their financial objectives and asset allocation is one example of how AHP is used in internet banking. Users can examine several financing options based on factors including projected return, risk tolerance, and time horizon for investments. Clients can use AHP to assign weights to each of these factors, demonstrating their

relative importance and helping them make more informed choices regarding investments (Li and Li, 2023). Another example of using AHP in internet banking is to help customers compare different banking products and services. For instance, customers can use AHP to evaluate different credit card offers based on criteria such as interest rates, annual fees, and rewards programs. By giving weights to each of these criteria, customers can prioritize their preferences and choose the credit card that best suits their needs (Katiyar and Badola, 2018). In summary, AHP is a useful tool for internet banking customers who want to make informed decisions about their financial transactions. By using AHP, customers can prioritize their preferences and compare different options based on a set of criteria, leading to better outcomes and increased satisfaction (Rodriguez et al., 2012).

3.2 Importance-Satisfaction Matrix (Eisenhower Matrix)

The Importance Performance Matrix Analysis (IPMA) is a technique that measures a product's or service's quality based on its importance and performance, two crucial elements. The technique makes use of a graph with four segments, each of which displays a different mix of importance and effectiveness. Data on the significance and performance of the good or service in numerous areas is gathered in order to make use of the tool. This information can be acquired using a variety of market research methods. The importance and performance scores are then shown on the graph, with the horizontal axis for performance and the vertical axis for importance. In this manner, it provides a deeper understanding of how effectively a product or service meets the wants and expectations of clients (Mansouri Rad and Bagherian, 2023; Miranda et al., 2010).

The Urgent/Important Matrix and the Eisenhower Matrix are both names for a management tool that helps assess how important and satisfying different internet banking features are for users when they decide to use or not use them. These two names mean the same thing, and there is no difference between them. Here are the steps to using the Importance-Satisfaction Matrix to measure internet bank acceptance in a questionnaire

3.2.1 Identification of Attributes

The first step is to find out the different attributes or features of internet banking that clients care about. This can be done by reviewing the existing literature or using open-ended questions in a survey to collect responses from clients.

3.2.2 Importance and Satisfaction Scaling

Importance and Satisfaction Scaling: Customers are asked to rate how important and satisfying each attribute is using a Likert scale. The scale goes from “1-Not important” to “5-Very important” for importance and “1-Very dissatisfied” to “5-Very satisfied” for satisfaction.

3.2.2 Construct Matrix

After getting all the responses, we can construct the Importance-Satisfaction Matrix by plotting each attribute on a two-dimensional graph. On the horizontal axis, we plot how important each attribute is, and on the vertical axis, we plot how satisfying it is. Then we have four quadrants that show different users' responses.

3.2.3 Interpret Quadrants

Interpret the four quadrants based on the results obtained. Quadrants I and II are usually the areas that need the most improvement because they show situations where there is a big difference between what clients expect and what they receive. In other words, the most significant and pressing issues can be found in these quadrants, as well as the greatest opportunity for development. On the other hand, Quadrants III and IV are areas that are doing well and may not need as much focus or resources as the other two quadrants. However, this does not mean that these areas can be overlooked or forgotten, as they still show important aspects of the overall situation that need to be maintained or strengthened.

Quadrant I: High Importance, Low Satisfaction: These attributes require immediate attention, and banks must make efforts to boost satisfaction levels in this quadrant.

Quadrant II: High Importance, High Satisfaction: These attributes are the strengths of the internet bank, and thus, it is important to maintain them and avoid making any changes that can reduce users' satisfaction levels.

Quadrant III: Low Importance, Low Satisfaction: Attributes in this quadrant are not critical; however, some clients may be dissatisfied with them. Banks can decide whether to improve them or not based on their overall business and marketing strategies.

Quadrant IV: Low Importance, High Satisfaction: These attributes are minor aspects of internet banking and do not contribute much to clients' acceptance. Nonetheless, banks should continue to maintain them to ensure client satisfaction.

3.3 Data Collection

To gather information, we first held group sessions with experts in the field to identify the relevant indicators. Numerous market research techniques can be used to obtain this data. In doing so, it gives a more comprehensive understanding of how well an item or service fulfills the requirements and desires of customers (Mansouri Rad and Bagherian, 2023). The indicators were then described and specified using the structural equations. Next, in order to rank the appropriate sub-criteria and construct an importance-satisfaction matrix, we transmitted a questionnaire to responders. All respondents had to use Tejarat Bank's internet banking services at least once in the past three months. The sample size was 169, based on the Cochran formula. We first distributed 30 questionnaires, then calculated the Cronbach's alpha coefficient for evaluating the questionnaire's validity. It was determined that the questionnaire was valid because Cronbach's alpha was greater than 0.7. Table 5 shows the exact Cronbach's alpha value.

Table 4. Cronbach's Alpha

Cronbach's alpha	0.78

Source: Research finding.

4. Finding

This article compares the efficacy, consistency, and integrity of two methods for making decisions for assessing internet bank indicators: Analytic Hierarchy Process (AHP) and Importance-Satisfaction Matrix, are in evaluating internet bank indicators. Banks can improve consumer satisfaction while establishing a competitive edge in the field of digital banking by focusing on important indicators including security, support, ease of use, speed, and efficiency. The findings of this study can help banks improve their internet banking services and add to the existing research on decision-making methods in the banking industry. Ultimately, data-driven decision-making can lead to better outcomes for both banks and their customers, resulting in a win-win situation.

At this point, we're going to begin by identifying the main criteria and sub-criteria that belong to the questionnaire. The outcomes of each sub-criteria is going to be evaluated using the Analytic Hierarchy Process (AHP) method in the order of importance. The questionnaire's major criteria are "security," "support," "ease of use," "speed," and "efficiency." There are specific sub-criteria for each of these criteria. As an example, the sub-criteria for "security" include "use of strong passwords", "protection of users' personal information", and "use of modern

security technologies". A scale for rating each sub-criteria will be presented in order to rank them. Evaluations for each sub-criteria will then be submitted via the AHP comparison matrix using the given scale, the output of each sub-criteria will be shown numerically and based on priority against other sub-criteria.

Table 6. Prioritization of Criteria

KPI	Rank
support	5
Speed	4
Ease of use	2
Security	3
Efficiency	1

Source: Research finding.

Table 7. Prioritization of Sub-criteria (Speed)

Internet Banking Speed	Performing transactions by receiving a one-time password that can be used without internet access in case of operator disruption of the mobile phone.	5
	Performing transactions with a one-time password that can be used in the transaction basket.	4
	Fast internet banking login via a one-time password.	2
	Fast activation of internet banking without visiting bank branches.	3
	Fast access to the bank's homepage.	1

Source: Research finding.

Table 8. Prioritization of Sub-criteria (Support)

Internet Banking Support	Responsiveness in case of problems through customer service center(1554)	2
	Quick response time.	4
	Attention to suggestions and criticisms.	3
	Appropriate response and follow-up through customer service personnel(1554)	1

Source: Research finding.

Table 9. Prioritization of Sub-criteria (Security)

Internet Banking Security	Possibility to deactivate and block the card via internet banking or by contacting the customer communication center.	2
	Use of one-time password and hardware token to enhance security.	4
	Use of two-factor authentication: personal static password + one-time SMS password.	3
	Protection of privacy regarding personal and financial information.	1

Source: Research finding.

Table 10. Prioritization of Sub-criteria (Ease of Use)

Ease of Use	Ease of accessing internet banking.	3
	Ease of learning how to use different sections.	1
	Clear and understandable process for performing different transactions.	4
	Suitable and user-friendly design.	2
	Ease of using provided features such as recurring payments, payment basket, batch transactions with a single password.	5

Source: Research finding.

Table 11. Prioritization of Sub-criteria (Efficiency)

Efficiency	Providing a wide range of services in one platform	3
	Successful transactions during banking operations	7
	Improvement of banking activity and providing necessary services for each group of customers.	6
	Control over banking operations by displaying entry times and performed transactions.	4
	Reduction of the costs of direct visits to branches or ATMs.	8
	Tracking unsuccessful transactions.	5
	Reduction of banking activity time.	1
	The minimal possible number of errors.	2

Source: Research finding.

After ranking the main criteria and relevant sub-criteria, it is now time to construct the satisfaction importance matrix.

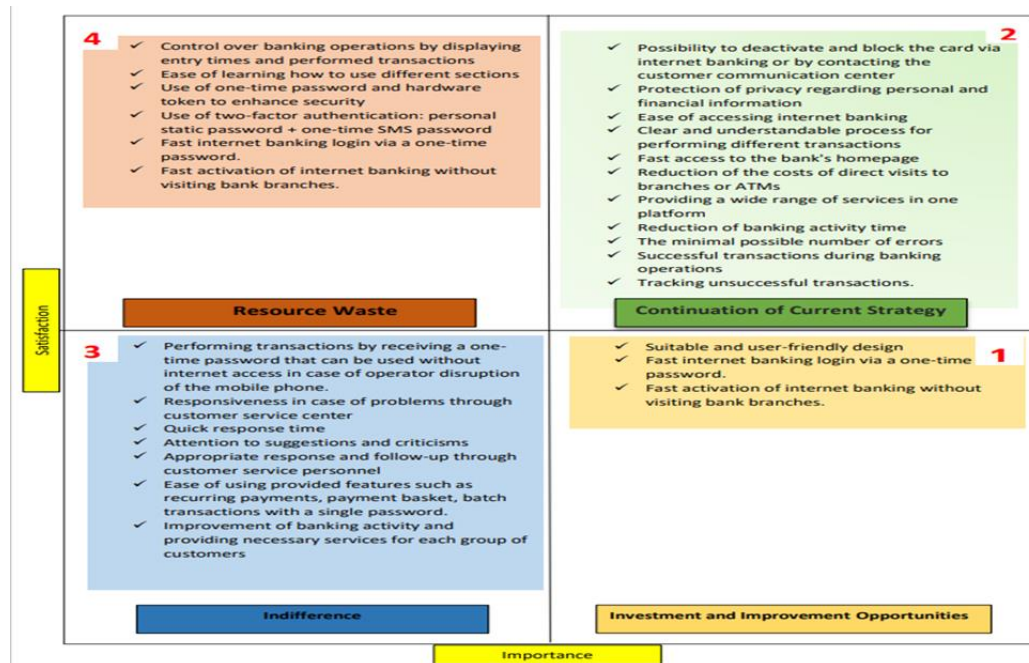


Figure 2. Importance-Performance Matrix
Source: Research finding.

Now we will evaluate the different parts of this matrix in more detail.

Quadrant 1: This quadrant has points that are very important but not satisfying. There is a direct link between electronic banking and customer satisfaction such that improving the quality of service with online banking also improves customer satisfaction. Low consumer satisfaction with internet banking services provides an opportunity for investment to meet the high customer satisfaction-focused objectives electronic banking. Therefore, directors can seize these opportunities quickly and utilize them to their advantage, developing their organization.

Quadrant 2: Shows the successful result of every careful and effective decision-making process. The services provided in this quadrant best achieve both significant and satisfying characteristics. By following to their previous methods, managers can take proactive measures to maintain and achieve the primary goals of customer engagement.

Quadrant 3: According to Figure 5-1, all points located in this quadrant show poor performance in terms of the two key and basic factors of this matrix – namely importance and satisfaction. According to the outcome of the questionnaire, both criteria obtain poor scores. It's necessary to keep in mind that while these factors

might be taken into account when managers are making decisions about the examination of desired plans, they do not necessarily need to be given priority.

Quadrant 4: In this quadrant, all points act as a warning signal for managers. Even though they have low importance, These criteria have managed to attain a high level of consumer satisfaction despite their modest priority. Although the fact that the satisfaction indicator is always measured, the desired indicator's significance should not be dismissed. As a result, there will be tremendous resource waste as a result of these conflicts.

To connect the importance-satisfaction matrix with the results of ranking using the AHP method, you can use a three-step approach:

- Rate the importance of each of the criteria that matter to you using the AHP method, and then calculate the importance-satisfaction matrix for each sub-criterion.
- Calculate the total ranked scores for each sub-criterion in the importance-satisfaction matrix.

Compare the total ranked scores with the importance of each sub-criterion in the importance-satisfaction matrix and identify a subset of sub-criteria that have the most impact on satisfaction. By following the steps outlined above, you can present your results in a way that is easy to understand. Providing more information on the methods used, such as evaluating importance with the AHP method and calculating the importance-satisfaction matrix, will allow readers to better analyze the results. By combining Tables 6 and 7 with Figure 2 as suggested, stakeholders and others can make informed decisions based on their analysis.

5. Conclusion and Policy Implications

According to a study conducted by (Munusamy et al., 2010), efficiency was identified as a significant factor impacting customer satisfaction in the banking industry. Efficiency is the most significant factor, followed by reducing the amount of time required for banking operations and limited errors, according to the evaluation of TEJARAT Internet Bank Services carried using the methodology known as AHP. The majority of the bank's services, according to the importance-performance Matrix approach, fall into the "important and urgent" quadrant, necessitating immediate attention and action. After reviewing previous studies, such as one conducted by Suhaimi et al. (2018) that examined the factors influencing the acceptance of DB in Malaysia, it is clear that the primary determinant is perceived ease of use. The relationship between perceived usefulness and intention to use DB is insignificant, as is that between perceived

self-efficacy and intention to use DB. However, the services' performance investigation reveals a number of areas that need improvement, including acceptable and user-friendly design, quick internet banking activation without entering bank workplaces, and swift internet banking authentication. The results presented imply that even while the bank has focused on the correct requirements for service evaluation and identified immediate issues, some areas still have room for improvement.

However, TEJARAT Bank can improve its digital banking services significantly by following these policy implications. First, to improve the security of its services, the bank should focus on investing in advanced security measures such as two-factor authentication and hardware token to enhance security. In a study by (Raza et al., 2020), A considerable improvement in client satisfaction with banking services via the internet was shown to result from the implementation of modern security measures, such as biometric verification. Second, TEJARAT Internet Bank should consider making improvements to its smartphone application and website's user interface and experience to make them easier to use and more user-friendly. Third, in order to cope with the challenges with response, TEJARAT Internet Bank has to hire more customer service representatives and improve their support and training so they can provide clients immediate and effective assistance. Fourth, in order to assure quick and successful execution, TEJARAT Internet Bank has to concentrate on the urgent and crucial tasks discovered using the Eisenhower Matrix approach. Overall, by following these policy implications, TEJARAT Internet Bank can improve its services and enhance its competitive edge in the digital banking market.

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RESEARCH PAPER

Spatial Linkage between Natural Disaster and Poverty in the Archipelago Country (Case Study: Indonesia)

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Abstract

This study employs spatial econometric modeling to investigate the relationship between natural disasters and poverty in Indonesia. Panel data spanning 2011 to 2019 are sourced from reputable authorities, including the Central Bureau of Statistics and the Natural Disaster Management Agency of the Republic of Indonesia. Empirical findings confirm the presence of spatial autocorrelation in provincial-level poverty in Indonesia, indicating interdependence among neighboring regions in terms of poverty dynamics. This study deviates from existing literature by revealing a surprising result: natural disasters are statistically associated with reduced provincial-level poverty. This counterintuitive outcome underscores the importance of governmental policies, programs, and external financial aid in mitigating the impact of natural disasters. Financial assistance and empowerment initiatives from third-party entities, such as NGOs, religious organizations, and youth groups, play a crucial role in helping disaster-affected communities. These findings offer valuable insights for policymakers. They can use this research to inform disaster response strategies and develop targeted poverty reduction programs at both inter-provincial and inter-regional levels. Ultimately, this study contributes to the understanding of the complex relationship between natural disasters and poverty in Indonesia, with implications for policy formulation and disaster resilience efforts.

Keywords: Indonesia, Natural Disaster, Poverty Reduction, Spatial Econometrics Modelling, Spatial Autocorrelation.

JEL Classification: C33, I3, Q54.

1. Introduction

Indonesia is classified as a disaster-prone country (World Bank, 2019). This situation is inseparable from the geographical condition of Indonesia, which is an archipelagic country and is located at the confluence of four world plates, namely the Asian Continental Plate, the Australian Continental Plate, the Indian Ocean

Plate, and the Pacific Ocean Plate. In the southern and eastern parts of Indonesia, there is also a volcanic arc that extends from the islands of Sumatra, Java-Bali-Nusa Tenggara, north of Sulawesi-Maluku, to Papua. This condition has the potential to cause geological disasters such as volcanic eruptions, earthquakes, and tsunamis. Not only these conditions, but the combination of Indonesia's climatic and topographical conditions also has the potential to cause hydrometeorological disasters such as floods, landslides, forest fires, and droughts (BNPB, 2016).

As a disaster-prone country, the frequency of disasters that occur in Indonesia can potentially threaten socio-economic stability, especially in cases of poverty. It was recorded that during 2021, there were 2,109 natural disasters with the value of losses reaching 1.172 trillion rupiah, which is almost 14.5 percent compared to the total GDP. This condition is exacerbated by the number of victims suffering and evacuating, as well as damage to houses and public facilities (Natural Disaster Management Statistics, 2020). Tasri et al. (2022) stated in their study that catastrophic events in Indonesia can have a direct impact on unemployment and poverty. Natural disasters may cause loss of livelihood, social and economic disruption (Awasthi, 2019). The existence of this natural disaster will also cause damage to the environment and residents' housing, which inhibits residents' activities to earn income (McMahon, 2007). More specifically, a disaster can also destroy people's assets and savings, which has the potential to plunge a person into a 'poverty trap' because productivity decreases significantly, making it difficult for them to rebuild their savings and assets (Carter et al., 2007).

However, growing literatures claim contradictory results on the impact of natural disasters on poverty. Although several studies have shown that natural disasters can affect and increase poverty (Awasthi, 2019; Kawasaki et al., 2020; Winsemius et al., 2018), some studies actually give opposite results. There are several researchers have found that natural disasters are not directly linked with reducing poverty or have no significant effect (Abdullah et al., 2016; Groeschl and Noy, 2020; Warr and Aung, 2019). Leichenko and Silva (2014) found that disasters did not directly affect poverty, but other factors were responsible for worsening poverty, especially in less developed regions. However, it also depends on how policymakers respond to the natural disaster, yearly or seasonal natural disaster, which means natural disasters that happen every season or every year will continuously provide negative externalities on the affected area, which will cause the poor to become poorer (Fang et al., 2017; Miljkovic and Miljkovic, 2014).

Research on the effect of disasters on poverty in Indonesia has been conducted by Putra (2017), which shows that households affected by disasters are more likely to experience poverty. At the household level, Putra (2017) claimed that natural disasters, especially floods and mountain eruptions, are statistically significant influences on poverty compared to other types of natural disasters. However, the research studies done by Putra (2017) could not examine the spillover effect of natural disasters between regions, which actually will give the

policy maker a better helicopter view of these issues and can generate more impactful policy recommendations that will help or enable thousands of people to survive from poverty when the disaster occurs. In addition, another research study focusing on Indonesia at the provincial level has been done by Tasri et al. (2022) to examine unemployment and poverty to a natural disaster. This study revealed that poverty and unemployment can increase the loss from natural disasters.

The differences in the results of previous literature reviews provide a signal that different geographical and regional contexts may lead to different empirical results. To address the research gap from the previous study, the present research aims to challenge the spatial approach to analyze the effect of natural disasters on poverty in Indonesia. This research is unique and contributes to the literature through model development and analysis that has never been done before. This study also uses a different method from previous research, namely, by using spatial analysis to reduce the heterogeneity of each province in Indonesia. This model is expected to be the basis for developing a theory about the impact of natural disasters on poverty at the provincial level. At the application level, this model is expected to be an evaluation model to see the effectiveness of disaster management and formulate strategic policies for poor communities affected. In the realm of theoretical investigation, this study seeks to engender a more profound understanding of the intricate nexus between natural disasters and poverty. The ambit of inquiry extends beyond the methodological innovation to encompass broader economic dimensions, notably exploring the intricate relationships with provincial gross domestic product (GDP) and key indicators of human development. The import of our findings transcends the novelty of the employed methodology, encapsulating the substantive integration of pivotal variables that enrich the analytical depth and scholarly significance of this research endeavor. The findings from this study will provide further recommendations on disaster risk reduction strategies, post-disaster recovery efforts, and the design of sustainable development programs

2. Literature Review

Natural disasters have been a recurring phenomenon throughout human history, causing immense destruction and often exacerbating poverty in affected regions. This literature review aims to explore the complex relationship between natural disasters and poverty by examining existing theories, research, and empirical evidence. The grand theory of natural disaster on the scope of economics has been published by Albala-Bertrand (1993). This grand theory measures the impact of natural disasters on the macroeconomic variables, namely capital and growth rate output. The assumption for this theory is (i) a Natural disaster has already taken place within the country; (ii) the country has capital stock; (iii) the disaster reduces stock capital in the long term; (iv) all losses are capital stocks; and (v) capital stocks are homogeneous. Moreover, the grand theory can be explained in the following

equations:

$$\Delta K = D \text{ where } \Delta K = K_a - K_b \quad (1)$$

where:

K: Capital

D: Total disaster loss

a: before the disaster impact

b: after disaster impact

with the assumption that the global capital-output ratio fluctuates so that it can defer for the loss of capital will be deferred.

$$c = \frac{K}{Y} = \frac{\Delta K}{\Delta Y} \quad (2)$$

where:

c: Capital Output Ratio

$\Delta Y = Y_a - Y_b$ (The expected output loss)

Y = Output (Income)

By solving equation 2 for ΔY and substituting ΔK for D:

$$\Delta Y = \frac{D}{c} \quad (3)$$

$$y = \frac{d}{c} \quad (4)$$

where:

$\frac{\Delta K}{\Delta Y}$: The growth rate of output

$d = \frac{D}{Y}$: Loss to output ratio

Hallegatte and Przyluski (2010) developed the concept study published by Albala-Bertrand (1993), by adding more comprehensive models, such as including direct and indirect losses from natural disasters. In these cases, Hallegatte and Przyluski (2010) explained that several negative effects from natural disaster do not have market value, hence, it's really hard to measure. From the national development point of view, one of the indirect effects of natural catastrophes is poverty and income inequality.

From the development of the theory of the influence of disasters on poverty, two main theories were obtained: the first is the vulnerability framework, in which poverty makes a person more vulnerable and plunges them into more severe poverty as a result of natural disasters through capital losses. The second scheme is through social capital and resilience. Several studies show that the role of social capital in mediating the impact of natural disasters on poverty.

Natural disasters can affect poverty through the capital channel. This argument is in line with the results of previous studies, which have been studied by researchers for several decades. Some studies found that natural disasters reduced income and increased poverty (Karim and Noy, 2016; Khan et al., 2020; 2021). This statement is also in line with the findings of Bui et al. (2014) for the case of Vietnam, where natural disasters reduce income and increase poverty both

in the affected area and the overall population. The resulting impact had a shocking effect on income, and poor households have difficulty adjusting in the post-disaster recovery (Warr and Aung, 2019). In addition, natural disasters can cause households with subsistence livelihoods to be trapped in a cycle of poverty where their assets are lost (Duncan et al., 2017). Another interesting study related to the indirect link between natural disasters on poverty was published by Ngoran et al. (2015). These studies explained that the bad infrastructure and water resources can leave unfortunate people no choice other than stay in poverty when a disaster occurs.

The second scheme is about social capital and resilience; poverty dynamics occur. Leichenko and Silva (2014) analyzed the relationship between climate change disasters and poverty. They found that disasters did not directly affect poverty, but other factors were responsible for worsening poverty, especially in less developed regions. However, it depends on how policymakers respond to the natural disaster. Yearly or seasonal natural disasters will continuously provide negative externalities on the affected area, which will cause the poor to become poorer (Fang et al., 2017; Miljkovic and Miljkovic, 2014). The government should handle the yearly or seasonal natural disasters by creating policy packages that will lower the impact of natural disasters.

The impact of natural disasters on poverty spans critical life sectors. Primarily, disasters can lead to Physical Damage to Infrastructure. Events such as hurricanes, earthquakes, floods, and wildfires can cause extensive harm to infrastructure, including factories, transportation networks, and utilities. Industries relying on physical facilities, like manufacturing, energy, and transportation, may encounter production halts, supply chain disruptions, and increased operational costs due to repair and reconstruction efforts. An additional study by Ngoran et al. (2015) emphasizes the indirect link between natural disasters and poverty. It underscores that poor infrastructure and limited water resources can leave vulnerable populations with no alternative but to remain in poverty when disasters occur.

In the business and industrial sectors, disasters can result in Supply Chain Disruptions. These events often disrupt supply chains by damaging production facilities, transportation routes, and warehouses. Industries reliant on a consistent flow of raw materials and components, such as manufacturing, electronics, automotive, and agriculture, are particularly affected. Supply chain interruptions can lead to shortages, increased costs, and delays in delivering goods and services (Alam and Ali, 2023). Supply chain impacts and reduced demand resulting from natural disasters can also lead to Business Interruption and Loss of Revenue. Industries relying on continuous operations, such as tourism, retail, and hospitality, may experience substantial revenue losses due to business interruptions caused by natural disasters. Temporary closures, reduced consumer demand, and a decline in tourist inflow can result in financial setbacks and long-term economic

repercussions (Ngin et al., 2020; Shen et al., 2023; Siodla, 2021).

In addition to the industrial sector, natural disasters can impact the income of the agricultural sector. Agriculture, being particularly vulnerable to disasters like droughts, floods, storms, and wildfires, can experience crop damage, livestock losses, and infrastructure destruction, disrupting food production. This disruption can lead to food shortages, price fluctuations, and economic instability in regions dependent on agriculture (Hua et al., 2023). Moreover, as a logical consequence of disaster mitigation efforts, changes in environmental regulations and policies may occur. Stricter regulations post-disaster can affect industries with environmental footprints, such as mining, energy production, and chemical manufacturing, necessitating costly upgrades or changes to comply with new standards (Boonmee et al., 2021; Joshi and Nishimura, 2016; Siriwardhana and Kulatunga, 2023)

Another study focused on natural disaster on developing countries such as Vietnam where natural disasters reduce income and increase poverty both in the affected area and the overall population (Bui et al., 2014). The impact of natural catastrophic such as natural disaster had a shocking effect on income, and poor households have difficulty adjusting in the post-disaster recovery (Warr and Aung, 2019). In addition, natural disasters can cause households with subsistence livelihoods to be trapped in a cycle of poverty where their assets were lost (Duncan et al., 2017). Another interesting studies related to indirect link between natural disaster on poverty is published by Ngoran et al. (2015). These studies explained the bad infrastructure and water resource can leave unfortunate people no other choice other than stay in poverty when disaster occurs. In the household level analysis, Ahmad and Afzal (2021) studied using the survey data of 398 households of erosion-prone riverbank area of Punjab, Pakistan. They found that natural disasters increased vulnerability and obstacles to socio-economic. It is in line with the study of Arouri et al. (2015) in Vietnam, they found that all the three disaster types considered in their study including storms, floods, and droughts have negative effects on household income and expenditure.

The influence of disasters on poverty can vary in magnitude across different locations. The value of the impact of disasters on economic aspects in the form of capital and income is strongly influenced by the level of risk and social vulnerability. Due to the unequal risk between poor and rich people, each person experiences the different impact of natural disaster. Less developed countries experienced worsen human impact than developed countries due to natural disasters, yet developed countries suffered larger economic losses (Tselios and Tompkins, 2019). The reason behind it is because the disaster mitigation plan, for example less developed countries that do not have an infrastructure, house and building that is resilient from natural disaster will make more people in dangerous situation compared to developed countries who are more prepared with advanced technology and less human loss. However, the contradictory argument stated by Sawada and Takasaki (2017) that is economic losses due to natural disasters

experienced by non-poor people were greater than poor people. This is because the proportion of financial assets and physical assets of rich people is greater.

The reality of the differences in risk and vulnerability that affect the economic and financial impacts refers to disaster management theory. Disaster management theory emphasizes; (i) Prevention encompasses activities focused on long-term risk assessment and reduction; (ii) Preparedness involves two main components: monitoring and detection, followed by forecasting and prediction; (iii) Response consists of two aspects: damage assessment and post-disaster coordination; (iv) Lastly, recovery involves the reconstruction and restoration of infrastructure (Djoumessi and Mbongo, 2022). Based on this theory, every location where a disaster occurs can either exacerbate or have no effect on poverty.

The magnitude of the impact of disasters on poverty can be influenced by two things, namely vulnerability and coping aspects. First, the risk of natural disasters is not distributed equally among people thus leads unequal resilience and vulnerability. Poorer people have a greater risk of natural disasters or other negative externality because poorer citizens generally are not ready. Second post-disaster, usually the richer have a better coping mechanism by using their saving and asset to manage their sufficient spending for everyday life, while the poorer only rely on the government and third parties' support. In another hand, in a macroeconomic level natural disaster is not directly multiplying the number of poor people but channeling by economic growth and financial development in each country (Lee and Tang, 2019). However, this has become the reason why the growing literature claims a contradictory results on how the impact of natural disasters on poverty.

In this study, other factors that influence poverty are captured through two explanatory variables, namely Gross Domestic Product (GDP) and Human Development Index (HDI). The GDP variable in this study refers to the theory of economic growth that is generally economic growth will reduce the level of poverty in macroeconomic level. To support the previous statements, an empirical study has proven that an increase in GDP by 10 percent can reduce poverty by 4 to 5 percent (Balasubramanian et al., 2023; Li et al., 2015; Siburian, 2022). The HDI variable captures the quality of human capital in each province. The quality of human capital plays an important rule in making household survive from internal and external shock. According to production theory, increasing the aspect of human capital can increase income (Todaro and Smith, 2012). The increase in HDI is also able to reduce poverty (Ottoni et al., 2018). The community organization, Non-Governmental Organization and other third parties will also make a big move to help the affected area. All of those could make a biased result of the impact of natural disasters on poverty. In addition, the inconsistent result can also be caused by the sample size, the absolute size of the income shock caused by the disaster, and the size of poverty (Warr and Aung, 2019).

Previous research, such as the study conducted by Rush in 2018, has shed

light on the interconnectedness of disasters and poverty in Indonesia. It highlighted that poverty amplifies an individual's vulnerability to the adverse effects of disasters. However, it is crucial to note that this particular investigation primarily focused on the impact of disasters on the education sector, leaving a notable gap in our understanding of the broader poverty-disaster nexus. Another valuable contribution to the literature was made by Putra (2017), who utilized microdata from the Indonesian Family Life Survey (IFLS) and employed the Linear Probability Model (LPM) method. This study, while significant, offered insights into the varying effects of disasters on poverty. Specifically, it demonstrated that events such as volcanic eruptions and floods can exert a substantial influence on poverty levels within Indonesia. However, it is worth mentioning that Putra's research did not delve into the intricate relationship between regions affected by disasters, thus leaving an important aspect unexplored. The present research seeks to bridge these gaps by adopting a novel approach—spatial analysis. Spatial analysis offers a more comprehensive perspective, as it allows for a holistic assessment of the overall economic and social conditions in each province across Indonesia. Importantly, it facilitates the examination of how a disaster's impact in one region can reverberate through spatial interdependencies, affecting neighboring provinces. By incorporating this spatial dimension, this research endeavors to provide a deeper and more nuanced understanding of how disasters influence poverty dynamics in Indonesia, thereby advancing the existing body of knowledge on this critical issue.

3. Data and Methodologies

3.1 Study Area and Focus

The geographical area of the present research studies consists of more than 17,000 islands divided into 34 provinces from Sabang to Merauke in 2022. Indonesia is an archipelago country that has an abundance of natural resources and is also prone to natural disasters every year. The main aim of this research is to further examine the linkages between natural disasters and poverty in the archipelago country, namely Indonesia. The data used in this paper mainly include spatial data and panel data of social economics, which will be explained further in Table 1. The spatial data are downloaded from Here. The panel data are collected from 2011 to 2019, from various sources, namely the Central Bureau of Statistics and the Natural Disaster Management Agency of the Republic of Indonesia.

Many researchers have different types of measurement for natural disasters, some of them using indices of natural disasters, such as Li et al. (2015) and Nepal et al. (2021), or the impacted people, death, or fatality, such as Akther et al. (2022), Hallegatte et al. (2020), Kim and Marcouiller (2015), and Padli et al. (2018), and economic losses, such as Ngoran et al. (2018), from natural disasters. Considering the majority of the literature review is based on the literature review paper published by Hallegatte et al. (2020), the present research uses the impacted or

affected people to measure the impact of all natural disasters. The impacted people face death or fatality because of natural disasters and natural disaster survival. Unfortunately, the present research sees natural disasters as general, not by a specific reason. We noted that each natural disaster had a different impact on society; nevertheless, the authors could not accommodate all the different impacts in the economic modeling. The socio-economic aspect of the society will be captured by GDP and HDI (Fang et al., 2017; Li et al., 2015).

Table 1. The Variable Description

Variables	Acronym	Definition	Source
Spatial Data	-	Shape File of Indonesia	https://tanahair.indonesia.go.id/portal-web
Poverty	LnPOV	The total population living under poverty in each province.	Central Bureau of Statistics, Republic of Indonesia
Natural Disaster	LnDIS	The affected people are when the catastrophe occurs.	Natural Disaster Management Agency of Indonesia
GDP	LnGDP	Regional Gross Domestic Product	Central Bureau of Statistics, Republic of Indonesia
HDI	HDI	Human Development Index	Central Bureau of Statistics, Republic of Indonesia

The spatial econometric model used to answer the present research question is generated from 34 provinces. The authors reviewed many variables from the previous studies before deciding to use the main and control variable for the present research. The general equation for the present research will be shown by Equation 5 and Statistic Descriptive of the data used for the present research are explained in Table 2.

$$LnPov_{it} = \beta_0 + \beta_1 LnDisaster_{it} + \beta_2 LnGDP_{it} + \beta_3 LnHDI_{it} + v_{it} \quad (5)$$

Table 2. Statistic Descriptive

No	Variables	Obs	Mean	Std Dev	Min	Max
1	LnPoverty	288	6.118044	1.05906	4.199005	8.586012
2	LnDis	288	4.641852	3.35548	0	14.71227
3	LnGDP	288	12.09413	1.177896	9.745555	14.85961
4	LnHDI	288	4.22669	0.065682	4.007515	4.391482

Source: Research finding.

The utilization of spatial econometrics in this research is of paramount importance as it aims to examine the relationship between natural disasters and poverty in Indonesia. By employing spatial econometric modeling techniques, the

study explores panel data collected from 2011 to 2019, sourced from the Central Bureau of Statistic and the Natural Disaster Management Agency of the Republic of Indonesia. The findings of the research reveal the presence of spatial autocorrelation in poverty at the provincial level, underscoring the interdependence of poverty outcomes across neighboring regions in Indonesia. This identification of spatial autocorrelation provides valuable insights into the geographical distribution of poverty, shedding light on the factors influencing poverty disparities throughout the country. The insights have significant implications for policymakers, aiding in the formulation of targeted and evidence-based poverty reduction programs. By leveraging spatial econometric modeling techniques, policymakers can enhance their understanding of the geographical distribution of poverty, effectively allocate resources, and develop strategies to assist survivors of natural disasters in their journey towards recovery and resilience.

3.2 Spatial Econometrics

The central goals of the present research are to empirically examine the regional interconnectedness of poverty after a natural disaster strikes. Since the end of the 1950s, the study regarding spatial linkages has been based on a theoretical and practical approach already developed by many researchers who focus on regional economic development. Elhorst (2014) explained that regional economic development can't distinguish between the concept of spaces and time in a different region. The spatial data is applied because the author hypothesizes that there is spatial dependence or interdependence among provinces that is observed. The spatial econometric methodology can perfectly observe, examine, and show by map the result of regional interdependence and autocorrelation (Anselin, 2003; Anselin et al., 2011). Spatial autocorrelation can be classified into two types: the first is clustering, which shows the coefficients of spatial autocorrelation are positive, and the second is dispersing, which shows the coefficients are negative. The spatial weighted matrix is generally a matrix that consists of 0 and 1 values (Anselin et al., 2011). This matrix demonstrates spatial interdependence or contiguity that has the symbol of W and is built based on the information of distance, neighbors' area, and neighborhood area.

The first step of spatial econometrics will be to generate Moran's test (Moran, 1948), which involves conducting the preliminary analysis to see if there is spatial autocorrelation among the regions or not. The Moran I Test generates the ratio amongst cross-products of deviations from the mean of the variable of interest and their corresponding spatial intervals, along with the square of assessed deviations:

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (y_i - \bar{y})(y_j - \bar{y})}{\sum_{i=1}^n \sum_{j=1}^n w_{ij} \sum_{i=1}^n (y_i - \bar{y})^2} \quad (6)$$

The coefficient of Moran-I index will be in the range $-1 < I < 1$. If the $I > 0$ so we can conclude the Index reflects there is positive clustering, while if the $I < 0$ is dispersing (Anselin et al., 2011; Elhorst, 2014).

The general assumption of spatial econometric analysis is that there is a spatial interdependence between observed regions, for example, local variables with neighboring WY , interaction between independent variables with local dependent variables WX , and error term interactions with local dependent variables Wu (Elhorst, 2014). The economics modeling of spatial econometrics is based on General Nesting Spatial Models (GNS) with the equation follows:

$$Y = \delta WY + \alpha_n + X\beta + WX\theta + u \quad (7)$$

where $u = \lambda Wu + \varepsilon$.

Where: δ is the coefficient of Spatial Autoregressive, λ is the coefficient of spatial autocorrelation, and θ , like β , represents the vector of $K \times 2$ from the fixed parameter but unknown to be estimated. W is a non-negative matrix $n \times X$ that represents the spatial configuration. From the GNS model, Belotti et al. (2017) classified the model as follows:

SDM (Spatial Durbin Model)

$$y_{it} = \alpha + \rho \sum_{j=1}^n w_{ij} y_{jt} + \sum_{k=1}^K x_{itk} \beta_k + \sum_{k=1}^K \sum_{j=1}^n w_{ij} x_{jtk} \theta_k + \mu_i + v_{it} \quad (8)$$

SAR (Spatial Auto-regressive Model- Spatial Lag)

$$y_{it} = \alpha + \rho \sum_{j=1}^n w_{ij} y_{jt} + \sum_{k=1}^K x_{itk} \beta_k + \mu_i + v_{it} \quad (9)$$

SEM (Spatial Error Model)

$$y_{it} = \alpha + \sum_{k=1}^K x_{itk} \beta_k + \mu_i + v_{it}$$

$$v_{it} = \lambda \sum_{j=1}^n w_{ij} v_{jt} + \epsilon_{it} \quad (10)$$

SACFE (Spatial Autoregressive Combined Model)

$$y_{it} = \alpha + \rho \sum_{j=1}^n w_{ij} y_{jt} + \sum_{k=1}^K x_{itk} \beta_k + \mu_i + v_{it}$$

$$v_{it} = \lambda \sum_{j=1}^n w_{ij} v_{jt} + \epsilon_{it} \quad (11)$$

GSPRE (Generalized Spatial Panel Random Effect Model)

$$y_{it} = \alpha + \sum_{k=1}^K x_{itk} \beta_k + \mu_i + v_{it}$$

$$v_{it} = \lambda \sum_{j=1}^n w_{ij} v_{jt} + \epsilon_{it}$$

$$\mu_i = \phi \sum_{j=1}^n w_{ij} \mu_j + \eta_i \quad (12)$$

The maximum likelihood (ML) estimation produces consistent estimators for all the spatial econometric models, if the estimated model follows the true data

generating process (Lee and Wong, 2001) while the OLS (Ordinary Least Squares) estimators are inconsistent. This study estimates the models in the above five spatial specifications with the ML approaches using the STATA codes provided by Belotti et al. (2017).

4. Result and Discussion

4.1 Empirical Finding

The existing study wants to empirically explain the linkage between Natural disasters and poverty in developing countries, namely Indonesia. First, the authors conducted Moran's I test to examine the spatial autocorrelation between provinces in each variable. Table 3 confirms that there is spatial autocorrelation and it is statistically significant clustering. Meanwhile, the dispersing patterns are found in GDP and Natural disasters, but it's not statistically significant. Since it confirms there is more than one variable that has an inter-regional linkage, the authors need to proceed to the next step of spatial econometrics analysis.

Table 3. Moran-I Test

Contiguity Matrix	Moran-I test Variable	Coeff	P-Value
Distance	Poverty	0.257**	0.0520
	Natural Disaster	-0.072	0.353
	GDP	-0.167	0.134
	HDI	0.237**	0.0380
Rook Contiguity	Poverty	0.230**	0.060
	Natural Disaster	-0.073	0.343
	GDP	-0.179	0.103
	HDI	0.267**	0.067
Queen Contiguity	Poverty	0.592**	0.0050
	Natural Disaster	-0.128**	0.077
	GDP	-0.179	0.103
	HDI	0.267**	0.067

Source: Research finding.

Considering the impact of natural disaster on poverty, since the poverty and HDI are clustering and have significant positive spatial spillover effect supported previous research in the tourism sector (Romão and Saito, 2017; Sun et al., 2018; Yang and Wong, 2012), Solid Waste Management (Cerciello et al., 2019; Gui et al., 2019; Ouchen and Montargot, 2021; Wang et al., 2021). However, the similar result is also found in the natural disaster sector namely flood (Kim et al., 2021; Nepal et al., 2021; Pathak and Olmo, 2021; Rosalia et al., 2021; Zhou et al., 2021).

According to the Moran's p value which is shown by Table 3, revealed that poverty has value below 0.05 in queen contiguity (0.592), rook contiguity (0.230) and distance (0.257), this study can successfully claim that there is a positive spatial autocorrelation or the location of an area has an influence on the level of poverty. Poverty cases between provinces in Indonesia are interconnected when viewed from the location of the eight cardinal directions, fourth cardinal direction and based on the distance. A province can have a high poverty rate if it is adjacent

to a province with a high poverty rate and vice versa. Meanwhile, the variables of natural disaster and GDP have a p-value of more than 0.05, which means that they do not have spatial autocorrelation between provinces. Considering the topography and geographical location of Indonesia, which is surrounded by sea, using queen and rook contiguity might be leading the bias result. So, for the present research the authors decided to use the distance for further estimations.

Next estimation, the author will explain the result of the empirical findings of spatial econometrics that is shown by Table 4. The authors estimate the relationship between natural disaster and poverty in 6 modeling economics which we adopted from Anselin et al. (2011) and Elhorst (2014), namely SDM, SAR, SEM, GSPRE and SACFE. First, the author will focus on the spatial autocorrelation in the present research. The value of rho (ρ) in SDM (FEM and REM) and SAR (FEM and REM) modeling shows significant results in the 1, 5, and 10 percent, respectively. These results from two models supported the previous Moran I result which as expected. The value of lambda in SEM modeling shows significant results in the 1 percent level of significance, respectively. So, it can be said that at the poverty level there is a spatial error dependency. These results were validated by the statistically significant GSPRE and SACFE models. This indicates a significant spatial heterogeneity which means there is autocorrelation between regions in the case of poverty or in another word the increase of poverty in one region can be determined by the increase of poverty in neighboring regions. The results of the SDM, SAR, and SEM modeling have similar results in terms of coefficients and significance. However, the best model is shown by the SDM model with an AIC value of 0.228. Therefore, for the next estimation, the authors only focus on SDM results with FE and RE models.

Along with spatial autocorrelation estimation, now we focus on the relationship between the independent variable and dependent variables. The results also shows that the sign of the coefficient of each variable has the same in all spatial models in the levels of 1, 5, and 10 percent of significance, respectively. First, we focus on the relationship between natural disaster on poverty which reveals there is strong and negative relationship between these variables in the levels of 1, 5, and 10 percent of significance. Thus, it can be verified that the presence of natural disasters can negatively affect poverty which is not supported the previous studies. However, the other independent variables such as GDP and HDI are also negatively influence the poverty in the area.

The local spillover can be seen from the regression of the W_x Matrix shown in Table 2 that is one of the benefits of using the SDM model. The present research reveals the relationship between HDI from neighboring provinces can statistically increase the poverty in one region as can be seen from the P-value for HDI for both FEM and REM are statistically significant at 1 percent level of significance. However, the present research reports the increase of GDP in neighboring provinces can reduce the level of poverty by 0.0003.

Table 4. Empirical Findings of Spatial Econometrics

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(5)	(6)
	SDM		SAR		SEM		GSPRE	SACFE
	FEM	REM	FEM	REM	FEM	REM	REM	FEM
LnDIS	-7.7589*** (0.031)	-7.665212** 0.044	-9.843516*** (0.007)	-9.364869** (0.016)	-9.968833*** (0.008)	-9.575451** (0.016)	-9.382558** (0.018)	-9.12055*** (0.008)
LnGDP	-0.0002605*** (0.000)	-0.0002339*** (0.000)	-0.0002754*** (0.000)	-0.0002442 *** (0.000)	-0.0002666*** (0.000)	-0.0002376*** (0.000)	-0.0002342*** (0.000)	-0.0002829*** (0.000)
HDI	-143.2638*** (0.000)	-130.3343*** (0.000)	-10.18875* (0.111)	-11.51179** (0.087)	-16.29082** (0.027)	-18.08154** (0.021)	-19.49525** (0.014)	-2.170217 (0.716)
cons		321.7825 (0.582)		1626.738*** (0.001)		2227.368*** (0.000)	2332.435*** (0.000)	
Wx								
LnDIS	-3.062473 (0.582)	-2.653587 (0.652)						
LnGDP	-0.0003432*** (0.000)	-0.0003112*** (0.001)						
HDI	154.0724*** (0.000)	139.4938*** (0.000)						
rho	0.1051131* (0.103)	0.153** (0.0625)	0.153313** (0.014)	0.1799377*** (0.004)			0.364*** (0.000)	0.3639051*** (0.001)
sigma2_e			20,120*** (0.000)		20322.82*** (0.000)	22861.53*** (0.000)	151.1983*** (0.000)	20985.13*** (0.000)
sigma2_mu							1147.307*** (0.000)	
lambda					0.1313863** (0.055)	0.142379** (0.048)	0.1455849** (0.044)	-0.2683031** (0.040)
phi						4.273546*** (0.000)	0.4431611** (0.016)	
Observations	288	288	288	288	288	288	288	288
AIC	0.228	0.228	0.228	0.303	0.303	0.303	0.303	0.303
Number of id	32	32	32	32	32	32	32	32

Source: Research finding.

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

4.2 Discussion

The present findings establish a strong negative relationship between the impact of natural disaster and poverty in Indonesia. Remarkably, the author can claim that the existing natural disaster can reduce the poverty in Indonesia which is really interesting to discuss. Figure 1 establishes the impact of natural disaster on Poverty in each region, providing a comprehensive visual representation supporting the central argument of the present research. Notably, all provinces in Papua, central and western Java exhibit the highest impact on poverty when disaster happens, while Kalimantan and Sulawesi Island demonstrate the lowest impact. Flood, the most frequent natural disaster in Papua, Central Java, and Western Java may be a contributing factor, trapping people in the cycle of poverty (*Natural Disaster Management Statistics*, 2020). Despite regional variations, the overall result of this study presents an intriguing outcome – natural disasters appear to have a positive impact on reducing poverty. This counterintuitive finding challenges conventional wisdom and suggests the necessity for further exploration and nuanced understanding of the complex relationship between natural disaster and poverty in Indonesia.

This finding is supported by Abdullah et al. (2016), particularly in the context of typhoons in Bangladesh. Their results revealed that after a natural disaster, poor people earn higher incomes than before after natural disaster occurred. The reason could be that the poorer people experienced an increase in income compared to the pre-disaster level. It appears that these individuals seized new opportunities generated by the aftermath of the disaster, leading to an income boost of more than 15 percent over the average income before. Similar cases in Myanmar have provided evidence of post-disaster poverty reduction (Warr and Aung, 2019) and creation of new sources (Groeschl and Noy, 2020). Warr and Aung (2019) observed that, in the short term, poorer individual tends to manage their consumption at the minimal level when a disaster strikes, while in the long term, they actively seek opportunities and jobs to recover. Importantly, these positive outcomes do not result directly from the impact of the disaster itself, but rather from effective policies and programs aimed at addressing the consequences of the disaster. Social protection policies and guarantees for those affected by the disaster play a crucial role in poverty reduction resulting from natural disasters.

While this study establishes that disasters can reduce poverty, it is essential to acknowledge the contextual nature of this finding. Hallegatte et al. (2020) and Xiang et al. (2021) highlight the diverse geographical, topographical, and climate condition across the islands in Indonesia, leading to varied vulnerabilities and risk for each population. This diversity prevents the generalization of disaster poverty pattern across the entire country. A similar complexity is observed in Sichuan Province, where not all regions exhibit a clear clustering of the natural disaster-poverty relationship. Moreover, the contextual variations extend to regulatory differences in each country, further influencing the interplay between natural

disaster and poverty. It is crucial to consider these nuanced factors when interpreting the study's findings and when formulating policies and strategies for disaster resilience and poverty reduction in specific regions.

Furthermore, the impact of disasters on poverty is intricately linked to the level of resilience within households in a given area. If the effect of disasters on income is substantial, the likelihood of a significant impact on poverty increases. Conversely, the impact is marginal, and the probability of a household falling into poverty diminishes. Thus, the occurrence of a disaster does not necessarily guarantee an increase in the poverty status of a household (Putra, 2013). Menendez (2014) supports this perspective between natural disasters on poverty in Indonesia, highlighting the importance of considering varying time frames in understanding the economic consequences of such events.

As we utilized provincial-level data, the direct consequences of natural disasters on poverty may vary across regions. Moreover, in the long term, areas adjacent to disaster-stricken zones may indirectly benefit from the heightened demand during rehabilitation and reconstruction in the core disaster area (Yu Xiao and Nilawar, 2013). Disasters can also reshape the economic structure of a region, leading to a focus on sectors that demonstrate greater resilience to such events. Production centers may shift to areas that are less vulnerable to disasters, reducing development inequality and creating new job opportunities in proximity to the affected areas. Consequently, at a broader level, natural disasters can indirectly contribute to poverty reduction in the long run. This aligns with the experiences of West Sumatra and Yogyakarta provinces in Indonesia, which demonstrated high positive growth in the years following disasters, consequently impacting poverty reduction (Nazamuddin and Nugroho, 2019). A recent study by Ilham et al. (2023) similarly found that natural disasters, by influencing regional economic growth, indirectly contribute to poverty reduction in Indonesia.

Disasters, often viewed as 'blessings in disguise', present opportunities for rebuilding and improving outcomes, including the potential to mitigate future disasters (Bănică et al., 2020). They serve as a valuable learning experience on how to cope with extreme shock, offering insights for enhancing resilience. Additionally, disaster injects economic stimulus into the affected development through insurance mechanism and support from both private and public sector (Rose, 2014). In the aspect of government policies addressing the natural disaster, Indonesia has implemented various packages of policies at the national, regional, and local levels. These policies encompass substantial financial assistance or aid (World Bank, 2021), as well as physical and mental health support from the national and regional level (Marfuah et al., 2021). In terms of budgeting for natural disasters, the Indonesian Government has established an instrument designed to allocate funds for sustainable pre-disaster, emergency response, and post-disaster financing. Social protection mechanisms are recognized as effective tools for enhancing welfare. Post-disaster intervention priorities include efforts to meet

people's basic needs, encompassing both food and non-food essentials such as housing, education, and health. This holistic approach underscores the government's commitment to addressing the multifaceted challenges posed by natural disasters and promoting long-term resilience and well-being.

Remarkably, third-party entities such as international, national, and local Non-Governmental Organizations (NGOs), community groups, cooperation initiatives, youth organizations, and religious organizations play significant roles in aiding affected areas and people (Smiley et al., 2018). Indonesia, with its strong societal values emphasizing cooperation ('*Gotong royong*' in Bahasa), witnesses a collective effort to help affected individuals maintain their consumption levels during the initial three months following a shock. The willingness of people to extend assistance and donations, even from regions outside the affected area, coupled with government-provided social protections, reflects the robust sense of community support. Moreover, the provision of social welfare emerges as a critical factor in assisting the most vulnerable populations through disasters (Tselios and Tompkins, 2019). This commitment to social welfare may explain why the impact of shocks after a disaster is often experienced only in the short term in Indonesia, and in certain instances, leads to a reduction in poverty levels.

As anticipated, the coefficient for regional GDP exhibits a significant negative effect. The reduction in the number of poor people appears to be closely tied to economic growth that benefits the impoverished. In line with findings from the World Bank (2006), the post-crisis period saw a substantial decrease in poverty, largely attributed to enhanced economic stability. This outcome suggests that an upswing in regional GDP is associated with the region's capacity to alleviate poverty and its potential to implement pro-poor policies (Li et al., 2015; Siburian, 2022). The extent of disaster losses is intricately linked to the social and economic conditions of the community. Communities with better socio-economic conditions tend to experience lower levels of economic losses (Tasri, 2021). In this context, GDP serves as an indicator of the level of welfare or the capacity for recovery. This finding aligns with a study conducted by Erman et al. (2020), which asserted that individuals in low-income countries, as indicated by purchasing power parity, generally have less protection compared to those in wealthier nations. Regions with higher incomes are more inclined to implement climate risk management strategies and leverage the latest technologies, resulting in reduced risk impacts and losses from disasters (Tasri et al., 2022). It emphasizes the interconnection between poverty alleviation and disaster risk management.

This estimation reveals a negative coefficient for the Human Development Index (HDI), indicating that an increase in HDI correlates with a poverty reduction. Highly developed countries are expected to mitigate the impact of natural disasters, evidenced by a reduction in the total number of casualties, affected individuals, and overall damage. The components of human capital, including education and health, play a significant role in boosting both total factor productivity and creating

opportunities for individuals in a country. The Human Development Index (HDI) serves as an indicator of household preparedness to overcome shocks caused by natural disasters. Human development consistently emerges as a key determinant of vulnerability to natural disasters. Improved education, health, and income indicators are associated with a reduced risk of natural disasters (Lutz, 2015). Higher human capital contributes to economic benefits such as enhanced productivity and reduced unemployment (Padli et al., 2018; Teixeira, 2014). Regions with a higher Human Development Index (HDI), as emphasized by Padli et al. (2018), exhibit faster recovery capabilities compared to those with a lower HDI. A heightened HDI acts as a barrier, reducing the fatality rate of disasters and representing an educational level that aids in mitigating natural disasters. Individuals with higher education levels among the affected population tend to be more open to opportunities, promoting increased income and mitigating poverty (Olopade et al., 2019). Public investments in education and health, contributing to higher human capital, have been shown to alleviate poverty in OPEC countries (Olopade et al., 2019). Cheng et al. (2021) support this argument in their latest publication, indicating that human capital, with education playing a prominent role, has a positive effect on poverty alleviation. These findings align with the assertions of Aldino (2018) and Nigrum (2017), who posit that higher HDI levels in an area enhance the quality of human resources, accelerating recovery and reducing poverty in affected areas.

The analysis results indicate that the impact of GDP is smaller compared to the role of HDI in reducing poverty. These findings underscore that addressing poverty solely through increased economic growth, in the anticipation of a trickle-down effect, may not be sufficient. Enhancing the quality of human resources proves to have a more substantial influence on reducing the poverty rate.

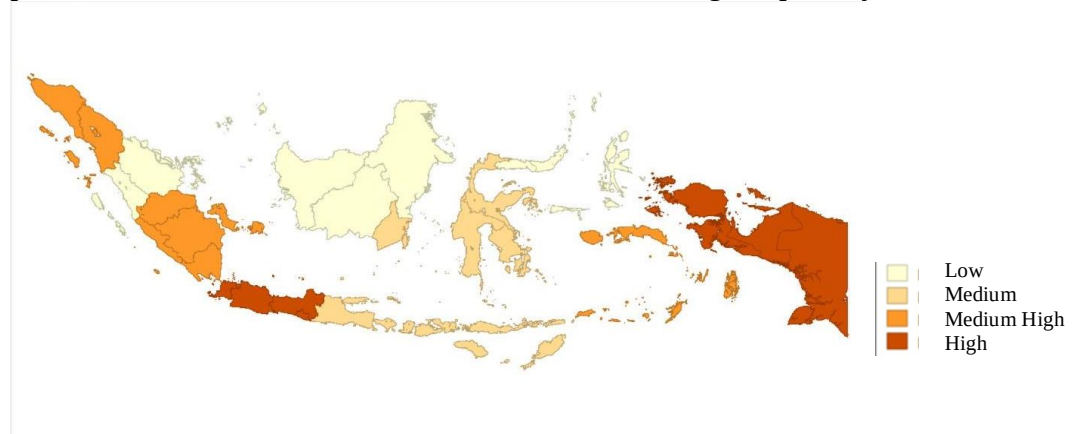


Figure 1. The Impact of Natural Disaster on Poverty in Indonesia

Source: Research finding.

With reference to the Sendai Framework, the Paris Agreement, and the agenda for Sustainable Development Goals (SDGs), resilience and disaster

mitigation play a crucial role in achieving sustainable development. Aligning with the Global Platform for Disaster Risk Reduction (GPDRR) implementation, Indonesia must not only prioritize disaster-induced poverty but also cultivate an adaptive and responsive institutional culture, along with ensuring adequate funding. Environmental conservation efforts and technological innovation must be synergized for comprehensive progress.

5. Conclusion and Policy Recommendation

The primary goal of this research is to establish the relationship between natural disasters and poverty using Spatial Econometric Modeling. The findings reveal intriguing insights into the impact of catastrophic disasters on poverty. Three key explanations can be derived from the results. Firstly, both the Moran I test and Spatial Econometrics consistently demonstrate spatial autocorrelation in poverty, indicating that the level of poverty in one area can influence neighboring areas. Secondly, the research shows a significant reduction in poverty due to the impact of natural disasters. The distinct geographical, topographical, and climatic characteristics of each province play a crucial role in this outcome. Notably, international, national, and local financial assistance effectively manages the consumption of affected individuals. Additionally, the strong moral value of mutual cooperation among Indonesians contributes significantly to aiding affected people and areas. Thirdly, higher GDP and HDI suggest a more prepared society, enabling faster recovery from negative external shocks. The relationship between GDP and HDI extends beyond education, encompassing familiarity with the latest technological advances. Based on the main finding of the present research, we can generate input for policymakers:

- Due to the spatial autocorrelation of poverty, which allows policymakers to treat poverty as an interregional policy. So, the policymakers need to coordinate between the regional and national levels to generate a poverty alleviation policy. However, the most important part to utilize the spatial autocorrelation based on the present research findings, are joint policy for poverty reduction.
- The strong and negative relationship between natural disasters and poverty is very interesting to discuss. However, the government can maximize the utility of third parties to help affected people and the area. Meanwhile, the assistance or aid from the central and regional government can be increased in order to help people maintain the same level of consumption when there is shock.
- The existing local spillover between HDI and GDP can be utilized by regional government. The joint policies between neighboring areas on one island can be one of the ways to reduce poverty. In addition, since the Government of Indonesia carries out massive inter-region infrastructure development to boost economic growth, it should also be developed to reduce poverty, especially with an emphasis on geographically disaster-prone areas.

- In addition, a structured and holistic disaster management framework involving stakeholders, both central and regional, is very necessary so that the government does not ignore disasters.

To contribute more to the Indonesian Government and society, future studies should incorporate government aid or assistance into econometric modeling. The authors believe that government aid can play a significant role in helping affected individuals. However, poverty is a multidimensional issue, and the authors cannot overlook the social aspects, such as mutual cooperation, religion-based organizations, and other third parties, which provide significant assistance during natural disasters.

Abbreviations:

AIC: Akaike information criterion

Coef: Coefficient

FEM: Fixed Effect Model

GDP: Gross Domestic Product

GPDRR: Global Platform for Disaster Risk Reduction

GSPRE: Generalized Spatial Panel Random Effect Model

HDI: Human Development Index

ML: Maximum Likelihood

NGOs: Non-Governmental Organizations

OLS: Ordinary Least Squares

OPEC: Organization of the Petroleum Exporting Countries

P value: Probability Value

R²: R-Squared (Squared Pearson's Correlation coefficient)

REM: Random Effect Model

S.D: Standard Deviation

SACFE: Spatial Autoregressive Combined Model

SAR: Spatial Auto-regressive Model- Spatial Lag

SDGs: Sustainable Development Goals

SDM: Spatial Durbin Model

SEM: Spatial Error Model

STATA: Statistics and Data Software

Statements and Declarations

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Developing a New Bisaliah Decomposition Model to Evaluate the Effect of the Sustainable Economic Development of Irrigation Technology on Palm Production

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Abstract

Analyzing the response of crop yields to varying irrigation methods is a focal point to ensure sound water resource management and the reduction of water loss. This paper investigates palm yield in both drip and traditional irrigation methods. So, the Bisaliah model and the Logit model were applied in Saravan city to evaluate palm yield and the economic factors underpinning the adoption of the drip irrigation system by farmers in this region. The results of the Bisaliah model indicated that the production yield of palms would increase by up to 28.98% by using drip irrigation compared to traditional irrigation considering no change in the consumption of inputs and by up to 5.35% versus the status quo taking changes in the use of inputs into account. Using drip irrigation in orchards and vineyards may cause a 38.54% increase in yield. The results of the Logit model revealed that farmer age, the number of family laborers, and the availability of water had negative impacts on the adoption of drip irrigation. Therefore, it is recommended that the results of this study be taken into consideration by planners to improve date production using irrigation technology.

Keywords: Bisaliah Model, Drip Irrigation, Logit Model, Palm, Saravan.

JEL Classification: B22, B41, C51.

1. Introduction

Water has always been considered the main factor in the development of societies. Water is a scarce resource, with irrigated agriculture accounting for up to 85% of global water consumption (Schilfgarde, 1994; Farrokhzadeh et al., 2020). It is thus important to increase crop yields.

Achieving agricultural productivity growth will not be possible without developing and disseminating yield-increasing technologies because it is no longer

possible to meet the needs of increasing numbers of people by expanding the area under cultivation (Asfaw et al., 2012). The selection of a proper irrigation system will help manage limited water resources and increase crop profitability.

Meeting the food requirement of a growing population needs increasing the exploitation of natural and agricultural resources and expanding technical knowledge (engineering) in the field of natural and agricultural resources. By applying appropriate technology, in addition to the significant growth in agricultural production, it is possible to reduce manufacturing and economic costs. Promoting technical knowledge takes time and a lot of expense in the context of science and research (Sardar Shahraki et al., 2018).

Sistan and Baluchestan province is one of the fertile regions of Iran, cultivating 57000 hectares of palm and producing 147000 kg/ha. A great portion of this crop is cultivated in Saravan, and the palm is considered the most economic product in this region. Since agriculture in arid regions has special conditions, water and irrigation are the keys to crops in such regions. That is why all efforts and measures are applied to enhance productivity or water consumption efficiency programs. The area under the drip irrigation system in Sistan and Baluchestan province has been around 18724 hectares since the beginning of the project in 1994-2006 (the beginning of the ninth presidential period) and it increased to 36350 hectares by the end of 2013. The fields in this area were equipped with drip irrigation, sprinkler irrigation, and subsurface (tape) irrigation. It should be mentioned that among all these regions in the province, sprinkler irrigation is used on 2632 hectares in Saravan County.

The average rainfall in Sistan and Baluchistan province is much less than Iran's average rainfall of 250 mm. So, it shows that the province is facing a water shortage due to the recent drought. Some new plans are, therefore, required to supply water in this area. So, research and studies have been undertaken to investigate necessary strategies for on-farm water management.

The aim of this prospective study is to evaluate the impact of irrigation technology change on palm yield and other economic factors in the study area (Saravan city). Moreover, the management and environmental influence of applying drip irrigation among farmers are to be examined. Therefore, the main objectives of the present research are as follows:

- Determining palm yield under two methods of drip irrigation and traditional irrigation using the Bisalialah and Logit models
- Investigating the economic, managerial, and environmental factors affecting the acceptance of drip irrigation by farmers.

2. Literature Review

In many studies, modern irrigation methods have been considered an innovation in agricultural science. On the one hand, these methods should be consistent with the local conditions and technical issues; on the other hand, they need to be accepted by the farmers and field managers. Researchers have highlighted economic, social, and agricultural factors that affect the general acceptance of modern drip irrigation. Darusman et al. (1997) found out that the application of drip irrigation to supply 75% of the water demand of the corn plant can lead to more efficient performance and a decrease in the penetration of water beneath the roots of the corn in that area. In India, Randhir and Krishnamorthy (1999) used the Cobb–Douglas production function to examine the production efficiency within a group of farmers accessing irrigation equipment and a group of farmers with no access to irrigation equipment. They claimed that the use of irrigation equipment can significantly affect the production efficiency and the income of the farmers. Ascough and Kiker (2002) investigated circular-central and semi-fixed sprinkler irrigation for sugarcane. They concluded that the average efficiency for these irrigation systems was 83.6% and 73.5%, respectively.

Water consumption has always been a great concern for farmers. Lamm (2004) reviewed some studies and claimed that one can grow corn by consuming the least amount of water. However, he suggested that such irrigation systems may reduce the efficiency and some qualitative features of the corn. Noroozi and Chizari (2006) studied the factors affecting the acceptance of sprinkler irrigation in Nahavand County. The findings showed that the proposed diagnostic model could help classify the farmers who used sprinkler irrigation and surface irrigation. The findings could lead to an increase in the acceptance of sprinkler irrigation among the farmers, thereby improving the efficiency of irrigation and water use on farms. In a seminal study, Kohansal et al. (2009) investigated the effect of environmental and non-environmental factors on the acceptance of sprinkler irrigation in Razavi Khorasan province, Iran. The results showed that educating farmers, providing necessary conditions for the farmers to receive bank facilities, and increasing farm size through land integrity could improve the adoption of sprinkler irrigation. Shahzadi (2013) concluded that education, land possession, farm size, bank facilities, and annual income had significant effects on the acceptance of drip irrigation. The results suggested that bank facilities played the most important role. Therefore, the banks should lower their interest rate to increase the farmers' acceptance of such irrigation methods. The factors affecting the adoption of drip irrigation by farmers in Shoosh, Andimeshk, and Dezfool

counties were investigated by Aghapoor et al. (2013). The results showed that the small farm size, the procedure of granting bank facilities, and lack of farm ownership were the most important factors impeding the use of drip irrigation by the farmers. Literacy, land possession, and cultivated farms can encourage the use of drip irrigation. Farm number and farmer age are considered to have negative effects on the farmers' attitudes towards the use of modern irrigation methods. Movahedi et al. (2017) examined the factors affecting farmers' acceptance of modern drip irrigation technology in Asadabad County. They claimed that perceived efficiency, perceived ease of use, and usage attitude had significant and positive effects on the adoption of drip irrigation and, consequently, on the acceptance of such irrigation methods.

However, few studies have looked at the impact of agricultural technologies on crop yields by decomposition analysis. Gawaria et al. (2010) evaluated wheat productivity by decomposition analysis. Production response functions for both modern and traditional technologies were estimated to understand the advantage of modern technology over traditional technology. The total difference in the productivity between modern and traditional wheat technology was estimated at about 62%. Ben-Ari and Makowski (2014) developed an analytical expression decomposing global crop yield inter-annual variability into three informative components that would quantify how evenly cropland was distributed in the world. According to the literature reviewed above, it can be concluded that the nature and effectiveness of the variables underpinning the acceptance of modern irrigation methods are different in various parts of the country. More importantly, though, the variety and the extent of such studies in Iran support the fact that irrigation has been considered a crucial issue among researchers. Palm is one of the most strategic products of Saravan that accounts for a great part of palm production in the whole province and plays an important role in the local economy. The Logit model has commonly been used in previous studies to form models and determine the effects of irrigation methods. However, for the present study, the Bisalial model was investigated too. We can claim that the present study is the first work in which both Logit and Bisalial models are used to investigate the effectiveness of irrigation technology and palm production in Saravan County.

3. Materials and Methods

3.1 Bisalial Model

In this study, the effectiveness of drip irrigation technology was investigated in palm production. The study assumed that "any changes in production technology

(using drip irrigation) can trigger changes in the production function (slope and intercept)". The objectives of the present study were that the acceptance of technology should first cause a change in the intercept function of how much is produced; second the production function should show a slight stretch; the third objective includes the two above-mentioned changes in the production function and the use of inputs and what production has been created; and the fourth objective is to determine the yield per unit area (ha) and any possible increase in the amount of production. Initially, knowing what form of function would fit there, an adequate amount of data was collected and various production functions (Cobb-Douglas, Translog, and Transdntal) were estimated and compared using F and R^2 . To determine the function of the independent variables, in the ones who were chosen in the pilot estimation, the means were significant. The overall logarithmic function used in the study is as follows:

$$\ln Y = \ln b_0 + b_1 \ln L + b_2 \ln P + b_3 \ln F + b_4 \ln H + b_5 \ln W + b_6 \ln K + U_i \quad (1)$$

where:

Y = Amount of product (kg)

L = Area under cultivation (ha)

P = Amount of toxin (Lt)

F = Amount of fertilizer (kg)

H = Human resources (people)

W = Amount of water (cubic meters)

K = Capital (thousand IRR)

$Slope =$ Function (i, the partial elasticity function)

U_i = any residual.

Here, using the Bisalialah decomposition model to detect and measure the share of the resources in different functions, one can identify the distinctive parameters in the performance of the two functions. The general changes in these two functions can happen either based on the changes in the parameters or as a result of any change in the disposal of the input materials. Since performance functions are the easiest econometric models to distinguish between performances, they were used for both groups of farmers whether they applied drip irrigation or traditional irrigation (Kiresur and Ichangi, 2011):

$$\ln y_1 = \ln b_{01} + b_{11} \ln P_1 + b_{21} \ln F_1 + b_{31} \ln H_1 + b_{41} \ln W_1 + b_{51} \ln K_1 + U_i \quad (2)$$

$$\ln y_2 = \ln b_{02} + b_{12} \ln P_2 + b_{22} \ln F_2 + b_{32} \ln H_2 + b_{42} \ln W_2 + b_{52} \ln K_2 + U_i \quad (3)$$

$$\begin{aligned}
Ln y_1 - Ln y_2 = & \{Ln b_{01} - Ln b_{02}\} + \{(b_{11} - b_{12}) Ln P_2 + \dots \\
& (b_{21} - b_{22}) Ln F_2 (b_{31} - b_{32}) Ln H_2 (b_{41} - b_{42}) Ln W_2 (b_{51} - b_{52}) Ln K_2\} + \{b_{11} Ln \frac{\partial P_1}{\partial P_2} + \dots \\
& + b_{21} Ln \frac{\partial F_1}{\partial F_2} + b_{31} Ln \frac{\partial H_1}{\partial H_2} + b_{41} Ln \frac{\partial W_1}{\partial W_2} + b_{51} Ln \frac{\partial K_1}{\partial K_2} + U_i
\end{aligned} \quad (4)$$

The left side of the above equation indicates the difference in performance due to the use of technology. The first part of the formula on the right includes the effects of neutral components of technology (the percentage of changes due to the change in the parameters), the second bracket reflects the effect of non-neutral components of technology being weighed based on the consumption of the input variables in the farms using traditional irrigation (the percentage of changes due to the change in the slope of the parameters), and the third bracket shows the difference in the performance caused by the change in the consumption of inputs weighed considering partial modification of each of the production factors in the drip irrigation function (Kiresur and Manjunath, 2011).

The data needed for the calculation and estimation of the model were related to the crop year 2016-2017 and were mostly visited by local farmers in Saravan a questionnaire was collected by random sampling. Having collected the information, the researchers used *Eviews8* software to estimate the studied pattern.

3.2 Logit Model

The Logit model is used when the dependent variable is not visible. The dependent variable appears in a dual selection. The Logistic model also follows the logistic curve, so the curve fitting is based on actual data. For the actual data related to the dependent variable, the two values 1 and 0 are assigned based on whether it has occurred or not, respectively. So, the top or the bottom of the chart was determined with respect to different levels of a linear combination of independent variables. Superior to that of logistic regression, to determine the values 0 and 1, it is only necessary to notice the occurrences in the question. Thus, the dependent variable can be used to estimate the occurrence or non-occurrence of the event (Abrishami, 2007):

$P_i = F(Z_i) = F(a + bX_i) = \frac{1}{1 + e^{-Z_i}} = \frac{1}{1 + e^{-(a + bX_i)}}$	(5)
$1 - P_i = \frac{1}{1 + e^{Z_i}} = \frac{1}{1 + e^{(a + bX_i)}}$	(6)

$\frac{P_i}{1 - P_i} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = e^{Z_i}$	(7)
$L_i = \ln \frac{P_i}{1 - P_i} = a + b X_i$	(8)

In this study, the dependent variable is farmers' decisions to accept or refuse the new system of drip irrigation. Therefore, the Logit model was applied as follows to determine and assess the factors affecting the acceptance of drip irrigation technology in Saravan County (Abrishami, 2007):

$$Y_i = F(Z_i) \quad (9)$$

$$Z_i = a + \sum_{j=1}^N b_j X_{ij} \quad (10)$$

$$Z_i = a + b_1 X_{i1} + b_2 X_{i2} + b_3 X_{i3} + \dots + b_n X_{in} + u_i \quad (11)$$

$$Z_i = a + \sum_{j=1}^9 b_j X_{ij} + u_i \quad (12)$$

where:

(Qualitative dependent variable) = probability of adopting irrigation technologies (1 for the adoption of irrigation technology and 0 for non-adoption).

α = intercept model

n = total number of observations

B_j = the estimated model parameters.

X_j = independent variables (explanatory) model, a set of economic, environmental, and management characteristics and the following tiller number is:

Table 1. Explanatory Variable Influencing the Adoption of Pressurized Irrigation

Variable	Definition
X_1	Farmer age
X_2	The number of family labor
X_3	Farm area

Source: Research finding.

Table 2. Dummy Variable Influencing the Adoption of Pressurized Irrigation

Variable	Definition	Value	
		1	0
D ₁	Education	High school diploma	School education
D ₂	Main occupation	Home jobs	Secondary jobs
D ₃	Land slope	High	Low
D ₄	Class educational and promotional level	Participation	Lack of participation

Source: Research finding.

The data needed for the calculation and estimation of the model were related to the crop year 2016-2017 and were mostly visited by local farmers in Saravan through questionnaires which were randomly distributed among the farmers. In this study, the statistical population included the farmers in Saravan County, Sistan and Baluchestan province.

4. Results and Discussion

In this study, the production functions were estimated for the group of farmers who used drip irrigation (90 farmers) and those who didn't (120 farmers) using function(1). Then, considering all the data (210 farmers), a function including the intercept and dummy slope was estimated. We considered a dummy variable whose value was 1 in the case of the use of drip irrigation and 0 in the case of the use of traditional irrigation. Furthermore, in this section, the production function was estimated using four different methods. The first function was estimated using a function where the farmers used drip irrigation, the second function was estimated using a function where the farmers didn't use drip irrigation, the third function was estimated using the parameters of all the fields, and the fourth function was estimated using the parameters of all the fields as well as the dummy parameters. The results are presented in Table (3).

Table 3. Estimation of Production Functions

Variable	Coefficients			
	The first function	The second function	The third function	The fourth function
Intercept	5.87***	5.23***	3.54***	3.54***
Dummy variable	8.87	1.78	0.144*	0.144*
Cultivation	8.547***	5.236***	2.325***	2.325***
Amount of pesticides	3.258*	0.874***	0.254***	0.254***
Amount of fertilizers	0.124**	0.213*	0.214*	0.214*
R ²	0.89	0.88	0.99	0.99
Number of samples (n)	101	202	125	125
Confidence level: ***: 99% ; **: 95% ; *: 90%				

Source: Research finding.

A significant percentage of the estimated value of F ($p=0.01$) is significant, and R^2 is reported above 70 in all the equations, which indicates the value of the models. Minor tractions of the cultivated acreage, labor, and the amount of pesticides were greater where the farmers did not use drip irrigation. However, other elements were lower for the farmers who didn't use drip irrigation. The F value ($p=0.01$) for the third function, in which all variables of farms were used, and for the fourth function, in which all those variables plus dummy variables were used, was significant. The coefficient index reveals a significant difference between the two functions. Therefore, the use of drip irrigation may increase the intercept and change the partial elasticity of the production factors.

Table 4. Results of Estimating Functions in Terms of Performance per Unit Area (ha)

Explanatory variables	Regression Coefficient		
	The first function	The second function	The third function
Intercept	2.87***	3.78***	4.98***
Amount of pesticides	5.25*	0.02***	0.21***
Amount of fertilizer	0.25**	0.87*	0.25*
Human resources	0.054*	0.257***	0.217*
Amount of water (m ³)	0.254***	0.214***	0.214***
Investment (IRR)	0.258*	0.658*	0.687*
R ²	0.87	0.85	0.97
Number of samples(n)	101	120	202
Confidence level: ***: 99% ; **: 95% ; *: 90%			

Source: Research finding.

To distinguish between the effects of factors affecting the performance of the functions, the first step was to identify the functions of those farmers who used drip irrigation and those who didn't in terms of unit area (ha). For this purpose, functions (1), (2), and (3) were used. Table (4) shows the results of the estimated functions for the performance of inputs whose regression coefficients were statistically significant. Since the intercept for the first function is significantly higher than that of the second function, it is concluded that drip irrigation caused the function to improve. Minor tractions for the pesticide level, human workforce, and amount of fertilizers were higher in the second function. However, the first function showed greater traction for water and capital compared to the second function.

To identify the effect of drip irrigation on the production and consumption of inputs, we could also compare the average consumption of the inputs between the situation where drip irrigation was used and the situation where traditional irrigation was used. Table (5) presents the average inputs used in production considering different irrigation modes. Hence, the results indicated that the use of drip irrigation has led to an increase (38.54%) in the average yield rate.

Table 5. Factors Affecting Yield

Factors altering yield	Percent change	
	Components	Total
The actual change in average yield	-	38.54
<i>Changes in performance due to changes in technology, including:</i>	-	28.98
A) changes due to neutral technology	-	87
B) changes due to non-neutral technology	-	-87.25
<i>Changes in performance due to changes in the level of consumer input, including:</i>	-	5.35
A) labor	-0.87	-
B) fertilizer	2.87	-
C) pesticide	-	-
D) water	-	-
E) investment	-	-
The total estimated change in the performance category	-	32.23

Source: Research finding.

The change rate was calculated using function (4) (the procedure is explained in Table (5), and the results showed that there was a 32.23% change in the performance. This value was compared to the percentage of the change observed

in Table (5), indicating little difference (0.62%). The difference between these two values can be related to the residual. Moreover, Table (5) shows that employing drip irrigation can cause direct and indirect changes in production technology (by changing the consumption of inputs). It is claimed that the change in the yield (kg/ha) has increased by 28.98% and 5.35%, respectively.

The maximum likelihood (MEL) model was used to estimate the Logit model. Multi co-linearity of the variables, asymmetrical variances for residual terms, and the specification of the model were taken into account before estimating the Logit model and after the initial estimates. There were no problems regarding these issues in the final model. The results of the estimation of the Logit model are shown in Table (6).

Table 6. The Logit Model Results by the Maximum Likelihood Method

Variable	Name	Coefficient	Standard error	T statistic	The ultimate effect of variable
Constant coefficient	<i>C</i>	-3.25***	2.87	-3.885	-0.253
Farmer age	<i>X1</i>	0.54***	0/023	-6/854	-0.254
The number of family labor	<i>X2</i>	-0.254	-0.254	-0.254	-0.254
Farm area	<i>X3</i>	0.2584***	0.214	0.254	0.214
Education level	<i>D₁</i>	0.254**	0.254	2.458	.897
Main occupation	<i>D₂</i>	2.235*	2.325	3.2145	0.2544
Land slope	<i>D₃</i>	0.254*	1.254	0.258	0.365
Class educational and promotional	<i>D₄</i>	0.254**	0.554	3.22	0.324
Factor for the calculation of marginal effects =0.2354					
Maximized value of the log-likelihood function = -87.60					
Goodness of fit =0.8795					
Confidence level: ***: 99% ; **: 95% ; *: 90%					

Source: Research finding.

According to Table (6), the efficiency of fit for this model is considered to be 0.87%, which indicates an acceptable fit index. The index for the ultimate effect of the model is 0.23, which was obtained by multiplying this index by the coefficients. All these indices suggest that the model can successfully explain the behavior of the variables.

The results in Table (6) showed a negative impact of farmer age ($P =$ at least 99% confidence level), indicating an inverse relationship between age and their willingness to invest in drip irrigation. This negative effect of age was not unexpected because as people (farmers) get older, they become more conservative

and less risk-taker. According to the index, the net effect of -0.254 shows that if a farmer gets one year older, the possibility of his investment in drip irrigation decreases by 2.5%.

The number of family members as the workforce for that family was claimed to have a negative effect on the acceptance of drip irrigation by the farmers. Although this is not considered a significant effect, it may impede the willingness of the farmers to invest in modern irrigation methods. It can be concluded that because the farmers should replace the workforce with capital, they are reluctant to invest in drip irrigation. The table suggests that their willingness decreases by 2.5% per each new member in their family.

The literacy and knowledge of the farmers were proved to influence the acceptance of drip irrigation by the farmers significantly. The results showed that the higher the farmers' educational status, the more willing they are to apply modern irrigation methods. The farmers holding a diploma or higher degrees are 8.9% more interested in applying drip irrigation compared to those who lack such degrees. Therefore, educating and training farmers may lead to their acceptance and exploitation of modern irrigation systems.

It is also claimed that the bigger the farm, the more eager the farmers are to use drip irrigation. According to the results of this study, an increase of a single hectare in the field leads to a 21% increase in the acceptance of drip irrigation by the farmers. However, it all depends on the fact that the farmers can equip their fields with such technologies. On the other hand, increasing the cultivated areas can encourage the farmers to adopt more cost-effective methods to save their workforce and improve their production efficiency. Using drip irrigation is an appropriate way to spend less but gain more, especially in wider and bigger fields.

The nature of farming as a major job can have a significantly positive effect on the acceptance of drip irrigation. The results indicated that it is 25% more probable for a farmer to use drip irrigation if farming is his/her main sole job, not an adjunct. The reason behind such an attitude is the farmers' honest effort to improve their cultivation.

The shape and the slope of a field can influence the farmers' decisions, too. It is claimed that the more steep the slope of a field is, the higher the possibility of using drip irrigation by the farmer will be. The results showed that for a field of an average or high slope, there is a 36.5% more probability of using drip irrigation. If a field is flat, the farmer can perform necessary agricultural activities and use traditional irrigation; however, for steeper fields, the farmers confronted with

difficulty in performing routine cultivation activities use the traditional irrigation system.

Holding meetings or workshops is considered an effective approach to training and improving farmers' knowledge. The data indicated that the farmers who take part in such classes and programs will tend to use drip irrigation 32% more than those who don't.

5. Conclusion and Suggestion

In summary, we can claim that the adoption of modern irrigation technology can lead to 38% variations in yield performance (kg/ha). Thus, the application of drip irrigation can cause changes in the production function and in partial elasticity of the production variables. These changes can lead to an improvement in the production performance and changes in the consumption of some variables and inputs. It was also revealed that where farmers exploited drip irrigation, the performance was reported higher, but water inputs and labor were reported fewer. The government should develop and enforce appropriate and timely policies to provide farmers with the required capital and other inputs (irrigation equipment, fertilizers, seeds, etc.) to encourage them to use modern irrigation systems. According to the results and findings of the study and the existing conditions in the region under investigation, we will propose the following guidelines and suggestions to help develop and enhance investments and encourage the use of effective drip irrigation systems:

1. Given the significantly positive effect of agricultural loans on the adoption of drip irrigation, it is suggested to facilitate the conditions for agricultural loans. It is also necessary to determine pre-agricultural loans, the bank rules and regulations, as well as how to get the necessary knowledge to find the pre-requisites for training farmers .
2. The goal is to promote pressurized irrigation and train farmers with higher educational levels because they are much more likely to accept drip irrigation compared to other farmers.
3. It is recommended to hold briefings and proceedings concerning the introduction of more efficient and sustainable irrigation systems, especially in rural areas where less pressurized irrigation systems are used.

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Asymmetric Impact of Oil Price on the Consumer Price Index in Saudi Arabia

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Abstract

This study aims to examine the impact of oil price variations on the consumer price index (CPI) in Saudi Arabia by employing the Nonlinear Autoregressive Distributed Lag (ARDL) model. The model estimation revealed a nonlinear relationship between the price of oil and the Consumer Price Index (CPI). The long-term estimates' findings indicate a significant impact of oil price variations on the Consumer Price Index (CPI) over an extended period. The research reveals that a partial escalation in oil prices leads to a decrease in the Consumer Price Index (CPI). Likewise, a reduction in oil prices leads to a corresponding decline in the Consumer Price Index (CPI). Based on the findings of the asymmetric impact, it can be observed that long-term variations in global prices, both positive and negative, have implications for the Consumer Price Index (CPI). Specifically, an upward movement in international oil prices is associated with a downward movement in the CPI, whereas a downward movement in oil prices is associated with an upward movement in the CPI.

Keywords: Cpi, Long Run Estimations, Oil Price Fluctuations, Nardl Model, Short Run Equilibrium.

JEL Classification: D12, C51.

1. Introduction

In light of the economic changes and the divergence of the pace of the global economy in recent years between recovery and recession that the world witnessed, a primary goal has emerged for many countries with natural resources, which is often the primary sector of production and export. Consequently, it is called the countries of rentier economies relying on a single resource, especially oil-producing countries.

Being an abundant commodity with a high demand in the global markets, it

enabled countries to generate sizable and significant revenues that helped in financing and executing economic as well as social projects; unlike Arab oil-producing/ exporting countries such as Saudi Arabia, this natural resource also enabled them to obtain huge profits, however, it leads them often and many times to ignore some of the productive sectors including agriculture, industry, and services.

Due to the significant drop in world oil prices, these countries were persuaded not to continue their dependency on one sector as a primary source of wealth. In addition, the price decline prompted the demand for some serious fundamental reviews, which aim at increasing economic diversification and production expansion, and it was all due to the direct impact on the government's budget, its stability, economic growth, and warnings from the International Monetary Fund to address the imbalance resulting from the price drop.

Because energy is so crucial to economic activity, authorities are investigating the link between oil prices and inflation, which has sparked a heated discussion over the years regarding the exact role that fluctuating oil prices play in driving consumer prices.

All economic activities are directly or indirectly related to the price of oil, as oil occupies an important place among the production inputs of the economy, including the supply of air and sea transport and household consumption, so an increase will follow the rise in oil prices in production costs.

An increase in production costs resulting from the rise in oil prices has led to the emergence of inflationary trends, so it has become necessary for policymakers in Saudi Arabia to answer the main question, namely whether changes in oil prices play an important role in inflationary trends in some oil economies such as Saudi Arabia, And if so, to what extent is this change in domestic inflation attributed to changes in oil prices, and do oil prices affect inflation rate in a symmetric or asymmetric effect?

1.1 Importance and Relevance of the Study

Despite the existence of numerous studies that have addressed the topic of the asymmetric impact of oil price fluctuations (Adebayo, 2020; Husaini and Lean, 2021; Köse and Ünal, 2021), the novelty and importance of our study are evident in that it is the first of its kind where we attempt to shed light on the extent of asymmetric impact of oil prices on consumption price indices during the period 1988-2022 in Saudi Arabia. The Kingdom of Saudi Arabia was chosen as it represents the third-largest oil producer in the world and has the second-largest

confirmed reserves of crude oil (\$326.16 billion in 2022, compared to \$202.05 billion in 2021). Given that the Saudi economy is almost entirely dependent on oil, we aim to study the impact of any shocks in oil prices on macroeconomic variables, especially inflation. Throughout this research paper, we will rely on the Nonlinear Autoregressive Distributed Lag (NARDL) model presented by (Shin et al., 2014a), as it allows for evaluating the potential asymmetry in the long and short-term relationship between oil prices and inflation. For developing countries, especially those that export oil, previous studies on the effects of oil price volatility on economic dynamics have produced inconclusive and ambiguous results. Our study stands out with its detailed analysis and some additions compared to previous studies that addressed the same topic. This work fills a gap in the literature by focusing on estimating the nonlinear NARDL model, which outperforms the linear ARDL model, making it a significant contribution to the modern literature that has rarely been applied in the case of Saudi Arabia with nonlinearity testing. Furthermore, choosing an appropriate standard economic methodology can make the economic effects of the analysis more reliable. The paper also used unit root tests for structural breaks. (Perron et al., 1989) pointed out that the problem of unit roots in the time series may be due to structural changes. Therefore, traditional unit root tests may provide ambiguous results due to their low interpretative power and weak distribution of the size (Shahbaz et al., 2017). This problem is solved by applying a unit root test that accommodates structural breakpoints, and the paper will examine time series using various unit root tests, including the Zivot and Andrews (1992) test and the Broock et al. (1996) test.

2. Theoretical Background

2.1 The Significance of Oil in the Saudi Arabia's Economy

Saudi Arabia is one of the leading oil-exporting countries in the world and ranks as the second-largest in global production. Oil constitutes approximately 60% of the Kingdom's Gross Domestic Product (GDP), equivalent to 238.5 billion Saudi Riyals at the end of the second quarter of 2021. (Gross Domestic Product | General Authority for Statistics, n.d.) Oil also accounts for around 62% of government revenues (The Kingdom of Saudi Arabia's Budget, n.d.), and more than 84% of Saudi exports, totaling 456 billion Saudi Riyals in 2020 (Export Performance Report, n.d.). Saudi Arabia is a prominent member of the G20 and has one of the world's strongest economies. It is also a significant member of the Organization of the Petroleum Exporting Countries (OPEC) since 1960, and it is a member of the Gulf Cooperation Council (GCC) since 1981.

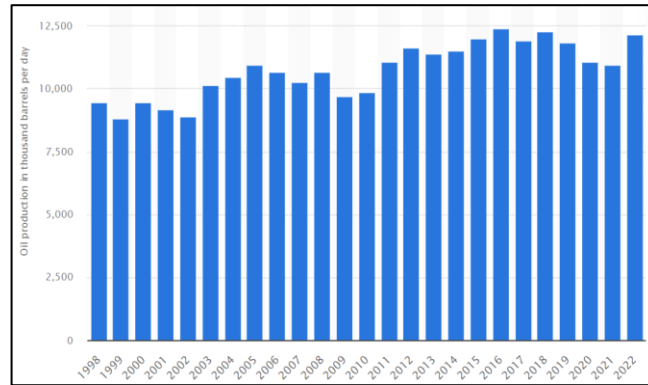


Figure 1. Saudi Arabia's Oil Production from 1998 to 2022 (in 1,000 Barrels per Day)

Source: (Saudi Arabia: Oil Production 2022 | Statista, n.d.).

In 2022, Saudi Arabia's oil production increased from 10.95 million barrels per day in 2021 to 12.14 million barrels per day. The volume of production in the world's most important oil-producing country rose by 2.6 million barrels per day between 1998 and 2021, reaching its peak at 12.4 million barrels per day in 2016.

2.2 Evolution of Inflation and Oil in Saudi Arabia

Some studies have confirmed that inflation in the Kingdom is of the imported type (Alogeel and Hasan, 2008), and a decrease in oil prices will have a positive effect on reducing local inflation rates (Algamdi et al., 2021). This, in turn, may have a positive impact on consumption (Alogeel and Hasan, 2008). Some studies suggest that the stronger impact of oil price fluctuations lies in reducing investments (Baek and Young, 2021).

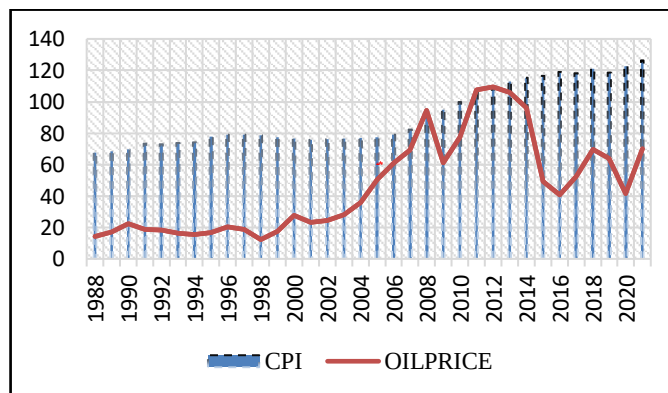


Figure 2. Inflation and Oil Saudi Arabia's from 1998 to 2020

Source: (Saudi Central Bank Portal For Open Data, n.d.).

As a result of the dominance of the oil sector in the local economy in Saudi Arabia, the performance of the economy depends significantly on developments in global oil markets. Improved oil prices and increased global demand for oil have a clear positive impact on export values and government revenues, but they may also bring inflationary pressures. The significant increase in financial flows from oil revenues has allowed the Kingdom to achieve high growth rates in recent years, but it has also contributed to inflationary pressure.

3. Previous Studies on the Subject

Oil price fluctuations have contributed to all economic activities, as they have contributed to the advent of numerous recessions in numerous economies. Numerous empirical studies have analyzed the effects of oil price fluctuations on macroeconomic stability and the efficacy of monetary policies in dealing with them, and the following is a summary of the most significant relevant studies.

Table 1. An Expedited Systematic Review of Literature

Author	Title of Study	Time Frame & Sample	Methodology	Key Findings
(Davari and Kamalian, 2018b)	Iran's Oil Price and Inflation: Nonlinear ARDL Exploration	Seasonally in Iran from 2003-2015	Utilising a nonlinear autoregressive distributed lag model with inflation rate as dependent, and oil price, GDP, and money supply as independent variables	A strong connection was found between falling oil prices and rising inflation, but not between growth in oil prices and the inflation rate.
(Osei, 2022)	Brazil's Inflation Reacts Differently to Shifts in Oil Prices	Quarterly in Brazil between M1 in 2000 and M4 in 2021	NARDL stands for the "Nonlinear Autoregressive Distributed Lag" model.	The empirical findings indicate a nonlinear or asymmetric relationship between oil prices and inflation, observed across different time horizons ranging from short-term to long-term.
(Sek, 2017)	Analysing the Effect of Rising Oil Prices on Consumer Price Inflation Using Linear and Nonlinear ARDL Models	Oil exporting and importing nations	Nonlinear autoregressive distributed lags (NARDL) with CPI as dependent and GDP, wholesale price index, and Brent crude oil price as independent variables	The results indicate that oil price fluctuations asymmetrically influence the consumer price index (CPI)
(Lacheheb and Sirag, 2019a)	Algerian Inflation and Oil Prices: A Nonlinear ARDL Approach	Algeria, 1970-2014	A nonlinear autoregressive model with CPI as dependent and oil price, exchange rate, GDP, and money supply as independent variables	There was a substantial correlation between oil price increases and inflation, but not between oil price falls and inflation.
(Bala and Chin, 2018a)	The Impact of Oil Prices on Inflation in OPEC Member Countries in Africa	Those four nations are Algeria, Angola, Libya, and Nigeria, and they all produce oil.	Analysing the relationship between oil prices and GDP, exchange rate, and money supply using short- and long-term autoregressive distributed lag (ARDL) dynamic panels	Both increases and decreases in oil prices were shown to have similar effects on inflation and a positive association was discovered between inflation and money supply, exchange rate, and GDP.
(S. Alimia et al., 2020)	The Impact of Oil Prices on Inflation in Nigeria: An Unbalanced Analysis	Nigeria, 2009Q1 to 2018Q4	Model the relationship between CPI and oil prices using a nonlinear autoregressive distributed lags (NARDL) structure.	The study found that long-term international oil prices had a nonlinear connection with inflation in Nigeria, with both price increases and declines having a deflationary effect.
(Okere et al., 2021)	The Impact of the Crude Oil Price and the Exchange Rate on Nigeria's Stock Market, Both Symmetric and Asymmetric	Nigeria, 1995Q1 to 2019Q12	Using a technique called nonlinear autoregressive distributed lag (NARDL)	Positive shocks in crude oil prices were found to significantly affect the growth of the Nigerian stock market, while negative shocks also increased stock market performance
(Chou and Lin, 2013)	Taiwanese Producer Prices and Oil Price Shocks: A Nonlinear Error-Correction Model	Taiwan, 1981M1-2011M5	Nonlinear error-correction models	The research revealed significant effects of oil prices on Taiwan's producer pricing indices, both in the short-term and long-term. These effects were observed to follow nonlinear error-correction relationships with oil prices.
(Nusair, 2019)	The Effects of Oil Price Shocks on the Economies of the Gulf Cooperation Council (GCC)	GCC Countries	Nonlinear analysis	The results suggest varied responses, with significant positive changes in oil prices causing real GDP growth, and only Kuwait and Qatar showing significant negative changes in oil prices causing GDP falls.
(Ayisi, 2021)	Impact of Oil Price Fluctuations on Inflation and Well-Being in Ghana: An Asymmetric Relationship	Ghana	Nonlinear approach	The research found an asymmetric response of inflation to oil prices in the long term but not in the short term, with an increased welfare cost due to the asymmetric response.

4. Data and Methodology

4.1 Data Description

Our study investigated the connection between the consumer price index, oil price, money supply and exchange rate in Saudi Arabia using annual data from 1988 to 2022. All data were collected from the World Bank data (Saudi Arabia | Data, n.d.) except the data for Brent crude oil price, which was collected from (Brent et al. Annually 1976-2022 | Statista, n.d.). Among the variables used in the study, the money supply variable is integrated with the model excited by (Rhee, 2006) and (Senda, 2001), the exchange rate inspired by (Nasir and Vo, 2020), (Balcilar et al., 2021), (Pham et al., 2023).

The model's variables are summarised in

Table 2 below.

Table 2. Components in the Model

Symbols	Variables	Explanation
CPI	Consumer Pricing Index (base year 2010 = 100)	The Consumer Pricing Index (CPI) tracks the mean change in costs urban customers pay for a standard set of goods and services, serving as an inflation proxy.
OILPRICE	Price of Oil (Brent)	Mean yearly price of Brent crude oil (denominated in U.S. dollars per barrel)
M2	Supply of Money	M2 encompasses currency, checking accounts, and readily convertible deposits, like Certificates of Deposit (CDs).
EXCH	Rate of Exchange	Genuine, effective exchange rate index (base year 2010 = 100)

Source: Research finding.

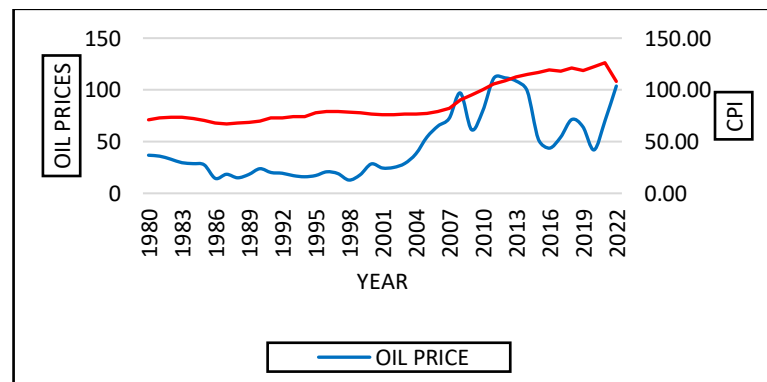


Figure 3. The Trend of Oil Price (Brent) and CPI in Saudi Arabia (1980-2022)

Source: Data on oil price was sourced from (Brent Crude Oil Price Annually 1976-2022| Statista, n.d.), where data on CPI was sourced from (Inflation, Consumer Prices

(Annual%) - Saudi Arabia | Data, n.d.).

We use annual data from 1988 to 2022 on the Consumer Price Index, oil price, Exchange rate, and Money Supply. All of the variables are expressed in natural log form.

4.2 Methodology

Following (Osei, 2022) and (Bawa et al., 2020a), the asymmetric nonlinear ARDL link between CPI rate and oil price will be specified as:

$$CPI_t = a_0 + a_1 OIL\ PRICE^+ + a_2 OIL\ PRICE^- + a_3 M2 + a_4 EXCH + e_t \quad (1)$$

In the equation above, (a_0 , a_1 , a_2 , a_3 , and a_4) are the parameters capturing the long-term connection. Where $oil\ price^+$ and $oil\ price^-$, these are the partial sums of both negative and positive oil price fluctuations.

$$oil\ price^+ = \sum_{i=1}^t \Delta oil\ price^+ = \sum_{i=1}^t \Delta \max(\Delta oil\ price_t, 0) \quad (2)$$

$$oil\ price^- = \sum_{i=1}^t \Delta oil\ price^- = \sum_{i=1}^t \Delta \min(\Delta oil\ price_t, 0) \quad (3)$$

Where:

$$oil\ price = oil\ price_0 + oil\ price^+ + oil\ price^- \quad (4)$$

a_1 and a_2 represent the long-term asymmetries between CPI and oil prices.

If a_1 is significantly positive, it indicates a (Osei, 2022) direct relationship between oil price and CPI, and vice versa. In the same way, a positive value for a_2 means that oil prices are going down, which makes CPI go down, and vice versa. But (Bawa et al., 2020a) if both a_1 and a_2 are insignificant, the increase and reduction in oil prices do not affect CPI.

Inspired by the work of (Shin et al., 2014b), we develop the following NARDL equation to predict the long term.

$$\Delta cpi_t = \sum_{i=1}^p \beta_i cpi_{t-i} + \sum_{j=1}^q (\beta_j^+ oil\ price^+ + t - j + \beta_j^- oil\ price^- - t - j) + e_t \quad (5)$$

where cpi_t is the respondent variable, $oil\ price_t$ Is a $K \times 1$ vector of multiple regressors representing the partial positive and negative sums of $oil\ price_t$ such that

$$oil\ price = oil\ price_0 + oil\ price^+ + oil\ price^- \quad (6)$$

The β_i coefficient is the autoregressive parameter, β_j^+ and β_j^- represent the asymmetric distributed-lag parameters.

The dynamic ECM of the NARDL specified in (4) can be written as follows:

$$\Delta cpi_t = \rho cpi_{t-1} + \varphi^+ oil\ price_{t-1}^+ + \varphi^- oil\ price_{t-1}^- + \sum_{i=1}^{p-1} \beta_i \Delta cpi_{t-1} + \sum_{j=0}^{q-1} (\beta_j^+ \Delta oil\ price_{t-j}^+ + \beta_j^- \Delta oil\ price_{t-j}^-) + e_t \quad (7)$$

In this case, ρ and q represent the lag orders of the dependent and independent variables.

The equation denotes the nonlinear error correction term (ECT):

$$\omega = cpi_t + \beta^+ oil\ price_t^+ + \beta^- oil\ price_t^- \quad (8)$$

5. Empirical Results and Discussion

This study presents its empirical findings in the following order: Descriptive statistics and visual analysis are used in the first part of the study to look at the correlation between oil prices and the CPI in Saudi Arabia. The integration degree of the utilised series is then evaluated using unit root tests, notably the Augmented Dickey-Fuller and Phillips-Perron tests. Cointegration tests, Nonlinear Autoregressive Distributed Lag (NARDL) outcomes, and other diagnostic tests comprise the last stage.

5.1 Descriptive Statistics

This section focuses on the initial analysis, which involves the examination of descriptive statistics and graphical representations of the relationship between oil prices and the Consumer Price Index (CPI) in Saudi Arabia within the specified time frame.

According to the data presented in

Table 3, the average price per barrel of Brent crude oil is \$46.12, with a range spanning from \$67.64 to \$126.23. In contrast, the average Consumer Price Index (CPI) stands at 90.64%, with the highest value observed at 126.23 and the lowest at 67.64. Notably, the standard deviation indicates that the CPI exhibits lower volatility throughout the study period, while crude oil prices demonstrate greater volatility in comparison to oil prices. This implies that the volatility of prices in Saudi Arabia's oil market is more significant than the fluctuations observed in the country's general consumer price index.

Only the exchange rate is negatively skewed, while the Brent crude oil price,

CPI, money supply, and exchange rate are all positively skewed. Compared to what would be predicted from a normal distribution, all of these variables have smaller kurtosis values, indicating less dispersion. The Jarque-Bera test showed that all of the study's variables followed a normal distribution (Table3).

Table 3. Descriptive Statistics

	CPI	OILPRICE	M2	EXCH
Mean	90.64727	46.12471	750089.3	114.3454
Median	78.88238	38.40500	428390.9	115.1237
Maximum	126.2311	109.4500	2059809.	137.8487
Minimum	67.64888	12.28000	134142.8	94.30739
Std. Dev.	19.64868	30.89295	645356.9	11.83680
Skewness	0.578681	0.720970	0.694338	-0.008783
Kurtosis	1.662734	2.268562	1.941220	2.065858
Jarque-Bera	4.431000	3.703438	4.320038	1.236651
Probability	0.109099	0.156967	0.115323	0.538846
Sum	3082.007	1568.240	25503038	3887.743
Sum Sq. Dev.	12740.33	31494.36	1.37E+13	4623.626
Observations	34	34	34	34

Source: Research finding, using Eviews10.

5.2 Stationarity Test

5.2.1 Unit Root Testing Using ADF and PP Tests

The augmented Dickey-Fuller (ADF) and Phillips-Perron procedures are employed to ascertain the stationarity of a variable. The analysis reveals that all variables exhibit non-stationarity in the level form, as indicated in Table 4. However, they attain stationarity when transformed into a different form. The proposition being put forth is that the series exhibits an integrated order $I(1)$. Consequently, the variable integration order justifies the utilisation of the nonlinear autoregressive distributed lag (NARDL) model in this study.

Table 4. Stationarity Test

			LNCPI	LNOILPRICE	LN M2	LN EXCH
ADF test	Level	T-Stat	-0.0470	-1.3726	-0.3194	-2.2159
		Prob	0.9470	0.5835	0.9111	0.2048
	First Diff	T-Stat	-3.2533	-5.3007	-3.5410	-4.4364
		Prob	0.0259***	0.0001***	0.0132**	0.0013**
PP test	Level	T-Stat	0.0382	-1.2956	0.0914	-1.8901
		Prob	0.9556	0.6198	0.9602	0.3327
	First Diff	T-Stat	-3.2719	-5.1404	-3.5285	-4.4481
		Prob	0.0248**	0.0002***	0.0136*	0.0013***
Order of integration			1	1	1	1
Optimal Lag lenght ¹			3	1	2	2

Source: Research finding, using Eviews10.

Note: (**) significant at 5%, (***) significant at 1% and (no) not significant.

¹Optimal Lag length selections follow the Akaike Information Criteria AIC.

5.2.2 Unit Root Testing with Structural Breaks

The application of the augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) unit root tests (Phillips and Perron, 1988) doesn't consider the structural breaks within the series, potentially leading to incorrect conclusions. The Zivot and Andrews (ZA) test (Zivot and Andrews, 1992) from 1992 is implemented to address this issue Table 5 reveals the ZA statistical results, affirming the stationarity of the series once the first difference is removed. This finding aligns with the results of the conventional unit root examinations (ADF and PP tests) and highlights different structural breaks, explicitly identifying two breaks in the years 2001 and 2015.

During 2008-2009, significant price fluctuations occurred in the oil market, attributed to the financial crisis of 2008. This crisis led to a slowdown in the growth rates of major global economies, resulting in reduced worldwide demand for oil, particularly impacting Saudi Arabia, one of the world's leading oil exporters. The crisis profoundly influenced Saudi Arabia's public spending and growth rates, with the latter declining to a mere 1.4% across all sectors.

Furthermore, the latter half of 2014 witnessed a collapse in oil prices, causing a loss of nearly 45% of their value. The price of Brent, the European standard, plummeted from \$115 to \$62 per barrel. This price drop led to Saudi Arabia experiencing the most substantial reduction in revenue in its local currency, attributable to the sharp decline in oil prices.

Table 5. Results of the Structural Breaks Unit Root Test by Zivot and Andrews (1992)

Variables	At level		At first difference	
	T-Statistic	Breaks	T-Statistic	Breaks
LNCPI	-6.06	2007	-5.22***	2007
LNOILPRICE	-3.55	2003	-6.05***	2015
LNLM2	-3.55	2003	-4.04***	2014
LNEXCH	-3.23	2001	-5.05***	2008

Source: Research finding.

Note: (***) significant at the 5%.

5.3 BDS Test for Nonlinearity

The nonlinearity is examined using the BDS test, which was established by Broock (Broock et al., 1996) The results of the BDS test, as shown in Table 6, indicate that

the series are characterised by non-identical and dependent distribution. Upon verifying the presence of structural breakdowns and nonlinearity, coefficients are estimated using the NARDL model.

Table 6. BDS Test for Nonlinearity

BDS Statistics					
Series	Dimension2	Dimension3	Dimension4	Dimension5	Dimension6
LNCPI	0.1803***	0.2862***	0.3469***	0.3708***	0.3684***
LOILPRICE	0.1350***	0.2524***	0.3139***	0.3520***	0.381263***
LM2	0.1925***	0.3184***	0.4015***	0.4559***	0.4887***
LNEXCH	0.1587***	0.2611***	0.3178***	0.3328***	0.3154***

Source: Authors' calculation. Triple asterisks denote the rejection of the null hypothesis of the residual of being (iid) at 1% significance level.

5.4 Optimal lag-length Selection Criteria

We continue investigating common trends among variables using an unlimited cointegration system, which is determined by minimising the AIC with a maximum lag length of eight lags. According to the AIC criteria, the optimal lag lengths for CPI, OIL PRICE, M2, and EXCH are 3.1.2.2 lags. As shown in the last section of Table 4, Cointegration Test.

The results of the Nonlinear Autoregressive Distributed Lag (NARDL) bounds test for asymmetric cointegration are detailed in Table 7. The findings point to an associated F-statistic value of 5.103946, with corresponding lower and upper bound values of 2.56 and 3.49, respectively, at a 5% significance level. This information underscores the statistical relationships being examined and provides insight into the asymmetric nature of the cointegration within the series under study.

Table 7. Bounds Test for Nonlinear Cointegration

Model Specification	F-statistic	Lower Bound	Upper Bound	Conclusion
Nonlinear	5.103946	2.56	3.49	Cointegration

Source: Research finding, using Eviews10.

When compared to the maximum bound of 3.49, the F-Statistic value of 5.103946 indicates that the Consumer Price Index (CPI) in Saudi Arabia has an asymmetric long-run connection with the other exogenous variables. In light of Saudi Arabia, this result bolsters the importance of the asymmetry between oil price, M2 (money supply), EXCH (exchange rate), and CPI (consumer price index).

5.5 NARDL Long-Run and Short-Run Estimations

In this investigation, we look into the asymmetric relationship between the oil price and the CPI. To eliminate the possibility of making an error in the specification, different variables, such as M2 and EXCH, are utilised as control variables, which are explained as follows:

$$CPI_t = a_0 + a_1 OIL\ PRICE^+ + a_2 OIL\ PRICE^- + a_3 M2^+ + a_4 M2^- + a_5 EXCH^+ + a_6 EXCH^- + e_t \quad (7)$$

Having identified evidence of cointegration in the models, we evaluate CPI dynamics and explore the influence of positive and negative oil price fluctuations on Saudi Arabia's CPI. Table 8 demonstrates the asymmetrical relationship between the oil price and the CPI. The error correction term reaches a level of 5%, which is statistically significant ($0.007 < 0.05$) and indicates a convergence rate of 47.80%. This consumer price index convergence is quicker than the rates of inflation observed in oil-importing and exporting countries (Kun Sek, 2019) which indicates a rate of 19.19% and 24.32%, respectively. Salisu et al. (2017) reached a rate equal to 19.32%; Bala and Chin (2018b) (23%), and inferior to Ibrahim (2015), who arrived at a rate of 55.92%.

According to the findings, in the short term, an increase in the oil price is positively related to the CPI by 0.3765%. These results are consistent with (Bawa et al., 2020b) and (Lacheheb and Sirag, 2019b).

The wave of inflation that prevailed in the oil-exporting countries, led by Saudi Arabia, after the significant rises in barrel prices, contributed to by many external and domestic factors. Firstly, there is an increase in the prices of imported commodities resulting from the increase in prices in the producing country, notably the price rise in the country of origin is, in turn, caused by the doubling of oil prices, which left unprecedented inflationary effects in the industrialised countries themselves, which are the main suppliers of most of the oil-producing countries' needs of goods and services. Secondly, in Saudi Arabia, local products depend on raw materials imported from abroad and oil energy sources. The prices of these locally manufactured products have increased, exacerbating inflation rates and rising prices, which constitutes the third factor that pushed prices upward in Saudi Arabia. In the same way, a decrease in the oil price leads to a 3.84% decrease in CPI. These findings are congruent with (Salisu et al., 2017).

In the near term, a surge in oil prices exhibits a positive correlation with the CPI, signifying that a rise in oil prices boosts the CPI temporarily. This occurs as the escalation in oil prices amplifies the production costs, thereby curtailing the

quantity of other producible goods. This observation aligns with the findings of (Lacheheb and Sirag, 2019b), who concluded that short-term oil price hikes exacerbate inflation in Algeria. Conversely, the study demonstrates that a global decrease in oil prices adversely affects inflation in the short span. This supports the conclusion reached by (Salisu et al., 2017), who determined that a price dip triggers a spike in inflation in oil-reliant nations.

Regarding other independent factors, an elevation in the EXCH is inversely correlated with the CPI in both short and long durations, by 67.21% and 127.26%, respectively. These findings are similar to (Bawa et al., 2020c). This implies that a rise in foreign exchange rates renders domestic goods more economically accessible to international buyers, thus spurring exports, overall demand, and pricing. Consequently, an upward shift in the foreign exchange rate leads to inflationary pressures, which also holds for a descending exchange rate.

A positive correlation exists between an increase in the M2 in both the short and long term and the CPI, with respective percentages of 10.35% and 39.42%. This implies that if the M2 expands beyond the size of the economy, the currency's unit value declines, resulting in a decline in purchasing power and an increase in prices. This accords with what was found by (Davari and Kamalian, 2018a) and (Bawa et al., 2020b)

The results of the estimates for the long term are presented in Table 8. displays the projected outcomes of these analyses. This shows that long-term changes in oil prices also impact CPI. Long-term, the research reveals that a rise in oil prices mitigates the CPI by 5.52%. The same 10.92% drop in CPI is seen when oil prices drop. Conclusions can be drawn about the long-term asymmetry between changes in oil prices and CPI.

The long-term findings also show that both an increase and a drop in the price of oil will reduce the CPI by 0.055% and 0.109%, respectively; hence, neither an increase nor a decrease in oil price will cause CPI in the long run. This positive oil price result contradicts the findings of (Xuan and Chin, 2015), (Bala and Chin, 2018a), and (Long and Liang, 2018), which claimed that increasing oil prices increase CPI. In contrast, the negative oil price result supports the findings of (Salisu et al., 2017) and (Nusair, 2019), which found that falling oil prices lower inflation in oil-exporting countries.

Table 8. NARDL Results on the Oil Price- Cpi Nexus in Saudi Arabia (Brent)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run Estimate				
C				
LNCP1 (-1) _(ECT)	-.4780746	0.1436508	-3.33	0.007***
LNOILPRICE_POS	-0.0552049	0.0416776	-1.32	0.212
LNOILPRICE_NEG	-0.1092683	0.0794211	-1.38	0.196
LNLM2_POS	0.3942837	0.09865	4.00	0.002***
LNLM2_NEG	-2.660838	2.576006	-1.03	0.324
LNEXCH_POS	-1.272627	0.3709168	-3.43	0.006***
LNEXCH_NEG	0.582949	0.2332649	2.50	0.030***
Short Run Estimate				
DLNOILPRICE_POS	0.0037653	0.0313608	0.12	0.907
D LNOILPRICE_NEG	-0.0384515	0.0437158	-0.88	0.398
D LNM2_POS	0.1035961	0.1099597	0.94	0.366
D LNM2_NEG	1.609529	2.460722	0.65	0.526
D LNEXCH_POS	-0.672115	0.3851763	-1.74	0.109
D LNEXCH_NEG	0.4192519	0.1987488	2.11	0.059
C	2.095294	0.627325	3.34	0.007 ***
Number of Observation	32	R-squared	0.8800	
F (20, 11)	4.03	Adj R-squared	0.6618	
Prob > F	0.0107	Root MSE	0.01462	

Source: Research finding, using Stata 17.

Note: *** Prob<0.05, Meaning that the variable is significative. The ECT is the error correction term.

Table 9 reports the asymmetric result on oil price and CPI. According to the findings, increases in oil prices are negatively related to CPI, whereas drops in oil prices are positively associated with CPI. These findings are contrary to the results obtained by (Babuga and Naseem, 2021)

The findings in Table 9 demonstrate that the positive and negative long-run variation in global price, DLNOILPRICE_POS and D LNOILPRICE_NEG, suggests that an increase in international oil price leads to a 0.115% fall in CPI, while a decrease in oil price leads to a 0.229% increase in CPI.

Furthermore, the R^2 indicates that Brent oil price, money supply and exchange rate explain 88% of the variation in CPI in Saudi Arabia. In contrast, the F-statistics ($F=4.03$) indicates that the estimated regression coefficient is

statistically significantly different from zero.

Table 9. Asymmetric Short and Long-run Estimates

Exog. var	Long-run Effect [+]			Long-run Effect [-]		
	Coeff	F-stat	P>F	Coeff	F-stat	P>F
LNOILPRICE	-0.115	2.161	0.170	0.229	1.977	0.187
LNLM2	0.825	19.87	0.001***	5.566	.9682	0.346
LNEXCH	-2.662	7.059	0.022***	-1.219	6.099	0.031***
Asymmetric	Long-run asymmetry		Short-run asymmetry			
	F-stat	P>F	F-stat	P>F		
LNOILPRICE	0.6618	0.433	0.0003604	0.985		
LNLM2	1.226	0.292	1.656	0.225		
LNEXCH	10.06	0.009***	0.3894	0.545		
Cointegration test statistics			t_{BDM}	-3.3280		
			F_{PSS}	5.0155		
Model diagnostics			Stat	P-value		
Portmanteau test up to lag 14 (chi2) ^a			10.54	0.7215		
Breusch/Pagan heteroskedasticity test (chi2) ^b			0.0693	0.7924		
Ramsey RESET test (F) ^c			2.346	0.1490		
Jarque-Bera test on normality (chi2) ^d			0.2197	0.8960		

Source: Research finding, using Stata 17.

Note: *** Prob<0.05, Meaning that the variable is significant

^a. The null hypothesis is there is no serial correlation in the residuals up to the specified order.

^b. The null hypothesis is no heteroskedasticity.

^c. Miss Specification.

^d. The null hypothesis is that there are normally distributed errors.

Several diagnostic tests are utilised to assess the reliability and consistency of the NARDL model. The diagnostic test conducted in the final section of Table 9 indicates the absence of serial correlation. Simultaneously, it is ensured that the stochastic disturbance term exhibits constant variance, a property known as homoscedasticity. Furthermore, it is affirmed that the specification of the NARDL model is accurate. Moreover, the test statistics CUSUM and CUSUMSQ depicted in Table 2 are utilised to assess the stability of the model. Based on the analysis, it can be inferred that both the CUSUM and CUSUMSQ test statistics do not surpass the lower and upper bounds, visually represented by two straight lines, at a significance level of 5%. As a result, it can be concluded that the NARDL model exhibits stability and efficiency.

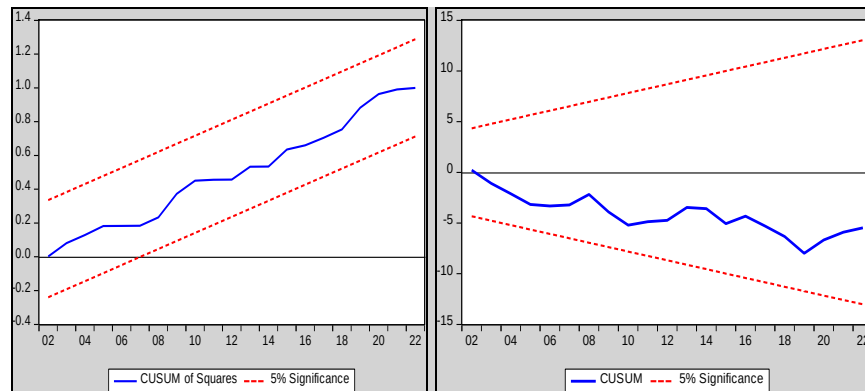


Figure 4. Cusum Stability Test

Source: Research finding, using Stata 17.

5.6 Dynamic Multiplier Effect

Asymmetric cumulative dynamic multipliers were devised per the methodology proposed by Shin et al. (2014b) to analyse the asymmetric adjustment patterns that occur in response to positive and negative oil price changes concerning the explanatory variable.

Figure 5 illustrates the dynamic multiplier effect of an increase in oil prices on the Consumer Price Index (CPI) in Saudi Arabia. It is observed that the impact of a decrease in oil prices is negligible in both the short and long term. It is important to acknowledge that the transmission of an oil price increase to the domestic price level occurs gradually over 4-5 years, eventually converging with the long-run coefficient of 0.055. This phenomenon resembles the findings of (Lacheheb and Sirag, 2019b), who have demonstrated that the complete manifestation of an initial oil price fluctuation requires a time of 4-5 years.

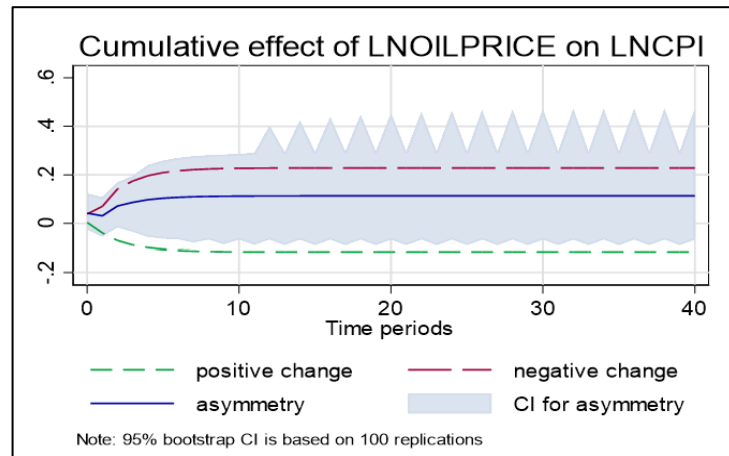


Figure 5. Multiplier Impact of the Oil Price Increase and Decrease on CPI

Source: Research finding, using Stata 17.

6. Conclusion and Policy Implication

This research aimed to assess the asymmetric influence of oil price variations on Saudi Arabia's Consumer Price Index (CPI), employing yearly data from 1980 to 2022. The analysis engaged a nonlinear Autoregressive Distributed Lag (ARDL) methodology to probe both long- and short-term impacts, exploring how oscillations in oil prices bear upon the country's consumer price index.

The study's findings reveal that a rise in oil prices in the short run corresponds to a 0.3765% increase in the CPI, whereas a decline in oil prices results in a 3.84% reduction in CPI.

For the long-term estimates, the results manifest that oil price swings also have an enduring effect on the CPI. The research uncovers that a marginal escalation in oil prices diminishes the CPI, while a contraction in oil prices prompts a decrease in the CPI. The conclusion can be drawn that long-term variations in oil prices exert a direct, asymmetric influence on the CPI.

Regarding the asymmetric impact, the outcomes denote that both positive and negative long-term changes in the global price, termed DLNOILPRICE_POS and DLNOILPRICE_NEG, imply that an uptick in international oil prices leads to a 0.115% drop in the CPI, whereas a downturn in oil prices results in a 0.229% ascent in CPI.

Price stability and maintaining inflation within a certain reasonable range are crucial goals for macroeconomic policy, as they reflect the strength and stability of a country's economy. Conversely, price instability leads to uncertainty, resulting in distortions and inefficiencies in resource allocation. Therefore, understanding

and knowledge of the inflationary effects of oil price shocks is a matter of utmost importance. Policymakers can use this knowledge to coordinate their policies to accommodate oil price shocks when they occur, especially during periods of excessive oil price increases. Additionally, the Saudi Central Bank should enhance its efforts to increase domestic production of foodstuffs by ensuring more financing through its interventions in the agricultural sector. This can help reduce the volume of imports contributing to imported inflation. Furthermore, exploring alternative energy sources to mitigate the impact of global oil price shocks on local prices in Saudi Arabia is essential.

Expanding into other productive sectors, such as agriculture and industry, is vital for economic diversification, aiming to achieve enhanced growth and mitigate the negative repercussions of global oil price fluctuations. This approach is important to avoid excessive reliance on this single resource, especially with Saudi Arabia's membership in the BRICS group of countries.

Statements and Declarations

- Funding: This research received no specific funding from public, commercial or non-profit organizations.
- Conflict of interest: The authors declare they have no identifier's financial interest or personal matters that may affect the work presented in this study.
- Data: The data used is generated from a publicly available source.

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Empirical Analysis of Factors Affecting Financial Distress at Companies: An Emphasis on Data Mining Models

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Abstract

This study aimed to analyze the effects of macroeconomic factors (e.g., inflation, economic growth, currency exchange rate, and market competitiveness), managerial characteristics (e.g., ability, optimism, entrenchment, and myopia), and corporate governance (e.g., institutional shareholders, ownership concentration, number of shareholders, and managerial independence) on the financial distress risks of companies listed in the Tehran Stock Exchange. For this purpose, data mining models (e.g., Artificial neural networks and decision trees) were used along with the regression method to analyze a sample of 140 TSE-listed companies within the 2007–2020 period. The research results indicated that macroeconomic factors (i.e., external factors) and managerial characteristics (i.e., internal factors) were identified as the first and second most effective factors in the financial distress risk of companies, respectively. However, corporate governance variables were identified as the least effective factors. According to the results of ranking the effects of research variables on financial distress risk, the most effective variables were identified as market competitiveness, managerial myopia, and inflation.

Keywords: Data Mining, Empirical Analysis, Financial Distress.

JEL Classification: G01.

1. Introduction

Financial distress and bankruptcy are two close but different terms. According to a definition given by Altman and Hotchkiss (2006), financial distress occurs when the realized rate of return for the capital used in a business is significantly lower than the expected rate of return. Moreover, Beneish (1999) defined financial distress as a situation in which numerous financial institutions or

financial assets plunge in value drastically. Therefore, although financial distress and bankruptcy are closely related, they are different (Platt and Platt, 2006).

Financial distress and bankruptcy can ultimately bring serious losses to shareholders, creditors, managers, employees, suppliers of raw materials, and customers. Emerging slowly, financial distress can be concealed in a mass of financial and nonfinancial problems. Thus, identifying the factors affecting financial distress is a method of properly benefiting from investment opportunities and preventing the loss of financial resources. (Mashikhi and Ganji, 2014; Andrade and Kaplan, 1998).

In this regard, predicting bankruptcy will be useful when its time horizon is sufficiently long. In other words, bankruptcy is to be predicted in financial distress so that the potentially bankrupt company can take the necessary measures to prevent bankruptcy. Furthermore, the prediction should be made when the signs of financial distress and performance disturbance are not very evident and the occurrence of bankruptcy cannot be foreseen through simple assessment. In other words, it is not very difficult to predict the bankruptcy of a company that has financial distress and many debts. The prediction needs no modeling in this case (Panahi et al., 2014).

Generally, many empirical studies have analyzed the factors affecting financial distress. They have introduced some variables that are correlated with financial distress. However, studies differ in the combination of these variables, which is usually determined concerning researcher's subjective background. the extensive spectrum of explanatory variables affecting financial distress has raised a serious question: what variables should be entered into the empirical model for the regression of financial distress? Given the transparency and sensitivity of this subject, recent cases of financial distress have indicated the failure of warning models in advance. This study considers the failure to be rooted in identifying explanatory variables and designing empirical models, the factors which it tries to improve (Gordon, 1971).

In brief, the innovations of this research as opposed to the other similar studies include both the type of variables and the type of models employed. Moreover, Artificial neural networks and decision trees were used in this study to overcome uncertainty in selecting the variables affecting financial distress and to rank the variables based on their roles in Iran's capital market. Another innovation of this study is to concurrently analyze the effects of macroeconomic factors, managerial characteristics, and corporate governance variables in predicting financial distress at the companies listed on the Tehran Stock

Exchange, to determine the most effective variables. Hence, this study aims to identify the key variables affecting financial distress in Iran's economy within the 2007–2019 period through data mining approaches such as Artificial neural networks and decision trees.

2. Literature Review

Ensuing from financial distress, bankruptcy has serious consequences for companies. After a company goes bankrupt, its shareholders sustain losses and lose some of their capital. Its employees become unemployed and experience consequent effects on their lives. Zubair et al. (2021) indicated that investment in small and medium-sized enterprises would decline during and after financial distress. They concluded that financial distress would have serious effects on all stakeholders of a company, especially the uncertainty about the return on investment, which could deprive a company of resources (Wang et al., 2014).

Financial distress can have either internal or external origins and can result from either the private or public sectors. Accordingly, a growing literature has emerged for the analysis and identification of financial distress. In brief, empirical studies of financial distress can be classified as below:

- Identifying and predicting financial distress (Reinhart and Rogoff, 2009; Cardarelli et al., 2006; Forbes and Warnock, 2012; Citterio and King, 2023; Zhang et al., 2022)
- Estimating costs of financial distress (Calvo et al., 2006; Dell'Ariccia et al., 2008; Campello et al., 2010; Ugur et al., 2022; Kalash, 2023)
- Analyzing determinants of financial distress (Edison, 2000; Percic et al., 2013; Laeven and Valencia, 2018; Abdu, 2022; Phan et al., 2022)
- Distribution mechanism of financial distress to different countries and markets (Frankel and Saravelos, 2012; Hannes Lang, 2018; Gunay and Can, 2022; Fu et al., 2022)
- Effects of financial distress on the legal sector (Claessens et al., 2009; Kose et al., 2013; Moglie and Sorrenti, 2022)

Probably, the most important area of the above mentioned studies is the identification of factors affecting financial distress. In this regard, previous studies have mainly used financial ratios as explanatory variables. However, some other studies have employed economic and managerial variables along with financial variables to predict the financial distress of companies. Despite the importance of financial variables (extracted from the major financial statements) in predicting bankruptcy, some researchers believe that they do not have the

necessary prediction power for particular reasons. Firstly, accounting information indicates events that happened in the past and cannot be used to predict the future. Secondly, the conservatism principle and the historical cost have made book values far away from their real values in the capital market. Finally, accounting information is greatly affected by the accounting procedures selected by management and sometimes earnings management (Bauer and Agarwal, 2014). Hence, this study benefited from a relatively complete series of macroeconomic variables, managerial characteristics, and corporate governance system. The correlation of each variable with financial distress is explained below:

Researchers have conducted many studies on the effectiveness of economic indices in predicting financial distress at different companies. The resultant evidence indicates that those indices were effective. According to Keasey and Watson (1987) and Zavgren (1985), an appropriate model cannot necessarily include financial ratios (*i.e.*, financial variables), and other pieces of information such as economic variables may greatly help predict bankruptcy and financial distress. Hence, these economic variables should be used along with other variables to predict the financial distress of companies. Bayani et al. (2019) indicated that the role of inflation has greatly increased in causing financial distress in recent periods. Rampant inflation and many origins of inflation have made this variable always an important factor in causing financial distress in Iran's economy. companies are affected by their economic environments, and Iran's economy is characterized by rampant inflation, drastic fluctuations in the currency exchange rate, and low rates of economic growth. Hence, this study aimed to first analyze the effects of macroeconomic variables on financial distress at the companies listed on the Tehran Stock Exchange.

Recent studies indicate that ability, optimism, stability, entrenchment, and managerial myopia have had considerable effects on financial distress at different companies. For instance, managerial myopia can jeopardize the competitive advantage of a company and cause financial distress in the long run. Most myopic managers avoid whatever prevents them from achieving their short-term interests (Brochet et al., 2017).

The effect of managerial optimism on financial distress can also be discussed. Most of the optimistic managers look very much forward to their decisions and consequent outcomes, especially investment decisions. They also believe that the stock market has undervalued their companies, something which results in costly external financing (Gervais, 2007). This study tries to analyze

the effects of some of the major personality traits and structural characteristics of managers on financial disasters at companies.

Eventually, the effect of corporate governance on financial distress risk reduction is justifiable in agency theory, according to which the risk of agency costs may drive companies toward financial distress. In agency theory, a company is a series of agency relationships, the most important of which connects the owner and the manager of a company. Given the separation of ownership from management in both intellectual and physical aspects with different utility functions, agency costs will be imposed on the company. there is always the risk that an agent takes action that does not favor the interests of owners. These costs will increase the financial distress risk (Wolk et al., 2013). At the same time, corporate governance mechanisms (i.e., a series of relationships among board of directors, shareholders, and other stakeholders as well as a series of attempts at balancing power among groups) can be considered factors in improving efficiency and performance (Meshki et al., 2015). Hence, the final goal of this study is to analyze the effect of corporate governance on the financial distress risks of companies.

3. Data Collection

In this study, a desk method was employed to codify the theoretical foundations, whereas a field method was adopted to collect financial data from various sources (e.g., financial statements of companies, CDs provided by Securities and Exchange Organization of Iran, Rahavard Novin, and www.codal.ir). Afterward, databases were created, abridged, and classified in Microsoft Excel, and research hypotheses were tested in IBM SPSS Modeler 18.

4. Statistical Population and Sample

The statistical population included the companies listed on the Tehran Stock Exchange due to their easily accessible, standard, and homogenous information. The systematic sampling method was employed to select the research samples meeting the following conditions:

- 1) The financial information should be available for the research period (i.e., from 2017 to 2020).
- 2) The fiscal year should end on March 20 (or March 21).
- 3) The companies should be listed on the Tehran Stock Exchange up to March 21, 2007 (i.e., before this date), and the companies should not be excluded from the Tehran Stock Exchange within the research period.

- 4) The fiscal year should not change during the research period.
- 5) companies should not be included among financial institutes, banks, and investment companies due to the specific nature of their activities, revenues, and activities.
- 6) There should not be any trading breaks longer than six months.

After the constraints were applied, 140 companies met the above conditions within the 2007–2020 period. No sampling was done, and all eligible companies were selected. Given the calculation of some research variables, the data from 2005 and 2006 were used.

5. Research Hypotheses

Hypothesis 1: Macroeconomic factors have significant effects on the financial distress risk at TSE-listed companies.

Hypothesis 2: Managerial characteristics have significant effects on the financial distress risk at TSE-listed companies.

Hypothesis 3: The corporate governance system has a significant effect on the financial distress risk at TSE-listed companies.

5.1 Research Variables and Methodology

5.1.1 Dependent Variable

In this study, the dependent variable is defined as the financial distress risk of companies. It was measured through Altman's Z-score (1983) and Ohlson's model (1980).

5.1.2 Altman's Z-Score

Altman (1968) sought to predict the financial distress and bankruptcy of businesses by adopting multiple discriminant analysis (MDA) and using financial ratios as independent variables. He introduced his famous model as Z-score, which is well-known for the prediction of financial distress and bankruptcy.

$$Z - Score = 0.717x_1 + 0.847x_2 + 3.107x_3 + 0.420x_4 + 0.998x_5 \quad (1)$$

where

x_1 : the ratio of working capital to total assets

x_2 : the ratio of retained earnings to total assets

x_3 : the ratio of earnings before interest and tax to total assets

x_4 : the ratio of book values of corporate shares (*i.e.*, equity) to book values of debts

x_5 : the ratio of sales (*i.e.*, incomes) to total assets

In this model, the lower the Z-score, the higher the financial distress risk at a company. In other words, companies with scores above 2.9 are classified as healthy companies, whereas the ones with scores below 1.23 are classified as bankrupt companies.

5.1.3 Ohlson's Model

Ohlson (1980) used the logistic regression model to predict financial distress and bankruptcy. Ohlson's prediction model managed to predict the bankruptcy risks of companies for the first, second, and third years with accuracies of 85.1%, 87.6%, and 82.6%, respectively, as below. The best separating ratios in Ohlson's model was the ratio of total debts to total assets and the ratio of net income to total assets (Ghadiri Moghadam *et al.*, 2009).

$$Z = -1.32 - 0.407x_1 + 6.03x_2 - 1.43x_3 + 0.0757x_4 - 2.37x_5 - 1.83x_6 + 0.285x_7 - 1.72x_8 - 0.521x_9 \quad (2)$$

where

x_1 : the logarithm of ratio of total assets to gross national product (GNP)

x_2 : the ratio of total debts to total assets

x_3 : the ratio of working capital to total assets

x_4 : the ratio of current debts to current assets

x_5 : virtual variable (If total debts exceed or equal to total assets, this variable is 1; otherwise, it is 0.)

x_6 : the ratio of net profit to total assets

x_7 : the ratio of operating cash to total debts

x_8 : virtual variable (If the net profit is negative for the previous two consecutive years, it is 1; otherwise, it is 0.)

x_9 : variations in the net profit (the ratio of variations in the net profit to the absolute value of current profit added by profit from last year)

According to the logit analysis, the resultant Z for each company-year was placed in the following equation to calculate the bankruptcy risk. The lower the resultant value of P(z), the more severe the financial distress. The company is classified as bankrupt if P(z) is greater than 0.5. If P(z) is smaller than 0.5, the company is classified as non-bankrupt or low bankruptcy risk (Ohlson, 1980).

$$P(z) = \frac{1}{(1 + e^{-z})} \quad (3)$$

5.2 Independent Variables

In this study, the independent variables were defined as macroeconomic factors, managerial characteristics, and corporate governance systems. They are measured as below.

5.2.1 Macroeconomic Factors

5.2.1.1 Inflation

Inflation denotes the constantly nonstop increase in prices of products and services which will finally reduce the public purchase power and disrupt an economy. Inflation is measured through variations in the consumer price index (CPI) announced by a central bank.

5.2.1.2 Economic Growth

Economic growth means the monetary value of final products and services manufactured inside a country in a specific year. Economic growth is measured through variations in gross national product (GNP) announced by a central bank.

5.2.1.3 Variations in Currency Exchange Rate

This variable is measured through variations in the per capita currency exchange rate in the free market.

5.2.1.4 Market Competitiveness

The Lerner index was employed to evaluate competitiveness in the market of products. This index is defined as the prices of products subtracted from the final costs of production in a company. This index can directly indicate the market power of a company (i.e., its ability to consider a price higher than the final cost) (Namazi et al., 2015). Although the Lerner index is utilized to determine the market power of products made by a company, it does not separate the special factors of a company such as the effect of pricing power of product market from industrial factors. Hence, the moderated version of the Lerner index that includes the competitiveness power is defined below (Sharma, 2010):

$$LI_{IA} = LI_i - \sum_{i=1}^N \omega_i LI_i \quad (4)$$

where

LI_i : the ratio of sales subtracted by the costs of production and sales (i.e., operating profit) divided by sales

ω_i : the ratio of sales by company i in an industry of interest

5.2.2 Managerial Characteristics

5.2.2.1 Managerial Ability

Managerial ability means management efficiency in creating income (Huang and Sun 2017). Management efficiency is evaluated through the data envelopment analysis (DEA) model described as the following conceptual model and variables (Figure 1) :

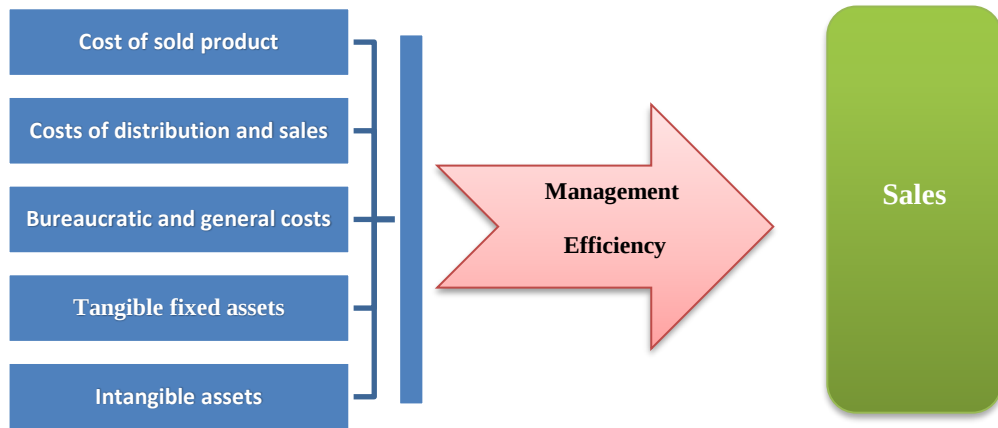


Figure 1. Managerial Ability Conceptual Model

Source: Demerijan et al. (2013).

In this method, management efficiency is evaluated through the production function which indicates the maximum outputs determined by a combination of inputs. The DEA model is analyzed separately for each industry year. The values of this model range between 0 and 1 (a value of 1 indicates the highest management efficiency). The resultant DEA values are then used as dependent variables in the following regression model. Finally, the residual values ($\varepsilon_{i,t}$) of the following regression model indicate managerial ability.

$$FirmEff = \beta_0 + \beta_1 Assets_{i,t} + \beta_2 MShare_{i,t} + \beta_3 PosFCF_{i,t} + \beta_4 Age_{i,t} + Year + \varepsilon_{i,t} \quad (5)$$

where

$Assets_{i,t}$: the natural logarithm of total assets of a company

$MShare_{i,t}$: a company's market share evaluated through the ratio of company sales to the industry sales

$PosFCF_{i,t}$: this variable is 1 if the free cash flow is positive; otherwise, it is 0.

$Age_{i,t}$: the natural logarithm of a company's age since establishment

5.2.2.2 Managerial Optimism

Managerial optimism is evaluated through methods based on the rates of investments, and a common method is to make more investments than sales. In this method, overinvestment will be used to identify managerial optimism. Overinvestment is identified through the following method (Schrand and Zehman, 2011):

$$Investment_{i,t} = \beta_0 + \beta_1 Sale\_Growth_{i,t-1} + \varepsilon_{i,t} \quad (6)$$

where

$Investment_{i,t}$: the capital expenditures (payable cash) to acquire or construct fixed assets, intangible assets, and other assets.

$Sale\_Growth_{i,t-1}$: the growth in previous sales of a company compared with that of its previous year

If future investment exceeds the sales growth (*i.e.*, the residual values of the above model ($\varepsilon_{i,t}$) are positive), overinvestment has been made; otherwise, underinvestment is observed. Hence, if overinvestment occurs, managerial optimism is observed (and $\varepsilon_{i,t}$ is 1); otherwise, the residual is 0.

5.2.2.3 Managerial Entrenchment

Managerial stability and entrenchment emerge over time. First, when a manager assumes responsibility, it is necessary to gain experience and acquire skills for the new position. However, after a transition period which has been specified three years in the research literature (Fredrickson et al., 1988), a manager reaches authority and stability. Hence, if a CEO's tenure is at least three years in this study, management is considered stable and given the value of 1; otherwise, it is given the value of 0.

5.2.2.4 Managerial Myopia

In this study, an independent variable is managerial myopia. When the manager of a company is myopic, he/she will spend the long-term future of the company on improving its short-term status. In other words, the long-term future of a company is sacrificed for its short-term status. In companies with myopic managers, despite financial success and the availability of necessary opportunities and resources for investment in long-term assets, none of such investments are made. Therefore, the companies that report excessive returns (*i.e.*, profitability) and lower costs of marketing, research, and development than expected will most probably be characterized by managerial myopia. To identify and determine myopic companies, it is first essential to estimate the expected

returns on assets, marketing fees, and R&D costs of each company within the research period through the following equations (Anderson and Hsiao, 1982):

$$ROA_{i,t} = \beta_0 + \beta_1 ROA_{i,t-1} + \varepsilon_{i,t} \quad (7)$$

$$Mktg_{i,t} = \beta_0 + \beta_1 Mktg_{i,t-1} + \varepsilon_{i,t} \quad (8)$$

$$R\&D_{i,t} = \beta_0 + \beta_1 R\&D_{i,t-1} + \varepsilon_{i,t} \quad (9)$$

where

$ROA_{i,t}$: returns on assets measured through the ratio of net profit to total assets

$Mktg_{i,t}$: the ratio of marketing fees and sales to total assets

$R\&D_{i,t}$: the ratio of R&D costs to total assets

After the expected (estimated) values of returns on assets, marketing fees, and R&D costs are calculated through the above models, the real values are compared with the predicted values. The companies are then classified into the following four major groups based on differences between the aforesaid values ($\varepsilon_{i,t}$) (Table 1).

Table 1. Classification of Companies

Group 1	Group 2	Group 3	Group 4
Positive difference between predicted and real returns on assets	Positive difference between predicted and real returns on assets	Positive difference between predicted and real returns on assets	Negative difference between predicted and real returns on assets
Negative difference between predicted and real marketing fees and R&D costs	Only the difference between one of marketing fees and R&D costs	Positive difference between predicted and real marketing fees and R&D costs	

Source: Research finding.

The companies of Group 1 are characterized by myopic management because their marketing fees and R&D costs decreased, although they had positive financial performance and increasing returns on assets.

5.2.3 Characteristics of Corporate Governance

5.2.3.1 Institutional Shareholders

The ownership of institutional shareholders is based on the ratio of total shares owned by banks, insurance companies, holdings, investment companies, pension funds, financing companies, investment funds, and public organizations, institutions, and companies to total shares.

5.2.3.2 Ownership Concentration

Ownership concentration means that a few shareholders own many of shares. The free float is used as an index of ownership structure in terms of ownership

concentration. The free float indicates the number of shares expected to be tradable soon in the future and be owned by individuals who are willing to sell them to the highest bidder. In other words, the free float percentage refers to the shares not owned by strategic shareholders; therefore, ownership concentration is measured through the non-float share percentage.

5.2.3.3 Number of Shareholders

The ownership structure of a company can also be evaluated through the number of its shareholders. The larger the number of shareholders, the higher its socioeconomic value in the capital market. Many economists believe that the number of shareholders is a major determinant of a company's value and policies. Given the incomplete publication or concealment of the number of shareholders on the financial statements of companies or the stock exchange databases, the logarithm of the number of shares is used as a criterion for determining the number of shareholders.

5.2.3.4 Management Independence

The management independence of a board of directors is operationally defined through the ratio of the number of non-governing members to the total number of members.

6. Methods and Material

This study analyzed the effects of a series of macroeconomic factors (e.g., inflation, GNP, currency exchange rate, and market competitiveness), managerial characteristics (e.g., ability, optimism, entrenchment, and myopia), and corporate governance variables (e.g., institutional shareholders, ownership concentration, number of shareholders, and management independence) on the financial distress risks of TSE-listed companies. For this purpose, data mining models (e.g., Artificial neural networks and decision trees) were employed to check the research hypotheses. Artificial neural networks are among the methods of developing classifiers. In Artificial neural networks, a learned model is represented as a series of interconnected nodes along with their weighted edges. Artificial neural networks can be employed to model a nonlinear function that maps an input vector like X onto a value like Y . Moreover, a neural network is a simplified model of information processing in the human brain. The basic units of Artificial neural networks are neurons, which are usually organized in different layers. Generally, a neural network consists of three layers: the input layer, the

hidden layer, and the output layer. These layers are interconnected with different weights. Learning in a neural network is achieved by moderating these weights mapped onto each edge between neurons. The decision tree model is a decision support tool that uses trees for modeling. Decision trees are usually used in various studies and operations, especially in decision analysis, to determine the most promising strategy. Decision trees are also adopted to describe calculations of conditional probabilities.

In Artificial neural networks and decision trees, all variables are entered as input variables into the research model. The significance level (*i.e.*, 95% in this study) of the logarithms is then considered excluding the insignificant variables. In the next step, the significant variables are presented in order of effectiveness.

7. Results

7.1 Descriptive Statistics and Frequency Tables

Measures of central tendency and measures of dispersion were used for descriptive statistics and data analysis. Moreover, frequency tables and frequency percentages of observations were presented for virtual variables. Winsorization was then applied to eliminate outliers in some research variables. According to the results of normality tests, research variables had normal or semi-normal distributions (Table 2).

Table 2. Descriptive Statistics of Main Variables

Variables		Average	Median	standard deviation	Skewness coeff	kurtosis coeff	min	max
Title	Abbr							
financial distress risks - Altman	AltmanZ	2.144	1.991	1.130	0.649	0.695	-0.446	5.543
financial distress risks - Ohlson	OhlsonZ	0.916	0.968	0.118	-2.161	4.086	0.505	0.999
Inflation	Inflation	0.225	0.200	0.114	0.442	-1.183	0.090	0.43
economic growth	Growth	0.012	0.019	0.050	0.316	-0.142	-0.065	0.125
currency exchange rate	Currency	0.347	0.058	0.535	1.617	1.532	-0.014	1.824
market competitiveness	Compet	-0.034	-0.032	0.141	-0.130	2.100	-0.681	0.591
managerial Abilities	ManAbility	0.500	0.500	0.289	0.000	-1.200	0.000	1.000
managerial independence	ManInd	0.664	0.600	0.190	-0.294	0.041	0.000	1.000
institutional shareholders	InstitOwn	0.718	0.783	0.231	-1.316	1.128	0.000	1.000
ownership concentration	ConcOwn	0.761	0.799	0.156	-1.026	1.168	0.068	1.000
number of shareholders	NumOwn	8.388	8.306	0.697	0.962	1.748	6.699	11.480

Source: Research finding.**Table 3.** Frequency Table of Virtual Variables

Variables		Sample size	Frequency		Percentage Frequency	
Title	Abbr		0	1	0	1
managerial optimism	ManOptim	1960	1310	650	66.8%	33.2%
managerial entrenchment	ManEntr	1960	1003	957	51.2%	48.8%
managerial myopia	ManMyopia	1960	1432	528	73.1%	26.9%

Source: Research finding.

Table 4. Data Mining Results of Artificial Neural Networks

Variables		Abbr.	Results of Artificial neural networks model Based on the measure of the financial Disaster			
			Altman Model		Ohlson Model	
			coeff	Sign	coeff	Sign
Macroeconomic factors	Inflation	Inflation	0.169	*	0.123	*
	economic growth	Growth	0.064	*	0.062	*
	currency exchange rate	Currency	0.015	*	0.064	*
	market competitiveness	Compet	0.419	*	0.417	*
Management features	managerial Ability	ManAbility	0.000	-	0.000	-
	managerial optimism	ManOptim	0.057	*	0.032	*
	managerial entrenchment	ManEntr	0.065	*	0.041	*
	managerial myopia	ManMyopia	0.108	*	0.104	*
Corporate governance variables	institutional shareholders	InstitOwn	0.103	*	0.082	*
	ownership concentration	ConcOwn	0.000	-	0.075	*
	managerial independence	ManInd	0.000	-	0.000	-
	number of shareholders	NumOwn	0.000	-	0.000	-
insignificance -			significance *			

Source: Research finding.

According to the results presented by descriptive statistics of research variables, the mean of financial distress was reported 2.144 by Altman's Z-score; however, it was reported 0.916 by Ohlson's model. These results indicate that most of the companies in the research sample were in healthy or relatively healthy conditions in terms of financial distress and that a few of them faced severe financial distress (and bankruptcy). The mean of inflation, economic growth, and currency exchange rate growth were also reported as nearly 23% (0.225), 1% (0.012), and 35% (0.347), respectively. The mean of competitiveness was determined -0.034 by the Herfindahl–Hirschman index (HHI) for companies in the research sample. Although this value approaches zero, it indicates a higher level of competitiveness in the market of products. According to the other results, the independence of the board of directors was 0.664, a value which means that nearly 66% of board members of companies were non-governing members. The frequency table of research variables demonstrated that the frequency percentage of companies with myopic management was 27%. Moreover, managerial myopia was measured at 33% at the sample companies. The other results suggested that management stability and entrenchment existed at a considerable percentage in nearly half of the sample companies (Table 3).

7.2 Results of Artificial Neural Networks

Table (4) presents the results of Artificial neural networks based on the two criteria for evaluating the financial distress risk (*i.e.*, Altman's Z-score and Ohlson's model). According to Table (4), all variables of macroeconomic factors were identified as effective in the financial distress risks of companies in both Altman's Z-score and Ohlson's model. The coefficients of effectiveness indicated that market competitiveness was the most effective variable of macroeconomic factors. Hence, this finding confirms the first research hypothesis stating that macroeconomic factors have significant effects on the financial distress risks of companies concerning Artificial neural networks as well as both Altman's Z-score and Ohlson's model.

The results indicated that optimism, entrenchment, and myopia were among the managerial characteristics affecting the financial distress risks of companies in terms of both criteria. Moreover, managerial ability had no significant effects. Given the significant effects of three out of five managerial characteristics on the financial distress risks of companies, it can be concluded that most managerial characteristics had significant effects on the financial distress risk. This finding confirms the second research hypothesis stating that

managerial characteristics had significant effects on the financial distress risks of companies based on Artificial neural networks.

Regarding corporate governance variables, the results indicated that only institutional shareholders had a significant effect on the financial distress risks of companies in terms of both Altman's Z-score and Ohlson's model. The other variables of corporate governance (*i.e.*, ownership concentration, number of shareholders, and management independence) had no significant effects. This finding rejects the third research hypothesis stating that the corporate governance system had significant effects on the financial distress risks of companies based on Artificial neural networks.

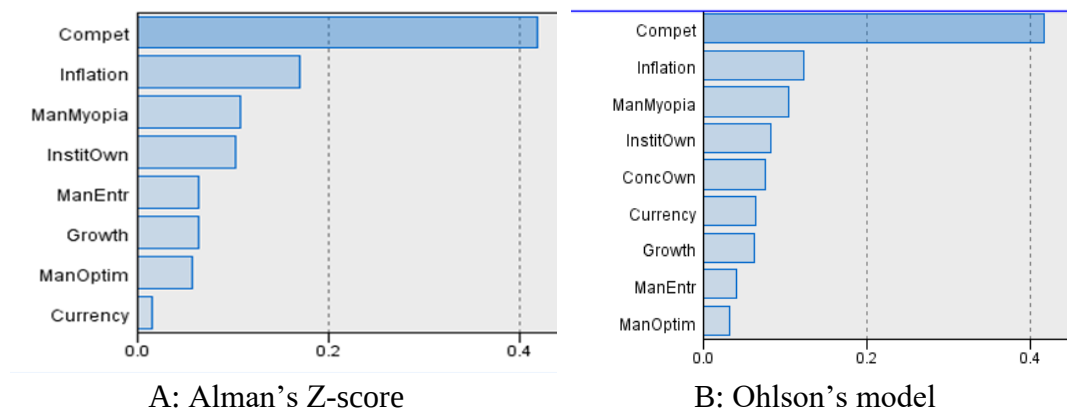


Figure 2. Identifying the Variables Affecting Financial Distress with Artificial Neural Networks

Source: Research finding.

In Figure 2, the vertical axis represents the variables having significant effects on the financial distress risk, whereas the horizontal axis indicates the effectiveness of each variable. These diagrams present the most effective variables first and then show the other significant variables in a downward order (the insignificant variables were excluded). The results of Artificial neural networks for both criteria indicated that market competitiveness, inflation, and managerial myopia were the most effective variables in the financial distress risks of companies.

7.3 Data Mining Results of Decision Trees

Table (5) reports the results of decision trees based on the C5 model and two criteria for evaluating the financial distress risk.

Table 5. Data Mining Results of Decision Tree Model

Variables			Results of Decision Tree Based on the measure of the financial Disaster			
			Altman Model		Ohlson Model	
			coeff	Sign	coeff	Sign
Macroeconomic factors	Inflation	Inflation	0.176	*	0.092	*
	economic growth	Growth	0.017	*	0.037	*
	currency exchange rate	Currency	0.054	*	0.028	*
	market competitiveness	Compet	0.291	*	0.391	*
Management features	managerial Ability	ManAbility	0.079	*	0.000	-
	managerial optimism	ManOptim	0.033	*	0.000	-
	managerial entrenchment	ManEntr	0.091	*	0.073	*
	managerial myopia	ManMyopia	0.242	*	0.267	*
Corporate governance variables	institutional shareholders	InstitOwn	0.018	*	0.042	*
	ownership concentration	ConcOwn	0.000	-	0.023	*
	managerial independence	ManInd	0.000	-	0.048	*
	number of shareholders	NumOwn	0.000	-	0.000	-
insignificance -			significance *			

Source: Research finding.

According to Table (5), all variables of macroeconomic factors affected the financial distress risks of companies in terms of both Altman's Z-score and Ohlson's model. The coefficients of effectiveness indicated that market competitiveness and inflation were the most effective variables of macroeconomic factors. This finding confirms the first research hypothesis stating that macroeconomic variables have significant effects on the financial

distress risks of companies based on the decision tree model in terms of both Altman's Z-score and Ohlson's model.

The results also indicated that entrenchment and myopia were reported to be among the managerial characteristics affecting the financial distress risks of companies based on the two criteria; however, managerial ability and managerial optimism had no significant effects (because they were significant in only one criterion). Given the significant effects of two out of five managerial characteristics on the financial distress risks of companies, it can be concluded that managerial characteristics had no significant effects on the financial distress risk. This finding rejects the second research hypothesis stating that managerial characteristics have significant effects on the financial distress risks of companies based on the decision tree model.

Regarding corporate governance variables, the results indicated that only institutional shareholders had a significant effect on the financial distress risk in terms of both Altman's Z-score and Ohlson's model. However, no significant effects were left by ownership concentration, number of shareholders, and management independence. This finding rejects the third research hypothesis stating that the corporate governance system had significant effects on the financial distress risks of companies based on the decision tree model.

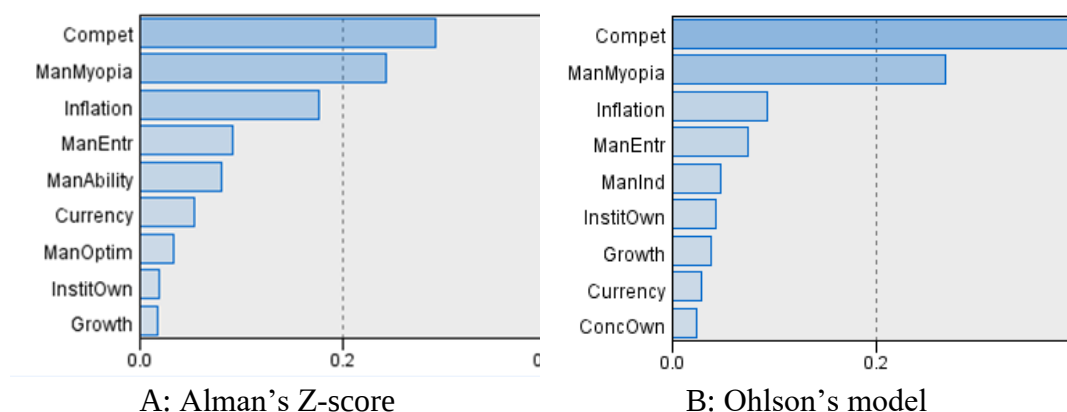


Figure 3. Identifying the Variables Affecting Financial Distress Risk with Decision Tree
Source: Research finding.

The results of the decision tree model indicated that market competitiveness, managerial myopia, and inflation had the most significant effects on the financial distress risks of companies (Figure 3).

7.4 Results of Regression Model

Table (6) presents an overview of the results obtained from the regression model based on the two criteria for evaluating the financial distress risk (for the sake of brevity, regression tables were not included). The coefficients of determination were reported 0.463 and 0.466 based on Altman's Z-score and Ohlson's model, respectively. These values were both significant. Moreover, the coefficients of determination were used instead of coefficients of variables to make the results of the regression model comparable to those of the data mining models. According to Table (6), all variables of macroeconomic factors affected the financial distress risks of companies in terms of both Altman's Z-score and Ohlson's model. The coefficients of determination indicated that market competitiveness and inflation were the most effective variables of macroeconomic factors. This finding confirms the first research hypothesis stating that macroeconomic factors have significant effects on the financial distress risks of companies based on the regression model in both Altman's Z-score and Ohlson's model.

Table 6. Results of the Regression Model

Variables			Results of Regression Based on the measure of the financial Disaster			
			Altman Model		Ohlson Model	
			coeff	Sign	coeff	Sign
Macroeconomic factors	Inflation	Inflation	0.082	*	0.167	*
	economic growth	Growth	0.059	*	0.074	*
	currency exchange rate	Currency	0.097	*	0.086	*
	market competitiveness	Compet	0.347	*	0.098	*
Management features	managerial Ability	ManAbility	0.000	-	0.000	-
	managerial optimism	ManOptim	0.038	*	0.093	*
	managerial entrenchment	ManEntr	0.000	-	0.099	*
	managerial myopia	ManMyopia	0.319	*	0.214	*
Corporate	institutional	InstitOwn	0.059	*	0.089	*

governance variables	shareholders					
	ownership concentration	ConcOwn	0.000	-	0.081	*
	managerial independence	ManInd	0.000	-	0.000	-
	number of shareholders	NumOwn	0.000	-	0.000	-
insignificance -				significance *		

Source: Research finding.

According to the results, managerial optimism and managerial myopia were among the managerial characteristics having significant effects on the financial distress risks of companies based on both criteria. However, managerial ability and managerial entrenchment had no significant effects. Given the significant effects of two out of five managerial characteristics on the financial distress risks of companies, it can be concluded that managerial characteristics had no significant effects on the financial distress risk. This finding rejects the second research hypothesis stating that managerial characteristics have significant effects on the financial distress risks of companies based on the regression model.

According to the findings, institutional shareholders proved to be the only variable of corporate governance having a significant effect on the financial distress risks of companies in terms of both Altman's Z-score and Ohlson's model. Moreover, no significant effects were left by ownership concentration, number of shareholders, and managerial independence. This finding rejects the third research hypothesis stating that corporate governance has a significant effect on the financial distress risks of companies based on the regression model.

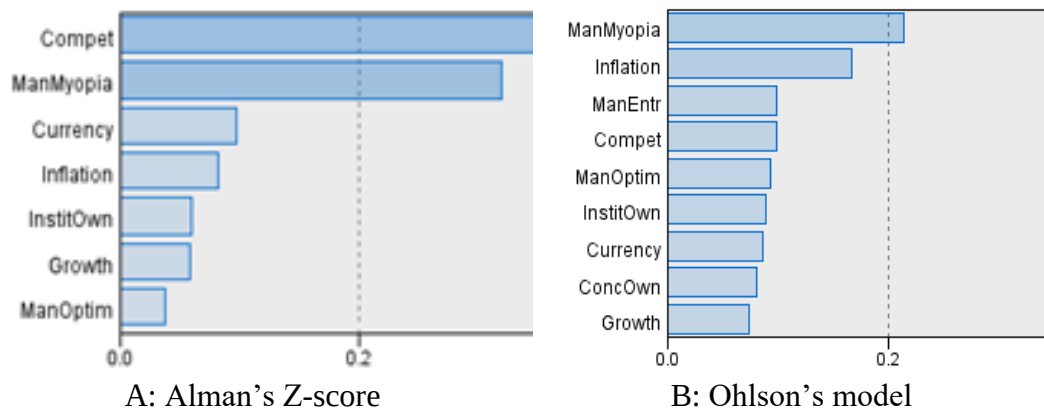


Figure 4. Identifying the Variables Affecting Financial Distress Risk with Regression Model

Source: Research finding.

The results of the regression model and Altman's Z-score indicated that market competitiveness, managerial myopia, and currency exchange rate had the greatest effects on the financial distress risks of companies, whereas Ohlson's model introduced the most effective variables as managerial myopia, inflation, and managerial entrenchment (Figure 4).

7.5 Aggregate Results of Data Mining Models and Regression Model

Table (7) reports the results regarding the effects of macroeconomic factors, managerial characteristics, and corporate governance on the financial distress risks of companies based on Artificial neural networks, decision tree, and regression model.

Table 7. Comparing the Results of Data Mining Models with Those of Regression Model

Variables	Abbr.	Results of Data Mining Models				Regression	
		ANN		DT		Altman	Ohlson
		Altman	Ohlson	Altman	Ohlson		
Macroeconomic factors	Inflation	Inflation	*	*	*	*	*
	economic growth	Growth	*	*	*	*	*
	currency exchange rate	Currency	*	*	*	*	*
	market competitiveness	Compet	*	*	*	*	*
Management features	managerial Ability	ManAbility	-	-	*	-	-
	managerial optimism	ManOptim	*	*	*	-	*
	managerial entrenchment	ManEntr	*	*	*	*	*
	managerial myopia	ManMyopia	*	*	*	*	*
Corporate governance variables	institutional shareholders	InstitOwn	*	*	*	*	*
	ownership concentration	ConcOwn	-	*	-	*	*
	managerial independence	ManInd	-	-	-	*	-
	number of shareholders	NumOwn	-	-	-	-	-
insignificance -				significance *			

Source: Research finding.**Table 8.** Results of Research Hypotheses

No.	Hypothesis	Result
1	Macroeconomic factors have significant effects on the financial distress risks of companies.	Confirmed
2	Managerial characteristics have significant effects on the financial distress risks of companies.	Confirmed
3	The corporate governance system has a significant effect on the financial distress risks of companies.	Rejected

Source: Research finding.

Table 9. Comparing the Three Variables with the Greatest Effectiveness in Data Mining Models and Regression Model

Ranking of variables in the degree of influence	Data Mining Models				Regression	
	ANN		DT			
	Altman	Ohlson	Altman	Ohlson	Altman	Ohlson
1st	Compet	Compet	Compet	Compet	Compet	ManMyopia
2nd	Inflation	Inflation	ManMyopia	ManMyopia	ManMyopia	Inflation
3rd	ManMyopia	ManMyopia	Inflation	Inflation	Currency	ManEntr

Source: Research finding.

According to the results, the three models indicated that all macroeconomic factors had significant effects on the financial distress risks of companies. The findings also demonstrated that managerial optimism, entrenchment, and myopia had significant effects on the financial distress risk. Given the effectiveness of three out of five managerial characteristics, it can generally be concluded that managerial characteristics had significant effects on the financial distress risks of companies. The other findings indicated that corporate governance variables had no significant effects on the financial distress risks of companies, and only one out of three variables had a significant effect. Given the results, Table (8) presents the conclusions on research hypotheses:

Table (9) presents three variables with the greatest effects on the financial distress risks of companies in each model. These results indicate that market competitiveness and managerial myopia were the first and second most effective variables in the financial distress risks of companies, respectively.

8. Conclusion

This study analyzed the effects of macroeconomic factors (e.g., inflation, GNP, currency exchange rate, and market competitiveness), managerial characteristics (e.g., ability, optimism, entrenchment, and myopia), and corporate governance variables (e.g., institutional ownership, ownership concentration, number of shareholders, and management independence) on the financial distress risks of companies listed in the Tehran Stock Exchange. According to all results obtained from the statistical methods, the variables of macroeconomic variables and managerial characteristics had the greatest effects on the financial distress risks of companies, whereas corporate governance variables were the least effective. This finding is inconsistent with the results reported by Meshki and Hashemi (2015) and Lashkan and Wijekoon (2012) but consistent with the results reported by Moradi and Hosseinzadeh (2017). In other words, the financial distress risks of companies are significantly affected by macroeconomic factors (known as external factors) and managerial characteristics (known as internal factors).

Regarding the effectiveness of each variable, the results indicated that market competitiveness, inflation, currency exchange rate, economic growth, managerial myopia, managerial optimism, managerial entrenchment, and institutional shareholders were among the variables affecting the financial distress risks of companies. Moreover, the results of ranking the independent variables in terms of their effects on the financial distress risk demonstrated that market competitiveness, managerial myopia, and inflation had the greatest effects

on the quality of financial distress at companies. Overall, the results suggested that macroeconomic factors, which are mainly hard to control by a company, had the greatest effects on the financial distress risks of companies. Therefore, policymakers should pay attention to these factors to improve the business atmosphere, mitigate the political and economic risks, and lower the financial distress risk. In addition, the effects of managerial characteristics on financial distress draw further attention from shareholders and public assemblies of companies to the better recruitment of more competent board members and managers.

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Islamic Banking and Economic Growth: A Panel Data Approach

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Abstract

The purpose of this investigation is to determine how Islamic banking affects economic expansion. To delve deeper into the research, a total of 90 Islamic institutions from 21 countries were chosen in accordance with specific criteria. An analysis of 953 observations was subsequently conducted. Explanatory variables include Return on assets, Return on equity, the ratio of a company's market value to its assets, asset quality, total deposits, total assets, bank size, and bank age. The Ordinary Least Square (OLS) estimation procedure is employed. The results of the study suggest that several economic indicators have a significant influence on GDP, including Return on Assets (ROA), Tobin's q, Asset Quality, Total Deposits, Total Assets, Bank Size, and Bank Age. The outcomes of this research provide a significant contribution to the body of knowledge regarding the influence of Islamic banking on economic expansion. This contribution to the scientific literature addresses a knowledge vacuum, thereby facilitating the formulation of novel theories and approaches concerning the interplay between Islamic finance and economic expansion. In addition, policymakers and practitioners involved in the management of the Islamic financial sector should consider these implications.

Keywords: Asset Quality, Bank Performance, Islamic Bank, Islamic Finance, Tobin's q.

JEL Classification: E23, E44, G21, O16, P45.

1. Introduction

Central to the dynamic realm of contemporary finance has arisen a unique paradigm that is positioned to reconfigure the trajectory of economic expansion. The intersection of Islamic banking principles and their influence on economic dynamics constitutes an intriguing area of study. This expedition explores the complex dynamics that exist between Islamic financial instruments and the course of economic advancement (Allah Pitchay et al., 2020; Khan, 2019; Khan and Badjie, 2022; Mustapha et al., 2021). In an effort to reveal novel perspectives and potential drivers for sustainable development, this research delves into the

complex corridors of Islamic finance in an effort to shed light on the mutually beneficial association it has with the wider economic landscape.

Amidst the global economic crisis, Islamic banking maintains its position as a steadfast alternative financial ecosystem grounded in Sharia-compliant and ethical principles (Abbas et al., 2020; Belal et al., 2019; Mergaliyev et al., 2021; Zainulldin and Lui, 2020). The rapid ascent of this subject not only initiated a resurgence of intellectual discourse but also initiated a shrewd discussion regarding its capacity to drive economic expansion. Equipped with an array of empirical methodologies, the research undertakes a paradigm-shifting expedition in an effort to reveal the intricate interplay between Islamic banking practises and the wider macroeconomic fabric.

The emergence of Islamic banking represents a fundamental change in the financial landscape, in which profit-driven models are abandoned in favour of an ethos grounded in ethical obligations. In accordance with the tenets of Sharia, Islamic finance integrates the notions of asset-backed transactions, risk-sharing, and equity (Dolgun et al., 2019; Hati et al., 2020; Hidayat et al., 2021; Musa et al., 2021; Šeho et al., 2020). This ethos surpasses traditional banking paradigms, garnering support from ethical investors, corporations, and policymakers.

In the context of the complexities of international finance, Islamic banking offers a complex array of prospects and obstacles. Its economic framework is founded upon distinctive risk-sharing mechanisms, asset-backed financing, and interest prohibitions (Riba), which serve to prevent speculative excesses (Burhanudin, 2022; Mateev et al., 2021, 2022; Musa et al., 2021). Concurrently, the infancy of Islamic banking engenders a fertile environment replete with prospects for groundbreaking advancements, financial investments, and comprehensive development.

The research is not conducted independently; instead, it is situated within a wider international dialogue. An extensive range of scholarly investigations has contributed to the understanding of the inherent potential of Islamic finance. As we stand on this precipice of exploration, we acknowledge the intellectual labour that has been planted by the contributions of academicians, practitioners, and policymakers. Recent research has examined the impact of Islamic banking on economic growth in the following ways: Banna and Alam, 2020; Hernawati et al., 2021; Mergaliyev et al., 2021.

Initially, a study was undertaken encompassing ninety global Islamic institutions across twenty-one countries and a total of 953 observations during the period 2021-2022. Secondly, the examined countries are diverse; therefore, it is

anticipated that Islamic banking will make a positive contribution to the economies of numerous nations. Researchers endeavour to furnish empirical evidence regarding the impact of Islamic banking on the economic development of numerous nations by utilising this distinctive context. Furthermore, a comprehensive analysis of the correlation between the contributions of Islamic banks (as assessed by Total Assets, Total Deposits, and Asset Quality), unemployment, and economic development remains a challenging task to locate.

Despite the considerable importance of this subject matter in relation to Islamic finance and economic expansion, a comprehensive scientific literature addressing each of these aspects remains scarce. The existing research limitations on this subject provide an opportunity for further comprehensive and meticulous investigation. Hence, this research study substantially enhances our comprehension of the manner in which Islamic banking influences economic expansion via variables including total assets, total deposits, and total quality of assets. Thus, in the context of Islamic finance and economic growth, your research may pave the way for the development of novel theories and strategies by filling voids in the scientific literature. This is a significant step that has the potential to provide academics, practitioners, and policymakers in this field with invaluable new insights.

Significantly advancing economic policy, this study contributes significantly to the field of Islamic banking and economic expansion. The significance of this research's contribution is substantial across various critical dimensions. The study begins with an overview of the distinctive environment in which Islamic banking is conducted. By conducting research across twenty-one countries and analysing ninety global Islamic institutions, we successfully developed a robust empirical framework. Furthermore, the variety of nations examined substantiates the conclusion that Islamic banking possesses considerable potential for fostering economic growth in numerous countries. By means of this distinctive methodology, we present compelling empirical data that underscores the substantial impact that Islamic banking has had on worldwide economic expansion. Furthermore, this research makes a significant contribution by addressing deficiencies in the current body of scientific literature. This research comprehensively examines the correlation between the impact of Islamic banks on economic growth, unemployment, and inflation, as assessed by Asset Quality, Total Deposits, and Total Assets. Within the framework of Islamic finance and economic development, this research offers a more profound and all-encompassing comprehension. Therefore, the investigation not only enhances

scholarly understanding but also offers practical recommendations for policymakers, academics, and practitioners who are intrigued by the intersection of Islamic finance and economic expansion.

The structure of the paper is delineated as follows. The paper proceeds from the introduction with a literature review examination concerning Islamic banking in the context of economic expansion, unemployment, and inflation. In the third section, the investigation methodology is described. In section four, the findings and discussion section were addressed. In the subsequent sections, limitations and recommendations for further research are presented subsequent to the conclusions.

2. Literature Review

The economic expansion of a nation is enhanced by the presence of adequately capitalised financial institutions, thus emphasising the need for a robustly developed banking sector. A well-capitalized bank can be defined as a financial entity that possesses substantial capital reserves and demonstrates significant financial robustness. The banking industry, when well-developed, assumes a crucial role in facilitating and bolstering economic progress. The presence of well-capitalised banks within a robust banking sector can yield substantial financial resources for the purposes of investment, lending, and facilitating a diverse array of economic endeavours. Due to their robust financial standing, they are capable of offering sufficient financial resources to support enterprises, entrepreneurs, and projects, thereby fostering economic growth. The number of highly capitalized banks that will have a favourable effect on a country's economic growth must be present in a well-developed banking industry (Bernard Azolibe, 2022).

Banks play a crucial role in the economy since they gather and distribute people's money. Financial institutions have enjoyed fairly competitive, quick, and dynamic growth in recent years (Boukhatem and Djelassi, 2022; Hoque et al., 2022; Nomran and Haron, 2022; Tok and Yesuf, 2022). The fundamental tenet of Islamic banking is that interest is strictly prohibited, and all Islamic banks adhere to this principle. Islamic banking is widely regarded as a dependable and resilient financial system that possesses the capacity to foster enduring economic well-being and facilitate the generation of employment opportunities. Islamic banking is a financial system that adheres to the principles of Islamic law, often known as Sharia. These rules prioritise ethical and socially responsible financial practices. Islamic banking is characterised by several significant attributes. Firstly, it

strictly prohibits the practice of charging or receiving interest, commonly referred to as usury. Secondly, it emphasises the concept of profit and loss sharing, wherein both the bank and the customer mutually participate in the outcomes of their financial transactions. Lastly, Islamic banking actively avoids engaging in speculative and exploitative activities, so promoting ethical and responsible financial practice. It is widely considered that these concepts play a significant role in fostering both financial stability and sustainability. The stability of Islamic banking is anticipated to arise from its emphasis on transactions backed by tangible assets and processes that distribute risk among stakeholders. This method has the potential to mitigate excessive risk-taking behaviours and decrease the probability of a financial crisis, thereby cultivating a more robust financial landscape.

The promotion of ethical and responsible financial practices in Islamic banking is widely thought to have a positive impact on the long-term economic well-being of society. Investment and financing in areas that adhere to Shariah principles, encompassing productive enterprises, infrastructure initiatives, and socially advantageous endeavours, have the potential to foster sustained economic expansion and advancement. Furthermore, the prioritisation of fairness, equitable wealth distribution, and the promotion of productive economic activity within the realm of Islamic banking can potentially lead to a rise in job opportunities. Islamic banking plays a pivotal role in fostering economic activity and facilitating job creation within communities through the provision of financial resources to enterprises and initiatives that yield favourable outcomes for the economy. Islamic banking is thought to be a stable financial system capable of encouraging long-term prosperity and job creation. In favor of productive activity and the real economy, it prohibits interest, speculation, hoarding, contractual uncertainty, and the secondary loan market (Alqahtani and Mayes, 2018; Ganguly, 2021; Creamer, 2022; Zabavnik and Verbič, 2021). It was unaffected by credit expansion and did not result in the type of speculation associated with traditional finance. Securitization and unrestricted credit growth were well-known causes of the recent financial crisis, as were the huge bankruptcies that exacerbated the situation.

The crisis brought to light the urgent need for financial stability, as demonstrated by Islamic financing rules, for example. Banking sectors in emerging and developing markets are characterized by the magnitude of market power. Sharia banks operate under different principles compared to a conventional system. Sharia banks perform on the basis of Islam principles

oriented to profit–loss sharing (Abbas, 2019). Although there was no considerable competition between Islamic banks and conventional banks at the time, Islamic banking has its own distinct characteristics among the community. As a result, research into the degree of productivity in the Islamic banking sector has become a significant element of the banking literature (Lina Nugraha, 2020). The Islamic Bank encompasses both the Islamic Bank and the Shariah Business Unit. It encompasses institutions, corporate activities, and the methods and processes by which they are carried out (Dina Fitrisia Septiarini, 2020).

When the Islamic Development Bank was established in 1975, it served as an announcement to the rest of the world that Islamic finance had entered the arena on a worldwide scale. Since then, both the number of Islamic financial institutions and the number of countries in which they operate have grown significantly (Abrorov and Imamnazarov, 2021). The purpose of banking activities in the real sector is to finance the business sector. Islamic banks are more focused on the actual economy than traditional banks. Finance distribution initiatives to expand the venture capital industry. In the Islamic economic perspective, capital difficulties are crucial. Capital is wealth that contributes to the generation of additional riches; it includes everything that provides personal satisfaction and also contributes to the generation of wealth. Capital is capital acquired through one's own efforts and then used to develop additional riches (Sri Herianingrum, 2019).

Islamic banking plays a key role in fostering economic development. Islamic banking is characterized by its adherence to sharia principles, which prohibit *riba* (interest) and emphasize fairness in transactions. As a result, Islamic banking tends to prioritize productive financing activities, such as investment in the real sector and micro, small, and medium enterprises (MSMEs). These endeavors have the potential to stimulate economic growth and facilitate job creation. By implementing sharia principles, Islamic banking has the potential to foster a more equitable and stable business milieu, mitigate economic uncertainties, and promote enduring investments that contribute to sustainable development. Moreover, Islamic banking has the potential to provide assistance to specific industries such as housing, agriculture, and renewable energy, all of which adhere to sharia principles. This, in turn, can facilitate economic diversification and enhance competitiveness. The principles governing the equitable allocation of wealth in Islamic banking contribute to the mitigation of economic inequality and the enhancement of overall welfare, hence serving as a crucial determinant of sustainable economic growth. Islamic banking goes

beyond being a mere financial institution, as it exerts a wide-ranging positive influence by enabling individuals to gain access to sharia-compliant financial services. Consequently, this facilitates inclusive and sustainable economic development. Islamic banking has an important role in encouraging economic development (Wasiaturrahma, 2020). Consequently, we must ask ourselves, "Why are we so interested in a topic that has been thoroughly discussed in the literature?" The majority of research on the association between banking development and economic growth has been based on samples from industrialized nations with banking systems and financial markets typified by less information asymmetry, lower transaction costs, and more effective banking regulation. It is also uncertain if the conclusions gained from these studies regarding the effect of financial development on economic growth apply to systems where Islamic banks play a prominent role.

2.1 Bank Performance and Economic Growth

Economic expansion and bank performance are two crucial pillars of a nation's economic dynamics. As the primary financial intermediaries, banks facilitate the distribution of funds from individuals or entities with surplus funds to those or entities that require those funds for investment or consumption. They facilitate diverse financial transactions and manage financial risks (de Barros et al., 2021; Nguyen and Ryu, 2022). However, economic growth encompasses activities such as augmenting output and gross domestic product, fostering employment opportunities, and stimulating investment and innovation. A reciprocal relationship exists between the two: robust economic expansion stimulates increased financing demand, whereas banks bolster economic expansion by supplying the requisite financial resources for productive endeavours. The stability of the financial system and monetary policy are significant regulators of the relationship between bank performance and economic expansion. Ensuring sustainable economic growth and sound bank performance are critical components in the pursuit of stable economic development and the betterment of society.

Return on Assets (ROA) is an important indicator of a bank's financial performance. ROA indicates the efficiency with which a financial institution makes a profit from its assets. A bank shows superior performance in converting its assets into profits when ROA increases (Almulhim and Aljughaiman, 2023; Porto et al., 2023; Setiawan et al., 2023). A high return on assets (ROA) signifies that a bank can provide financing with competitive profit sharing, facilitate

business investment, and encourage development in productive sectors, all of which are related to economic expansion. Conversely, a low ROA may indicate that the bank is experiencing profit pressure, which may adversely affect its ability to sustain economic expansion. Simply put, bank performance, especially as measured by ROA, is critical in building a strong financial framework that facilitates long-term economic expansion.

Return on Equity (ROE) is a significant metric utilised to assess the financial performance of a financial institution. ROI assesses the effectiveness with which a financial institution generates net income using equity or capital contributed by shareholders or proprietors. A bank demonstrates superior financial performance in utilising its capital to generate profits, as indicated by a higher return on equity (ROE) (Gutiérrez-Ponce and Wibowo, 2023; Sathyamoorthi et al., 2023; Sharma and Dhiman, 2023). A high return on equity (ROE) signifies that the bank is capable of generating substantial returns on its capital, which may be utilised to finance expansion and productive project investments, with respect to economic growth. Additionally, investment is more likely to be attracted to banks with a robust ROE, which enables them to mobilise funds to support economic expansion as a whole. Conversely, a low ROE may suggest that the financial institution is struggling to generate sufficient returns on its invested capital. The capacity of banks to extend financing and facilitate business investment may be constrained, thereby potentially impeding economic expansion. Since such, ROE is a pivotal metric for determining whether a financial institution possesses the stability of its assets to sustain long-term economic expansion. Banks that consistently attain high return on equity (ROE) tend to have a positive impact on long-term economic growth.

Tobin's q is an economic concept that quantifies the correlation between the book value (or market value) of assets disclosed in financial statements and the market value of a company or asset (Anas et al., 2023; Lee et al., 2023; Ozdemir et al., 2023; Ricca et al., 2023). Tobin's q pertains to the correlation between the market value of a bank and the book value, which represents the value of assets as documented in its financial statements. A Tobin's q value exceeding one ($q > 1$) signifies that the market assigns a higher valuation to the bank in comparison to its book value or asset value. This may suggest that the market has confidence in the bank's ability to effectively manage its assets and generate profits in excess of their value. This may incentivize financial institutions to pursue additional investments or expansions, given the prospect of higher returns. On the contrary, a Tobin's q value below one ($q < 1$) indicates that

the bank is undervalued by the market in comparison to its book value or asset value. This may serve as an indication of market skepticism regarding a bank's capacity to effectively manage its assets or generate satisfactory returns on their value. Banks may encounter circumstances where they are compelled to enhance their performance or modify their strategies to augment their market value.

2.2 Asset Quality and Economic Growth

The banking sector's asset quality is a significant indicator that influences the economic growth of a nation. It assesses the degree to which a financial institution effectively oversees its loan portfolio through the maintenance of punctual payments from borrowers. A high level of asset quality indicates a diminished likelihood of default, which in turn empowers financial institutions to extend financing with greater assurance (Adelopo et al., 2022; Kočenda and Iwasaki, 2022; Saleem et al., 2021; Tok and Yesuf, 2022). This phenomenon fosters consumer expenditure and investment, thereby potentially stimulating economic expansion. In addition, high-quality assets contribute to the stability of the financial sector by mitigating systemic risks that could have an effect on the economy as a whole. Good asset quality fosters customer confidence and contentment, which in turn encourages corporations to engage in fruitful investment activities. In general, their contribution to economic development is greater because they facilitate investment in growth-stimulating projects through the provision of funds. Therefore, the quality of bank assets plays a crucial role in fostering sustainable and sound economic expansion, whereas substandard asset quality can impede development and amplify economic risks. Therefore, monitoring and maintaining asset quality is essential for ensuring that institutions play a positive role in the economy.

H1. There is a significant influence between the asset quality of Islamic banking and economic growth

2.3 Economic Growth and Islamic Bank Deposits

The entire number of deposits is a source of funds from which banks may provide financing. In addition to deposits from clients, there are also deposits from other banks. After receiving deposits (current accounts, savings accounts, and time deposits) from the general public, banks reinvest the funds into the economy through a number of financing processes (Appiah-Otoo and Song, 2022; Butt et al., 2023; Louembé et al., 2023; Maebayashi and Tanaka, 2022; Sadeghi et al., 2023). The greater the number of deposits retained, the greater the

potential to provide finance to clients, which has a positive impact on economic growth via production or consumption channels. Islamic banks utilize deposits to fund productive projects that align with sharia principles, including investments in the real sector, housing, and micro, small, and medium enterprises (MSMEs). Therefore, these deposits possess the potential to stimulate economic expansion through the facilitation of investment and advancement in pivotal industries. Additionally, Islamic financial institutions have the potential to contribute to a more equitable distribution of wealth within a given society, as they adhere to principles of justice and sustainability. This measure has the potential to mitigate economic inequality and enhance overall societal well-being.

The deposit placed in the custody of Islamic banks can exert a significant impact on economic growth through multiple channels (Belkhaoui, 2023; Butt et al., 2023; Halim et al., 2023; Soedarmono and Yusciantoro, 2023). Firstly, it is common for Islamic banks to dedicate their deposits towards financing tangible economic activities and projects that are in accordance with Shariah principles. Consequently, this methodology has the potential to foster heightened entrepreneurial activities, yield employment prospects, and enhance the general economic vitality. Moreover, Islamic financial institutions frequently advocate for the support of small and medium firms (SMEs) by enabling their access to financial resources. This not only promotes the development of entrepreneurship and innovation but also contributes to the advancement of the economy. Moreover, deposits in Islamic banks frequently function as sources of funding for vital infrastructure initiatives, public services, and community-driven projects that significantly contribute to economic advancement. Islamic banks have the ability to allocate deposits towards initiatives that aim to improve marginalised populations, therefore lowering economic disparity and promoting comprehensive prosperity, by adhering to Sharia principles that advocate for a fair allocation of wealth. The unwavering dedication of Islamic banks to uphold ethical and transparent financial practises has the potential to enhance financial stability as well. The aforementioned stability serves as the fundamental basis for a robust economic environment capable of effectively assimilating unforeseen disruptions and fostering long-term, sustainable expansion.

Islamic banks are very important to economic growth because they help move money around (Albusheekh Saleh and Alaallah, 2022; Kismawadi, 2023a, 2023b; Kismawadi et al., 2023; Ledhem and Mekidiche, 2022; Siddique et al., 2022). These include helping to fund projects that are morally acceptable, encouraging loans, promoting financial stability, and getting people to save

money. Islamic banks help the economy grow by doing things like giving business capital in the real economy, which is more productive than just lending money. Also, they have a more positive effect on the growth of the economy (Anwar et al., 2020). When total deposits grow in Islamic banking, banks can make more investments, which helps the economy grow. High regulatory and prudential standards for changes in macroeconomic variables will also help manage bank assets and raise national income (Mohamad et al., 2018). Based on the discussion above, I propose the following hypothesis:

H1. There is a significant influence between total Islamic banking deposits and economic growth

2.4 Assets and Economic Growth

Within the realm of banking, the term "Total Assets" pertains to the comprehensive sum of resources possessed by an institution, encompassing currency, investments, granted loans, and additional financial assets. It is related to economic expansion in the following way: The total assets of a bank are a significant contributor to the economic expansion of a nation. Banks, being prominent financial institutions, possess the ability to amass funds from the general public for the purpose of allocating them towards fruitful investments (Azzam and Rettab, 2022; Priyadi et al., 2021). As a bank's total assets increase, so does its capacity to extend financing to individuals and organizations in need of capital for investment purposes, expansion endeavors, or consumption financing. It generates new employment opportunities, augments national income, and stimulates the production of products and services, thereby positively influencing overall economic activity.

The total assets of the bank serve as an indicator of the financial institution's robustness and stability (Mansour et al., 2022; Rizvi et al., 2020; Saif-Alyousfi and Saha, 2021; Trinh et al., 2020). In general, financial institutions that possess substantial total assets are better equipped to manage economic crises and incur risks. This decreases the probability of significant disturbances in the financial system, which may detrimentally affect the expansion of the economy as a whole.

Given the imperative of achieving sustainable economic growth, prudent investment and expenditure decisions by banks are of utmost significance. Banks that effectively manage their total assets can contribute to risk mitigation and foster stable and balanced growth. Nevertheless, it is critical to guarantee that banks have implemented suitable risk management policies and measures to

prevent excessive jeopardy to financial stability posed by their substantial total assets. The total assets of the bank are instrumental in fostering sustainable economic growth through the provision of investment capital, the establishment of financial stability, and the reduction of potential risks. Proficiently managed total assets by banks can make a substantial contribution to the promotion of sustainable and sound economic expansion.

H1. There is a significant influence between Islamic banking assets and economic growth

2.5 Bank Size and Economic Growth

The size of a bank, which is frequently measured by its total assets, has a significant impact on the economic development of a nation. Major financial institutions possessing substantial total assets are capable of exerting a substantial influence on the tides of economic expansion. Large banks possess an inherent advantage in terms of their ability to procure funds from the general public and extend financing to both corporations and individuals. This facilitates substantial corporate investments in infrastructure, production, and innovation, thereby stimulating the expansion of economic sectors. Furthermore, major banks possess the capacity to significantly contribute to the facilitation of global commerce and the allocation of capital to sectors that are imperative for fostering economic expansion (Bolarinwa et al., 2021; Kumar et al., 2022; Kumar and Bird, 2020; Martens et al., 2021; Sari et al., 2022). They possess robust infrastructure and networks to facilitate cross-border business transactions, which stimulate worldwide economic expansion and broaden product and service markets.

It is essential to observe, nevertheless, that substantial banks may also pose threats to financial stability. Failures or issues that arise within major institutions can potentially have severe consequences for the entire financial system and the economy at large, thus constituting "systemic" risks. Strong oversight and regulation are thus required to guarantee that large banks can function securely, foster economic expansion, and do so without jeopardizing the stability of the financial system.

Conversely, tiny and medium-sized banks play a significant role in bolstering economic expansion. Typically, their focus lies on providing financial support to small and medium-sized enterprises (SMEs), which frequently serve as the fundamental engines of an economy (Khalaf and Alajlani, 2021; Khan, 2023). By offering financing and financial assistance to small and medium-sized enterprises (SMEs), these banks contribute to job creation, innovation, and

economic competitiveness.

The expansion of the economy is substantially influenced by the scope of the bank. Major financial institutions amass substantial capital infusions to bolster the expansion and investment of critical sectors within the economy (Ibrahim et al., 2022; Sari et al., 2022; Soedarmono and Yusciantoro, 2023). The backbone of the economy, small and medium-sized enterprises (SMEs), however, are significantly aided by the financial support provided by small and medium-sized institutions. Hence, the preservation of equilibrium and the enforcement of sound banking practices are fundamental in fostering sustainable economic expansion.

H1. There is a significant influence between the size of Islamic banking and economic growth

2.6 Bank Age and Economic Growth

Financial institutions that have been in operation for an extended duration can significantly contribute to fostering economic expansion. To begin with, financial institutions that have been in operation for a prolonged duration generally possess greater expertise and the confidence of both individuals and organizations. They build a solid reputation in the financial services industry, which can result in increased client and consumer interest. It has the ability to raise increased public funds for investment in productive initiatives that drive economic expansion.

Banks with a lengthier operational history have established relationships and broader networks with numerous economic sectors (Charoenrat and Amornkitvikai, 2021; Gómez et al., 2021; Pham, 2021). This enables them to enhance their comprehension of market demands and prospects, thereby facilitating the provision of financial solutions that are more suitable in light of the evolving economic climate. They typically possess a greater quantity of data and information pertaining to the performance of businesses. This can be utilized to more effectively evaluate financing risk and extend financing.

Nevertheless, it is critical to bear in mind that youthful institutions may also contribute significantly to the expansion of the economy. New and innovative financial institutions frequently introduce innovative concepts and technologies to the industry. In addition to expanding access to financial services for previously unreachable groups or regions, they can introduce new products and services to satisfy the demands of expanding markets.

Elderly banks generally possess greater expertise in risk management with

regard to navigating diverse economic circumstances and financial crises. They may have implemented and validated risk policies and strategies, enabling them to manage risk more effectively. Alternately, more recent institutions might be more adaptable in their adoption of cutting-edge risk mitigation technologies and procedures.

Economic growth is profoundly influenced by the age of banks. Established financial institutions possess network advantages, reputation, and experience that they can utilize to foster economic expansion by offer financing and financial services (Biru, 2021; Gupta and Mahakud, 2020). Younger institutions, conversely, are capable of introducing novel concepts and satisfying the demands of an expanding market. The contribution of both traditional and modern institutions to the promotion of sustainable and robust economic expansion is substantial.

H1. There is a significant influence between bank age of Islamic banking and economic growth

2.7 Islamic Banks and Inflation

Numerous facets of the operations of Islamic institutions are significantly impacted by inflation (Fakhrunnas et al., 2021; Kamarudin et al., 2022; Mabkhot and Al-Wesabi, 2022; Mensi et al., 2020; Priyadi et al., 2021). Islamic banks, in accordance with sharia principles, abstain from the practice of riba and advocate for the integrity of financial transactions. When contemplating inflation, Islamic institutions must take into account the ramifications for the purchasing power of currency. An increase in inflation rates has the potential to diminish the purchasing power of currency, which could result in a gradual depreciation of funds deposited or invested in Islamic banks. Hence, it is imperative for Islamic financial institutions to exercise prudent management of their investment portfolios in order to safeguard consumer funds against the detrimental consequences of inflation.

Furthermore, Islamic banks ought to incorporate the inflation rate into a reasonable profit margin calculation for their financial instruments. Alternatively stated, it is their responsibility to ensure that the profit share they establish yields satisfactory returns for customers, taking into account the dynamic nature of currency values resulting from inflation. When considering financing, Islamic institutions must additionally consider the ramifications of inflation on the repayment capacity of borrowers. In light of the possibility that borrowers will face greater strain due to rising inflation, Islamic banks must ensure that the

financing they extend is compliant with sharia law and remains sustainable. Therefore, it is imperative for Islamic banks to meticulously contemplate the ramifications of inflation when formulating investment strategies, determining profit-sharing, and assessing financing risk. This will guarantee the endurance and equity of their operations amidst fluctuations in the economic landscape.

H1. There is a significant influence between inflation and economic growth

2.8 Islamic Banks and Unemployment

Islamic banks contribute significantly to the struggle against unemployment by implementing a variety of initiatives that emphasize economic inclusion and community development (Selim and Hassan, 2020; Yuli and Rofik, 2023). To begin with, they offer exclusive financial assistance to small and medium-sized businesses (SMEs). SMEs are frequently the driving force behind the creation of new employment in a variety of economic sectors. Through the provision of more affordable capital and financing to small and medium-sized enterprises (SMEs), Islamic banks foster their expansion and progress, thereby generating sustainable employment prospects (Bilal et al., 2020; Doruk, 2023; Saif-Alyousfi, 2022; Tayem, 2022). Furthermore, Islamic banks advance financial inclusivity by granting entry to demographics that were hitherto inaccessible to traditional financial institutions. These groups consist of the impoverished, rural communities, and those with restricted availability of conventional financial services. Islamic banks facilitate opportunities for these individuals to manage their finances, obtain loans, and invest in home-based enterprises or small projects in accordance with sharia law, thereby contributing to the reduction of the unemployment rate.

H1. There is a significant influence between unemployment and economic growth

The main objective of the study was to investigate the influence of Islamic banking on the economic growth of twenty-one countries, with eighty-three Islamic banks. This study used a Ordinary Least Square (OLS) analysis panel and utilized the E-Views statistical program

3. Methods and Material

The purpose of this study is to examine the empirical effect of Islamic banking (ROA, ROE, Tobin's q, Asset Quality, Total Deposits, Total Assets, Bank Size, Bank age) on GDP, Unemployment, and Inflation. The following assumptions were made in twenty-one countries covering the years 2021 to 2022. This study

used 953 observations were selected for further analysis based on these criteria. This survey took a sample of 90 global Islamic banks registered in each country, data obtained from the capital market of each country of origin of Islamic banking and from OSIRIS

To empirically investigate the relationship between Islamic banking (ROA, ROE, Tobin's q, Asset Quality, Total Deposits, Total Assets, Bank Size, Bank age) on GDP, Unemployment, and Inflation., we use the following Ordinary Least Square (OLS), Here is the model:

$$GDP = \alpha_0 + \alpha_1 ROA_1 + \alpha_2 ROE_2 + \alpha_3 Tobins_3 + \alpha_4 AQ_4 + \alpha_5 TD_5 + \alpha_6 TA_6 + \alpha_7 Size_7 + \alpha_8 Age_8 + \epsilon_t \quad (1)$$

$$Unp = \alpha_0 + \alpha_1 ROA_1 + \alpha_2 ROE_2 + \alpha_3 Tobins_3 + \alpha_4 AQ_4 + \alpha_5 TD_5 + \alpha_6 TA_6 + \alpha_7 Size_7 + \alpha_8 Age_8 + \epsilon_t \quad (2)$$

$$Inf = \alpha_0 + \alpha_1 ROA_1 + \alpha_2 ROE_2 + \alpha_3 Tobins_3 + \alpha_4 AQ_4 + \alpha_5 TD_5 + \alpha_6 TA_6 + \alpha_7 Size_7 + \alpha_8 Age_8 + \epsilon_t \quad (3)$$

Table 1 shows where, GDP: Gross Domestic Product, Unp: Unemployment, Inf: Inflation, ROA: Return on assets, ROE: Return on Equity, Tobins: Ratio of the market value of a company divided by its assets, AQ: Asset Quality, TD: Total Deposits, TA: Total Assets, Size: Bank Size, Age: Bank age.

Table 1. The Variables Used in the Study

Variables	Code	Defines	Source
Return on Assets	ROA	Ratio of operating income over assets	(Amrani and Najab, 2023; Chowdhury et al., 2022; Fitri et al., 2022; Prasojo et al., 2022; Qabajeh et al., 2023)
Return on Equity	ROE	Ratio of operating income over equity	(Awad, 2022; Farooq et al., 2023; Khatib et al., 2023; Qabajeh et al., 2023)
Tobin's q	Tobin's q	Ratio of the market value of a company divided by its assets	(Awwad and Al-Qaissi, 2023; Grassa et al., 2023; Wijayanti and Setiawan, 2022)
Asset Quality	Asset Quality	Net income to total assets	(Ali et al., 2021; Aljughaiman et al., 2023; Handayani et al., 2020; Shaikh, 2023)
Total Deposits	Total Deposits	Total Islamic bank's Deposits quarter	(Abduh et al., 2011; Khasharmeh, 2018; Khatib et al., 2023; Mennawi, 2020; Solarin et al., 2018)
Total Asset Islamic Banking	Total Asset	Total Islamic bank's assets quarter	(Khan and Ibrahim, 2022; Nurkhin et al., 2021; Qabajeh et al., 2023; Sidaoui et al., 2022; Utami et al., 2022)
	Bank Size	Natural log of total corporate assets	(Asif et al., 2022; Hasan et al., 2023; Soedarmono and Yusciantoro, 2023; Trichilli et al., 2023)
	Bank age	Bank age: The natural logarithm of the number of years since the firm was listed	(Al-Homaidi et al., 2020; Basuony et al., 2014; Hasan et al., 2023; Muhammad and Nugraheni, 2021)
Gross Domestic Product	GDP	GDP per capita (current US\$)	(Abusharbeh, 2020; Hernawati et al., 2021; Kismawadi, 2023a; Sobol et al., 2023)
Unemployment	Unemployment	Total (% of total labor force) (modeled ILO estimate)	(Nugraheni and Muhammad, 2023; Yuli and Rofik, 2023)
Inflation	Inflation	Consumer Prices	(Abdo, 2023; Albusheekh Saleh and Alaallah, 2022; Neifar and Gharbi, 2023)

4. Result and Discussion

Islamic finance refers to a financial system that operates in accordance with the Sharia, or principles of Islamic law. Sharia prohibits, among other practices, usury, speculation, and gambling, and mandates that all financial transactions be based on actual assets and risk-sharing.

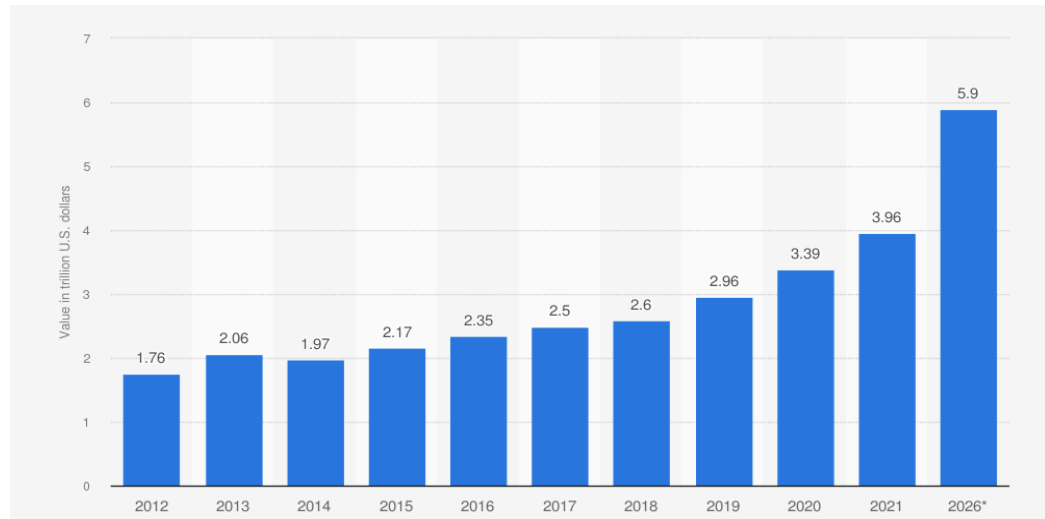


Figure 1. Total Value of Islamic Finance Assets Worldwide from 2012 to 2021 with a Projection for 2026 (in Trillion U.S. Dollars)

Source: ICD Statista, 2023.

In recent years, the Islamic finance industry has expanded significantly and become an integral part of the global financial system. As indicated, Figure 1 above shows that the global Islamic finance market's total asset value in 2021 was approximately \$3.95 trillion US dollars. This consists of the assets possessed by Islamic banks, Islamic insurance companies (takaful), and Islamic asset management firms. Significant expansion is also taking place in Africa and Europe. It is anticipated that the global Islamic finance market's total asset value will reach \$5.9 trillion US dollars by 2026. This growth is anticipated to be driven by a number of factors, including a rising demand for Islamic financial products and services, the expansion of Islamic finance into new markets, and an increased awareness of the advantages of Shariah-compliant finance. It is anticipated that the continued expansion of the global Islamic finance industry will have a significant impact on the global financial system as well as the economies and societies of the countries in which it operates.

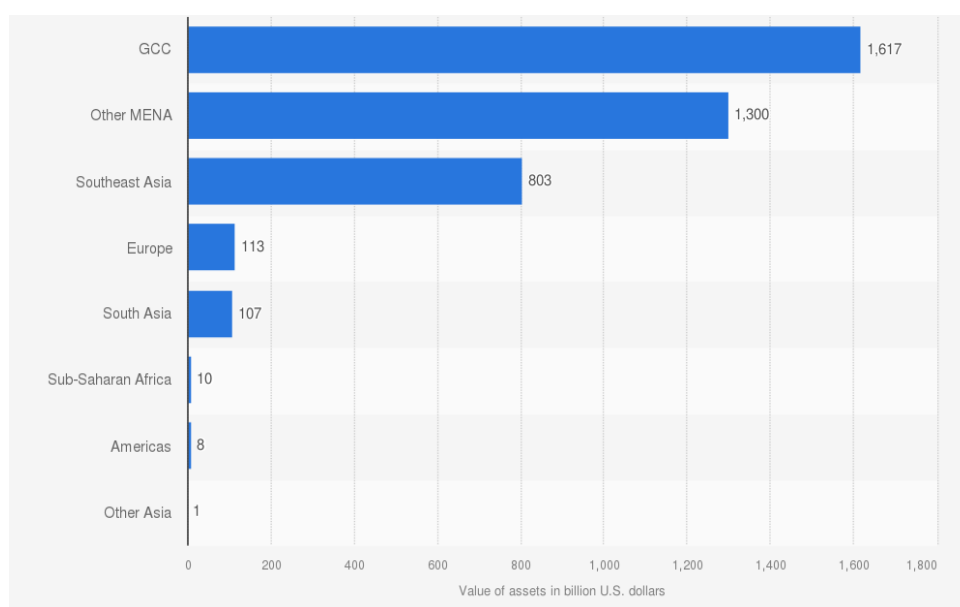


Figure 2. The Value of Islamic Finance Assets Worldwide in 2021, by Region (Billion U.S. Dollars)

Source: ICD Statista, 2023.

Gulf Cooperation Council (GCC) is a regional intergovernmental organization comprised of six Arab nations in the Persian Gulf region: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). The GCC is home to a substantial and rapidly expanding Islamic finance industry, which has become a vital source of capital and investment in the region.

As previously stated, Figure 2 shows the value of Islamic financial assets in the GCC region in 2021 amounted to 1.61 trillion US dollars. This number represents the total value of Islamic financial assets held by GCC-based banks, insurance companies, and other financial institutions. The GCC region is one of the world's largest and fastest-growing Islamic finance markets, propelled by factors such as a robust demand for Sharia-compliant financial products, favorable regulatory frameworks, and an increasing pool of skilled professionals.

In the same year, the total value of Islamic finance assets worldwide amounted to 3.95 trillion US dollars. In 2021, the GCC region accounted for approximately 40% of global Islamic finance assets. It highlights the significant role that GCC nations play in the global Islamic finance industry and their position as crucial players in the sector's development and growth.

Through various initiatives and policies geared at fostering the growth of Sharia-compliant financial products and services, GCC countries have been

active in promoting the development of Islamic finance in the region. The establishment of regulatory bodies for Islamic finance, the development of Sharia-compliant financial standards and guidelines, and the promotion of Islamic finance education and training are among these initiatives. In the coming years, the strong development of the Islamic finance industry in the GCC region is anticipated to be driven by favorable demographics, rising levels of prosperity, and a growing demand for Sharia-compliant financial products and services.

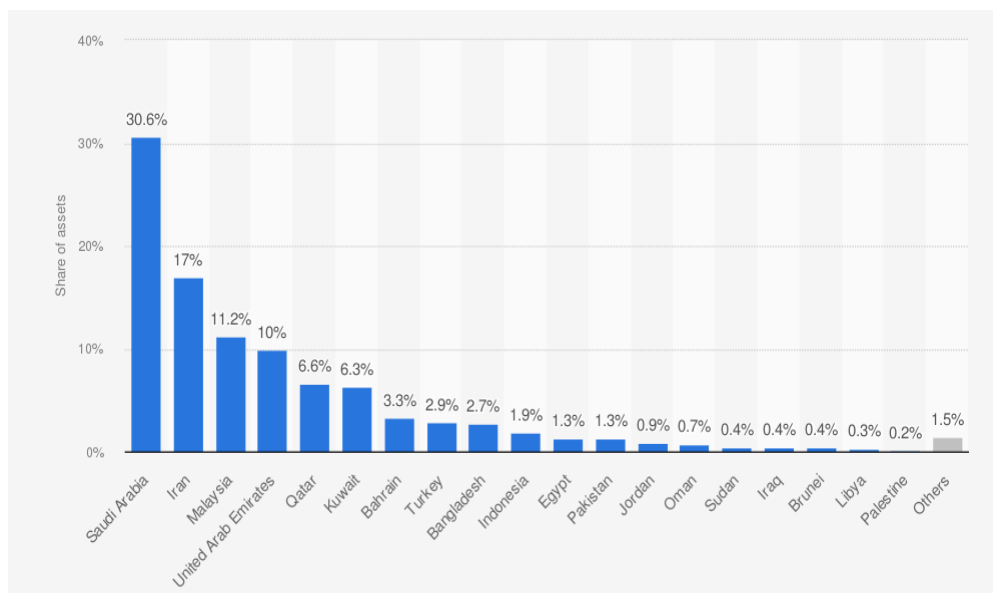


Figure 3. The Distribution of Assets of Islamic Banks Worldwide in 2021, by Country (in Billion Dollars)

Source: ICD Statista, 2023.

Islamic banking is a vital component of the global Islamic finance industry, offering Sharia-compliant financial services and products to clients worldwide. Figure 3 above shows that Saudi Arabia and Iran accounted for 47.6 percent of Islamic bank assets in 2021, as stated. Iran follows Saudi Arabia as the largest Islamic banking sector in terms of assets. This indicates that these two nations dominate the global Islamic banking market.

The high concentration of assets held by Saudi Arabia and Iran can be attributed to several factors, including their large and developing populations, a favorable regulatory environment, and a high demand for Sharia-compliant financial products and services in these countries. Moreover, these nations have made substantial investments in their Islamic finance industries, such as the establishment of Islamic banks and financial institutions and the creation of

Sharia-compliant financial products and services.

Malaysia, on the other hand, accounted for approximately 11.2% of Islamic bank assets in 2021. Malaysia is a major participant in the global Islamic finance industry, with a well-established regulatory framework and a history of innovation and development in Shariah-compliant financial products and services. Malaysia has also made substantial investments in the development of its Islamic banking sector, with a concentration on expanding the availability of Sharia-compliant financial products and services throughout the region. In 2021, no other country possessed more than 10 percent of the total assets held by Islamic banks. This demonstrates the highly concentrated nature of the global Islamic banking market, with a small number of countries accounting for the vast majority of Islamic institutions' assets.

In 2020, Islamic bank assets totaled \$1,844 trillion dollars. This highlights the significant growth and significance of the Islamic banking industry in the global financial landscape, as well as the increasing demand for Sharia-compliant financial products and services around the globe.

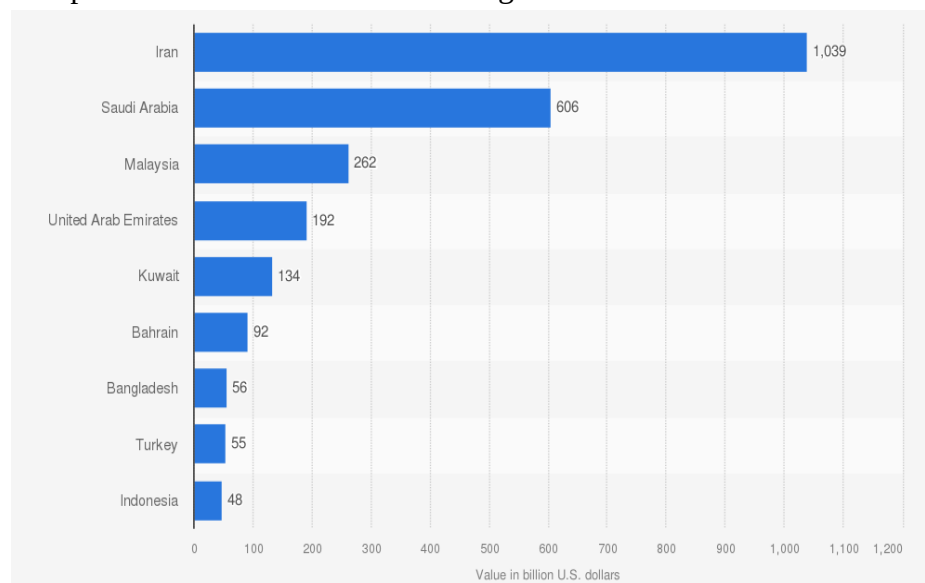


Figure 4. Leading Countries in Islamic Banking Assets Worldwide in 2021, by Value (in Billion U.S. Dollars)

Source: ICD Statista, 2023.

Iran has one of the world's largest Islamic banking systems, with a well-developed network of Sharia-compliant Islamic banks and financial institutions. Figure 4 shows in 2021, Islamic banking assets in Iran totaled 1,039 billion U.S. dollars. It represents the total asset value of Islamic banks and financial

institutions in the country.

Increasing demand for Sharia-compliant financial products and services, a favorable regulatory environment, and a strong emphasis on Islamic finance education and training have all contributed to significant growth in the Islamic banking industry in Iran over the past several years. In 2021, the total global value of Islamic banking assets was \$2.76 trillion. It represents the global total value of assets held by Islamic banks and financial institutions. In recent years, the global Islamic banking industry has experienced significant growth due to factors such as an increasing demand for Sharia-compliant financial products and services, a favorable regulatory environment, and increased awareness and education regarding Islamic finance.

Multiple factors have contributed to the expansion of the global Islamic banking industry, including the rising demand for ethical and socially responsible investment opportunities, particularly in Muslim-majority nations, as well as favorable demographics and rising prosperity. In addition, many governments around the globe are actively promoting the growth of Islamic finance as part of broader efforts to promote economic growth and financial inclusion.

The Islamic banking industry is anticipated to continue to develop and expand due to a number of factors, including favorable demographics, rising prosperity, and rising demand for Sharia-compliant financial products and services. This presents substantial opportunities for Islamic banking institutions and investors seeking to capitalize on the increasing demand for ethical and socially responsible investment opportunities.

Table 2 shows Descriptive Statistics. The default mean and deviation in the Descriptive statistical table for the first bound variable is Gross Domestic Product (GDP) of 2.54 and 2.114, respectively. The second dependent variable, Unemployment, has a mean is 1.488, and the standard deviation is 1.210. The third dependent variable, Inflation, is 9,331 and 3,431 respectively. This low deviation mark for all dependent variables indicates that the value of the data set is close to the mean. It is more likely to be distributed normally. The same applies to independent variables except for the Bank age variable which has a relatively high standard deviation indicating that the data is distributed over a wider range.

Table 2. Descriptive Statistics

	Mean	Median	SD	Min	Max	Obs
Return on Assets	1.385	1.100	3.431	-2.759	5.055	953
Return on Equity	7.314	5.310	1.206	-1.276	8.975	953
Tobin's q	0.246	0.081	0.767	0.000	1.034.	953
Asset Quality	0.001	0.005	0.022	1.290	0.241	953
Total Deposits	7.796	8.306	2.382	-0.002	1.215.	953
Total Asset	8.467	8.630	1.778	3.177	1.257	953
Bank Size	8.696	7.204	7.362	-0.002	1.215	953
Bank age	5.056	2.613	3.526	0.634	2.790	953
GDP	2.547	4.609	2.114	-4.863	3.590	953
Unemployment	1.488	1.729	1.210	-2.407	3.680	953
Inflation	9.331	1.100	3.431	-2.759	5.055	953

Source: Research finding.

The Correlation Matrix (Table 3) displays the Pearson correlation coefficients between explanatory variables. All correlation coefficients are less than 0.90, suggesting that collinearity between variables is not a concern, as suggested by (Gujarati and Porter, 2009). Thus, all independent variables are included in the model (Gujarati and Porter, 2009).

Table 3. The Correlation Matrix

	Variable	1	2	3	4	5	6	7	8	9	10	11
1	Return on Assets	1										
2	Return on Equity	0.009	1									
3	Tobin's q	-0.014	-0.060	1								
4	Asset Quality	0.024	-0.086	0.068	1							
5	Total Deposits	-0.033	0.028	-0.108	-0.199	1						
6	Total Asset	-0.053	0.033	-0.112	-0.224	0.711	1					
7	Bank Size	0.120	0.028	-0.108	-0.199	0.800	0.811	1				
8	Bank age	-0.033	0.057	0.032	-0.287	0.373	0.358	0.35	1			
9	GDP	-0.002	-0.039	-0.012	-0.010	0.014	0.013	0.13	0.373	1		
10	Unemployment	-0.027	-0.003	-0.057	0.033	-0.051	-0.091	-0.04	0.014	0.047	1	
11	Inflation	0.071	-0.060	0.068	-0.199	0.711	0.611	0.12	-0.051	-0.017	0.089	1

Source: Research finding.

Table 4. The Influence of Macroeconomic Variables on Islamic Banks

Variable	Model 1	Model 2	Model 3
	GDP	Unemployment	Inflation
Return on Assets	-8.250 (0.000) *	0.006 (0.295)	-0.230 (0.247)
Return on Equity	1.670 (0.006)	0.005 (0.709)	-0.076 (0.176)
Tobin's q	2.840 (0.003) *	0.061 (0.816) *	-0.232 (0.794) *
Asset Quality	4.900 (0.130)	14.841 (0.097)	7270 (0.809)
Total Deposits	0.015 (0.033) *	0.342 (0.621)	0.031 (0.024) *
Total Asset	66210 (0.758)	-9910 (0.095)	4.580 (0.818)
Bank Size	2423 (0.042) **	0.055 (0.032) *	0.013 (0.452)
Bank age	0.034 (0.040) *	0.150 (0.672)	0.523 (0.852)
Constant	2.620 (0.000)	7.124 (0.000)	6.943 (0.000)
R Square	0.431	0.201	0.319
F Stat (<i>p-value</i>)	15.874	5.147	3.891
Obs	953	953	953

Source: Research finding.

Note: ***, **, and * indicates significance at the 1%, 5% and 10% levels, respectively.

In this section, we examine the relationship of Islamic banks to GDP, Unemployment, and inflation. Table 4 shows the results of Ordinary Least Square (OLS) estimates, we find that Return on Assets, Tobin's q, Total Deposits, Bank Size, and Bank age affect GDP. This is in line with (Kantharia and Biradar, 2023; Khatri Chettri, 2022; X. Li and Wye, 2023; Mahmood et al., 2019; Prenaj et al., 2023; Tiwari et al., 2023).

Return on Assets (ROA) is a financial metric utilized to assess the profitability of an Islamic bank, as it pertains to the capacity of the institution or company to generate income from its owned assets (Aslam and Haron, 2020; Buallay, 2019; Musleh Alsartawi, 2019; Tabash, 2019; Ur Rehman et al., 2022). A strong correlation exists between the Return on Assets (ROA) of Islamic banks and economic growth, as measured by the Gross Domestic Product (GDP). The ROA of Islamic institutions is generally enhanced by robust economic expansion,

as evidenced by skyrocketing GDP growth rates. This is as a result of increased business expansion and investment opportunities created by stable economic conditions. On the contrary, periods of economic contraction or recession are characterized by a decrease in business activity and investment prospects, both of which can exert adverse effects on the return on assets (ROA) of Islamic banks. Banks' credit risk and asset integrity are additionally impacted by the state of the economy. Credit risk is typically diminished in a stable economy due to the increased capacity of businesses and individuals to fulfil their financial commitments. However, credit risk may increase during economic downturns as a greater number of borrower's struggle to repay their loans. Understanding and monitoring macroeconomic indicators, such as the expansion of the gross domestic product, is thus essential for gaining a deeper understanding of the financial stability and performance of Islamic institutions.

Tobin's q , a notion in economics that was initially proposed by James Tobin, examines the correlation between the market value of a company and the expense associated with physically replacing its assets (Alaali, 2020; Dao and Nguyen, 2020). A value of one or greater for Tobin's q signifies that the market assigns a greater worth to the assets of the company in comparison to their tangible replacement cost. On the contrary, when Tobin's q is below one, the asset is valued by the market at a level below its tangible replacement cost. The relationship between Tobin's q and GDP is economically significant. A higher value of Tobin's q signifies an increased valuation of the company's market share, which in turn encourages the company to allocate resources towards new ventures. Consequently, this investment may have an effect on economic expansion, as measured by GDP. Furthermore, a low q value for Tobin may serve as an indicator that businesses are capable of enhancing their productivity and efficiency, thereby generating added value and influencing microeconomic growth that contributes to macroeconomic expansion or GDP. Therefore, by utilizing Tobin's q , one can gain not only an understanding of the value of a company, but also the impact that its investment decisions may have on the GDP-measured economic growth.

The total funds held by consumers and account holders in Islamic banks, which comprise total deposits, exert a substantial influence on economic growth, as evidenced by the Gross Domestic Product (GDP) (Afzal et al., 2021; Batrancea et al., 2022; Yoon, 2021). A significant quantity of deposits signifies the presence of substantial funds within the financial system. If invested in or utilized for consumption, these funds possess the capacity to stimulate aggregate

economic activity. In addition to serving as financial intermediaries, Islamic banks receive deposits from clients in order to finance loans for borrowers. Large deposits enable banks to facilitate a greater number of loans and investments, thereby fostering robust economic expansion. The robustness of the financial system and the availability of adequate liquidity are further evidenced by the substantial Total Deposits, which instill confidence in economic participants. This practice aids in mitigating risk and bolsters confidence when engaging in economic transactions. Furthermore, the level of Total Deposits may be influenced by the interest rate setting and other monetary policies implemented by monetary authorities. This policy influences individuals' inclination to save or invest in banking institutions, thereby contributing to the regulation of the funds accessible for the purpose of bolstering economic expansion. Therefore, insofar as changes in a nation's GDP are concerned, Total Deposits in Islamic Banks are instrumental in influencing macroeconomic conditions, fostering economic activity, and supplying the funds required to support robust economic expansion (Akhter, 2023; Ali et al., 2019; Barik and Raje, 2019; Khatri Chettri, 2022; Mahmood et al., 2019; Olubukola et al., 2021).

The magnitude or scope of Islamic bank activities, commonly denoted as "Bank Size," significantly impacts the economic expansion of a nation, as measured by GDP (Gross Domestic Product). Large banks offer a broader selection of financial products and services due to their increased capacity to finance business entities and consumers. Additionally, they are capable of diversifying their portfolios and managing risk more efficiently due to their ample resources (Al-Harbi, 2019; Goswami et al., 2019; Gupta and Mahakud, 2020; Phan et al., 2019). This enables them to preserve financial sector stability, which positively affects the overall stability of the economy. Furthermore, major financial institutions possess the ability to exert substantial sway over the economy. They may provide assistance to enterprises, infrastructure, and other substantial undertakings that possess the capacity to stimulate economic expansion and generate employment. Moreover, by facilitating more complex financial transactions and granting access to a variety of financial instruments, significant banks contribute to the depth of the financial markets. Large banks cannot only serve as a crucial pillar in mitigating risks during challenging economic conditions, but they can also significantly contribute to the preservation of overall economic stability. Bank Size in Islamic Banks: As a result of its contribution to providing funds, mitigating risks, and supporting

diversified economic activities, bank size has a significant impact on the economic development of a nation, which is ultimately reflected in GDP growth.

There exists a strong correlation between the duration of a bank's operations, referred to as its "bank age," and economic expansion, as measured by the Gross Domestic Product (GDP). Prolonged operation of a bank typically results in the establishment of a robust and reliable reputation within the financial markets (Antony, 2023; Biru, 2021; Gupta and Mahakud, 2020). This credibility is transformed into capital of value, enabling financial institutions to engage in larger-scale transactions and attract additional deposits. Furthermore, banks with a lengthy history possess a robust network and a significant presence within the economy. They may exert significant influence over the allocation of resources and the movement of capital across various sectors of the economy. Additionally, the presence of well-established banks is indicative of their past policies and experiences, which have equipped them to surmount intricate economic obstacles. Additionally, long-established banks can offer additional stability during challenging economic conditions or crises, thereby contributing to the preservation of economic stability as a whole. Therefore, the age of a bank not only influences its credibility and competitiveness, but it can also significantly contribute to the stability and development of the economy of a nation, as evidenced by its GDP growth.

Furthermore, Table 4 above also shows that Tobin's q and bank size affect Unemployment. This is in line with (Aqel, 2022; Đaković et al., 2023; Jadah et al., 2020; Li and Strahan, 2021; Mahmood et al., 2019; Naili and Lahrichi, 2022; Wang et al., 2022).

The unemployment rate has a significant correlation with Tobin's q , which assesses the relationship between the market value of an asset or company and its physical replacement costs. An elevated value of Tobin's q , signifying that the market assigns a higher worth to a company or asset than its tangible replacement costs, could potentially motivate the organization to broaden its operational scope. Adding new personnel is a common byproduct of this procedure, which can ultimately help to reduce the unemployment rate (Coleman and Wu, 2020; Dimand, 2018; Warburton and Booser, 2015). Moreover, Tobin's high q motivates organizations to allocate resources towards the development of more effective production technologies and processes, thereby potentially enhancing labor productivity. This may increase the competitiveness of businesses and decrease production expenses, thereby impacting the unemployment rate in a positive way. Important roles are also played by monetary and fiscal policies, in

addition to market factors. The impact of monetary policy on interest rates on Tobin's q can subsequently have repercussions on investment rates and, by extension, unemployment rates. The relationship between Tobin's q and the unemployment rate is therefore intricate, as economic, policy, and corporate innovation factors all influence the interplay between the two.

The magnitude of a bank significantly impacts the rate of unemployment within an economy. Prominent financial institutions possess extensive access to a wealth of financial resources and the capacity to extend substantial financing. They can provide assistance to economic initiatives that necessitate substantial capital outlays, generate employment opportunities, or sustain reduced levels of unemployment. Furthermore, diversified credit portfolios enable major banks to extend loans across numerous economic sectors. This implies that banks maintain investments in sectors that may be experiencing growth, thereby mitigating the adverse effects of a struggling sector on the unemployment rate. Additionally, large banks wield more sway when it comes to managing economic fluctuations and recessions. Their capacity to furnish supplementary funding or aid organizations experiencing challenging financial circumstances can aid in alleviating the repercussions on the workforce. Additionally, large banks are frequently regarded as more dependable and stable, which provides businesses with the benefit of obtaining credit facilities. Lastly, certain sizable banks might implement initiatives and programmes designed to reduce unemployment, such as workforce skill-building education or training. Therefore, the magnitude of the financial institution significantly impacts the unemployment rate via an array of mechanisms, including its financial prowess, impact on business cycles, and involvement in social initiatives. Prominent financial institutions exert considerable influence over labor management and employment conditions within the economy.

Furthermore, Table 4 above also shows that Tobin's q and Total Deposits affect Inflation. This is in line with (Akhter, 2023; Ali et al., 2019; Fitri et al., 2020; Khatri Chettri, 2022; Tura, 2022). When Tobin's q is elevated, signifying that the market assigns a greater value to a company or asset than its tangible replacement cost, the organization is probable to be incentivized to allocate resources towards the growth or improvement of its activities. Nevertheless, when considering high inflation, the expenses associated with physically replacing assets can escalate significantly, thereby altering the investment landscape. Businesses might exhibit a greater propensity to allocate resources towards novel endeavors as opposed to substituting or enlarging current assets.

Furthermore, elevated levels of inflation may have an impact on the valuation of corporate assets and stock pricing. An increase in productivity or an increase in the face value of assets may not invariably coincide with a corresponding rise in inflation. This may introduce inaccuracies into the market value of the company, thereby influencing Tobin's evaluation q . Moreover, inflation can influence investment decisions; resource allocation policies may be impacted by the economic uncertainty that is generated by high inflation rates. When this occurs, an investment level determined by Tobin's high q may not consistently correspond to the asset's physical replacement rate. As a result, Tobin's q and inflation are interrelated via a variety of mechanisms that can impact the manner in which corporations assess the worth of assets and determine investment strategies, particularly when elevated inflation emerges as a critical determinant in economic decision-making.

Total Deposits, denoting the sum of money deposited by clientele in banking and other financial institutions, exert a substantial impact on the inflation rate of an economy. The quantity of deposits constitutes a significant component of the money supply of a nation. A significant rise in Total Deposits signifies the presence of substantial funds within the financial system (Abduh et al., 2011; Akhter, 2023; Ali et al., 2019; Ben Moussa, 2015; Fitri et al., 2020; Khatri Chettri, 2022; Tura, 2022; Türsoy and Faisal, 2018). Customers who have made sufficient deposits are more likely to engage in spending and investing activities, thereby potentially stimulating demand for products and services. If this surge in demand is not counterbalanced by commensurate expansions in production and economic output, it may lead to elevated prices and the possibility of inflation. Furthermore, total deposits have the potential to impact monetary policy. Monetary authorities' adjustments to interest rates have the potential to impact individuals' saving and investment choices, thereby influencing the quantity of deposits accessible within the financial system. Moreover, banks' capacity to extend credit and lending is impacted by the substantial volume of deposits. Increased liquidity enables financial institutions to extend more credit to consumers, thereby stimulating economic activity and contributing to inflation. An inflationary pressure may ensue when total deposits expand in tandem with robust economic expansion and lax monetary policy, due to the concomitant surge in economic activity and demand. On the contrary, a reduction in deposits observed during recessionary periods has a tendency to mitigate inflationary forces. Hence, the inflation rate of a nation is significantly influenced by Total

Deposits via intricate interplays among consumer demand, monetary policy, money supply, and banking operations.

6. Conclusion

The study's findings indicate that variables such as Return on Assets (ROA), Tobin's q , Total Deposits, Bank Size, and Bank age exert a substantial impact on GDP. The Return on Assets (ROA) of Islamic banks is a direct indicator of economic growth, demonstrating that the financial success of these banks significantly influences the general stability and expansion of the economy. Tobin's q is a significant factor in investment and business decision-making, and it has consequences for economic growth as shown in GDP. The magnitude of deposits in Islamic banks exerts a substantial influence on the expansion of the economy, so influencing the availability of money, the level of consumer demand, and the formulation of monetary policy. The size and age of a bank are significant factors in influencing economic growth. greater banks have the capacity to offer lending on a greater magnitude, while older banks own established reputations and enjoy trust within financial markets.

These data suggest that the performance of Islamic banks has a substantial influence on economic development, financial stability, and monetary policy. The Return on Assets (ROA) of Islamic banks is a crucial indicator of their ability to earn profits from their assets, which directly impacts a country's economic progress. By taking into account variables such as Tobin's q , Total Deposits, Bank Size, and Bank age, economic and monetary policies can be formulated and fine-tuned to optimize the potential for economic growth. Furthermore, the study offers a more profound comprehension of the interconnectedness between macroeconomic indicators, such as inflation, unemployment, and GDP, and the performance of Islamic banks. This can aid economic and financial authorities in making better knowledgeable decisions about monetary policy, banking regulation, and economic development strategies. The findings of this study have important implications for both policy makers and professionals in the financial industry, especially those working in the Islamic banking sector. These insights can be utilized to enhance operational and risk management techniques, as well as uncover investment opportunities that can potentially contribute to economic growth.

A suggestion for future research is to expand the analysis to encompass additional economic variables that could potentially impact the success of Islamic banks, such as interest rates, political stability, and global influences. Moreover,

taking into account these variables within the framework of several financial markets or encompassing multiple countries can yield more complete insights. Moreover, future investigations could delve into the interplay among these parameters and examine how the intricate dynamics among these variables impact the long-term success of Islamic banks.

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Investigating the Impacts of Changeable Policies with Climate Change on Iran's Agricultural Sector

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Abstract

In recent decades, climate change has been one of the most discussed and debated topics, and given its significant impact on the agricultural sector, the primary concern of policymakers in different countries is how to address this phenomenon in the agricultural sector within the context of emission reduction and adaptation. Accordingly, the current study investigated the effects of changeable policies on climate change in Iran's agricultural sector by enhancing technology and energy consumption efficiency, which is one of the emission reduction policies. To this end, Iran's economy is divided into agricultural and non-agricultural sectors, and based on the relationships between these two sectors and the dynamic stochastic general equilibrium (DSGE) approach within the New-Keynesian framework, two scenarios of technology improvement and energy efficiency improvement in the agricultural sector are developed. The results revealed that as a result of technological advancements and increased energy consumption efficiency in the agricultural sector, the price index has decreased, while production, real labor wages, investment, and capital stock have increased. Therefore, it is recommended that planners and policymakers take measures such as increasing the financial power of agricultural producers, bolstering the insurance of agricultural products and the prosperity of the insurance market, and creating favorable conditions for attracting labor with technical knowledge and high-level skills to develop the agricultural sector's technology infrastructure. In addition, since energy is relatively inexpensive in Iran compared to other countries, this vital input in the production process is frequently underutilized.

Keywords: Agricultural Sector, Climate Change, Dynamic Stochastic General Equilibrium (DSGE) Model, Energy Efficiency Improvement, Technology Improvement.

JEL Classification: B22, E71, Q43, Q54.

1. Introduction

Climate change issues that affect both humans and the environment have become the main concern of international organizations and the people of the world during

the past decades (Wang et al., 2023; Farajzadeh et al., 2022). Many natural disasters that have occurred as a result of severe climate changes, un scenic fluctuations in temperature and rainfall have caused collective awareness and commitment to climate change management (Ojo and Baiyegunhi, 2021). Accordingly, in the 21st Paris Agreement, it is emphasized to keep the global temperature below 1.5 degrees Celsius. Also, the use of renewable energy and financial aid from developed countries to developing countries has been suggested to accelerate the achievement of this goal (Nugroho et al., 2023).

Agriculture is one of the most important sectors of any region, and more than 60% of the world's population is directly dependent on it, and it is the main source of livelihood and the backbone of the economic systems of most countries (Mateo-Sagasta, 2018). This sector is severely affected by climate change in the areas of production, investment, and consumption (Farajzadeh et al., 2022; Wu et al., 2023; Oduor et al., 2023; Demem, 2023; Nugroho et al., 2023). Due to being located in an arid and semi-arid climate, Iran has received the most negative effects of climate change in economic sectors, especially agriculture (Bahadoran et al., 2020; Asfew and Bedemo, 2022). The air temperature in Iran has increased by an average of 1.5 degrees since 1950. The average rainfall in the country has decreased by 45 mm in the last 50 years. Information from meteorological stations and satellite data shows that the level and depth of snow cover have decreased greatly in winter and the mountains of Iran. This decrease in the level and depth of snow is a sign of the decrease in the amount of water received by the rivers in the hot season of the year. Accordingly, Climate variability and change need appropriate adaptation measures and minimization of the effects at national and farm levels through designing policies that prevent the destruction of the natural environment (Ochieng et al., 2016). Adaptations to climate variability and change must be undertaken within the multifaceted context and address climate change, complementing overall governance for sustainable use. Adaptation responses are also tailored to the specific environmental, socio-economic, and cultural conditions of a particular area community, or nation, since climate change impacts vary between geographic areas (Demem, 2023). In other words, the main goal of this study is to investigate the impact of improving agricultural technology and energy consumption efficiency in the presence of climate change in the form of a DSGE model. The current study is separated from other previous studies due to the consideration of climate change in the New-Keynesian model. The rest of the paper is organized as follows. Theoretical literature, empirical studies, materials, and methods related to

the article have been examined. The findings, conclusion, and recommendations are the final parts of this study.

2. Theoretical Literature

In order to reduce and regulate the emission of environmental pollutants, a number of economists have attempted to value climate management tools and market-based environmental policies to minimize the economic costs of achieving greenhouse gas emission reduction goals (Tiba and Omri, 2017). All of these climate management tools and market-based environmental policies can be divided into three categories: price-based tools, quantity-based tools, and intensity-based tools. These tools are exemplified by environmental tax policies (Rausch and Schwarz, 2016), greenhouse gas emission trading schemes¹(Liu and Fan, 2018), and emission permit policies (Jiang et al., 2016).

Weitzman (1974) utilized a partial equilibrium model to compare quantitative environmental policy and price-based environmental policy. Since then, numerous studies have analyzed the performance and effects of alternative environmental policies on controlling greenhouse gas emissions using various alternative methods (Quirion, 2005), such as the system dynamics model (Liu et al., 2015; Xiao et al., 2016), computable general equilibrium model (Cui et al., 2014; Xiao et al., 2015; Fan et al., 2017), input-output model (Dong et al., 2018) and dynamic stochastic general equilibrium model (Xu et al., 2016), all of which are primarily concerned with the macro effects of environmental policies.

Due to their theoretical foundation, DSGE models play an essential role in the simulation and analysis of policies within the branch of general equilibrium models. The structural DSGE model based on microeconomic principles can simulate the response of dynamic behavior and fluctuations to stochastic shocks in short-run and long-run equilibrium, which represents a transition from reduced-form modeling to structural modeling based on microeconomic principles (Benavides et al., 2015). Some researchers have therefore focused on the dynamic effects of the environment and macroeconomics and incorporated environmental policies into the DSGE model.

In summary, DSGE models that include pollution and environmental policies can be categorized into two categories: models that consider the real business cycle (RBC) with flexible prices and models that consider a New-Keynesian framework with price rigidity, such as Angelopoulos et al. (2010), Fischer and Springborn

¹. Trading emissions is a cost-effective method for reducing greenhouse gas emissions. In order to encourage businesses to reduce emissions, the government establishes a cap on emissions and issues permits for each unit of emissions permitted below the cap.

(2011), and Heutel (2012) who regarded pollutant emissions as a byproduct of production; whereas in Fischer and Springborn's (2011) study, pollutant emissions are emitted by energy consumption. Fischer and Heutel (2013) reviewed the literature on environmental economics in depth. They concentrated on the application of two macroeconomic instruments, real business cycle models and endogenous technological growth models, to environmental economics. Since then, some researchers have begun to integrate environmental policies into DSGE models. Fried et al. (2013) examined a conventional DSGE model based on microeconomics and environmental feedback. The study's findings confirmed the correlation between carbon dioxide emissions and economic expansion.

Following the contributions of previous literature, we try to combine macroeconomics and environmental economics by embedding the environmental block into a New Keynesian DSGE model. Different from Annicchiarico and Di Dio (2015), we embedded energy consumption and energy efficiency into our model, and we used them to analyze the three different environmental policy regimes. In addition, along with the development of the economy, the uncertain factors from the economy and environment have gradually increased, which will affect the environmental policy effects. Hence, more uncertainties need to be taken into consideration when evaluating and selecting environmental policies.

3. Empirical Studies

Lintunen and Vilmi (2013) analyzed the periodicity of environmental policies using a DSGE model and determined that the optimal emission tax policy is periodic. In a study, Ponce et al. (2014) developed a multi-market agricultural model to analyze the effects of climate change in developing countries in light of climate change uncertainty. The obtained results demonstrated that the economic effects of climate change vary based on the type of activity. Tokunaga et al. (2015) used a dynamic panel data model to examine the effects of climate change on the production of agricultural products in Japan. Analysis of static and dynamic panel data models revealed that a one-degree Celsius increase in the average annual temperature reduces rice production by 5.8% in the short term and 3.9% in the long term. Using the DSGE model, Elshnnawy et al. (2016) investigated the impacts of climate change on Egypt's economic growth. According to the findings of their study, the phenomenon of climate change has a negative impact on economic development and the growth of the agricultural sector in this country. Huong et al. (2018) investigated the effects of climate change on the agricultural sector in the northwest region of Vietnam for the years 2050 and 2100 using the Ricardian

method. According to the results, in 2050 and 2100, the net income will decrease by 17.7% and 21.28% due to climate change, respectively. Using the DSGE method, Xiao et al. (2018) analyzed China's macroeconomic fluctuations under distinct environmental policies. According to their results, the response of macroeconomic variables to various shock conditions indicates the effectiveness of environmental policies' "automatic stabilizer." Additionally, a positive energy efficiency shock results in an increase in energy inputs. Moreover, a policy regarding the intensity of greenhouse gas emissions will have a greater impact on the economy than environmental levies and greenhouse gas emissions. Etwire et al. (2019) used a Ricardian model to examine the impacts of climate change on farmers' income in Ghana's agricultural sector. The results indicated that severe climate change will reduce the average net income per hectare of maize, which accounts for more than half of Ghana's current food production.

Asad Falsafizadeh and Sabouhi Sabouni (2012) examined the effects of climate change on agricultural production in the city of Shiraz. According to their results, in contrast to the short-term decrease in agricultural income and profit in the same scenario, from the estimated values of 54% and 30% to 74% and 85%, respectively, the long-term decrease in agricultural income and profit under mild climate change in the dry year was estimated to be 4.5% and 6.4%, respectively. Khaleghi et al. (2015) investigated the effects of climate change on agricultural production and the Iranian economy. Their results indicated that the agricultural sector's output will decrease by 37.5% between 2000 and 2050 as a consequence of the predicted climate change in Iran. Using the dynamic stochastic general equilibrium model, Permeh et al. (2016) investigated the influence of economic shocks on the macro variables of the agricultural sector. In order to accomplish this, the coefficients of the model were estimated using the Bayesian method and data from 1971 to 2012. With these explanations, the results of the mentioned shocks on the agricultural sector indicate that, among the numerous investigated shocks, the productivity shock (technology) will have the most positive effect on the agricultural sector. Because it increases production, export, consumption, and investment in the agricultural sector, while simultaneously decreasing agricultural inflation and imports. Using the DSGE model, Khosravi et al. (2017) analyzed domestic utility shocks and the performance of Iran's agricultural sector. The results demonstrated that the positive shock of preferences increases consumption, production, prices, and employment, while decreasing investment, export, and the agricultural sector's real wage rate. Other investigated variables have decreased following the occurrence of a positive shock in the demand for money, except the

price index for agricultural products, other investigated variables have decreased. The positive shock of labor supply increases employment in the agricultural sector, although production, investment, and exports decrease in the first period. Moreover, as a result of the increase in labor supply, the level of consumption and prices has increased while the real wage has declined. Using the DSGE model, Khosravi et al. (2017) simulated the impact of macroeconomic shocks on Iran's agricultural sector. According to the results, a positive productivity shock increases agricultural production, consumption of domestically produced products, capital stock, employment, and real wages while decreasing final costs and price indices. Except for the real wage, a positive monetary shock increases all other variables. In addition, production, employment, real wages, and price indices have declined as a result of the positive impact of oil revenues. As a result, government expenditure reduces real wages and capital stock. Ghaffari Esmaeili et al. (2019) examined the impact of climate change on the agricultural sector's economic development in Iran. The results indicated that the agricultural sector's production, consumption, investment, and export will decrease by 4.469%, 5.025%, 4.462%, and 13.770%, respectively, if the decrease in precipitation over the next twenty years until 2030 is accounted for. However, imports in this sector will increase by 5.504%. Environmental issues (climate change) and macroeconomic issues are going to be investigated concurrently within the framework of DSGE models, which distinguishes this study from those previously reviewed. In other words, in previous research, either environmental and climate change issues were investigated using econometric and Ricardian methods, or macroeconomic issues were investigated within the framework of DSGE models. In addition, the purpose of this study is to examine changeability policies (improvement of technology and improvement of energy consumption efficiency) in Iran's agricultural sector in the framework of macroeconomics using the DSGE method. In some studies, the effects of climate change on agricultural products using the DSSAT simulation model and meteorological data from MarkSim have been predicted and analyzed under different climate change scenarios during different periods. The results indicated that the yield of agricultural products will decrease under climate change scenarios. (Sayahi et al., 2023; Nouri et al., 2016).

Other studies, such as Barnard et al. (2023), Furtak and Wolińska (2023), and Odour et al. (2023), have measured the effects of climate change on the environment. Some other studies, such as Tokunaga et al. (2015), Al-Shanawi et al. (2016), Huang et al. (2018), Etoir et al. (2019), have measured the effects of climate change on the economic and agricultural sectors with use of Ricardian,

econometrics methods. Also, other studies, such as Permeh et al. (2016), Khosravi et al. (2017), measured the effects of different shocks on the agricultural sector using the DSGE method. The innovation of the present research is that, contrary to the mentioned studies, the effects of climate change on both the agricultural and non-agricultural sectors have been investigated using the DSGE method, which has not been studied in this field so far.

4. Methods and Material

Greenhouse gases (NO_x, SO₂, SO₃, CO, SPM, CO₂, CH₄, and N₂O) are the leading cause of climate change, with 97% of greenhouse gas emissions attributable to CO₂. The quantity of CO₂ emissions in the industrial and agricultural sectors has been on the rise, with industrial emissions increasing from 89 million tons in 2011 to 114 million tons in 2019, a growth of 27.91%. The agricultural sector's CO₂ emissions were 12,376,837 tons in 2011 and 13,869,836 tons in 2019, representing an increase of 12.063%. In addition, per capita CO₂ emissions increased by 3.05% from 7224.5 kg in 2011 to 7445.14 kg in 2019 (Ministry of Energy, 2019).

The relationship between carbon intensity¹ and energy intensity² is one indicator of the quantity of greenhouse gases utilized in the production process of various economic sectors. Energy intensity is defined as energy consumption per unit of GDP, and carbon intensity is defined as carbon emissions per unit of GDP. The agricultural sector's carbon intensity increased from 40.52 units in 2011 to 48.91 units in 2019. Similarly, the energy intensity increased from 84.58 units to 107.09 units over the same time period, indicating that both carbon intensity and energy intensity increased during the period under study. In other terms, the utilization of carbon and energy in Iran's GDP has increased (Ministry of Energy, 2019). If these values are compared to the added value of agriculture, we will see that the growth of agriculture's added value during this time period has been driven by the increased use of energy and emissions. This sector's inability to use appropriate methods to reduce the use of energy and carbon in its production process contributes to climate change conditions in this and other economic sectors. In this sector, it is crucial to give close attention to adaptable climate-

¹. It refers to how many grams of carbon dioxide (CO₂) are released to produce a kilowatt hour (kWh) of electricity. Electricity that's generated using fossil fuels is more carbon intensive, as the process by which it's generated creates CO₂ emissions.

². Energy intensity is a measure of the energy inefficiency of an economy. It is calculated as units of energy per unit of GDP or some other measure of economic output. High energy intensities indicate a high price or cost of converting energy into GDP.

related policies. In other words, the primary objective of this study is to determine the effectiveness of adaptable climate change policies in Iran's agricultural and other macroeconomic sectors. To this end, the Iranian economy was divided into agricultural and non-agricultural sectors, and the DSGE model was employed to analyze the related policies.

DSGE models are derived from the fundamentals of microeconomics and constrained decision-making. In these models, the general equilibrium and prices in the economy are determined so that all agents dynamically maximize their objectives under budget or resource constraints. These characteristics have made DSGE models an accepted method for analyzing economic shocks among economists. To this end, DSGE models have been utilized to investigate the impact of climate change on the agricultural sector of Iran. Iran's economy is divided into agricultural and non-agricultural sectors for this reason. In addition, this article illustrates the structure of the DSGE model with four economic agents: the representative household, producers of intermediate goods, producers of final goods, and the government.

4.1 Representative Household

Household is the owner of the workforce (L_t), capital stock (K_t), and energy (M_t) allocated by firms for the production of intermediate products. Labor force, capital stock, and energy are homogeneous goods; yet the economic agent does not differentiate between their various types.

The representative household has an infinite lifespan and maximizes its life function through Equation 1:

$$U = E_t \sum_{t=0}^{\infty} \beta^t \left\{ \ln C_t - \frac{L_t^{1+\theta}}{1+\theta} - \frac{[(1 - er_t)\mu M_t]^{1+\nu}}{1+\nu} \right\} \quad (1)$$

In addition, it is presumed that the supply of household labor (L_t) and energy (M_t) is distributed according to a Cobb-Douglas function.

$$L_t = l_{na,t}^{\alpha_1} l_{ag,t}^{\alpha_2}$$

$$M_t = M_{na,t}^{\gamma_1} M_{ag,t}^{\gamma_2}$$

where $l_{na,t}$ and $l_{ag,t}$ represent the agricultural and non-agricultural labor forces, respectively. Additionally, α_1 and α_2 represent the labor share of each component of the total labor supply, such that $\alpha_1 + \alpha_2 = 1$. In addition, $M_{na,t}$ and $M_{ag,t}$ represent the energy consumed by the non-agricultural and agricultural sectors, respectively, and $\gamma_1 + \gamma_2 = 1$.

In addition, Equation 1 is simplified as follows (Khosravi et al., 2017; Xiao et al., 2018):

$$Z_t = [(1 - er_t)\mu M_t] \quad (2)$$

The budget limit is expressed as Equation 3:

$$\begin{aligned} P_t C_t + P_t I_{na,t} + P_t I_{ag,t} + B_{t+1} \\ = (1 - \tau_{na,t}^L) W_{na,t} L_{na,t} + (1 - \tau_{ag,t}^L) W_{ag,t} L_{ag,t} \\ + (1 - \tau_{na,t}^K) R_{na,t} K_{na,t} + (1 - \tau_{ag,t}^K) R_{ag,t} K_{ag,t} \\ + (1 - \tau_{ag,t}^M) P_{ag,t}^M M_{ag,t} + (1 - \tau_{na,t}^M) P_{na,t}^M M_{na,t} + (1 + R_t^B) B_t \\ + D_t P_t + Tr_t \end{aligned} \quad (3)$$

Households own firms. Profit (D_t) is distributed as a dividend to the representative household for each intermediate product produced by the firm. The representative household also receives all payments for labor (W_t), capital stock (R_t), energy in the agricultural sector ($P_{ag,t}^M$), and energy in the non-agricultural sector ($P_{na,t}^M$) supplied for intermediate products as a single transfer from the government. Whereas the government imposes various tax rates on the income factor. The household spends its income on consumption (C_t), investment (I_t), and the acquisition of assets, such as government bonds (B_t).

The investment adjustment cost is a key feature of modern DSGE models (Christiano et al., 2007; Smets and Wouters, 2005). Equations 4 and 5 represent the law of capital movement, where δ_1 and δ_2 are the capital depreciation rates in the non-agricultural and agricultural sectors, respectively.

$$K_{na,t+1} = (1 - \delta_1) K_{na,t} + i_{na,t} \quad (4)$$

$$K_{ag,t+1} = (1 - \delta_2) K_{ag,t} + i_{ag,t} \quad (5)$$

4.1.1 Allocation of Consumption

The CES production function divides the total consumption of $C_{tag,t}$ into the consumption of agricultural goods ($C_{tna,t}$) and non-agricultural goods ($C_{tna,t}$):

$$\begin{aligned} C_t = [\alpha_c^{\frac{1}{\omega_c}} (c_{tna,t})^{(\omega_c-1)/\omega_c} \\ + (1 - \alpha_c)^{1/\omega_c} (c_{tag,t})^{(\omega_c-1)/\omega_c}]^{\frac{\omega_c}{\omega_c-1}} \end{aligned} \quad (6)$$

So that α_c is the proportion of non-agricultural goods in total household consumption, and ω_c is the elasticity of substitution between agricultural and non-agricultural goods. To select the optimal combination of consumer goods, the household minimizes the purchase price of the consumer bundle, which consists of agricultural and non-agricultural products. Considering $P_{tag,t}$ and $P_{tna,t}$ as price

indices for agricultural and non-agricultural products, the minimization problem for households is as follows:

$$\begin{aligned} & \min(c_{tag,t}P_{tag,t} + c_{tna,t}P_{tna,t}) \\ & \text{subject to} \\ & C_t = [\alpha_c^{\frac{1}{\omega_c}}(c_{tna,t})^{(\omega_c-1)/\omega_c} + (1 - \alpha_c)^{1/\omega_c}(c_{tag,t})^{(\omega_c-1)/\omega_c}]^{\frac{\omega_c}{\omega_c-1}} \end{aligned} \quad (7)$$

From the solution of the above problem's first-order conditions, household demand functions for agricultural and non-agricultural products can be obtained.

$$c_{tna,t} = \alpha_c \left(\frac{P_{tna,t}}{P_t} \right)^{-\omega_c} C_t \quad (8)$$

$$c_{tag,t} = (1 - \alpha_c) \left(\frac{P_{tag,t}}{P_t} \right)^{-\omega_c} C_t \quad (9)$$

As can be seen, the relative demand for consumer products $C_{tag,t}$ and $C_{tna,t}$ by domestic households depends on their relative prices. In addition, the greater the price elasticity of demand ω_c , the closer the products are to one another and the weaker the market power of the producing firms. By inserting Equations 8 and 9 into Equation 7, P_t of consumer price index (CPI) is obtained, which is a combination of its components (price indices of agricultural and non-agricultural products) (Khosravi et al., 2017):

$$P_t = [\alpha_c (P_{tna,t})^{1-\omega_c} + (1 - \alpha_c) (P_{tag,t})^{1-\omega_c}]^{\frac{1}{1-\omega_c}} \quad (10)$$

4.2 Production in the Non-Agricultural Sector

4.2.1 Producer of the Final Product

In addition to firms that produce intermediate goods, there are companies that purchase differentiated goods from companies that produce intermediate goods and integrate them to create final goods to sell to the final purchasers. Intermediate goods, having fixed elasticity of substitution, are differentiated and imperfect substitutes for each other. According to the constant returns to scale technology proposed by Stiglitz and Dixit (1977), the representative producer of the final good, utilizes $Y_{na,t}(j)$ units of each intermediate good from the interval $[0,1]$ to produce the final good Y_{na} , where $\varphi > 1$ is the elasticity of substitution between various intermediate products:

$$y_{na,t} = \left(\int_0^1 (y_{na,t}(i))^{\frac{\varphi-1}{\varphi}} di \right)^{\frac{\varphi}{\varphi-1}} \quad (11)$$

In order to maximize its profit, the company producing the final goods purchases a portion of the intermediate goods based on their prices. The problem of maximizing profits for a firm producing final goods can be stated as follows:

$$\begin{aligned} \max P_{na} y_{na} - \int_{i=0}^1 P_{na,t}(i) y_{na,t}(i) di \\ \text{Subject to} \end{aligned} \quad (12)$$

$$y_{na,t} = \left(\int_0^1 (y_{na,t}(i))^{\frac{\varphi-1}{\varphi}} di \right)^{\frac{\varphi}{\varphi-1}}$$

By solving the first-order conditions, the above equation will be subject to the demand for each intermediary company's differentiated product as follows:

$$y_{na,t}(i) = \left(\frac{P_{na,t}(i)}{P_{na,t}} \right)^{-\varphi} y_{na,t} \quad (13)$$

Integrating the above equations results in obtaining the price index for non-agricultural goods:

$$P_{na,t} = \left(\int_0^1 (P_{na,t}(i))^{1-\varphi} di \right)^{-\frac{1}{1-\varphi}} \quad (14)$$

4.2.2 Producer of Intermediate Goods

Among the chains of production companies ($i \in [0,1]$), each company producing intermediate goods using the Cobb-Douglas function under monopolistic competition conditions produces goods:

$$y_{na,t}(i) = A_{na,t} \left(K_{na,t}(i) \right)^{\alpha_{na}} \left(l_{na,t}(i) \right)^{\beta_{na}} \left(M_{na,t}(i) \right)^{\kappa_{na}} \quad (15)$$

where α_{na} is the share of capital, β_{na} is the share of labor force, and κ_{na} is the share of energy in production, so that $\alpha_{na} + \beta_{na} + \kappa_{na} = 1$.

Where A_t is the total productivity factor, which is exogenous in the following way:

$$\ln A_t - \ln A = \rho_A \ln A_{t-1} - \rho_A \ln A + \varepsilon_{t,A} \quad \varepsilon_{t,A} \sim i.i.d. N(0, \sigma_A^2) \quad (16)$$

The intermediary company maximizes its profit by selecting the optimal quantity of input use and its optimal price. During each period, only $\varphi_{na} - 1$ percent of companies can optimize the final price of their product. So that the remaining companies (φ_{na} percent) only revise their prices based on the historical inflation rate (Calvo, 1983). Therefore, for those businesses unable to optimize their price in the new period, the following equation determines the price:

$$P_{na,t} = \pi P_{na,t-1} \quad (17)$$

The problem of maximizing the profits of non-agricultural intermediary enterprises is as follows:

$$\max E. \sum_{s=.}^{\infty} \left[\frac{(\beta \varphi_{na})^s \lambda_{t+s} D_{na,t+s}(i)}{P_{t+s}} \right]$$

Subject to:

$$y_{na,t}(i) = A_{na,t} \left(K_{na,t}(i) \right)^{\alpha_{na}} \left(l_{na,t}(i) \right)^{\beta_{na}} \left(M_{na,t}(i) \right)^{\kappa_{na}} \quad (18)$$

$$y_{na,t}(i) = \left(\frac{P_{na,t}(i)}{P_{na,t}} \right)^{-\varphi} y_{na,t}$$

So that the company's profit function of $D_{na,t+s}(i)$ is:

$$D_{na,t+s}(i) = \pi^s \tilde{P}_{na,t}(i) Y_{na,t+s}(i) - R_{na,t+s} k_{na,t+s}(i) - W_{na,t+s} l_{na,t+s}(i) - P_{na,t+s}^M M_{na,t+s}(i) \quad (19)$$

where $\beta^s \lambda_{t+s}$ is the producer's time discount factor and λ_{t+s} is the final utility of consumption in period $t+s$. The first order conditions of the maximization problem regarding production inputs are:

$$r_{na,t} = \alpha_{na} \frac{Y_{na,t}(i)}{K_{na,t}(i)} mc_{na,t} \quad (20)$$

$$w_{na,t} = \beta_{na} \frac{Y_{na,t}(i)}{l_{na,t}(i)} mc_{na,t} \quad (21)$$

$$p_{na}^M = \kappa_{na} \frac{Y_{na,t}(i)}{M_{na,t}(i)} mc_{na,t} \quad (22)$$

Where $rr_{na,t} = \frac{R_{na,t}}{P_t}$, $w_{na,t} = \frac{W_{na,t}}{P_t}$, $p_{na,t} = \frac{P_{na,t}}{P_t}$ and $mc_{na,t} = \frac{MC_{na,t}}{P_t}$, respectively, are the real return rate of capital, the real wage, the real price of energy, and the final cost of production in the non-agricultural sector. The real final cost can be obtained by inserting Equations 20 to 22 into Equation 16:

$$mc_{na,t} = \left(\frac{1}{\beta_{na}} \right)^{\beta_{na}} \left(\frac{1}{\alpha_{na}} \right)^{\alpha_{na}} \left(\frac{1}{\kappa_{na}} \right)^{\kappa_{na}} (w_{na,t})^{\beta_{na}} (r_{na,t})^{\alpha_{na}} (p_{na}^M)^{\kappa_{na}} \quad (23)$$

The first order condition for the above optimal price obtaining problem is:

$$\begin{aligned} \frac{\delta \pi_t}{\delta \tilde{P}_{na,t}(i)} = 0 \Rightarrow E. \sum_{s=0}^{\infty} (\beta \varphi_{na})^s \lambda_{t+s} \left[\pi^s \left(\frac{\pi^s \tilde{P}_{na,t}(i)}{P_{na,t+s}} \right)^{\theta} Y_{na,t+s} \right. \\ \left. - \theta \left(\frac{\pi^s \tilde{P}_{na,t}(i)}{P_{na,t+s}} \right)^{-\theta-1} \frac{\pi^s Y_{na,t+s}}{P_{na,t+s}} \pi^s \tilde{P}_{na,t}(i) \right. \\ \left. + \theta \left(\frac{\pi^s \tilde{P}_{na,t}(i)}{P_{na,t+s}} \right)^{-\theta-1} \frac{\pi^s Y_{na,t+s}}{P_{na,t+s}} MC_{na,t+s} \right] = 0 \end{aligned} \quad (24)$$

$$\begin{aligned} \frac{\delta \pi_t}{\delta \tilde{P}_{na,t}(i)} = 0 \Rightarrow E. \sum_{s=0}^{\infty} (\beta \varphi_{na})^s \lambda_{t+s} Y_{na,t+s} \\ + s p_{na,t+s}^{\theta} \prod_{k=1}^s \pi^{-s\theta} \pi_{t+k}^{\theta} [(1 \\ - \theta) \tilde{P}_{na,t}(i) \prod_{k=1}^s \pi^{-s} \pi_{t+s}^{-1} + \theta mc_{na,t+s} \end{aligned} \quad (25)$$

In conclusion, the optimal price of the intermediary firm can be calculated as follows:

$$\begin{aligned} \tilde{P}_{na,t}(i) \\ = \left(\frac{\theta}{\theta - 1} \right) \frac{E. \sum_{s=0}^{\infty} (\beta \varphi_{na})^s \lambda_{t+s} Y_{na,t+s} + s p_{na,t+s}^{\theta} mc_{na,t+s} \prod_{k=1}^s \pi^{-s\theta} \pi_{t+k}^{\theta}}{E. \sum_{s=0}^{\infty} (\beta \varphi_{na})^s \lambda_{t+s} Y_{na,t+s} + s p_{na,t+s}^{\theta} \prod_{k=1}^s \pi^{s(1-\theta)} \pi_{t+k}^{\theta-1}} \end{aligned} \quad (26)$$

So that $p_{na,t+s} = \frac{P_{na,t+s}}{P_{t+s}}$, $\tilde{p}_{na,t}(i) = \frac{\tilde{P}_{na,t}(i)}{P_t}$, and $\pi_{t+s} = \frac{P_{t+s}}{P_t}$ are the relative price of non-agricultural goods, the real optimal price in the non-agricultural sector, and the inflation index, respectively.

Finally, the price index for non-agricultural products, which is a composite of the prices of companies that can optimize their prices and those that cannot, is:

$$(p_{na,t})^{1-\theta} = \varphi_{na} \left(\pi \frac{p_{na,t-1}}{\pi_t} \right)^{1-\theta} + (1 - \varphi_{na}) (\tilde{P}_{na,t})^{1-\theta} \quad (27)$$

4.3 Production in the Agricultural Sector

4.3.1 Producer of the Final Product

In the agricultural sector, there are chains of businesses that produce intermediate goods, each of which is a producer of $Y_{ag,t}(i)$ per unit of goods. In addition to

intermediary companies, some companies purchase differentiated goods from companies that produce intermediate goods and then combine them to create final goods that are sold to final purchasers. Intermediate goods, having fixed elasticity of substitution, are differentiated and imperfect substitutes for each other. The constant returns to scale technology suggested by Stiglitz and Dixit (1977), the representative producer of the final good utilizes $Y_{ag,t}(i)$ units of each intermediate good in the interval $[0,1]$ to create the final good of Y_{ag} , where $\varphi > 1$ is the elasticity of substitution between various intermediate products:

$$y_{ag,t} = \left(\int_0^1 (y_{ag,t}(i))^{\frac{\varphi-1}{\varphi}} di \right)^{\frac{\varphi}{\varphi-1}} \quad (28)$$

To maximize its profit, the company producing the final goods purchases a portion of the intermediate goods based on their prices. The problem of maximizing profits for a firm producing final commodities can be stated as follows:

$$\begin{aligned} \max P_{ag} y_{ag} - \int_{i=0}^1 P_{ag,t}(i) y_{ag,t}(i) di \\ \text{Subject to} \\ y_{ag,t} = \left(\int_0^1 (y_{ag,t}(i))^{\frac{\varphi-1}{\varphi}} di \right)^{\frac{\varphi}{\varphi-1}} \end{aligned} \quad (29)$$

By solving the first-order conditions of the aforementioned equation, the demand function for the differentiated product manufactured by each of the intermediary firms will be as follows:

$$y_{ag,t}(i) = \left(\frac{P_{ag,t}(i)}{P_{ag,t}} \right)^{-\varphi} y_{ag,t} \quad (30)$$

Combining the above equations enables the calculation of the agricultural commodities price index:

$$P_{ag,t} = \left(\int_0^1 (P_{ag,t}(i))^{1-\varphi} di \right)^{\frac{1}{1-\varphi}} \quad (31)$$

4.3.2 Producer of Intermediate Goods

On the product market, producers of intermediate goods are monopolistic, and the prices are constant. The representative firm utilizes labor ($L_{ag,t}(j)$), capital stock ($K_{ag,t}(j)$), and energy ($M_{ag,t}(j)$) to produce ($Y_{ag,t}(j)$) by using Cobb-Douglas production function as follows:

$$y_{ag,t}(j) = A_{ag,t} \left(K_{ag,t}(j) \right)^{\alpha_{ag}} \left(\eta_{ag,t}^L L_{ag,t}(j) \right)^{\beta_{ag}} \left(\eta_{ag,t}^M M_{ag,t}(j) \right)^{\kappa_{ag}} \quad (32)$$

where A_t represents the total productivity factor that, if exogenous, is defined as follows:

$$\begin{aligned} \ln A_{ag,t} - \ln A &= \rho_A \ln A_{ag,t-1} - \rho_A \ln A + \varepsilon_{t,A} \quad \varepsilon_{t,A} \\ &\sim i.i.d. N(0, \sigma_A^2) \end{aligned} \quad (33)$$

In Equation (32), efficiency variables are added to labor and energy. It is also assumed that energy efficiency can be enhanced by increasing energy consumption. It is assumed that there is a correlation between energy input efficacy and energy consumption during the production process. q_t is a variable that improves energy consumption efficiency and follows the AR (1) process.

$$\eta_{ag,t}^M = q_{ag,t} M_{ag,t}^{(o-1)} \quad (34)$$

$$\ln q_{ag,t} - \ln q = \rho_q \ln q_{ag,t} - \rho_q \ln q + \varepsilon_{t,q} \quad \varepsilon_{t,q} \sim i.i.d(0, \sigma_q^2) \quad (35)$$

The consumption of energy results in the emission of $Z_{ag,t}(j)$ pollutants. The emission coefficient is signed by μ . It is presumed that a representative firm can calculate its contribution to pollution reduction in $er_{ag,t}(j)$ as follows:

$$Z_{ag,t}(j) = (1 - er_{ag,t}(j)) \mu M_{ag,t}(j) \quad (36)$$

The final (shadow) mitigated expense of $MCE_{ag,t}(j)$ is a function of the proportion of pollution reduction:

$$MCE_{ag,t}(j) = \Lambda \ln(1 - er_{ag,t}(j)) \quad (37)$$

The total emission reduction cost of $CE_{ag,t}(j)$ can be calculated using the integral of $MCE_{ag,t}(j)$ in the interval between 0 and $RE_{ag,t}(j)$, where the emission reduction is equal to $RE_{ag,t}(j) = \mu \cdot er_{ag,t}(j)$.

$$\begin{aligned} CE_{ag,t}(j) &= \int_0^{RE_{ag,t}(j)} \Lambda \ln\left(1 - \frac{RE_{ag,t}(j)}{\mu M_{ag,t}(j)}\right) dRE_{ag,t}(j) = \\ &= -\Lambda \mu M_{ag,t}(j) \cdot [\ln(1 - er_{ag,t}(j)) (1 - er_{ag,t}(j)) + er_{ag,t}(j)] \end{aligned} \quad (38)$$

It is anticipated that the emission of pollutants will reduce the productivity of the workforce. Equation 40 depicts the law of movement of pollution accumulation, and δ_z is the rate of depletion of pollutant reserves:

$$\eta_{ag,t}^L = 1 - (\eta_0 + \eta_1 ST_{ag,t} + \eta_2 ST_{ag,t}^2) \quad (39)$$

$$ST_{ag,t} = (1 - \delta_z) ST_{ag,t-1} + Z_t \quad (40)$$

Now, the problem for the production of intermediate commodities by the representative firm J can be expressed as follows, where P_t^z is the cost of purchasing one emission permit from the government:

$$\begin{aligned}
\max \Pi &= \frac{P_{ag,t}(j)}{P_t} Y_{ag,t}(j) - \frac{W_{ag,t}}{P_{ag,t}} L_{ag,t}(j) - \frac{R_{ag,t}}{P_t} K_{ag,t}(j) - \\
&\frac{P_{ag,t}^M}{P_t} M_t(j) - \frac{P_{ag,t}^Z}{P_{ag,t}} \left(1 - er_{ag,t}(j) \right) \mu M_{ag,t} - CE_{ag,t}(j) \\
\text{s.t.} \quad &y_{ag,t}(j) = \\
&A_{ag,t} \left(K_{ag,t}(j) \right)^{\alpha_{ag}} \left(\eta_{ag,t}^L l_{ag,t}(j) \right)^{\beta_{ag}} \left(\eta_{ag,t}^M M_{ag,t}(j) \right)^{\kappa_{ag}}
\end{aligned} \tag{41}$$

By applying the aforementioned functions to the solution of the first-order conditions, we have:

$$\begin{aligned}
-\frac{W_t}{P_t} &= \psi_t \beta A_t K_t^\alpha(j) (\eta_t^L)^\beta L_t(j)^{\beta-1} [\eta_t^M M_t(j)]^\kappa \\
-\frac{R_t}{P_t} &= \psi_t \alpha A_t K_t^{\alpha-1}(j) (\eta_t^L L_t(j))^\beta [\eta_t^M M_t(j)]^\kappa \\
-\frac{P_t^Z}{P_t} \mu (1 - er_t(j)) - \frac{P_t^M}{P_t} &= \psi_t (1 - \alpha \\
&\quad - \beta) A_t K_t^\alpha(j) [\eta_t^L L_t(j)]^\beta \frac{(\eta_t^M M_t(j))^{(1-\alpha-\beta)}}{M_t(j)} \\
\frac{P_t^Z}{P_t} &= \lambda \ln(1 - er_t(j))
\end{aligned} \tag{42}$$

Based on the approach of Calvo (1983), we presume that intermediary firms can only alter their nominal prices in response to a random signal. The probability that a company will alter its price during any given time interval is equal to $\omega - 1$. Firms with the ability to alter their prices at t choose their prices so as to maximize their future total discounted real profit.

$$\begin{aligned}
max R_{P_t(j)} &= E_t \sum_{i=0}^{\infty} (\beta \omega)^t \frac{U(C_{t+1})}{U(C_t)} Y_{t+1} \left[\frac{P_t(j)}{P_{t+1}} \left(\frac{P_{t+1}}{P_t(j)} \right)^\varphi \right. \\
&\quad \left. - MC_{t+1} \left(\frac{P_{t+1}}{P_t(j)} \right)^\varphi \right]
\end{aligned} \tag{43}$$

By applying the aforementioned functions to the solution of the first-order conditions, we have:

$$\begin{aligned}
(\varphi - 1)X_{1,t} &= \varphi X_{2,t} \\
X_{1,t} &= \dot{U}(C_t) Y_t (p_t^*)^{\varphi-1} + \beta \omega E_t [X_{1,t+1} (p_t^*)^{1-\varphi} (p_{t+1}^*)^{\varphi-1} \pi_{t+1}^{\varphi-1}] \\
X_{2,t} &= \dot{U}(C_t) Y_t MC_t (p_t^*)^{-\varphi} + \beta \omega E_t [X_{2,t+1} (p_t^*)^{-\varphi} (p_{t+1}^*)^{-\varphi} \pi_{t+1}^\varphi]
\end{aligned} \tag{44}$$

$$1 = (1 - \omega)(p_t^*)^{1-\varphi} + \omega\pi_t^{\varphi-1}$$

4.4 Producer of the Final Product

Produced under conditions of perfect competition, the final commodity in the economy is a combination of agricultural and non-agricultural goods combined using CES technology,

$$V_t = [\gamma_{na}^{\frac{1}{v}} \gamma_{na,t}^{\frac{v-1}{v}} + \gamma_{ag}^{\frac{1}{v}} \gamma_{ag,t}^{\frac{v-1}{v}}]^{\frac{v}{v-1}} \quad (45)$$

where v is the elasticity of substitution between agricultural and non-agricultural domestically produced products. γ_{na} and γ_{ag} are the proportions of non-agricultural and agricultural goods, respectively, so that $\gamma_{na} + \gamma_{ag} = 1$.

The final producer optimizes their profit by determining the quantity of each product to produce. Equation 46 maximizes the final product's manufacturer's profit:

$$\begin{aligned} & \max P_t V_t - P_{ag,t} \gamma_{ag,t} - P_{na,t} \gamma_{na,t} \\ & \text{subject to} \\ & V_t = [\gamma_{na}^{\frac{1}{v}} \gamma_{na,t}^{\frac{v-1}{v}} + \gamma_{ag}^{\frac{1}{v}} \gamma_{ag,t}^{\frac{v-1}{v}}]^{\frac{v}{v-1}} \end{aligned} \quad (46)$$

Solving the aforementioned problem results in the obtaining of the pertinent demand functions and price index:

$$\gamma_{na,t} = \gamma_{na} \left(\frac{P_{na,t}}{P_t} \right)^{-\vartheta} V_t \quad (47)$$

$$\gamma_{ag,t} = \gamma_{ag} \left(\frac{P_{ag,t}}{P_t} \right)^{-\vartheta} V_t \quad (48)$$

$$P_t = [\gamma_{na} (P_{na,t})^{1-\vartheta} + \gamma_{ag} (P_{ag,t})^{1-\vartheta}]^{\frac{1}{1-\vartheta}}$$

4.5 The Government

Periodically, the government passively modifies aggregate transfers to balance the budget. Assume that there is no net supply of bonds. Accordingly, the government's spending limit is calculated as follows (Xiao et al., 2018):

$$\begin{aligned} & P_{ag,t} G_{ag,t} + P_{na,t} G_{na,t} + (1 + R_t^B) B_t + Tr_t \\ & = \tau_t^L W_L L_t + \tau_t^K R_t K_t + \tau_t^M P_t^M M_t + P_t^Z Z_t + B_{t+1} \end{aligned} \quad (50)$$

4.6 Market Settlement

On the market for final commodities, equilibrium in the economy is described as follows:

$$C_t = C_{ag,t} + C_{na,t} \quad (51)$$

$$i_t = i_{ag,t} + i_{na,t} \quad (52)$$

$$G_t = G_{na} + G_{ag} \quad (53)$$

$$y_t = \frac{P_{na,t}}{P_t} y_{na,t} + \frac{P_{ag,t}}{P_t} y_{ag,t} \quad (54)$$

$$y_t = C_t + i_t + G_t + CE_{ag} \quad (55)$$

Based on the above equations, all production of agricultural and non-agricultural final goods is allocated to the consumption of households, the government, and investment in the production sector to ensure a balanced market for final goods. In addition, the time series of Iran's economic data published by the Statistics Center of Iran, the Central Bank of the Islamic Republic of Iran, and the energy balance sheet from 1991 to 2019 were used to calculate the model's parameters.

5. Results

The current study's model consists of 49 equations and 49 unknown variables, which were logarithmically linearized using Ehlig's method and solved using the Dynar software in the Matlab environment. After logarithmically linearizing the equations, the parameters are calculated depending on the researcher's objective, their perspective, the computational features of the model using the calibration or estimation method (such as Bayesian estimation), or both. If the objective of the research is to elucidate economic realities or to obtain the dynamic properties of the model, quantification can be used in place of econometric estimation (Kydland and Prescott, 1982). Quantification is a prevalent technique used in dynamic stochastic general equilibrium-based research. In this method, numerical values for the parameters of the desired economic world are determined, and its use has increased over the past few decades due to its success.

According to Hoover (1995), a model is validated when its coefficients are selected from other empirical studies or econometric studies (even unrelated ones) or by the researcher in general in such a way that the model can reproduce certain characteristics of the actual world. The valuation method, according to Canova (1994), is an econometric technique in which the coefficients are estimated using econometric criteria rather than statistical criteria. Therefore, in this investigation, two calibration and quantification methods were used to estimate the required parameters (Table 1).

Table 1. Values of Model Parameters

No.	Parameter	Value	Description	Source
1	α_1	0.84	Share of non-agricultural workforce	Research finding
2	α_2	0.16	Share of agricultural workforce	Pop (2017)
3	θ	1.97	Elasticity of labor supply	Research finding
4	γ_1	0.96	Share of energy consumption in the non-agricultural sector	Research finding
5	γ_2	0.04	Share of energy consumption in the agricultural sector	Research finding
6	ν	0.42	Elasticity of substitution of energy and workforce	Kemfert (1998)
7	β	0.99	Rate of consumer's time preferences	Xiao et al. (2018)
8	δ_1	4.60	Cost of agricultural sector's capital stock adjustment	Khosravi (2017)
9	δ_2	4.21	Cost of non-agricultural sector's capital stock adjustment	Khosravi (2017)
10	ω_c	3	Elasticity of substitution between agricultural and non-agricultural goods	Khosravi (2017)
11	α_c	0.68	Non-agricultural products' share of total household consumption	Khosravi (2017)
12	α_{na}	0.483	Share of investment in the non-agricultural production	Khosravi (2017)
13	β_{na}	0.5021	Share of workforce in the non-agricultural production	Khosravi (2017)
14	κ_{na}	0.0149	Share of energy in the non-agricultural production	Research finding
15	φ_{na}	0.367	Share of non-agricultural businesses unable to alter prices	Khosravi (2017)
16	σ	2.136	Elasticity of energy consumption in efficiency	Yang et al. (2014)
17	α_{ag}	0.33	Share of investment in the agricultural production	Nalban (2018)
18	β_{ag}	0.58	Share of workforce in the agricultural production	Fischer and Springborn (2011), Pop (2017)
19	μ	0.6	Pollution diffusion coefficient	Xu et al. (2016)
20	δ_z	0.005	Rate of polluting reserves depreciation	Xiao et al. (2018)
21	φ	6	Intermediate good price elasticity	Xu et al. (2016)
22	ω	0.75	Nominal rigidity	Nalban (2018)

No.	Parameter	Value	Description	Source
23	ν	3.2	Elasticity of substitution between agricultural and non-agricultural goods	Khosravi (2017)
24	γ_{na}	0.823	Share of non-agricultural goods in production	Research findings
25	γ_{ag}	0.176	Share of agricultural goods in production	Research finding

After devising, specifying, and estimating the DSGE model for Iran's economy, it is essential to ensure the model's ability and efficiency in generating and simulating data, as well as to assess its predictive capability. One of the common experimental evaluation techniques for DSGE models is to compare the secondary moments of the actual data (logarithmized and detrended via the HP filter) to the results derived from the estimated data (simulated data) of the model. The proximity and similarity between actual and simulated moments demonstrate the model's precision and efficacy. The results in Table 2 indicate that the model is well-fitted and has performed reasonably well in simulating the actual economic data of Iran. Therefore, the model can simulate the relevant fluctuations.

Table 2. A Comparison of Moments of the Model's Actual and Simulated Values

Variable	Standard deviation		First-order autoregression	
	Real	Simulated	Real	Simulated
Consumption	1.921	1.916	0.935	0.930
Production in the agricultural sector	2.362	2.358	0.945	0.940
Production in the non-agricultural sector	1.260	1.247	0.871	0.861
Price index	2.245	2.240	0.880	0.872
Wages in the agricultural sector	3.260	3.258	0.895	0.890
Wages in the non-agricultural sector	1.258	1.257	0.862	0.860
Energy costs in the agricultural sector	2.457	2.450	0.869	0.867
Energy costs in the non-agricultural sector	2.550	2.545	0.958	0.951
Investment in the agricultural sector	1.360	1.355	0.962	0.960
Investment in the non-agricultural sector	2.251	2.249	0.972	0.970
Agricultural sector's capital stock	3.657	3.651	0.960	0.952
Non-agricultural sector's capital stock	2.260	2.258	0.953	0.950

Source: Research finding.

5.1 An Analysis of Response Functions

In the current study, impulse response functions are utilized to explain the behavior of variables when an economy is in a steady state and a sudden positive shock occurs. The response of a variable to a shock is expressed as a proportion of the variable's logarithmic deviation from its stable values a percentage. Therefore, the percentage values depicted on the vertical axis of the impulse response diagrams represent the changes of the variable in question. To combat the effects of climate change, after ensuring the model's viability, two policies involving the development of technology and energy consumption efficiency in the agricultural sector were studied.

5.2 The Effects of Technology Improvement Shock

Figure 1 depicts the impulse response functions of technological advancement in the agricultural sector, which is a one standard deviation shock to the technological factor in this sector. According to the results of the research modeling, technological advancement in the agricultural sector has an effect on the production costs in this sector, which in turn influences the wages of labor, the real rate of return on capital, and the production and prices in the agricultural sector. The results of impulse response functions indicate that, as a consequence of technological progress, the average production per unit of production factor has increased, enabling firms to produce more with the same amount of production inputs. In addition, technological advancements reduce the final cost of production by increasing output per unit of input, conserving production resources, and reducing agricultural sector risk. After the aforementioned shock, it is not remarkable that the prices of domestically produced agricultural products decreased. Because, on the one hand, the company's final cost of production has decreased, and its pricing is a function of its final cost of production. On the other hand, technological progress will cause the product's supply curve to migrate to the right, so that even with an increase in demand (less than the shift in the supply curve), an excess supply will be created, resulting in a decline in agricultural sector prices. Due to the rigidity of the prices, the quantity of (total) price level reduction has gradually decreased, and after 10 periods, it has attained a stable trend. Employment has increased as a consequence of technological advancements in the agricultural sector. Companies are motivated to hire more workers with technical expertise and advanced skills to reduce production costs, improve the quality of goods, increase the profitability of production, and increase their ability to compete with other firms that produce the same goods. In conclusion, the increase in labor

demand in the agricultural sector has led to a rise in real wage. In other words, the results of this study are consistent with the principles of the New-Keynesian framework with price rigidity. Also, the findings of this study are similar to the results of Fischer and Springborn, 2011; Fischer and Heutel, 2013; Fried et al., 2013; Elshnnawy et al., 2016; Huong et al., 2018; Etwire et al., 2019. The price of energy fluctuates in both the agricultural and non-agricultural sectors, but the introduction of technology has led to a greater decrease in the agricultural sector. As a result of the technological shock in the agricultural sector, investment in this sector (K2) has increased relative to the non-agricultural sector (K1). Similar to the study of Permeh et al., 2016; Khosravi et al., 2017, this increase in investment is attributable to the presence of technology in this sector, which has increased performance and production, thereby making it more profitable than other economic sectors; consequently, the agricultural sector has experienced an influx of capital. The capital stock variable in the agricultural and non-agricultural sectors (L2, L1) follows the same trend as investment.

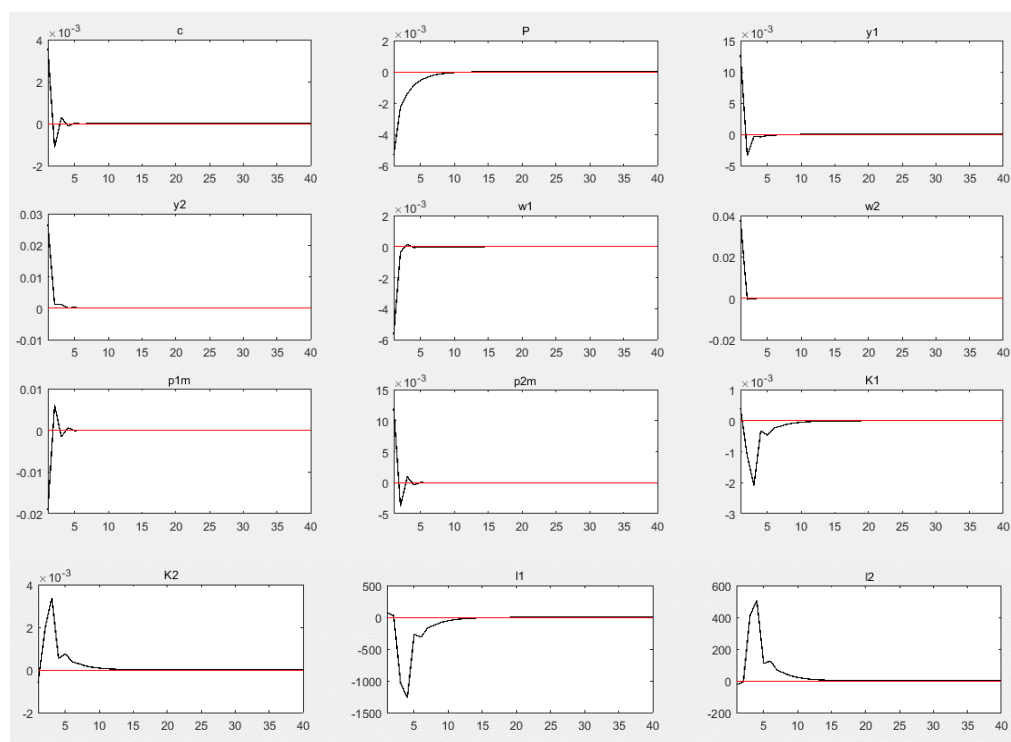


Figure 1. Impulse Response Functions of Technology Improvement

Source: Research finding.

5.3 The Effects of Energy Consumption Efficiency Shock

Figure 2 depicts the impulse response functions of energy efficiency improvement in the agricultural sector, which corresponds to a shock of one standard deviation to the sector's energy efficiency factor. The trend of the amount of consumption (c) fluctuates, and after 8 periods, the amount of consumption remains constant. The variable representing the price index (P) has decreased. In other words, by increasing the efficacy of energy consumption in the agricultural sector, the cost of products in this sector will decrease, resulting in a decline in the general price level (P). The quantity of agricultural products produced (y2) has increased. While the trend for non-agricultural products (y1) is fluctuating. In other words, the improvement in energy consumption in the agricultural sector has led to an increase in production in this sector, and the link between agricultural and non-agricultural production (industry and services) has led to changes in production in the non-agricultural sector. The theoretical foundations of the New-Keynesian framework with price rigidity and the results of studies by Khaleghi et al., 2015; Permeh et al., 2016; Xiao et al., 2018; Khosravi et al., 2017 confirm this subject. As a result of the improvement in energy consumption efficiency and the high proportion of energy costs in the production of agricultural products, the final cost of production in this sector has decreased significantly, and producers are less willing to hire labor with higher wages to maintain or increase production profit. Consequently, agricultural sector wages (w2) have decreased. This shifts the labor force from the agricultural sector to the non-agricultural sector. Since the non-agricultural sector's energy efficiency has not improved, more workforce is required in the production process, resulting in an increase in wages in the non-agricultural sector (w1). The price of energy fluctuates in both the agricultural and non-agricultural sectors, but it has decreased more in the agricultural sector than in the non-agricultural sector due to increased energy efficiency. The results of the study of Khosravi et al., 2017 confirm this subject. the next variable to be examined in this section is investment (K). Investments in the agricultural sector (K2) have increased relative to the non-agricultural sector (K1) as a result of the agricultural sector's enhanced energy efficiency. Similarly, to investment, the capital stock variable in the agricultural and non-agricultural sectors (L2, L1) exhibits a similar trend. The results of studies by Permeh et al., 2016; Khosravi et al., 2017; Xiao et al., 2018 confirm this subject.

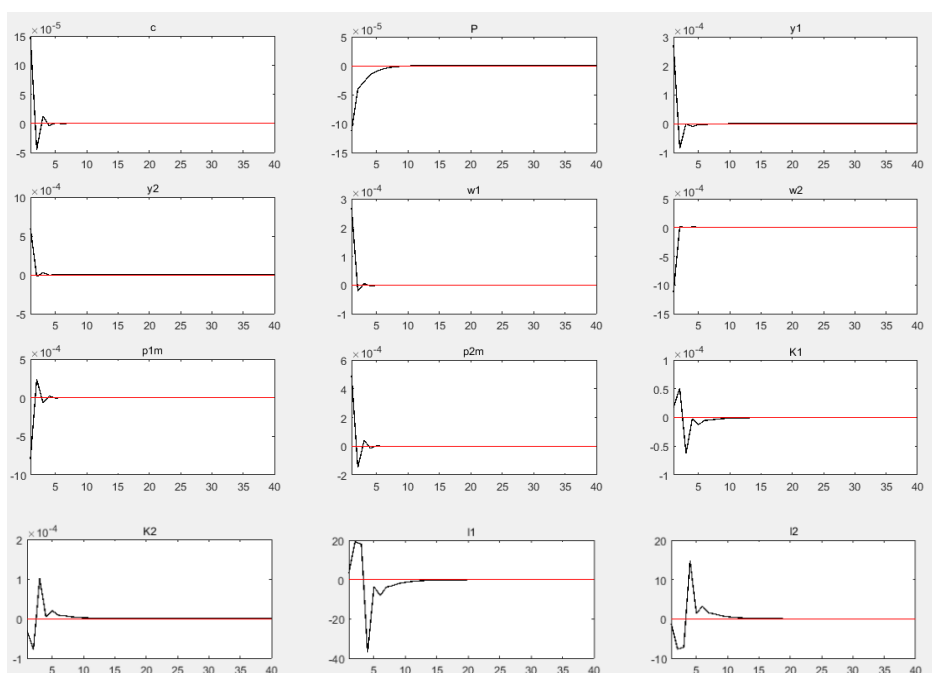


Figure 2. Impulse Response Functions of Energy Efficiency

Source: Research finding.

6. Conclusion and Recommendation

In recent decades, the issue of climate change has received considerable attention from the international community and scholars from various disciplines have attempted to discuss and investigate various aspects of climate change. In this study, the effects of variable policies with climate change on Iran's agricultural sector were analyzed, and Iran's economy has been investigated in a three-sector model (household, enterprise, government) and in the form of two agricultural and non-agricultural sectors and using the dynamic stochastic general equilibrium model approach. The variable of energy consumption was entered into the model as a variable affecting climate change. After initializing and solving the model and ensuring that the simulated results match the actual values of the model variables, the results of improving agricultural technology and energy consumption efficiency were investigated and analyzed.

The results of the survey showed that with the improvement of technology in the agricultural sector, the variable of energy consumption is considered an influential variable in climate change. Therefore, it is suggested to provide the conditions for the use of new and up-to-date technologies in the agricultural sector for producers of this sector to increase the amount of production and waste less

energy in this sector. Also, the survey revealed that labor wages, investment, and capital stock in the non-agricultural sector have decreased due to technological advancements in the agricultural sector. In the agricultural sector, production, labor wages, investment, and capital stock have increased. Therefore, to re-establish the balance between the agricultural and non-agricultural sectors, it is suggested to provide the conditions for the use of modern technologies in the non-agricultural sector (industry and services).

By implementing the shock of improving energy consumption efficiency, the amount of energy consumption will decrease as a variable affecting climate change. Investment and capital stock in the non-agricultural sector and labor wages in the agricultural sector have decreased. In contrast, production, investment, and capital stock in the agricultural sector and labor wages in the non-agricultural sector have increased. Therefore, it is suggested that the government provide conditions for optimal energy consumption in various industries by increasing environmental standards. In addition, an important factor in the optimal consumption of energy and thus the control of climate change is the use of incentive and punishment tools for households and producers. According to the price stickiness based on the New Keynesian model, fewer intermediate goods are needed to produce the product, resulting in a reduction in emissions. Additionally, considering that countries worldwide are required to take action on climate change by 2030, Iran can take effective steps in this field by utilizing climate management tools and environmental policies based on market mechanisms.

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How Has the Multidimensional Poverty Map in Iran Changed During the Last Decade?

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Abstract

This paper measures the multidimensional poverty index (MPI) in both urban and rural areas of the 31 Iranian provinces from 2005 to 2019 using Alkire & Foster's method. The study draws different maps of Iran's MPI during critical events such as the fourth development plan, the Iranian subsidy reform plan, nuclear sanctions, the JCPOA agreement, and the US withdrawal from JCPOA to show changes in poverty. Also, we have examined the effect of macroeconomic variables on MPI using a dynamic panel data model. The results indicate that rural poverty was higher than urban poverty throughout the years under investigation. The study also finds that after imposing severe sanctions on Iran's nuclear program, MPI increased by about 1.4% and 2.4% in urban and rural areas, respectively. One year after the JCPOA agreement, both urban and rural MPI decreased significantly, especially in rural areas where it decreased by 3%. After the US withdrawal from JCPOA, both urban and rural MPI increased by about 1.4%. Finally, the findings from the panel data model demonstrate that the previous period's MPI has a significant negative influence on current MPI. Moreover, government size, income inequality, and inflation exhibit a nonlinear effect on MPI. Lastly, per capita income has a significant positive effect on MPI, indicating an anti-poor growth pattern in Iran during the last decade.

Keywords: Alkire & Foster's Method, Iran, Multidimensional Poverty, Sanction, Subsidy Reform Plan.

JEL Classification: I32, O53, R10.

1. Introduction

Reducing poverty is a key objective of sustainable development, and the initial step in policymaking to achieve this goal is to understand the extent and trends of

poverty over time. However, measuring poverty is a complex issue in economics. In earlier studies, income poverty was used as a measure of poverty, but this approach has been criticized by scholars such as Sen (1985), who introduced the capability approach that considers poverty as not only income deprivation but also includes other forms of deprivation such as social, educational, health, and other dimensions. Due to the multidimensionality of poverty, various multidimensional poverty indexes have been proposed using different methods including fuzzy sets, composite index, Venn diagrams, dashboard, dominance, counting, and statistical approaches (Alkire et al., 2015). In this study, we have employed Alkire & Foster's (2011) method to measure multidimensional poverty in Iranian provinces. This method is widely used and counts the number of indicators in three dimensions: education, health and living facilities. A family is considered poor if they are deprived of more than one-third of these indicators. The Alkire & Foster's poverty index is then calculated using conventional aggregation functions with adjustments.

Although there have been some studies on poverty measurement in Iran, the majority of them have focused solely on income. For instance, Mahoozi (2015) conducted a study that measured the MPI for Iranian provinces for only one year. Additionally, the Global Multidimensional Poverty Index has not been utilized to measure poverty in Iran. As a result, researchers and policymakers have limited access to multidimensional poverty data in Iran, which has obscured the true extent of poverty in the country. To address this issue, this article aims to provide policymakers and researchers with a more comprehensive understanding of poverty in Iran by calculating the MPI for 31 provinces over a period of 15 years (2005-2019). Furthermore, we have examined the effects of macroeconomic variables on MPI at both urban and rural levels, with a focus on their nonlinear impacts. This aspect is particularly novel as previous studies have paid less attention to the nonlinear relationship between macroeconomic variables and poverty in Iran.

This article is important for policymakers because it provides valuable insights into the relationship between macroeconomic variables and the Multidimensional Poverty Index (MPI) in Iran. By calculating the MPI for 31 Iranian provinces over a period of 15 years, policymakers can gain a comprehensive understanding of poverty levels and trends across different regions. The study's emphasis on examining the effects of macroeconomic variables on MPI at both urban and rural levels is particularly significant. By considering the nonlinearity effects of these variables, policymakers can better understand how

different economic factors impact poverty in different contexts. This knowledge can inform targeted policy interventions to address poverty effectively. Furthermore, this study contributes to our overall understanding of the macroeconomic effect on poverty. By shedding light on the nonlinear effects of macroeconomic variables, it provides a more nuanced perspective on how economic factors influence poverty levels. This understanding can help policymakers design more effective strategies to alleviate poverty and promote inclusive economic growth.

This article is structured into five sections. The subsequent section provides a literature review. The third section presents the research methodology and data used. In section four, we analyze the MPI for urban and rural areas and present empirical results of how macroeconomic factors affect poverty using a dynamic panel data approach. Finally, we conclude our study.

2. Review of Literature

2.1 Measuring Poverty in Iran

Previous research on poverty in Iran has primarily focused on income poverty, neglecting a multidimensional approach. Pajooyan (1994) introduced a technique for determining a support criterion or poverty line based on Engel's Law and domestic nutritional values. He discovered that individuals who spend less than 108,000 Rials per year in urban areas are considered to be below the poverty line for the year 1989. Additionally, he argued that providing food rather than money to the poor is more beneficial, as it ensures appropriate utilization and prevents potential misuse. Asgari (2001) utilized spatial analysis methods, specifically spatial autoregressive models, to examine the influence of geographical location on the human poverty index (HPI). His findings indicate a significant spatial relationship between HPI and the provinces in Iran. This implies that the geographical location of provinces contributes to variations in HPI across the country. Ultimately, his results demonstrate that space plays a partial role in explaining poverty disparities.

Assadzadeh and Paul (2004) examined poverty changes in rural and urban areas using household data from 1983, 1988, and 1993, finding that rural poverty decreased while urban poverty increased. Salehi-Isfahani (2009) measured poverty and inequality from 1984 to 2005, revealing a significant decline in poverty but constant inequality. Mahmoudi (2011) measured a poverty index during the four development plans from 1995 to 2007, discovering higher levels of poverty in rural areas than urban areas. Salehi-Isfahani and Majbouri (2013) investigated both

poverty and inequality during the 1992-1995 period, finding higher chronic poverty in urban areas than rural areas but more equally distributed transient poverty. Finally, Einian and Souri (2018) measured the poverty headcount ratio for both urban and rural areas of Iran in 2014 across 397 counties. However, some studies have utilized a multidimensional approach to measure poverty in Iran. Maasoumi and Mahmoudi (2013) used a nonparametric approach to decompose change in poverty into growth and redistribution components from 2000 to 2009, finding that both components significantly impacted changes in poverty. Mahoozi (2015) measured the MPI using Alkire-Foster's method for Iranian provinces only for the year 2008, identifying severe deprivation among female-headed households and rural households compared to male-headed and urban households.

Fotros and Ghodsi (2017) utilized Alkire-Foster's approach to gauge the MPI for Iran's economy as a whole in both rural and urban areas during the commencement and conclusion of development programs from 1989 to 2014. Their findings indicated that development programs in Iran reduced the MPI in both rural and urban areas, but they did not measure the MPI for Iranian provinces. Dadgar et al. (2020) conducted a similar study, measuring the MPI for Iran's economy from 2006 to 2018 and calculating the MPI for Iranian provinces only in 2018. Mohaqeqi Kamal et al. (2019) computed a multidimensional child poverty index (MCPI) using ten indicators across three dimensions of education, health, and living standards for Iranian provinces in 2015, revealing that child poverty is higher in border provinces than central ones. Kamal et al. (2022) measured the MPI for Tehran's elderly population in 2019, discovering that multidimensional poverty among Tehran's elderly is at 59%.

Therefore, this study is unique as it calculates the MPI for Iranian provinces over a lengthy period of fifteen years, providing valuable insights for policymakers and researchers.

2.2 Macroeconomic Variables and Poverty in Iran

Piraei (2004) examined the correlation between growth and poverty in Iran during the first five-year plan. He used a measure of pro poor growth to assess how much the economic growth in Iran benefited or harmed poor individuals. His findings revealed that poverty decreased in Iran from 1988 to 1993. The analysis of changes in poverty, separating them into the effects of pure growth and pure inequality, demonstrated that the former had a negative impact while the latter had a positive impact in both urban and rural areas. The pro poor growth index, measured by various poverty indicators such as headcount ratio, poverty gap ratio, and Foster-

Greer-Thorbecke index, indicated that economic growth was beneficial for both urban and rural areas in Iran. Therefore, based on his results, economic growth helps alleviate poverty.

Khodadad Kashi and Shahiki Tash (2010) investigated how macroeconomic variables influence the level of poverty in Iranian society. Their findings suggested that economic growth did not have a significant effect on poverty intensity in Iran. Furthermore, they found a negative relationship between poverty and growth, meaning that an increase in the growth rate led to a reduction in poverty. Their results also indicated that unemployment and inflation had positive effects on poverty, while social security expenditure relative to government expenditure did not have any meaningful impact on poverty.

Karami and Mardani (2010) examined the relationship between macroeconomic variables such as inequality and economic growth on poverty from 2000 to 2010. Their study revealed a slight decrease in both poverty and income inequality during this period. They found that due to increasing inequality and economic participation, the percentage of poor families increased; however, an increase in savings contributed to a decline in absolute poverty.

Farahmand et al. (2013) conducted a study on poverty and welfare in Iranian households from 2000 to 2007. They included variables for human education and health as control variables in their model, which was estimated using GMM. The results showed that while overall welfare increased with economic growth, there was also an increase in inequality among households in most provinces of the country. Additionally, the service sector experienced higher average growth compared to the agricultural and industrial sectors. The study also found that human education and health had a clear positive impact on prosperity and reducing poverty.

Mostafaei et al. (2020) focused on factors influencing poverty with an emphasis on industrial development in Iranian provinces from 2004 to 2015 using spatial panel econometric models. They used two scenarios: one using the concentration index and another using the relative regional advantage index. Both scenarios revealed that inequality, inflation, and concentration ratio had a positive effect on poverty, while industry per capita value added, depth of industrial activities, and relative advantage based on employment had a negative impact on poverty.

Heshmati Dayari et al. (2022) used the Log-Normal curve approach developed by Bourguignon to analyze the impact of economic growth on poverty in urban households in Iran from 2013 to 2019. They estimated the effects of

growth and distribution on poverty. The results indicated that only during the one-year period of 2015-2016, all the necessary conditions for pro-poor growth were met, resulting in a successful combination of poverty reduction, growth, and reduced inequality.

3. Research Methodology and Data

3.1 Measuring Multidimensional Poverty Index (MPI)

Suppose poverty is established based on d dimensions. We regard an individual's position in one dimension as a success and posit that each dimension's accomplishments can be expressed through a non-negative quantitative indicator. Person i 's accomplishment in dimension j is denoted by x_{ij} for all $i=1,\dots,n$ and $j=1,\dots,d$. The accomplishments of all community members are depicted by the $n \times d$ achievement matrix X .

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1d} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nd} \end{bmatrix} \quad (1)$$

What is done to measure multidimensional poverty is to convert the achievement matrix into a scalar. By having the achievement matrix X and the deprivation limit vector Z , it is possible to determine whether each person is deprived or not, and the deprivation matrix g^0 can be obtained. Deprivation matrix elements for all individuals ($i = 1, \dots, n$) and dimensions ($j = 1, \dots, d$) when $x_{ij} < z_j$, is $g_{ij}^0 = 1$, otherwise, $g_{ij}^0 = 0$. In other words, if the person i is deprived in dimension j , then the value of 1 is assigned to their deprivation status, and otherwise the deprivation status of the person is zero. Therefore, the matrix $g^0(X)$ shows the deprivation status of all n individuals in all j dimensions of the X matrix. The vector g_i^0 indicates the deprivation status of person i in all dimensions and the vector g_j^0 indicates the deprivation status of all individuals in dimension j . According to the matrix g^0 , the degree of deprivation c_i for the person i can be obtained as $c_i = \sum_{j=1}^d w_j g_{ij}^0$. c_i represents the weighted sum of the deprivations that the person i suffers from them.

Also, we name the identification function with ρ , so that $\rho(.) = 1$ identifies person i as poor and $\rho(.) = 0$ identifies person i as non-poor. There are numerous methods for identifying poverty within a multidimensional framework. Two possible approaches to specify the identification function are "the aggregate achievement approach" and "the censored achievement approach." The former involves combining an individual's achievements across various dimensions using

an aggregation function, and comparing this to an aggregate poverty line derived from deprivation limits in each dimension. If an individual's overall achievement falls below this line, they are considered poor. In contrast, the censored achievement approach first determines whether a person is deprived in any dimension by applying deprivation limits, and then assesses their status based only on their achievements in those dimensions where they are deprived. (Alkire et al., 2015).

Consider a society with n members (household) and d dimension as dimensions of multidimensional poverty. Given the $n \times d$ matrix of the achievements of X and a deprivation vector Z , the deprivation matrix associated with X is obtained as $g^0 = [g_{ij}^0]$, in which the sample element g_{ij}^0 when $x_{ij} < z_j$ is $g_{ij}^0 = w_j$ and otherwise ($x_{ij} \geq z_j$) is $g_{ij}^0 = 0$. The matrix g^0 is an $n \times d$ matrix that element ij equals w_j when the person i is deprived in dimension j , and is equal to zero when the person is not deprived in that dimension. The sum of the weights for each dimension ($\sum w_j$) is equal to one. The line vector i of the matrix g^0 , denoted by g_i^0 , is the deprivation vector of person i . Also, the column vector j of the matrix g^0 , which we represent as g_j^0 , shows the distribution of deprivation in the j th dimension among the community. From the matrix g^0 , a column vector c can be made, which is the degree of weight deprivation of individuals, and in which the i -th member, $c_i = g_i^0$, shows the weighted sum of the dimensions in which the person i is deprived.

In Alkire and Foster's method, a second limit (k) is also used to identify the poor. For $0 < k \leq 1$, we consider the ρ_k function as an identification function, which is defined as follows:

$$\begin{cases} \rho_k(x_i, z) = 1 & \text{if } c_i \geq k \\ \rho_k(x_i, z) = 0 & \text{if } c_i < k \end{cases} \quad (2)$$

In other words, ρ_k identifies person i as poor if their degree of deprivation is at least equal to k ; Otherwise, they will not be considered poor.

We obtain the matrix $g^0(k)$ from the matrix g^0 by substituting the zero vector instead of its i -th row, when $\rho_k(x_i, z) = 0$. It is clear that $g_{ij}^0(k) = g_{ij}^0 \rho_k(x_i, z)$. We also define the censored vector of degrees of deprivation $c(k)$ for all $i = 1, \dots, n$ as $c_i(k) = \rho_k(x_i, z) c_i$.

Finally, as an aggregation step, the adjusted headcount ratio (M_0) is:

$$M_0 = d[\mu(g^0(k))] = \mu(c(k)) = \frac{1}{n} \sum_{i=1}^n c_i(k) = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^d w_j g_{ij}^0 \quad (3)$$

The process of applying a multidimensional approach to poverty is complex and involves various challenges. One such challenge is determining a comprehensive list of related features that must be taken into account, along with deciding on the weightage assigned to each feature. Additionally, it is crucial to consider the relationships and interactions between these attributes, as they may either complement or substitute each other. If the dimensions of poverty are substitutes, then an individual can maintain their well-being by adjusting one attribute over others. Conversely, if the attributes are complementary, then the addition of one attribute enhances the utility of another. Defining poverty or its meaning is a prerequisite for measuring it; however, broader definitions make it harder to measure accurately. The limitations of measuring poverty in a multidimensional way impose restrictions on the number and type of attributes that constitute poverty. Therefore, defining these attributes and features associated with poverty becomes a critical task. This paper follows the Global Multidimensional Poverty Index (MPI) approach to determine these attributes and their weights.

However, due to limitations in statistical data collection, adjustments have been made to the dimensions, weights, and limits of deprivation in MPI Global as shown in Table 1.

Table 1. Dimensions, Indicators, Weights, and Limits of Deprivation Used in Measuring Iran's Multidimensional Poverty

Dimension (Weight)	Index (Weight)	z_j : Deprivation limit
Education ($\frac{1}{3}$)	Years of study ($\frac{1}{6}$)	The head of the household has less education than in middle school.
	Children's education ($\frac{1}{6}$)	There should be at least one school-age child (6 to 16 years old) in the household who is not studying.
Health ($\frac{1}{3}$)	Existence of disability ($\frac{1}{6}$)	Existence of a specific disability or patient in the family
	Get proper nutrition ($\frac{1}{6}$)	The per capita caloric intake of households should be less than 2300 calories per day.
Living Facilities ($\frac{1}{3}$)	Access to electricity ($\frac{1}{21}$)	Do not have access to electricity at home.
	Existence of a bathroom in the house ($\frac{1}{21}$)	No bathroom at home

Cooking fuel ($\frac{1}{21}$)	Household cooking fuel is wood, charcoal, or animal manure.
Access to safe water ($\frac{1}{21}$)	The household does not have access to tap water.
Living Location status ($\frac{1}{21}$)	The per capita area of the household is less than 10 square meters.
Possession of durable goods ($\frac{1}{21}$)	The household owns at most one the goods refrigerators, televisions, telephones, washing machines, and vehicles (cars or motorcycles).
Generate heat and provide hot water ($\frac{1}{21}$)	Create heat with firewood, animal manure and coal.

Source: MPI Dimensions with own adjustments due to limitations in statistical data.

Table 1 provides a summary of the dimensions, weights, and deprivation limits utilized in calculating the MPI for Iranian provinces. To compute the MPI using Alkire and Foster's approach, it is necessary to determine another quantity known as the second limit (k), which we previously referred to. Consistent with the global MPI, we have adopted a value of one-third for k or $k=0.33$. This implies that an individual is considered impoverished and deprived if they lack more than one-third of the weighted indicators.

3.2 Econometric Modeling of Poverty

In this section, we have modeled poverty using the most important macroeconomic variables. Therefore, according to the poverty literature, we have used the following model:

$$MPI_{it} = \beta_0 + \beta_1 MPI_{it-1} + \beta_2 GS_{it} + \beta_3 GS_{it}^2 + \beta_4 Gini_{it} + \beta_5 Gini_{it}^2 + \beta_6 Inf_{it} + \beta_7 Inf_{it}^2 + \beta_8 Y_{it} + \varepsilon_{it} \quad (4)$$

The multidimensional poverty index (MPI) is denoted as MPI_{it} , and the first lag of the multidimensional poverty index is denoted as MPI_{it-1} . We applied a dynamic model for poverty because when individuals or communities experience poverty in multiple dimensions over time, it creates a cumulative disadvantage. For example, if a person grows up in a poor household with limited access to education and healthcare, they are more likely to face difficulties in finding employment and breaking out of the cycle of poverty. We use both urban and rural poverty indexes to examine how macroeconomic variables affect poverty in urban and rural areas.

The government size (GS) is denoted as GS_{it} , and the square of government size is denoted as GS_{it}^2 . For government size, we have used the share of consumption government expenditure in GDP. We have applied a quadratic form

of government size to capture the nonlinearities of government size on poverty. According to Yusoff et al (2023), government expenditure could have a nonlinear impact on the level of poverty.

The Gini coefficient (Gini) is denoted as $Gini_{it}$, and the square of the Gini coefficient is denoted as $Gini_{it}^2$. We have applied a quadratic form of the Gini coefficient to capture the nonlinearities of income inequality on poverty. According to Zaman & Shamsuddin (2018), there is a possible nonlinear relationship between inequality and poverty.

The inflation rate (Inf) is denoted as Inf_{it} , and the square of inflation rate is denoted as Inf_{it}^2 . For measuring inflation rate, we have used the growth rate of consumer price index (CPI). Meo et al (2018) suggest that there could be a nonlinear or asymmetric relationship between inflation and poverty.

Y_{it} represents the logarithm of per capita income, and ε_{it} represents the error term. Finally, for estimating equation 4, we have applied the GMM method.

3.3 Data

The data used in this study pertains to household expenditure and income and is gathered annually through extensive field surveys and detailed questionnaires from various households across Iran. To account for rural areas, we have utilized data from the Statistics Center of Iran, which has revised its household expenditure and income survey questionnaire since 2004 based on COICOP classifications. Due to this data limitation, we have measured the MPI between 2005-2019.

4. Empirical Results

4.1 Analyzing MPI

Tables A1-A4 in appendix present the MPI values for Iranian provinces and the country as a whole in both urban and rural areas from 2005 to 2019. Additionally, descriptive statistics are provided below these tables.

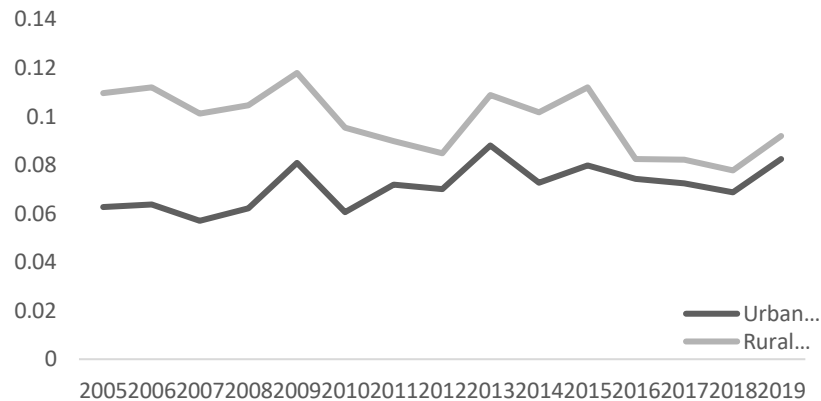


Figure 1. Urban and Rural MPI in Iran

Source: Research finding.

The findings from the multidimensional poverty assessment conducted in urban areas indicate that, with the exception of 2006 (when North Khorasan province had the highest poverty) and 2012-2013 (when Qom province had the highest poverty), Sistan & Baluchestan province consistently had the highest levels of multidimensional poverty. Conversely, the province with the lowest MPI varied across different years, with Bushehr province having the lowest MPI in 2005 and 2009, Zanjan province in 2006, Chaharmahal province in 2007-2008 and 2015, Khozestan province in 2010, Alborz province in 2011 and 2019, South Khorasan province in 2012-2014, Tehran province in 2016, and Mazandaran province in 2017-2018.

In rural areas of Iran, Sistan & Baluchestan province consistently had the highest MPI between 2005 and 2019. On the other hand, Bushehr province had the lowest MPI in rural areas during 2005 and between 2007-2009. Rural areas of Mazandaran had the longest period of low MPI between 2006 and from 2010 to 2015-17. Alborz province had the lowest MPI in rural areas during 2011, as well as in both years of 2018 and 2019. Zanjan Province held this distinction for rural areas during only one year - that being in year of 2012 - while South Khorasan held it for two years - those being in years of 2013 and of 2104.

According to figure 1, findings from the multidimensional poverty assessment of Iran's urban and rural areas indicate that rural poverty was more prevalent than urban poverty throughout the years studied. However, there was an improvement in poverty levels in both sectors one year after the fourth development plan was completed. A comparison of the multidimensional poverty maps from 2005 (Figure 2) and 2010 (Figure 3) revealed a reduction in poverty,

albeit at a slow pace. Nevertheless, the fourth development plan failed to address rural poverty in border provinces, particularly in the eastern regions where conditions were worse than other border provinces. The provinces of Sistan & Baluchistan and Qom remained among the highest in urban poverty, with Sistan & Baluchistan being the poorest province overall in both urban and rural areas during this period (2005-2010). Rural poverty rates were significantly higher in this province compared to other provinces across Iran.

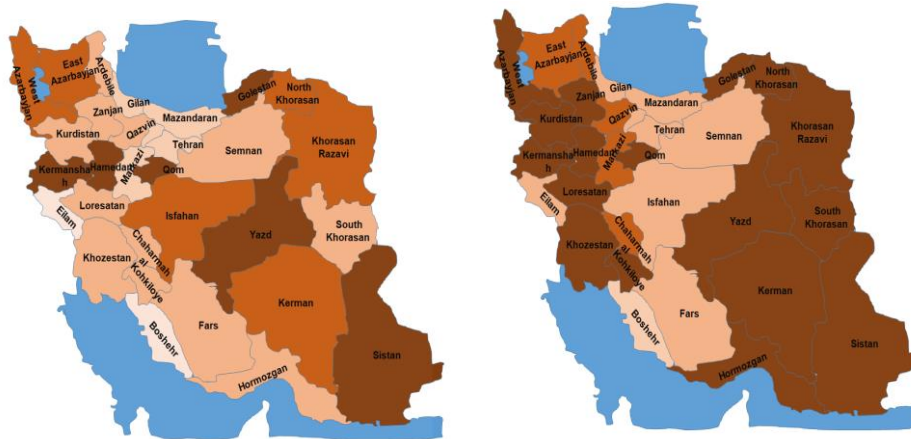


Figure 2. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2005 year

Source: Research finding.

Poverty Range	Color
Very Low ($MPI < 3\%$)	
Low ($3\% \leq MPI < 4\%$)	
Medium ($4\% \leq MPI < 7\%$)	
High ($7\% \leq MPI < 9\%$)	
Very High ($MPI \geq 9\%$)	

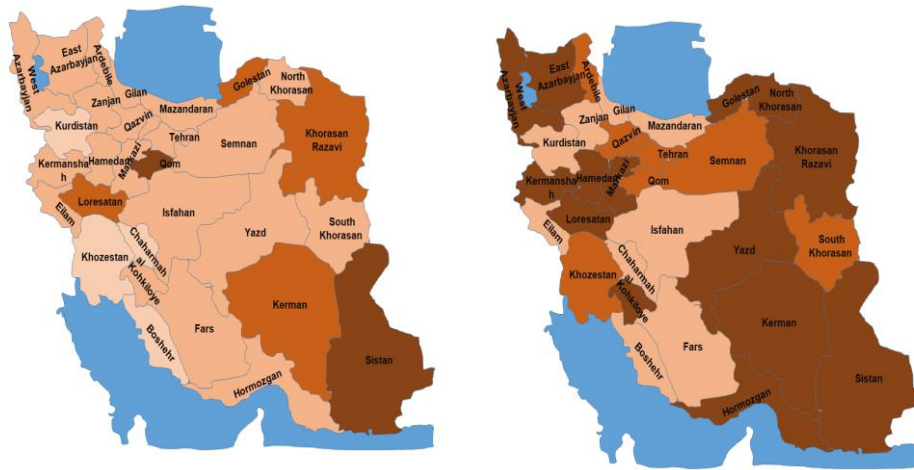


Figure 3. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2010 year

Source: Research finding.

The Iranian government implemented the subsidy reform plan at the end of 2010, which aimed to liberalize energy prices and provide direct cash subsidies to citizens. One year later, in 2011, calculations showed that the multidimensional poverty index in urban areas had increased by approximately 1%, while rural areas experienced a decrease of about half a percent.

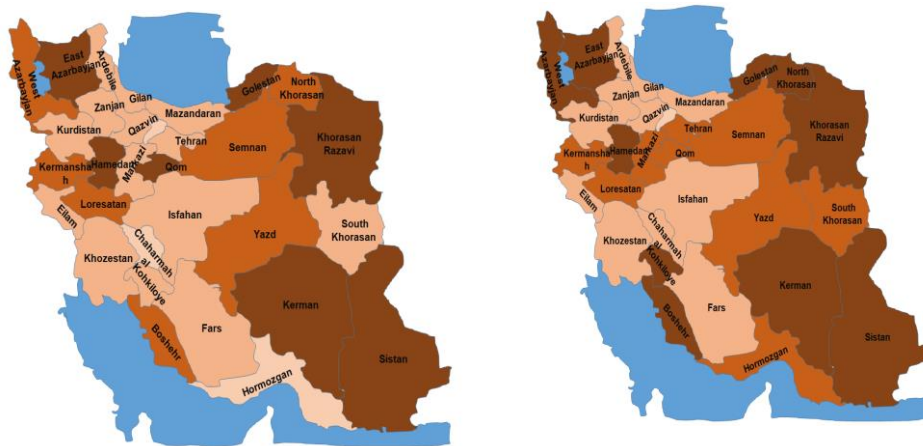


Figure 4. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2011 year

Source: Research finding.

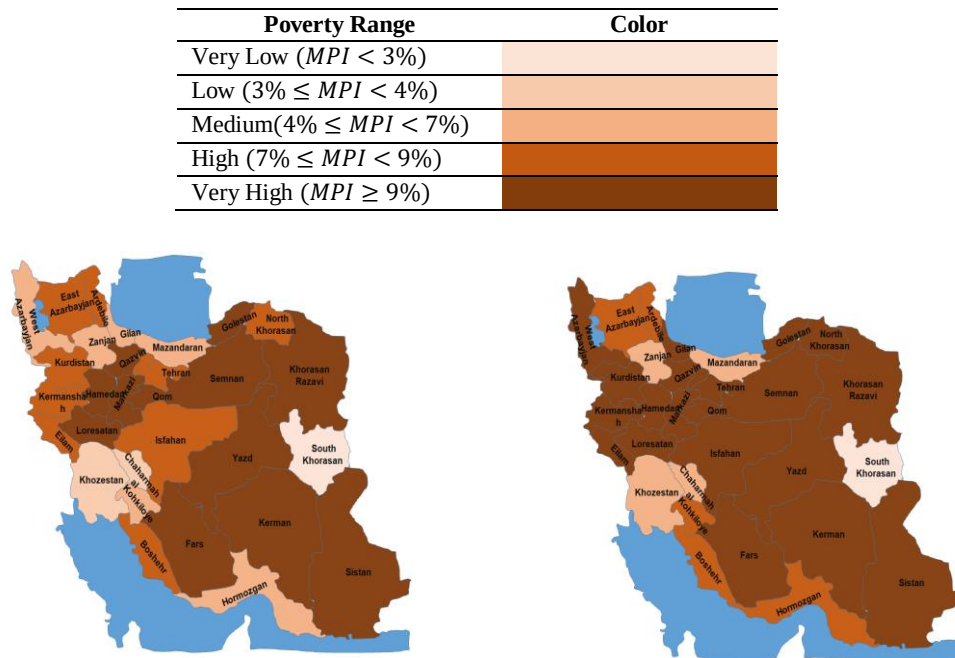


Figure 5. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2013 year

Source: Research finding.

In early 2012, the United States imposed severe sanctions on Iran's nuclear program, including central bank sanctions, swift sanctions, oil exports sanctions, and shipping insurance sanctions. Figure 4 illustrates the multidimensional poverty map one year after these sanctions were imposed. By the end of 2013, calculations revealed that both urban and rural areas experienced an increase in multidimensional poverty index by about 1.4% and 2.4%, respectively. The poverty map was noticeably darker compared to the previous year before the sanctions were imposed. After Iran's elections in 2013, negotiations with P5 + 1+EU (permanent members of UN Security Council plus Germany and European Union) continued regarding Iran's nuclear program. On July 14, 2015, Iran signed the Joint Comprehensive Plan of Action (JCPOA), which restricted its nuclear program in exchange for lifted sanctions.

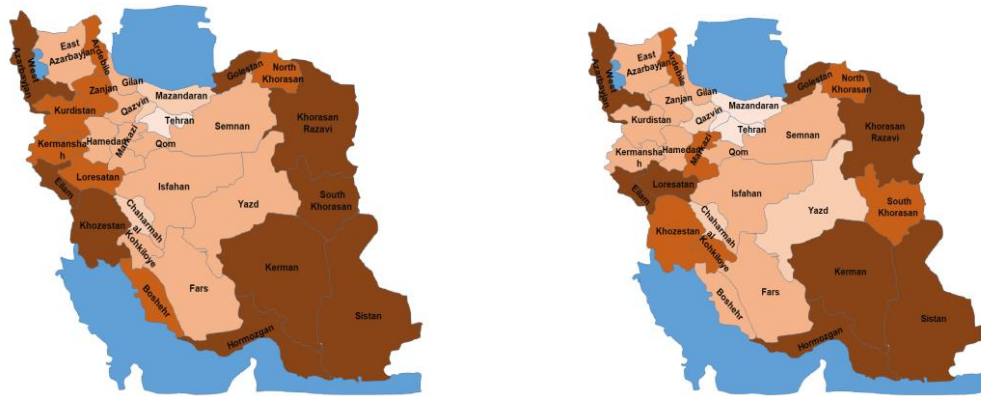


Figure 6. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2016 year

Source: Research finding.

Poverty Range	Color
Very Low ($MPI < 3\%$)	Lightest Orange
Low ($3\% \leq MPI < 4\%$)	Light Orange
Medium ($4\% \leq MPI < 7\%$)	Medium Orange
High ($7\% \leq MPI < 9\%$)	Dark Orange
Very High ($MPI \geq 9\%$)	Dark Brown

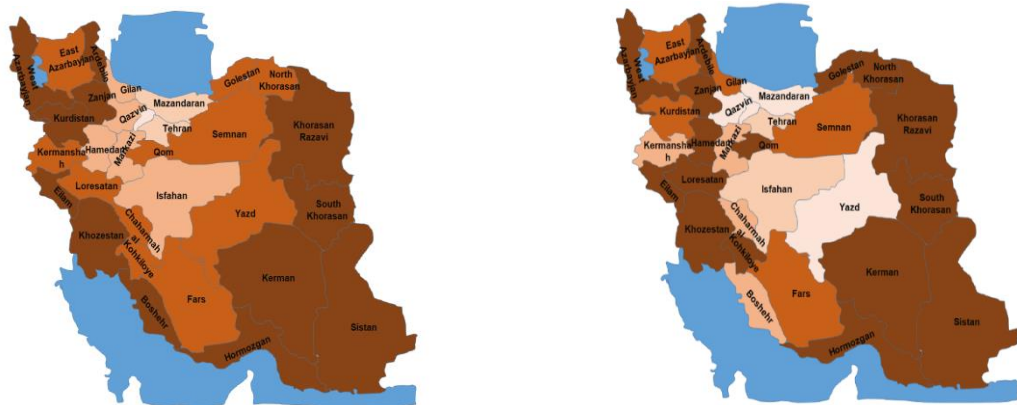


Figure 7. Multidimensional Poverty Map in Urban (Left Map) and Rural (Right Map) Areas in the 2019 year

Source: Research finding.

Figure 6 illustrates the poverty map one year after the JACOPA agreement, which indicates a decrease in multidimensional poverty in both urban and rural areas. The reduction in rural poverty has been particularly significant, with a 3% decrease in multidimensional poverty compared to 2015. In the same period, urban multidimensional poverty decreased by half a percent.

The US-elected government of 2017 did not have faith in the JACOPA agreement and subsequently withdrew from it in May 2018. As a result, all US government sanctions against Iran were reinstated. Figure 7 displays a multidimensional poverty map for urban and rural areas one year after the US withdrawal from the JACOPA agreement. The statistics reveal an increase of approximately 1.4% in multidimensional poverty in both urban and rural areas at the end of 2019 compared to 2018.

4.2 Empirical Results of Econometric Model

Before estimating the model, we should examine the stationarity of the variables to avoid the problem of spurious regression. Table 9 presents the results of the Levin, Lin, & Chu test.

Table 9. Unit Root Test (Levin, Lin, & Chu Test)

Variable	Test Type	Statistic	P-value
$MPI_{it}(\text{Urban})$	With Intercept	-5.16	0.00
$MPI_{it-1}(\text{Urban})$	With Intercept	-5.80	0.00
$MPI_{it}(\text{Rural})$	With Intercept	-5.12	0.00
$MPI_{it-1}(\text{Rural})$	With Intercept	-5.26	0.00
GS_{it}	With Intercept	-38.54	0.00
GS_{it}^2	With Intercept	-959.86	0.00
$Gini_{it}$	With Intercept	-4.93	0.00
$Gini_{it}^2$	With Intercept	-5.62	0.00
Inf_{it}	With Intercept	-9.63	0.00
Inf_{it}^2	With Intercept	-9.62	0.00
Y_{it}	With Intercept	-4.26	0.00

Source: Research finding.

According to these results, all variables are stationary. Therefore, in the next step, we estimate the econometric models for poverty. Table 10 displays the estimation results for the urban poverty model.

Table 10. Estimation Results

Variables	Urban Model	Rural Model
	Coefficient (St.Dev)	Coefficient (St.Dev)
MPI_{it-1}	-0.15** (0.07)	-0.10*** (0.03)
GS_{it}	-0.22*** (0.04)	0.03 (0.08)
GS_{it}^2	0.54*** (0.15)	0.39** (0.17)
$Gini_{it}$	-2.87*** (1.02)	-2.54*** (0.38)
$Gini_{it}^2$	4.35*** (1.43)	4.18*** (0.55)
Inf_{it}	-0.002*** (0.0003)	-0.002*** (0.0006)
Inf_{it}^2	0.00006*** (0.000008)	0.00005*** (0.00001)
Y_{it}	0.016*** (0.004)	0.014*** (0.004)
J-Statistic (P-value)	21.31 (0.31)	21.27 (0.32)
AR (1)- Arellano-Bond Serial Correlation Test (P-value)	-2.87 (0.00)	-2.45 (0.01)
AR (2)- Arellano-Bond Serial Correlation Test (P-value)	-0.36 (0.71)	-0.85 (0.39)

Source: Research finding.

Based on these results, we can summarize as follows:

The first lag of MPI has a significant negative impact on current MPI in both urban and rural models. This is because during an economic downturn or recession, poverty rates tend to increase due to factors such as job losses, reduced income levels, and limited access to basic services. However, it takes some time for these changes to be fully reflected in the index due to the lag of MPI. For example, let's consider a hypothetical business cycle where an economy enters a recession. Initially, there may be a decrease in employment opportunities and income levels, leading to an increase in poverty rates across multiple dimensions. However, the lag of MPI means that this increase might not be immediately captured by the index. The index relies on data collection and analysis processes that take time to accurately reflect changes. Therefore, during the early stages of a recession, the current MPI might not fully capture the extent of poverty caused by economic

downturns. As time progresses and data is collected and analyzed, this lag diminishes and eventually reflects the increased poverty rates resulting from the recession. This delayed reflection is influenced by factors such as data collection cycles, survey periods, and processing times.

Government size has a nonlinear impact on MPI in urban model. At lower levels of government intervention, there may be limited resources and inadequate social safety nets, resulting in higher levels of poverty. In such cases, an increase in government size and intervention can have a positive impact on reducing poverty. This can be achieved through policies such as increased public spending on education, healthcare, social welfare programs, and infrastructure development. However, as government size continues to increase beyond a certain point, it may lead to inefficiencies, corruption, and misallocation of resources. Excessive bureaucracy and red tape can hinder economic growth and discourage private sector investment. In such cases, the negative effects of a bloated government can outweigh its positive impact on poverty reduction.

Gini coefficient has a nonlinear impact on MPI. Inequality may have a minimal impact on poverty levels until it reaches a certain threshold. Below this threshold, the distribution of income may not significantly affect the MPI. However, once inequality surpasses this threshold, it can exacerbate poverty levels and lead to a U-shaped relationship. In other words, as income increases, the additional benefits derived from each additional unit of income tend to diminish. This means that the impact of income inequality on poverty reduction becomes less significant as incomes rise. However, beyond a certain point, when income disparities become extreme, the negative effects of inequality start to outweigh any positive impacts from increased incomes. Furthermore, high levels of income inequality can lead to social exclusion and deprivation among certain groups in society. This can result in limited access to education, healthcare, housing, and other essential services for those at the lower end of the income distribution. As a result, poverty levels may increase disproportionately among these marginalized groups. Finally, Nonlinear relationships between income inequality and MPI can also be influenced by political and institutional factors. In some cases, high levels of inequality may be associated with weak governance structures or policies that favor specific groups or elites. These factors can further exacerbate poverty levels among disadvantaged populations.

Inflation has a nonlinear impact on MPI. At low levels of inflation, an increase in inflation can be a positive force for producers. It encourages them to increase their sales and ultimately boost their profits. Additionally, it leads to an

increase in the income of producers and employment levels. Consequently, a low level of inflation may have a positive impact on reducing poverty. However, in high levels of inflation, the situation changes. It causes a decrease in the real income of employers, which subsequently affects their ability to provide necessary goods and services. As a result, the poverty rate tends to increase. To summarize, while low levels of inflation can be beneficial for producers and help alleviate poverty, high levels of inflation have adverse effects on employers' income and contribute to an increase in poverty rates.

Per capita income has a significant positive impact on MPI. If the increase in per capita income is concentrated among a small portion of the population, while the majority of people continue to earn low incomes, it can exacerbate income inequality. This means that even though the average income may be higher, those at the bottom end of the spectrum may still remain in poverty. Secondly, an increase in per capita income does not necessarily mean that the cost of living decreases proportionally. If basic necessities such as housing, healthcare, education, and food become more expensive, people with low incomes may struggle to afford these essentials despite an overall increase in average income. If an increase in per capita income is accompanied by high inflation rates, it can erode purchasing power and make it difficult for individuals to afford basic goods and services. In some cases, certain marginalized groups or regions may not have equal access to resources and opportunities even when overall per capita income increases. This can perpetuate poverty within these communities despite improvements at a broader level.

The Sargan test indicates no correlation between instrumental variables and error terms. Additionally, the Arellano-Bond serial correlation test confirms the relevance of the GMM method.

5. Discussion

Our results show that both urban and rural poverty rates have fluctuated over the years. However, it is important to note that rural poverty rates tend to be higher than urban poverty rates in most years. Based on our calculations, the average urban poverty rate is approximately 6.85% while the average rural poverty rate is around 10.29%. This finding is consistent with studies of Mahmoudi (2011) and Mahoozi (2015).

The nonlinear impact of government size on poverty is consistent with Zare and Zare (2018). The U-shaped relationship suggests that both excessive and insufficient government intervention can contribute to higher poverty rates.

Therefore, policymakers should strive to find the optimal level of government involvement in addressing poverty. This could involve targeted social welfare programs and policies that aim to reduce income inequality while avoiding excessive bureaucracy. The findings indicate that a certain level of government intervention is necessary to alleviate poverty. However, it is important to strike a balance between providing social welfare programs and ensuring fiscal sustainability. Policymakers should focus on designing effective and efficient social safety nets that target the most vulnerable populations while also promoting economic growth. Furthermore, excessive government intervention can lead to corruption, which can exacerbate poverty levels. To address this issue, policymakers should prioritize anti-corruption measures and promote transparency in governance. Strengthening institutions responsible for monitoring and combating corruption can help ensure that resources are allocated efficiently and effectively towards poverty reduction efforts. Also, The U-shaped relationship suggests that there may be an optimal level of government size beyond which it becomes detrimental to poverty reduction efforts. Therefore, policymakers should focus on creating an enabling environment for economic growth by implementing pro-growth policies such as investment in infrastructure, education, and innovation. Economic growth can help create job opportunities and increase incomes, thereby reducing poverty levels. Finally, it is important to recognize regional variations within Iran when formulating policies aimed at reducing poverty. Different regions may require different approaches based on their unique socio-economic characteristics and needs. Policymakers should consider implementing region-specific policies that address the specific challenges faced by each area.

The effect of income inequality and inflation on MPI is not consistent with previous research, which found a positive relationship between inequality and poverty, as well as between inflation and poverty. Since high inflation rates contribute to higher poverty levels, it is important for the Iranian government to adopt effective monetary policies to manage inflation. This can be done by controlling the money supply, interest rates, and practicing fiscal discipline. Additionally, reducing income inequality is crucial in order to decrease poverty rates. The government should concentrate on implementing policies that encourage fair distribution of income, such as progressive taxation, social welfare programs, and targeted subsidies for low-income individuals and households.

The positive impact of per capita income on the Multidimensional Poverty Index (MPI) reflects a growth pattern that is not beneficial for the poor, which

contrasts with a growth pattern that is beneficial for the poor. The focus should be on creating more job opportunities and promoting programs that develop skills to improve the employability of those in poverty. This can be achieved by investing in sectors with high potential for labor-intensive work, implementing vocational training programs, and providing support for entrepreneurship. It is also important to prioritize initiatives for rural development in order to reduce poverty rates in rural areas, where poverty tends to be more prevalent. This may involve investing in infrastructure development, modernizing agriculture, providing access to credit for farmers, and improving basic services such as healthcare and education. Additionally, it is crucial to improve access to quality healthcare and education for all individuals, regardless of their socio-economic background. This can be done by increasing public spending on these sectors, expanding coverage of health insurance programs, reducing out-of-pocket expenses for essential services, and enhancing the quality of education in low-income areas. Lastly, it is essential to ensure that economic policies are designed with inclusivity in mind by considering their impact on different segments of society. Encouraging investment in sectors that have a high potential for job creation and income generation for those living in poverty is key.

6. Conclusion

The purpose of this article is to gain a comprehensive understanding of multidimensional poverty in the Iranian economy in recent years. The Alkire & Foster method was used to calculate the multidimensional poverty index for urban and rural areas in all 31 provinces of Iran from 2005 to 2019. The findings indicate that rural poverty has consistently been higher than urban poverty during this period. Additionally, the border provinces, particularly those in the eastern region, experience higher levels of multidimensional poverty compared to other regions, particularly central regions. For instance, Sistan & Baluchestan province had the highest rate of rural multidimensional poverty throughout the study period. The results also reveal that multidimensional poverty has increased since the imposition of U.S sanctions, while there was a reduction in multidimensional poverty following the JACOPA agreement. However, one year after the United States withdrew from this agreement, multidimensional poverty increased again. Therefore, this study suggests that Iran's return to the JACOPA agreement could help curb the rising trend of multidimensional poverty in Iran.

Additionally, our study conducted a dynamic panel data analysis to assess the influence of macroeconomic variables on MPI. The findings indicate that the

preceding period's MPI has a noteworthy detrimental effect on the present MPI in both urban and rural models. Moreover, government size, income inequality, and inflation exhibit a nonlinear relationship with MPI. Lastly, per capita income demonstrates a substantial positive association with MPI, reflecting a pattern of growth that disproportionately affects the poor in Iran. Based on these results, we can present some policy implications for reducing poverty in Iran:

Given that government size has a nonlinear impact on MPI with a U-shaped relationship, policymakers need to find an optimal balance in terms of government intervention and regulation. It is crucial to ensure that government policies and programs effectively target poverty reduction and social welfare, while avoiding excessive bureaucracy and inefficiencies that could hinder economic growth and exacerbate income inequality.

The finding that income inequality has a U-shaped impact on MPI suggests that both extreme inequality and extreme equality can be detrimental to poverty reduction efforts. Policymakers should aim to address income disparities by implementing progressive taxation, redistributive policies, and social safety nets. This may involve initiatives such as targeted cash transfer programs, skills development programs, and policies that promote inclusive economic growth and job creation.

Given the nonlinear impact of inflation on MPI, policymakers should strive to maintain price stability and manage inflation effectively. High or volatile inflation can erode the purchasing power of low-income households, making it more difficult for them to escape poverty. Implementing sound monetary policies, fiscal discipline, and targeted social protection programs can help mitigate the adverse effects of inflation on poverty.

The finding that per capita income has a significant positive impact on MPI reflects anti-poor growth in Iran. To address this, policymakers should focus on implementing policies that promote inclusive economic growth, job creation, and income generation for the poor. This could involve investments in sectors with high poverty reduction potential, promoting entrepreneurship and small business development, and ensuring equitable access to economic opportunities and resources.

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Appendix

Table A1. The MPI in Urban Areas during 2005-2012

	2005	2006	2007	2008	2009	2010	2011	2012
East Azarbayjan	0.074026	0.083333	0.105556	0.083193	0.079762	0.059171	0.091036	0.070019
West Azarbayjan	0.066502	0.060224	0.069824	0.070518	0.089018	0.062514	0.077741	0.070184
Ardebile	0.053894	0.062571	0.030864	0.063161	0.057307	0.045102	0.048404	0.058986
Isfahan	0.067296	0.051797	0.04925	0.064152	0.065756	0.056252	0.057475	0.067138
Alborz	-	-	-	-	-	-	0.034627	0.057616
Eilam	0.033772	0.035238	0.036791	0.046985	0.05251	0.047974	0.052418	0.071171
Boshehr	0.028734	0.036934	0.022381	0.020343	0.05095	0.036878	0.080968	0.089364
Tehran	0.034566	0.043123	0.034524	0.041203	0.069482	0.044874	0.050294	0.053885
Chaharmahal	0.046788	0.036384	0.012355	0.020315	0.063128	0.03877	0.038491	0.034601
South Khorasan	0.060544	0.052381	0.050595	0.065939	0.083144	0.065576	0.060274	0.018681
Khorasan Razavi	0.083378	0.084524	0.055696	0.061615	0.086139	0.063027	0.080012	0.063421
North Khorasan	0.093333	0.129286	0.09949	0.08583	0.087108	0.078435	0.095406	0.087503
Khozestan	0.042857	0.068824	0.067489	0.037826	0.067054	0.036064	0.046218	0.037964
Zanjan	0.061968	0.034226	0.047738	0.041013	0.066864	0.051342	0.041118	0.038103
Semnan	0.052765	0.065382	0.038844	0.052629	0.062945	0.055008	0.070437	0.074327
Sistan & Balouchestan	0.132804	0.124431	0.145623	0.133589	0.177696	0.12516	0.138525	0.122354
Fars	0.050818	0.062093	0.06539	0.054762	0.074908	0.047098	0.061404	0.06472
Qazvin	0.049524	0.04756	0.040408	0.034791	0.064172	0.054185	0.058776	0.05842
Qom	0.093773	0.103242	0.083694	0.10532	0.128519	0.105217	0.129664	0.164245
Kurdistan	0.06	0.066726	0.043484	0.059576	0.073731	0.036614	0.048766	0.067247
Kerman	0.078804	0.069048	0.052934	0.059627	0.087376	0.084456	0.111936	0.107758
Kermanshah	0.111172	0.082978	0.053324	0.073366	0.076339	0.06863	0.074108	0.07374
Kohkiloye	0.049048	0.068231	0.050794	0.072408	0.089173	0.054942	0.069133	0.060602
Golestan	0.097889	0.081688	0.085927	0.085614	0.118281	0.087844	0.106745	0.100158
Gilan	0.034709	0.039002	0.032412	0.037282	0.05372	0.04276	0.052455	0.047992
Lorestan	0.060534	0.052143	0.042517	0.047852	0.069947	0.081413	0.07656	0.093224
Mazandaran	0.036585	0.045714	0.02719	0.034952	0.055432	0.042604	0.063873	0.063346
Markazi	0.037128	0.046429	0.056019	0.075304	0.076652	0.067621	0.05716	0.062721
Hormozgan	0.050331	0.067914	0.062681	0.070605	0.061745	0.048005	0.039695	0.034512
Hamedan	0.092043	0.083333	0.081755	0.051002	0.098719	0.063025	0.108202	0.099615
Yazd	0.11	0.076771	0.066071	0.093725	0.097216	0.060145	0.076512	0.062939
Country as a Whole	0.062754	0.06383	0.056995	0.062212	0.080918	0.060595	0.071919	0.070116
Mean	0.064853	0.065384	0.057054	0.061483	0.079493	0.060357	0.070917	0.070211
Median	0.060267	0.0639765	0.051864	0.060621	0.0743195	0.05563	0.063873	0.06472
St. Dev	0.026660	0.0242972	0.0276527	0.024822	0.0260859	0.0207043	0.0267131	0.0287249
Max	0.132804	0.129286	0.145623	0.133589	0.177696	0.12516	0.138525	0.164245
Min	0.028734	0.034226	0.012355	0.020315	0.05095	0.036064	0.034627	0.018681

Source: Research finding.

Table A2. The MPI in Urban Areas during 2013-2019

	2013	2014	2015	2016	2017	2018	2019
East Azarbayjan	0.082402	0.074713	0.097045	0.069767	0.061044	0.069332	0.088905
West Azarbayjan	0.065079	0.074672	0.090599	0.117155	0.11305	0.093838	0.112558
Ardebile	0.081057	0.065769	0.08221	0.079337	0.074145	0.089144	0.115596
Isfahan	0.082266	0.059724	0.083468	0.05819	0.047721	0.046611	0.047272
Alborz	0.07627	0.035845	0.035597	0.035444	0.027111	0.028527	0.027845
Eilam	0.084547	0.090636	0.109189	0.100907	0.089891	0.083034	0.10865
Boshehr	0.071986	0.056639	0.09316	0.086046	0.06649	0.074748	0.096458
Tehran	0.083965	0.043713	0.047993	0.02569	0.031227	0.029501	0.031133
Chaharmahal	0.030312	0.025445	0.030821	0.038054	0.056346	0.054266	0.074772
South Khorasan	0.007937	0.016991	0.051474	0.09293	0.103425	0.100696	0.108649
Khorasan Razavi	0.080851	0.056263	0.072719	0.070318	0.063568	0.066013	0.074944
North Khorasan	0.115578	0.106633	0.091886	0.092959	0.091701	0.089821	0.099012
Khozestan	0.033877	0.051189	0.062045	0.101347	0.097403	0.076995	0.098887
Zanjan	0.052897	0.084041	0.094028	0.084591	0.088805	0.071155	0.098495
Semnan	0.097434	0.079316	0.072462	0.066677	0.063792	0.056448	0.078217
Sistan & Balouchestan	0.140231	0.135721	0.145363	0.161329	0.15111	0.152346	0.162901
Fars	0.104267	0.089304	0.080357	0.05989	0.063582	0.054525	0.073058
Qazvin	0.098615	0.084316	0.081985	0.05043	0.044388	0.055612	0.061565
Qom	0.187468	0.123101	0.120316	0.06796	0.061645	0.0652	0.088835
Kurdistan	0.083277	0.074243	0.062749	0.086845	0.095878	0.077275	0.0938
Kerman	0.130558	0.119048	0.116504	0.103091	0.109671	0.114064	0.13813
Kermanshah	0.08419	0.07749	0.081522	0.070871	0.071297	0.061905	0.084162
Kohkiloye	0.043783	0.027697	0.057994	0.065521	0.064854	0.049828	0.071869
Golestan	0.155064	0.127785	0.131678	0.117404	0.096898	0.076377	0.086615
Gilan	0.050965	0.047972	0.062302	0.049815	0.05087	0.043598	0.054259
 Lorestan	0.106333	0.077846	0.090339	0.083849	0.089482	0.069717	0.084028
Mazandaran	0.063276	0.046718	0.043093	0.033087	0.024616	0.024821	0.032309
Markazi	0.111575	0.07483	0.070035	0.065069	0.06169	0.052744	0.061767
Hormozgan	0.054263	0.090632	0.082992	0.108301	0.095591	0.079649	0.099267
Hamedan	0.150406	0.07892	0.085744	0.055076	0.075712	0.088224	0.06608
Yazd	0.098982	0.07527	0.062564	0.047146	0.048714	0.051712	0.07612
Country as a Whole	0.088027	0.072617	0.079824	0.074292	0.072498	0.068774	0.08238
Mean	0.08741	0.073306	0.08033	0.075648	0.073604	0.069281	0.083747
Median	0.083277	0.07483	0.081985	0.070318	0.06649	0.069332	0.084162
St. Dev	0.038806	0.029566	0.026681	0.029318	0.027755	0.02608	0.029485
Max	0.187468	0.135721	0.145363	0.161329	0.15111	0.152346	0.162901
Min	0.007937	0.016991	0.030821	0.02569	0.024616	0.024821	0.027845

Source: Research finding.

Table A3. The MPI in Rural Areas during 2005-2012

	2005	2006	2007	2008	2009	2010	2011	2012
East Azarbayjan	0.089309	0.132833	0.117579	0.100229	0.109484	0.093585	0.120519206	0.051199427
West Azarbayjan	0.114723	0.117832	0.122262	0.110409	0.113076	0.093724	0.095131485	0.084192817
Ardebile	0.088839	0.093238	0.087192	0.081486	0.079762	0.073858	0.06474434	0.057592647
Isfahan	0.060187	0.066577	0.059558	0.058841	0.07562	0.064559	0.064880113	0.069571091
Alborz	-	-	-	-	-	-	0.035803127	0.078787879
Eilam	0.062759	0.078018	0.061341	0.069324	0.070902	0.058493	0.043994765	0.052946081
Boshehr	0.037472	0.046402	0.030213	0.026706	0.052941	0.050928	0.092121212	0.092879395
Tehran	0.057976	0.065591	0.060664	0.077989	0.095927	0.089643	0.078960155	0.092828224
Chaharmahal	0.087805	0.070093	0.049557	0.054266	0.068254	0.059033	0.064304462	0.050940219
South Khorasan	0.135868	0.109219	0.137623	0.150016	0.128692	0.079126	0.073533915	0.04977287
Khorasan Razavi	0.158251	0.133653	0.115806	0.124805	0.153314	0.12638	0.117382413	0.100175285
North Khorasan	0.195938	0.188095	0.18019	0.181881	0.149695	0.132162	0.156778175	0.12694901
Khozestan	0.137973	0.111015	0.131848	0.093074	0.101495	0.075437	0.061825637	0.047907211
Zanjan	0.121955	0.109091	0.108381	0.064268	0.079352	0.051351	0.046057767	0.029597474
Semnan	0.044583	0.091837	0.072063	0.070401	0.088084	0.075822	0.085811467	0.082417582
Sistan & Balouchestan	0.193463	0.211622	0.23623	0.240919	0.246192	0.259003	0.231507491	0.208518818
Fars	0.069333	0.078906	0.069762	0.074449	0.077778	0.050009	0.060185185	0.06260342
Qazvin	0.072506	0.084702	0.068466	0.071962	0.085578	0.079811	0.066831683	0.053807947
Qom	0.115449	0.106995	0.098547	0.121184	0.15121	0.086548	0.077872073	0.131375393
Kurdistan	0.104709	0.109107	0.088192	0.086222	0.091865	0.067238	0.062307988	0.077560602
Kerman	0.161806	0.131125	0.111839	0.121336	0.17189	0.119954	0.111068727	0.119014132
Kermanshah	0.122595	0.147291	0.098519	0.101867	0.122164	0.092646	0.078201369	0.083832335
Kohkiloye	0.144121	0.189453	0.096944	0.130412	0.139774	0.122109	0.11462585	0.123911565
Golestan	0.188571	0.154762	0.166735	0.176405	0.200035	0.162146	0.160434174	0.155204132
Gilan	0.065403	0.053934	0.059112	0.077372	0.074115	0.061158	0.064138476	0.055171918
Lorestan	0.132561	0.112514	0.057087	0.083785	0.11717	0.098481	0.072168764	0.100091256
Mazandaran	0.042328	0.045693	0.043269	0.052619	0.058856	0.042902	0.053848506	0.059011164
Markazi	0.084772	0.078664	0.095938	0.130952	0.135845	0.115916	0.076335656	0.082343695
Hormozgan	0.177174	0.161529	0.13159	0.155121	0.127613	0.101262	0.074132217	0.04375483
Hamedan	0.116035	0.126706	0.1132	0.073441	0.134654	0.108729	0.121586276	0.103482947
Yazd	0.107476	0.092399	0.10518	0.108318	0.122298	0.092824	0.086526538	0.069517544
Country as a Whole	0.109648	0.111969	0.101205	0.104563	0.117886	0.095417	0.089727946	0.084812874
Mean	0.1097313	0.109963	0.099162	0.102335	0.1141211	0.092827	0.0875361	0.0837728
Median	0.1110995	0.109099	0.097731	0.089648	0.11128	0.088095	0.07633565	0.07878787
St. Dev	0.0463079	0.042337	0.044007	0.045425	0.0433462	0.042146	0.0401488	0.0377443
Max	0.195938	0.211622	0.23623	0.240919	0.246192	0.259003	0.2315074	0.2085188
Min	0.037472	0.045693	0.030213	0.026706	0.052941	0.042902	0.0358031	0.0295974

Source: Research finding.

Table A4. The MPI in Rural Areas during 2013-2019

	2013	2014	2015	2016	2017	2018	2019
East Azarbayjan	0.089923469	0.105291005	0.123788297	0.064620811	0.078849265	0.071604158	0.089470352
West Azarbayjan	0.091857506	0.085348559	0.102459941	0.100232838	0.095801412	0.100609524	0.148951472
Ardebile	0.081221198	0.074280011	0.101596864	0.084195997	0.079133115	0.074378882	0.090674145
Isfahan	0.095723297	0.093923034	0.105780797	0.046522324	0.031611099	0.040519878	0.039405124
Alborz	0.090678825	0.061336828	0.068498803	0.024328062	0.028031071	0.01562636	0.018639456
Eilam	0.100848656	0.144371043	0.16753496	0.132568515	0.104183609	0.086073675	0.091396408
Boshehr	0.070835614	0.057881773	0.090429043	0.066386555	0.030580217	0.034045394	0.061757392
Tehran	0.15033165	0.09552964	0.105122212	0.028	0.033363033	0.032309476	0.036426117
Chaharmahal	0.054715219	0.05184559	0.054064454	0.033082198	0.047619048	0.045043732	0.064195298
South Khorasan	0.027239997	0.038466734	0.091309695	0.082750103	0.143817758	0.146870363	0.168591692
Khorasan Razavi	0.103043111	0.0821513	0.090047393	0.075231284	0.077731935	0.083672661	0.098593604
North Khorasan	0.160509031	0.163519431	0.138273125	0.106321839	0.106731165	0.100513875	0.119568995
Khozestan	0.056132139	0.070896515	0.095405297	0.081811418	0.095674659	0.089269226	0.101077558
Zanjan	0.064056777	0.080494505	0.102353585	0.069107955	0.076533927	0.058412081	0.093554121
Semnan	0.103317175	0.090785908	0.105782313	0.05593985	0.060956333	0.06809822	0.088717645
Sistan & Balouchestan	0.217467015	0.232624113	0.246884893	0.251823849	0.24587721	0.264756408	0.251680672
Fars	0.109871032	0.09662567	0.097374847	0.06876964	0.070238095	0.058706379	0.079828378
Qazvin	0.091660704	0.088163958	0.096245266	0.031692134	0.041768243	0.030696229	0.02997003
Qom	0.171031746	0.134737996	0.128193657	0.066815476	0.078581433	0.080769231	0.096642247
Kurdistan	0.099271137	0.095188075	0.078103208	0.065086297	0.064063761	0.065626884	0.089963834
Kerman	0.181160984	0.205525264	0.199971443	0.166593294	0.160950804	0.147378464	0.178825553
Kermanshah	0.100918367	0.079114573	0.102198332	0.05651341	0.053323029	0.040355125	0.048474275
Kohkiloye	0.072390572	0.039281706	0.081265558	0.080477799	0.068021485	0.052770342	0.110159817
Golestan	0.203259596	0.188872621	0.182225019	0.117124677	0.093253968	0.089673147	0.100981621
Gilan	0.093067122	0.093034826	0.098746867	0.045305716	0.058106576	0.065759637	0.074426808
Lorestan	0.122298066	0.073736638	0.10621118	0.130870561	0.11973952	0.100598355	0.105977356
Mazandaran	0.069383345	0.059642069	0.04781713	0.017886562	0.013008515	0.018626212	0.02950408
Markazi	0.109265194	0.080867347	0.092874029	0.07831123	0.0594115	0.047816754	0.049014582
Hormozgan	0.088992035	0.147665963	0.134304786	0.155052975	0.13706485	0.112042737	0.116866594
Hamedan	0.176649958	0.120954076	0.117094017	0.060792014	0.087354942	0.103319864	0.095800209
Yazd	0.107279246	0.072270709	0.079634767	0.031565069	0.026541764	0.022715671	0.025049223
Country as a Whole	0.108671684	0.101593851	0.112024295	0.082546	0.08214	0.077751	0.09195
Mean	0.108206445	0.100142822	0.110696509	0.079863886	0.07961043	0.075763192	0.090134989
Median	0.099271137	0.088163958	0.102198332	0.06876964	0.076533927	0.06809822	0.090674145
St. Dev	0.045021217	0.047013962	0.041320313	0.048979338	0.04725935	0.048775759	0.049520935
Max	0.217467015	0.232624113	0.246884893	0.251823849	0.24587721	0.264756408	0.251680672
Min	0.027239997	0.038466734	0.04781713	0.017886562	0.013008515	0.01562636	0.018639456

Source: Research finding.



Microfinance as a Catalyst for Change: Evaluating the Success of Iran's Rural Employment Program from 2017 to 2022

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Abstract

The Iranian economy has long been challenged by elevated unemployment rates, a situation further complicated by enduring inflation, as illustrated by the Phillips curve, which highlights the inherent trade-off between these two economic variables. The severity of unemployment is underscored by public policy debates about employment objectives and inaccurately estimating job creation costs. Despite the implementation of numerous plans over decades to reduce unemployment, including the Rural Employment Plan (REP), their causal effects are rarely identified. The REP, a notable microfinance initiative, was launched from 2017 to 2022. In the present paper, we use instrumented GMM, AB GMM, BB GMM, ARDL, and FE to examine the program's impact and present findings that challenge conventional academic expectations. Our results indicate that lagged logarithmic payments exert a consistently positive and significant effect, particularly in areas with higher employment rates, thereby suggesting enhanced benefits in regions with more robust economic activity. Furthermore, microfinance initiatives have proven instrumental in supporting impoverished areas by providing essential financial resources, enabling individuals to establish or maintain micro-enterprises, thus facilitating income generation and promoting local economic growth. Overall, one of our key findings is that the cost of job creation in this plan is 214 million Tomans at a fixed price for the year 2022, as we clearly demonstrate.

Keywords: Entrepreneurship, Job Creation Program, Microfinance, Panel Data Models, Rural Employment in Iran.

JEL Classification: C23, C32, G21, J680, O170.

1. Introduction

Unemployment is one of the key indicators in analyzing the economic and social status of any society. It not only reflects the dynamism of the labor market and the

economy's capacity to absorb human resources but also has profound impacts on social structures, cultural norms, and even the psychological well-being of individuals and households. This phenomenon, as a multifaceted problem, arises from the complex interaction of economic factors such as the structure of production, fiscal and monetary policies, and labor market developments, with social variables like inequality, poverty, and migration in developing economies like Iran, particularly in rural areas, unemployment has become a chronic challenge rooted in issues such as insufficient investment, weak infrastructure, and a lack of productive employment opportunities. From an economic perspective, this situation not only leads to a reduction in the productivity of all production factors but also imposes significant social and welfare costs on governments, thereby weakening the potential for long-term economic growth (Behnia et al., 2021; Mankiw, 2024; Pourmohammadi and Yousefi, 2021).

Small and medium-sized enterprises (SME), with own account workers, account for a staggering 70% of employment worldwide (ILO, 2023), acting as both direct and indirect job creators. Directly, they hire employees to fulfill various roles within their operations, from production and sales to administration and management. The number of employees hired varies greatly depending on the size and nature of the business. Indirectly, small businesses stimulate employment by creating demand for goods and services from other businesses, leading to further job creation in related industries like manufacturing, transportation, and professional services. This ripple effect amplifies their employment impact, contributing to a broader and more diversified employment landscape. Furthermore, small businesses often provide flexible work arrangements and opportunities for entrepreneurship, increasing participation in the workforce and fostering economic dynamism.

Many small businesses, such as rural businesses, lack the initial capital or reserves to cover invest in equipment or inventory, or weather unexpected downturns. Loans provide the necessary financial bridge to cover these needs, enabling small businesses to launch, expand operations, hire employees, and contribute to economic growth. Without access to credit, many promising ventures would fail, limiting job creation and hindering overall economic development. Therefore, facilitating access to appropriate and affordable loans is essential for fostering a vibrant and dynamic small business sector.

However, many rural residents and small business owners lack access to bank loans. Microfinance fills a critical gap in the financial landscape by providing loans specifically tailored to the needs of small businesses or enterprises who lack

access to traditional banking systems. Because traditional lenders often hesitate to work with businesses lacking extensive collateral or credit history, microfinance institutions play a vital role in bridging this financial divide, enabling small business or enterprises to build their businesses and contribute to economic growth at a grassroots level.

In 2006, Mohammad Yunus and Grameen Bank won the Nobel Peace Prize for expressing and proving the importance of microfinance in reducing global poverty. The Nobel Committee acknowledged that perpetual peace would not happen except by eliminating global poverty (Banerjee et al., 2019; Esther et al., 2013). One of the best ways to reduce poverty is microfinance, which credits applicants who do not have physical collateral to receive loans. Thenceforth, Policymakers have considered microfinance as a poverty alleviation policy, and many financial institutions were established for this purpose.

The 1990s saw growing interest in the link between financial development and economic growth. Studies (King and Levine, 1993; Levine and Zervos, 1998) established a significant relationship, although causality remained unclear due to a lack of experimental evidence. Research further demonstrated that financial intermediary development positively impacts total factor productivity and GDP growth (Levine et al., 2000; Levine and Loayza, 2000). These findings contributed to the widespread adoption of microfinance as a poverty reduction and welfare-enhancing policy, culminating in the 2006 Nobel Prize (Banerjee et al., 2015).

However, the effectiveness of microfinance remains a subject of ongoing debate. Empirical studies examining microfinance programs for low-income households and firms have yielded mixed results, highlighting the need for further research to definitively assess the impact of these initiatives.

Early studies on microcredit impact often showed insignificant results. However, more recent research increasingly demonstrates positive economic effects. These studies have examined micro-level impacts (income, consumption, savings, investment) and macro-level impacts (GDP growth, aggregate consumption and investment) (Ayyagari et al., 2021).

Although many articles have worked on the effects of financial development on economic growth, few have addressed the effects of financial development on the labor market. The effect of increasing facilities on the labor market and employment is not apparent. By increasing the facilities, the firm invests and increases its production without increasing the labor demand. On, some articles admit that the labor force that needs training and hiring also has a fixed cost for the

company, in which case the increase in facilities can affect the company's decision to demand labor, that has the positive effect on employment rate.

There is clear evidence for the importance of microfinance in the labor market. During the Great Recession in 2007-2009, the financial crisis caused an employment crisis. In other words, there is a significant relationship between financial changes and the labor market.

If microfinance is not viewed as consumer loans and is considered commercial investment, it will increase the demand for labor. Investing in a firm significantly impacts employment through job creation and economic growth (Bloom et al., 2006). An influx of capital from investments allows a firm to expand operations and infrastructure, necessitating the hiring of additional staff across various roles, from manufacturing to administrative functions. This expansion enhances productivity by enabling the acquisition of advanced equipment and technology. Furthermore, the increase in employment fuels the local economy through a multiplier effect, as employees' disposable income leads to higher overall spending. Given the relative neglect of labor market impacts in recent microfinance research, further investigation into this area is crucial for informing effective policymaking. This research area presents a significant opportunity for contribution.

The current research focuses on the impact of Rural Employment Plan, REP, as a microfinance policy on Iran's employment rate. It aims to reduce unemployment by analyzing data to evaluate the effectiveness of these programs and suggest improvements in supportive policies. Theoretical perspectives on the labor market will be discussed, followed by an in-depth examination of labor market policies, mechanisms of unemployment in Iran, and a review of relevant data including the Labor Force Survey (LFS). The research progresses through sections discussing the theoretical framework, data analysis, model examination, findings, and concludes with policy recommendations.

2. Theoretical Framework

Unemployment exhibits significant heterogeneity across different groups of people. Unemployment is commonly categorized into short-term and long-term unemployment. Short-term employment, includes seasonal unemployment, frictional unemployment (due to job transitions), and structural unemployment (unemployment that happens because of economic restructuring, often impacting low-skilled workers due to technological advancements). Long-term unemployment (lasting more than six months, for example), sometimes considered

permanent, is particularly detrimental to the economy, leading to financial hardship and decreased job-seeking motivation.

All these types of unemployment can be classified by their origin: demand-side and supply-side. Demand-side unemployment arises when there's a drop in the demand for goods and services, leading to fewer labor requirements, often influenced by economic recessions or technological changes (Hamermesh, 2021). Supply-side unemployment, however, is related to the labor supply, such as changes due to immigration, education, or retirement, and mismatches in skills or geographic locations relative to job opportunities. Effective policy responses for these types vary, with demand-side solutions focusing on stimulating economic activity and supply-side measures aimed at enhancing labor market flexibility and aligning skills with job market needs (Farajnia et al., 2020).

Governments must carefully consider the specific type of unemployment occurring and then choose the most appropriate policies to effectively address and mitigate it. Macroeconomic stabilization, including monetary policies (whose effects on employment are described by the Phillips curve) and fiscal policies, improves labor market conditions. Labor market policies are further categorized into structural reforms (affecting the business environment), active policies and passive labor market policies. All types of policies can aim to reduce unemployment or achieve redistributive goals; reforms generally impact unemployment rates, active policies often focus on income redistribution and welfare improvements, while passive policies include Income Support Programs for unemployment. These categories are presented in Figure 1.

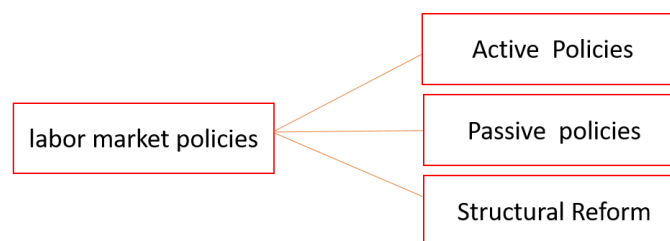


Figure 1. Labor Market Policies

Source: Research finding.

Active policies include fiscal measures (government spending, taxation, and subsidies) and monetary actions (interest rates and money supply management), both of which influence employment by adjusting economic levers. For example, fiscal policies stimulate labor demand through initiatives like increased public

spending and tax incentives for hiring, as demonstrated by the U.S. Paycheck Protection Program, which supported businesses in retaining employees (Granja et al., 2022). Monetary policies, managed by central banks, influence employment by affecting borrowing costs and credit availability (Bernanke, 2020).

Passive labor market policies provide financial relief primarily through income support to stabilize individuals during periods of unemployment, focusing on social protection rather than skills development or job placement.

Structural policies aim to reshape the labor market through labor law reforms, tax system adjustments, and enhanced access to labor markets, thereby improving labor market efficiency and workforce quality (Aiginger and Rodrik, 2020).

Active labor market policies further enhance job opportunities by improving worker employability through job training, search assistance, wage subsidies, and tax incentives (Mckenzie, 2017).

By strategically combining these diverse policy approaches, effective solutions to unemployment can be crafted, ensuring both immediate relief and long-term labor market stability. Such initiatives are particularly relevant in the context of Iranian labor market policies, which encompass a range of strategies designed to address these challenges (Behnia et al., 2021; Escudero, 2018; Martin, 2015).

- minimum wage regulation;
- unemployment benefits and job search assistance;
- youth employment programs;
- employer subsidies;
- a labor market information system;
- support for labor unions and guilds;
- active labor market policies (e.g., training and skills development);
- targeted employment programs for people with disabilities and veterans;
- job mobility and transfer programs;
- measures to improve working conditions;
- microfinance as REP.

As discussed, microfinance refers to the provision of small-scale financial services to low-income individuals or groups who lack access to traditional banking systems. The mechanism through which microfinance influence employment operates primarily through household-level and microenterprise investment. Recipients of microfinance typically use the funds to establish or

expand small-scale businesses, often in informal sectors. This leads to direct self-employment and, in some cases, the involvement of family labor, as highlighted by (Morduch, 2000), who notes that microfinance primarily enables self-employment rather than generating wage jobs (Hulme, 2000), further emphasizes that when loans are used for productive investments—such as tools, inventory, or market expansion—they can improve business returns and support modest employment gains, particularly within the household. The effect of microfinance on employment largely depends on the scale of investment and the extent of enterprise growth, with more substantial impacts observed when businesses are able to expand beyond subsistence levels. The findings also indicate that while microfinance can play a crucial role in enhancing employment, the magnitude of its impact depends not only on the strategy for selecting target regions and economic activities, but also on the amount of financial allocation.

After implementing a labor market program, a critical step is assessing its effectiveness through data modeling to identify the specific impacts of each policy on employment. It is essential to capture the temporal dynamics in employment modeling to ensure the accuracy of these effects. Factors such as existing labor contracts, adjustment costs, and employer and employee expectations often cause historical employment levels to influence current figures. Including previous employment rates as a lagged independent variable helps account for this persistence in the labor market. Additionally, it is crucial to consider unobserved individual heterogeneity related to variables such as city, which can provide valuable information, as well as the presence of time dummy variables (Arulampalam et al., 1998).

We investigate the effect of REP by using General Method of Moments (GMM) and Fixed Effect (FE). The core principle of the GMM is to estimate model parameters by exploiting moment conditions, that is, expectations based on theoretical relationships between variables and their instruments. In dynamic panel data models, higher-order lags of the dependent variable (typically lags 2 or 3) are commonly used as instruments, as they are assumed to be correlated with the endogenous regressors but uncorrelated with the error term. These valid instruments satisfy the orthogonality conditions required for consistent estimation. GMM identifies the parameter vector θ by minimizing the distance between the sample moments and their theoretical counterparts, thereby ensuring that the empirical moment conditions are as close to zero as possible. The basic GMM estimator minimizes the quadratic form:

$$\hat{\theta}_{GMM} = \arg \min \left[\frac{1}{n} \sum_{i=1}^n Z_i' \cdot \epsilon_i(\theta) \right]' W \left[\frac{1}{n} \sum_{i=1}^n Z_i' \cdot \epsilon_i(\theta) \right] \quad (1)$$

where W is a weighting matrix, Z_i are instruments, and $\epsilon_i(\theta)$ are residuals (Arellano and Bond, 1991).

For the sake of simplicity, we assume a balanced longitudinal data set of i units and t time periods with no missing data. For each unit i at time t , we observe the outcome variable Y_{it} and the treatment variable X_{it} . The most basic linear regression model with unit fixed effects is based on the following linear specification (Imai and Kim, 2021):

$$Y_{it} = \alpha_i + X_{it}\beta + \epsilon_{it} \quad (2)$$

where Y_{it} represents the dependent variable for entity i at time t . α_i is the unique intercept for each entity, capturing all unobservable individual-specific effects, X_{it} is a vector of explanatory variables that may change over time, β is the coefficient vector, ϵ_{it} is the error term, assumed to be idiosyncratic. Formally, we assume $\epsilon_{it} \perp \{X_i, \alpha_i\}$. The least squares estimate of β is obtained by regressing the deviation of the outcome variable from its mean on the deviation of the treatment variable from its mean (Ramos and Herrera, 2023):

$$\hat{\beta}_{FE} = \arg \min \sum_{i=1}^i \sum_{t=1}^t \{(Y_{it} - \bar{Y}_i) - \beta(X_{it} - \bar{X}_i)\} \quad (3)$$

In Section 5, we will develop our model using the FE model outlined here.

3. Unemployment Dynamics and Underlying Mechanisms in Iran

Iran's economy has struggled with persistently high unemployment, exceeding 10% in recent decades, as it is shown in Figure 2. Several factors contribute to this challenge, including the effects of Dutch Disease, extensive labor protections (Labor law), international sanctions, and the COVID-19 pandemic. These issues have been compounded by population growth and intensified sanctions.

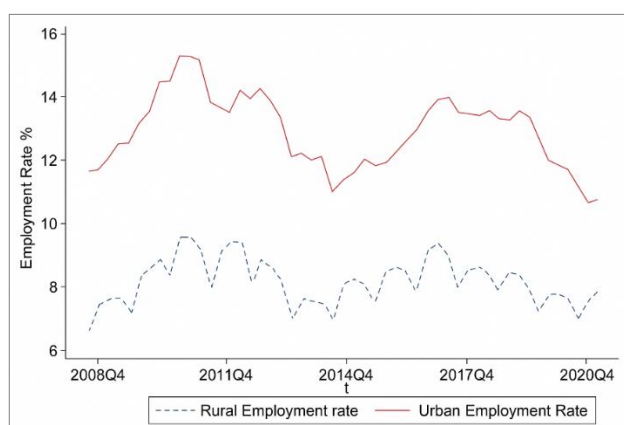


Figure 2. Moving Average of Urban and Rural Unemployment Rates, Seasonally Adjusted

Source: Research finding.

Dutch Disease, stemming from substantial oil exports, negatively impacts the Iranian economy in several ways. First, it concentrates economic activity in the capital-intensive oil sector, limiting job creation. Second, it leads to real exchange rate appreciation, increasing imports and contributing to deindustrialization. Third, it raises reservation wages in other sectors, hindering employment growth. The Dutch disease negatively impacts the structural integrity of the economy, disrupting the channels through which different sectors should function effectively (Dadgar and Orooji, 2020; Kulish et al., 2024).

Labor market regulations, such as those emphasizing worker redistribution and union representation, have set a minimum wage above market equilibrium, which discourages hiring and contributes to higher unemployment rates. This situation was exacerbated by the COVID-19 pandemic, which severely disrupted economic activity, particularly within the service sector, affecting small businesses that form a substantial portion of the Iranian workforce. Moreover, international sanctions, mainly targeting the industrial sector, have further reduced employment opportunities. These combined forces have led to a significant decline in overall employment, with heightened sanctions during the pandemic amplifying these negative impacts (Heckman and Pages, 2003; Pourmohammadi and Yousefi, 2021).

Rural unemployment in Iran is also a significant concern. The agricultural sector, a primary source of rural employment, has been negatively impacted by sanctions, increasing production costs and limiting market access. This has led many rural workers to seek alternative employment, often in poorly-paid or less

stable jobs. While rural unemployment rates may be lower than urban rates, seasonal fluctuations in rural employment, coinciding with agricultural cycles, create considerable income variability. Limited access to financial resources further exacerbates this income instability, motivating rural-to-urban migration, which also strains urban employment markets. This migration negatively impacts the overall economy, as rural production declines, and exacerbates the overall unemployment trend. The REP represents a crucial government initiative to address this issue and promote sustainable rural employment.

4. Dataset Description and Model Specification

4.1 Rural Employment Plan

The REP, initiative was born to eliminate severe poverty in rural areas, improve villagers' level and quality of life, create employment and increase their productivity. In Iran, the REP provided low-interest loans to low-income individuals in villages and small towns who lacked the collateral typically required for conventional loans. The REP operated on the principle of job creation in exchange for funding. Instead of traditional collateral, the program used a combination of low-value assets and a commitment to generate a specified number of jobs, thereby functioning as a form of microfinance.

Welfare goals and poverty reduction are generally considered in microfinance payments. The REP regards employment and its increases. However, to reduce poverty, it is necessary to increase income and employment. Therefore, although the REP was primarily aimed at increasing employment, it can also be said to encompass welfare objectives.

In the REP, facilities were given at average rate of 10% for each project to manufacturing unit located in rural areas and cities with fewer than 10,000 people. The rate of mentioned facilities for projects in rural border areas and border nomads is 4% and in non-border villages and non-border nomads is 6%.

Information about the funds disbursed for implementing the REP is recorded on the KARA website.¹ KARA contains 157,392 observations which report 51 variables for each observation. These variables include the requested amount, amount of payment, time of payment, occupation, city of the recipient of the facility, and the number of job creations pledged.

In Table 1, we summarized the statistical information related to the payment of facilities in implementing the REP based on the information recorded in the

¹. which is managed by the Ministry of Cooperatives, Labor, and Social Welfare.

KARA. As you can see, the REP has been implemented since 2017 and continues until 2022, but most payments were made in 2017 and 2018. However, the average payment in 2021 was very higher than in 2018.

Table 1. Summary Statistics of Microfinance Payment (Million Toman)

t	#	Sum	Mean	Max	Min	sd
Q4 2017	13	9.9	761	8700	9	2390
Q1 2018	174	44.4	255	2500	5.7	547
Q2 2018	4439	483	109	6000	0.00001	329
Q3 2018	27417	2310	84.2	15000	1.18	327
Q4 2018	27344	2270	82.9	27300	0.1	391
Q1 2019	26287	1970	74.9	21000	E-071	351
Q2 2019	10493	909	86.7	93000	0.01	988
Q3 2019	12154	1060	87.3	15000	1	452
Q4 2019	11149	919	82.4	15000	2.2	440
Q1 2020	14041	1320	94.3	45500	3.2	622
Q2 2020	2072	296	143	10000	0.25	565
Q3 2020	2199	343	156	15000	5	676
Q4 2020	2280	316	138	13000	2	626
Q1 2021	4034	533	132	15000	1.2	650
Q2 2021	2586	301	116	12000	3.2	577
Q3 2021	1732	285	164	15000	0.01	763
Q4 2021	982	208	212	15000	10	803
Q1 2022	23	0.828	36	200	8	38.8

Source: Research finding.

Therefore, total payments in 2018 and 2021 are almost the same. Between January 2018 and April 2020, 1500 million dollars (9,752 billion Toman) was paid to 145,041 borrowers. The distribution of REP payments is shown in Figure 3. Our investigation shows that cities with a higher number of loans also tend to have more valuable loans. The observed high correlation between payment amounts per capita and payment count per capita reveals a significant pattern in the distribution of loans across different cities. This strong positive relationship indicates that cities with higher per capita loan amounts also tend to exhibit a greater number of loans per capita, and vice-versa. In other words, the data suggests that loan allocation is not merely a matter of distributing funds widely; rather, it appears that certain cities receive both a larger volume of loans and a greater amount of loan capital per

resident. This implies that financial resources are not evenly dispersed but rather concentrated in specific geographic areas. This concentration could arise due to a variety of factors, including variations in economic activity, investment opportunities, or lending practices across different cities. Understanding the drivers of this correlation is crucial for policy makers who intend to promote more inclusive and equitable distribution of resources.

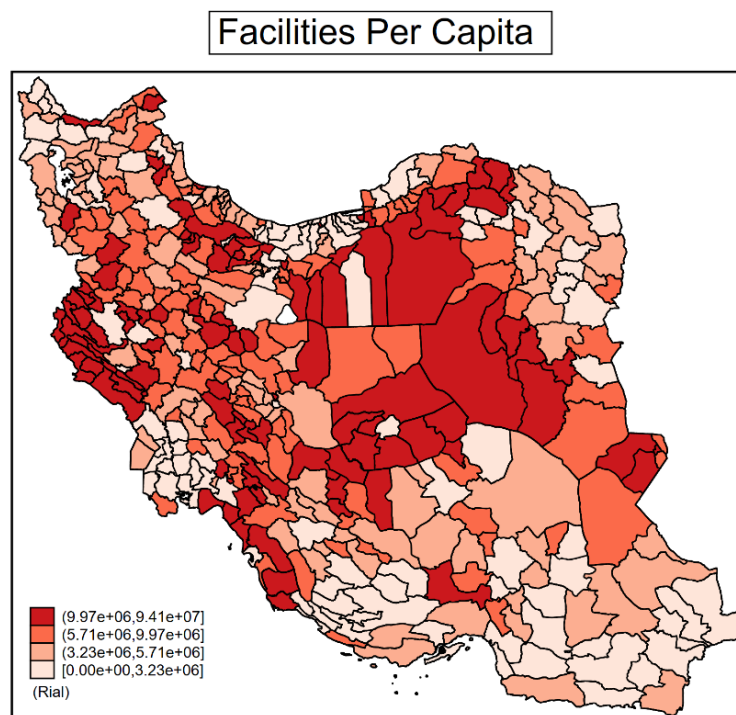


Figure 3. The Distribution of Average Payment Amounts per Capita by City

Source: Research finding.

Table 2. Ratio of Payment by Section

Target Section	Number of Facilities	Ratio
Agriculture and Natural Resources	92250	59.15
Small industries and mines	18512	11.86
Service and IT	15121	9.7
Tourism	2743	1.76
Handicrafts (e.g., carpet)	25255	16.2

Source: Research finding.

A policymaker selected the series of activities with the most capacity to create added value and employment simultaneously. In Table 2, we report the ratio of payment in each section.

4.2 Labor Force Survey

Information on Iran's labor force is obtained from a quarterly survey. The Iran Labor Force Survey (LFS), is conducted by the Statistical Center of Iran to collect information on employment, unemployment, and other characteristics of the country's labor market. The survey is conducted in all cities of Iran and covers all individuals aged 15 years and older. The survey provides information on the number of active and inactive labor forces, employed and unemployed, the sectors in which individuals are or were employed, the occupational structure of the labor force, the types of contracts in which individuals are employed, and the insurance status of individuals. It also provides data on the characteristics of the unemployed, the duration of unemployment, and the sector in which individuals are looking for work.

Table 3. Summary Statistics of Employment Rate

t	#	Mean	Max	Min	sd
Q2 2017	11821	41.04	68.71	14.68	7.94
Q3 2017	11821	41.74	71.31	13.50	8.20
Q4 2017	11821	40.55	67.30	15.86	7.78
Q1 2018	11731	39.51	59.68	24.14	6.79
Q2 2018	12661	42.12	74.95	0.00	8.16
Q3 2018	12721	42.15	71.05	10.18	7.99
Q4 2018	12721	41.57	8.07	15.85	70.43
Q1 2019	12751	39.59	69.63	14.57	6.86
Q2 2019	12751	42.12	73.96	10.41	7.87
Q3 2019	12751	42.36	78.79	6.31	7.73
Q4 2019	12751	41.84	72.04	13.15	7.61
Q1 2020	12751	39.30	61.56	19.86	6.51
Q2 2020	12751	38.80	75.26	9.37	7.50
Q3 2020	12721	39.62	7.24	8.04	69.60
Q4 2020	13291	38.96	7.58	12.90	71.85
Q1 2021	930	37.48	3.36	31.21	43.71
Q2 2021	930	38.23	3.65	31.29	44.03

Source: Research finding.

The Iran LFS is used to understand the state of the country's labor market and inform policy decisions.

In this study, data from the LFS between 2017 and 2021, as shown in Table 3, are used to test the research hypothesis that microcredit payments to the population living in villages and small towns have an impact on employment rates.

The provincial employment rates, calculated as the number of employed individuals relative to the total population aged 15 years and older within each province, Tehran, Isfahan, Golestan, Alborz, and Kerman exhibit the highest employment rates relative to their respective populations over 15 years of age.

By comparing the payment structural and employment rate, pattern suggests a potential strategic direction in the allocation of resources and infrastructure. Specifically, it implies that infrastructure and facilities might have been targeted toward provinces with comparatively lower employment rates, potentially as a means to stimulate local economies and create employment opportunities. These findings raise important questions about the effectiveness of current rural employment policies and highlight the need for further analysis. Future research could investigate whether these targeted investments effectively translated into increased employment and assess the mechanisms through which facility deployment impacts job creation, thereby providing valuable insights for evidence-based policy refinement. A quantitative causal assessment of these results is needed to establish which factors are contributing most to employment in these regions. This, in turn, will enable a more robust policy design.

4.3 Setting

This research analyzes the impact of the REP on employment rates, using two independent datasets: the LFS and KARA data sources. Early studies on microfinance suggested a lack of long-term macroeconomic effects. However, subsequent research presented a more nuanced view and found a positive and long-run but insignificant effect of microfinance. Ongoing research has progressively established a long-run positive impact on the economy. Building on these findings, our study aims to investigate whether the REP, as a form of microfinance, demonstrates similar effects on Iranian employment. The analysis will consider the findings of prior microfinance studies and their evolving conclusions on the subject to interpret the results obtained using LFS and KARA data (Esther et al., 2013; Banerjee et al., 2015).

As Banerjee et al. (2019) result for find a long-run effect of microfinance, it seems that Autoregressive Distributed Lag (ARDL) models offer a simultaneous

analysis of short-run and long-run relationships between variables. (Nkoro and Uko, 2016) In applied econometrics, the ARDL approach, including the bound testing procedure for cointegration (B. Pesaran and Pesaran, 2009; M. H. Pesaran, 2021), offers a solution for investigating long-run relationships among non-stationary time series. This approach allows reparameterization into an Error Correction Model (ECM), offering advantages over other cointegration techniques such as the Johansen-Juselius method (Johansen and Juselius, 1990) .

Another method, which is commonly used to address panel data with dynamic endogeneity bias, is the Generalized Method of Moments (GMM), a robust econometric technique effective for analyzing employment impacts. (Arellano and Bond, 1991). Theoretically, it is well established that using second or third lags of the dependent variable as instruments in GMM estimations effectively addresses the endogeneity introduced by including the first lag of the dependent variable as a regressor. In basic GMM, a wide variety of potential IVs can be used, selected based on theoretical justification and exogeneity. Meanwhile, Arellano-Bond GMM (AB GMM) primarily utilizes lagged differences of the dependent variable to eliminate unobserved effects and address autoregressive structures. Blundell-Bond GMM (BB GMM) extends this by combining both lagged differences and levels, aiming to both eliminate fixed effects and enhance the strength and efficiency of instruments in the presence of persistent data. (Baum et al., 2003; Blundell et al., 2000; Zsohar, 2012) As mentioned earlier, these methods are well-established in analyzing panel datasets, especially in macro-level analysis.

Ayyagari et al. (2021), among others, have successfully used the introduction of credit bureaus as an instrumental variable to analyze microfinance's effects on employment, where the credit bureaus introduce a positive shock to credit supply. They analyzed the impact of access to finance on job growth in a sample of 50,000 firms across 70 developing countries. The findings indicate that increased access to finance positively correlates with employment growth, particularly for small and medium-sized enterprises (SMEs).

However, the overall effect of financial interventions is complex and not always straightforward, as seen in the analysis by (Dizikes, 2012) and (Kaboski and Townsend, 2012) on the Thai government's Million Baht program. They result that consumption grew, incomes for those in agriculture and other forms of business increased, and wages for workers rose. These are signs of economic growth, but the overall growth of assets in villages slowed down.

To see other side of the story, (Breza and Kinnan, 2021) using data from the state of Andhra Pradesh which resource allocation was suddenly stopped in 2010 and

comparing it with other states that microfinance program continued. The results of this study indicate that consumption, income, and employment in general equilibrium in the rural labor market have decreased.

Our analysis seeks to elucidate the complex relationship between financial access and employment, a question with significant policy implications. To rigorously investigate this relationship, we employ econometric techniques that account for heterogeneity across activities, cities, and time periods. Motivated by Banerjee et al. (2019), which suggest that microfinance impacts manifest with a time lag, our models incorporate lagged payment terms to capture these dynamics. The panel data, spanning quarterly observations from 2017 to 2022, 426 cities, and activities classified by 2-digit ASIC codes, necessitate a flexible and robust modeling framework. beside GMM models which is most popular in this context (Ullah et al., 2018), we adopt a Fixed Effects (FE) regression approach (Mroua and Trabelsi, 2020). City-specific fixed effects control for unobserved heterogeneity across cities, ensuring that estimated coefficients are robust to time-invariant city characteristics. To account for Iran's high inflation, we include time dummies to capture inflationary effects.

The general form of a panel data linear regression FE model with a large number of group-specific fixed effects can be expressed as follows:

$$\begin{aligned} emp.rate_{t,c,a} = & \alpha + \beta.emp.rate_{t-1,c,a} + \gamma.log.Payment_{t-3,c,a} + \phi_{city} \\ & + \sum \theta_i Year\_Dummy_i + \epsilon_{t,c,a} \end{aligned} \quad (4)$$

where $emp.rate_{t,c,a}$ is the employment rate at time t , city c and activity a . $log.Payment_{t-3,c,a}$ is natural logarithm of microfinance payment in REP at time $t-3$, city c and activity a . The terms ϕ_{city} are characteristics representing the fixed effect for city c , allowing for city-specific time-invariant unobserved heterogeneity. $Year\_Dummy_i$ is dummy for year time controlling for individual-specific effects and other time-varying covariates. $\epsilon_{t,c,a}$ is the error term at time t , city c and activity a , capturing the unobserved factors affecting the employment rate for a given city-time combination?

The corresponding GMM models is represented by equation (4), where we use lags of the employment rate as IVs in all GMM models—GMM, AB GMM, BB GMM—to address endogeneity issues associated with using the employment rate's lag as an explanatory variable with different lag formats, level, or difference.

$$\begin{aligned} emp.rate_{t,c,a} = & \alpha + \beta.emp.rate_{t-1,c,a} + \gamma.log.Payment_{t-3,c,a} + \phi_{city} \\ & + \lambda_{time} + IV + \epsilon_{t,c,a} \end{aligned} \quad (5)$$

where all notations are the same as in the FE specification, except that λ_{time} is dummy for year time, controlling for individual-specific effects and other time-varying covariates. The instruments used in the GMM models include lags of the dependent variable (lags(2/.), lags(2/4), lags(2/3) employment rate) as well as first differences of the employment rate.

Specifically, α is the model's intercept, and β is the coefficient on the first lag of the employment rate. This coefficient measures the extent to which past employment levels influence current employment rates. γ is the coefficient for the lagged log-payment variable. It represents the effect of a change in the corresponding lagged variable on employment rate at the current time period, that quantify the effect of log-payments, where 3 denotes 3 period lags from the current period. θ is the coefficient for the *Year_Dummy* which provides a measure of the effect that specific year has on the employment rate.

5. Result

To ensure the robustness of our findings, we explore a range of econometric approaches, including GMM, AB GMM, BB GMM, and ARDL models. However, due to the unbalanced structure of the panel data and the limited number of groups, the ARDL model is not applicable in this context. While each of these methods offers unique advantages, they also come with specific assumptions and requirements regarding instrument validity or cross-sectional heterogeneity. Table 4 presents result of the FE and GMM models, including standard GMM, AB GMM, BB GMM, revealing significant coefficient, robust standard errors and reliable estimates for the REP effect on Iranian employment. the REP coefficient ranges in all models, reflecting differences in model assumptions and estimation. while FE and GMMs models consistently pass validity tests for heteroskedasticity, serial correlation, and cross-sectional dependence, ensuring robust and reliable estimates; In contrast, the ARDL model is unsuitable for our unbalanced panel data, requiring restrictive assumptions that undermine result validity.

The log-payment variable exhibits positive and statistically significant coefficients in all models, indicating a positive association between previous payments and current employment rates. To assess the validity of our models We teste for multicollinearity using Variance Inflation Factors (VIFs), finding an average VIF of 1.00, indicating a no correlation between independent variables, does not any significant concern to the analysis. The R_squared, indicating that the overall FE model is highly significant. The overall models F-statistic indicates that

the predictors are statistically significant. Additionally, the fixed effects F-test confirms that the city fixed effects are jointly significant.

Prior to regression, we confirmed the stationarity of key variables using Augmented Dickey-Fuller (ADF) tests. These tests strongly indicate stationarity for both employment rates and log-payments, which is crucial for the valid estimation of our dynamic model. Further, inclusion of the robust option in the command suggests heteroscedasticity is likely not a significant concern in this model.¹

Our analysis, based on a dynamic panel-data model, reveals significant insights into the impact of microfinance payments on employment rates. The summary statistics indicate that the average employment rate across observed periods is approximately 40.94%, with payments averaging around 27.4 billion Tomans per city, quarter and activity. (The reported averages are calculated by disaggregating the data across individual cities, quarters (Q42017, ..., Q12022), and economic activity. For each combination of city, quarter, and activity sector, the employment rate and total payments were computed, and then averaged across all observations. The figure of 27.4 billion Tomans refers to the mean payment value per sector, per city, per quarter, not the aggregate across all sectors.) The model results demonstrate that microfinance payments have a positive and statistically significant effect on employment rates, particularly when considering the lagged log-payment at period 3.

Specifically, our findings show that an increase in average sum of payment per city, quarter, and activity, by 1 billion Tomans is associated with an approximate increase of 1.6 percentage points in the employment rate. This effect, while modest, underscores the potential of microfinance to stimulate economic activity and employment.

¹. As requested by referees of this paper, we run the Sargan test for instrument validity, while we believe that the AB GMM is well established and using the 2nd lagged of macro variable as the instrument for the 1st variables are conceptually accepted. This concept is consistent with the assumption of an AR(1) distribution for most macro variables, unless other evidence exists. Though, the Sargent tests reject the null hypothesis of valid IVs, but this does not conclusively invalidate the underlying GMM models as explained above. As noted by (Baum et al., 2003), the Hansen–Sargan test reflects the joint validity of instruments and its rejection may result from issues such as instrument proliferation or non-homogeneous errors, rather than necessarily indicating a flawed model structure.

Table 4. Comparison of Regression Results Across Different Model Specifications and Time Dummies.

	GMM		AB GMM		BB GMM		FE	
Dependent Var.	Employment_Rate(t,city,activity)							
IV (emp_rate)	L(2/4)		L(2/3)		L(2/4)		N/A	
	Year Quarter Dummy							
Constant	-363.3***	(10.54)	-21.97***	(4.197)	15.87***	(0.987)	35.23***	(0.495)
L.emp_rate	0.967***	(0.01)	0.346***	(0.005)	0.365***	(0.004)	0.120***	(0.003)
L3.log_payment	8.830***	(0.44)	2.190***	(0.172)	0.361***	(0.002)	0.103***	(0.016)
Observations	70,680		85,440		85,440		85,440	
GMM Test	760		3,597		7,937		N/A	
P_Value	0.00		0.00		0.00		0.00	
R-squared	N/A		N/A		N/A		0.6874	
	Year Dummy							
Constant	-2,219***	(10.96)	-18.10***	(0.919)	9.148***	(0.524)	28.62***	(0.481)
L.emp_rate	0.948***	(0.010)	0.325***	(0.005)	0.332***	(0.004)	0.108***	(0.003)
L3.log_payment	9.393***	(0.458)	2.103***	(0.037)	0.841***	(0.019)	0.438***	(0.015)
Observations	70,680		85,440		85,440		85,440	
GMM Test	693		5,426		11,126		N/A	
P_Value	0.00		0.00		0.00		0.00	
R-squared	N/A		N/A		N/A		0.664	

Source: Research finding.

Note: Standard errors are reported in parentheses below each coefficient. Statistical significance is denoted as follows: * p<0.05, ** p<0.01, *** p<0.001. The city effects are absorbed in all models.

To further explore the heterogeneity in our findings, we conduct a quantile regression analysis, allowing us to examine the effect of our key variables across different levels of the employment rate and expenditure distribution. In Table 5, we present the results of this quantile analysis alongside one of our baseline models, comparing the estimated coefficients and standard errors. We select the cities exhibiting the highest and lowest average employment rates to represent the extremes of our distribution and perform the quantile regression model using these subsamples, alongside running the model for the entire sample. We similarly select cities with the highest and lowest total expenditures to verify if the effects are driven by the cities with the highest activity. This method enables us to assess if the impact of lagged employment rates and log-payments varies systematically across cities with varying performance. This procedure will allow us to see how the explanatory variables influence the dependent variable at different quantiles of its distribution. The quantile regression results are presented in Table 5, with columns 1 through 5 representing the base model, highest employment, lowest Employment, highest expenditure, lowest expenditure, respectively. We report the estimated coefficients for each explanatory variable within these subgroups and conduct tests for coefficient equality across different quantiles to determine if these effects are statistically consistent or vary significantly across the distribution.

Table 5. Quantile Models

	1	2	3	4	5
Dependent Var.	Employment_Rate(t,city,activity)				
L.emp_rate	0.108*** (0.003)	0.0358*** (0.005)	0.0689*** (0.004)	0.127*** (0.007)	0.0445*** (0.008)
L3.log_payment	0.438*** (0.015)	0.477*** (0.03)	-0.00971 (0.019)	0.275*** (0.025)	0.553*** (0.042)
year_dummy1	-4.828*** (0.904)	N/A N/A	0.991 ()	N/A N/A	N/A N/A
year_dummy2	-3.064*** (0.345)	-0.13 (0.112)	-0.162 (0.522)	-5.696*** (0.393)	1.188*** (0.158)
year_dummy3	-2.046*** (-0.346)	1.246*** (-0.075)	0.407 (-0.519)	-4.402*** (-0.395)	1.967*** (-0.105)
year_dummy4	-3.598*** (0.345)	N/A N/A	-1.057** (0.516)	-4.891*** (0.393)	N/A N/A
Constant	28.62*** (0.481)	37.97*** (0.748)	29.13*** (0.696)	33.47*** (0.715)	23.08*** (1.031)
Observations	85440	16200	17460	17969	16560
R-squared	0.664	0.576	0.702	0.699	0.604

Source: Research finding.

Note: The results are presented for five models in the following order: 1-Base model. 2-Highest Employment. 3-Lowest Employment. 4-Highest Expenditure. 5-Lowest Expenditure. The coefficient of dummy for year 1400 can't release because of low observation in that year. Standard errors are reported in parentheses below each coefficient. Statistical significance is denoted as follows: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The quantile regression results, present in Table 5, reveal several important patterns across the distribution of employment rates. First, we observe that the impact of lagged employment rates remains consistently positive and statistically significant across all quantiles, indicating that past employment levels are a robust predictor of current employment, regardless of a city's employment performance. Second, the effects of lagged logarithm of payments present an interesting pattern. The effect of lag logarithm of payments is always positive and highly significant. Although, our

analysis reveals that the impact of microfinance payments is more pronounced in cities with higher employment rates. This finding suggests that microfinance initiatives yield greater benefits in areas where economic activity is already robust. One plausible explanation for this phenomenon is the presence of more productive activities in these cities. Higher employment rates often indicate a more dynamic and diversified economy, where businesses and entrepreneurs can leverage microfinance to expand operations, invest in new opportunities, and create additional jobs. Consequently, the infusion of microfinance payments in such environments amplifies economic growth and employment, highlighting the synergistic relationship between microfinance and existing economic growth.

Interestingly, our findings also indicate that the effect of microfinance is significant in the poorest cities, although the mechanisms differ. In these areas, microfinance can play a crucial role in alleviating poverty by providing essential financial services to underserved populations. By offering small loans and financial support, microfinance enables individuals to start or sustain micro-enterprises, which can generate income and contribute to local economic development. This dual impact of microfinance, enhancing growth in economically vibrant cities and reducing poverty in the poorest areas, underscores its versatility and importance as a tool for inclusive economic development.

Following the omission of outlier observations—defined as firms with a payment and commitment to generate a job exceeding the 99th percentile and corresponding to six companies, namely Rojin Tak Kermanshah, Novin Safran, Safran Mostafavi, Tabarok, Kafsh Azar Sharghi and Dehkade Khormaye Bam—and accounting for a negligible 0.67% of the total sample, as shown in Figure 4, the analysis reveals that the estimated average cost of creating one job within the REP is approximately 214 million Tomans at a fixed price for the year 2022. This finding, based on the remaining 99.33% of the observations, provides a more robust estimate of the typical cost associated with job creation in the REP, as it mitigates the influence of extreme values that could skew the overall average. This estimate suggests that the average cost is a substantial investment.

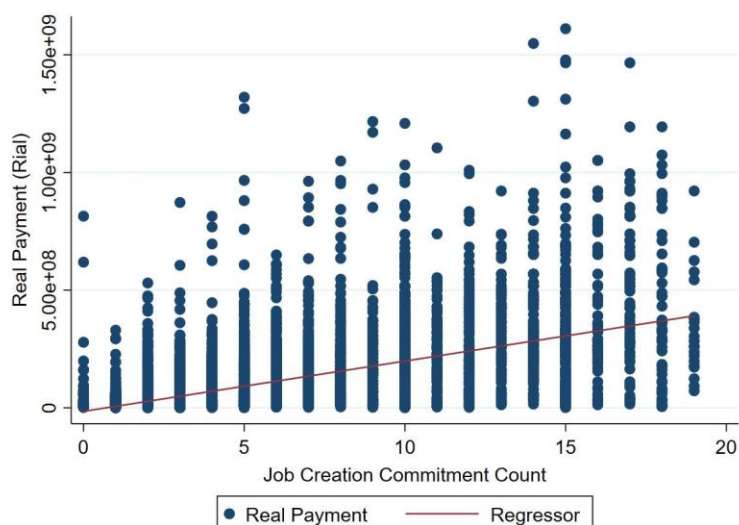


Figure 4. Job Creation Cost

Source: Research finding.

6. Conclusion

Microfinance is widely recognized as a crucial tool in welfare policies, significantly impacting various economic outcomes. In Iran, the REP was implemented to enhance rural employment rates. The REP provided low-interest loans to low-income individuals in villages and small towns who lacked the collateral typically required for conventional loans. The REP operated on the principle of job creation in exchange for funding. Instead of traditional collateral, the program used a combination of low-value assets and a commitment to generate a specified number of jobs. This paper investigates the effect of REP payments on the employment rate. Our analysis, using a linear regression with city fixed effects, confirms that REP payments have a significant impact on employment rate. While the immediate, short-run effect is limited, the cumulative impact over the following three quarters leads to a substantial increase in the employment rate. The results indicate that by increasing the average sum of payment per city, quarter, and activity by 1 billion Tomans, we can observe an increase in the employment rate by 1.6%.

Policymakers should consider the potential of the REP to generate increases in employment. However, it is essential to note that the program's effects do not manifest immediately and are more of a long-term solution to increasing employment rates. Furthermore, our estimations suggest that the impact of the REP is amplified by robust previous economic activity, and it plays a crucial role in alleviating poverty

by providing essential financial services to underserved populations. These results, demonstrate through quantile regression, indicate that the REP has a more significant effect on the employment rate in cities with higher employment rates or in cities with lower expenditures.

REP investigating results are robust and carry important policy implications that the cost of creating a job is 214 million Tomans at a fixed price of 2022, highlighting the substantial financial investment required for each employment opportunity.

This study is limited by the availability of data. As discussed, the microfinance effect has a long-run impact, which is better realized over time. However, the LFS has not been released quarterly since 2022 and is now only available annually. Therefore, we cannot observe its long-run effect over.

Future research should focus on longitudinal studies comparing various microfinance policies in Iran to determine which are most effective at boosting employment and other economic outcomes. Despite these challenges, our study contributes to the understanding of microfinance efficacy and underscores the necessity of carefully designing interventions to maximize their impact and ensure sustainable employment growth in Iran. Additionally, a valuable research topic would be to explore the differential effects of microfinance across various cities or activities, examining how local conditions or specific industries influence the effectiveness of these financial interventions.

Moreover, our results challenge the prevailing academic view in Iran that such programs have limited effects on economic variables. We provide robust evidence that the REP has a positive and significant impact on employment rates, persisting even amidst the adverse economic conditions imposed by sanctions and the COVID-19 pandemic. Policymakers must, therefore, ensure the transparent and effective allocation of financial resources and maintain consistent program implementation over time to optimize these impacts.

The observed link between loan volume and loan size in cities also suggests a reinforcing cycle where regions already benefiting from more loans receive larger financial infusions. This pattern necessitates a careful evaluation and possibly the formulation of policies that ensure broader access to finance across all regions to avoid reinforcing regional disparities.

Statements and Declarations

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- Conflict of interest: The authors declare that there is no conflict of interest.

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Oil Price Pass-Through and Stock Market Dynamics in an Oil-Exporting Economy: Results from a Quantile Regression for Iran

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Abstract

Linkages between oil prices and macroeconomic variables are widely studied in economics while there is some debate regarding oil price pass-through (OPP-T) and its impact on the stock market in oil-rich countries. OPP-T refers to the extent to which a change in oil prices affects the prices of other goods and services in the economy. the relationship between the two markets can be both positive and negative, and the magnitude of their correlation is dependent on various economic factors. In This study, the direct and indirect OPP-T effects of oil price on the stock market are empirically analyzed for Iran as a major oil-exporting economy, during March 2001 to February 2019. The quantile regression (QR) model is used because this model is extremely effective to recognize the distribution pattern form of the dependent variable at different levels of the independent variable. The results show that there is a positive and significant relationship between OPP-T and stock market returns. Moreover, the results indicate OPP-T directly on the stock market, as well as indirectly through the exchange rate channel. in higher quantities, i.e., when the stock market is booming, the change of crude oil price returns on the stock market, passes only through an indirect path (through the exchange rate channel) while, the decline in the crude oil price (or crude oil revenues), strengthens the stock market index by increasing the exchange rate. Additionally, the paper highlights the importance of understanding the oil market dynamics and policy implications for stock market participants, policymakers, and investors. Stock market traders in oil-exporting countries are advised to take into account the risk that arises from the fluctuations in crude oil and foreign exchange markets to the stock market.

Keywords: Exchange Rate, Oil-Exporting Economy, Oil Price Pass-Through, Stock Market.

JEL Classification: B23, C01, N75.

1. Introduction

The oil market is strongly associated with other financial markets so that fluctuations in this market affect other financial markets (Qamruzzaman, 2023;

Bashir, 2022; Basher et al., 2018; Dutta et al., 2017; Kang et al., 2015; Liu et al., 2013; Sadorsky, 1999). Before the 1980s, due to the organizational structure of the international oil market, crude oil prices did not fluctuate significantly, thus did not involve oil agents at significant risk. From the late 1980s, after the establishment of the NYMEX stock exchange in New York and with graduate deepening of this market in the subsequent decade, the discovery of dominant oil price indexes (such as Brent and WTI) was affected by the demand and supply conditions in future markets and spot prices (Buyuksahin et al., 2013; Silverio and Szklo, 2012). With the development and financialization of the oil market and the presence of other non-fundamental effective factors, global oil prices were volatile with a wide range (Fattouh and Mahadeva, 2012). During various periods, global oil prices experience excessive volatility. For example, after a peak of 148\$ per barrel in July 2008, the oil price has declined to about 40\$ per barrel in late December. Another example is the decline of global oil prices from 107\$ in August 2014 to about 40\$ in September 2015. These price volatilities and fluctuations yield frequent market risks and lead to heavy potential losses for activists in the international oil market and other financial markets.

Investigating the impact of oil price variations on financial markets is highly important because the factors influencing this market affect other financial markets greatly. In recent decades, global oil price volatilities have been about two times the volatility of other products. The concept of excess volatility of global oil price is that trade periods, as well as other financial markets, are constantly affected by global oil price volatilities (Filis et al., 2011). Recently, investigation of the impact of oil price shocks on stock market returns has attracted the attention of many researchers (Rahman, S. 2022; Boldanov et al., 2016; Degiannakis et al., 2013; Kilian, 2009; Ready, 2018; Soyemi et al., 2019; Zankawah and Stewart, 2019), but a small body of literature focus on emerging markets or net oil-exporters.

Although developing oil-exporting countries mostly have narrow stock markets, there is frequent evidence of the relationship between stocks and the oil market in these countries because the stock value depends on the present value of its future cash flows (Elwood, 2001; Khamis et al., 2018). Moreover, oil price volatility in oil-exporting countries can be considered as one of the most important macro factors influencing the stock market. Theoretically, the stock value equals the sum of the discounted value of the expected future cash flows (Ali et al., 2022; Arouri and Rault, 2010; Khamis et al., 2018; Narayan and Narayan, 2010). These cash flows can certainly be affected by macroeconomic variables such as oil shocks. An increase in oil price is expected that positively affects the currency

inflow of the country, budget expenditure supply, and aggregate demand (Shahrestani and Rafei, 2020). Note that since oil-exporting countries supply a major part of their required goods from advanced and emerging countries, therefore, a rise in oil price may lead to an increase in the cost of importing consuming and capital goods for oil-exporting countries.

On the other hand, the effect of crude oil price on stock price and the exchange rate is important for both groups of importing and exporting countries, because it is a strategic factor for supplying -energy and supplying raw materials for the products of industrial enterprises. Since the crude oil in the importing country is considered as a factor of production, increasing the price of imported crude oil increases the cost of production and, the price of consumer goods increases. This increase in the price of consumer goods reduces the value of the importing country's currency against other currencies, which in turn leads to changes in firms' costs and changes in their stock prices. In contrast, rising crude oil prices in exporting countries have led to optimistic expectations about a boom and boost in economic activity and the level of profitability, and their stock prices will rise with increasing demand for corporate stocks.

Moreover, the crude oil price pass-through can be considered as an important economic risk, which in some cases can have negative effects on investing in the stock market. Fluctuations in crude oil prices affect the economy of a country whose budget is based on crude oil. Given the coverage of the bulk of the annual budgets of countries with crude oil revenues and their reliance on crude oil, the slightest change in the price of crude oil affects the budget and, the changes in the price of crude oil through the budget channel affect macroeconomic variables and, consequently, the returns of enterprises and, ultimately, the returns of the capital market.

Therefore, according to the mentioned discussions, the change in the price of crude oil has a great impact on other economic variables. It also plays a key role in economic growth and development, social welfare, improving the quality of life and security of a society. Although the stability of supply and demand of various energy carriers is one of the most important issues in energy security, crude oil as a common usable fuel, unfortunately, has not had price stability.

Therefore, understanding the mechanism of the formation of crude oil prices can reduce the risk of crude oil price fluctuations and their negative effects on the Iranian economy, such as financial and capital markets, including the stock market. Many empirical studies in developed markets also show that stock prices fluctuate with changes in many factors. Naturally, many factors are influential in shaping

the information and views of market participants and ultimately the stock prices of companies. Some of these factors are internal and some are due to the situation of variables outside the scope of the domestic economy. Accordingly, the factors affecting the stock price can be classified into internal and external factors: external factors such as economic factors (sectoral economics, macroeconomics, microeconomics), political-military factors as well as cultural-behavioral factors, and internal factors such as earnings per share, the financial structure of the company, changes in accounting procedures, etc. fall into this category.

Therefore, it is expected that the stock price index has a strong relationship with macroeconomic variables, variables such as expected value, appropriate discount rate and cash payment at the end of the period, etc. that addressing all the variables in the economy is not within the scope of this study, but crude oil price changes are specifically considered. Since the share of crude oil in the stock market is constantly changing and is experiencing several fluctuations, it is important to study the reasons for the change in crude oil prices and the effect of crude oil price pass-through on other sectors, including the stock market.

Considering the importance of crude oil market and capital market interactions, in this study, the effect of crude oil price pass-through on stock price index in Iran is investigated using quantile regression (QR) model. One of the advantages of QR model is the ability to assess the relationships between the independent and dependent variables not only in the center of the distribution but also in the upper and lower tails of the conditional distribution of the response variable. Also, conducting the role of the exchange rate for an indirect oil price path pass-through analysis is another research contribution. Moreover, most studies in this regard have been conducted on oil importing countries. It seems that applying this model to Iran as a major oil-exporting country can provide policy recommendations for effective stock market management in oil-exporting countries.

2. Theoretical Background

As shown in Figure 1, global crude oil price volatility can lead to changes in stock prices in oil-exporting countries from various channels. These channels can be categorized into five groups. In the liquidity creation channel, revenue obtained from selling oil is transferred to the central bank's foreign currency account and leads to an increase in the central bank's foreign net assets and the monetary base. In the case of a decrease in oil revenues (caused by oil price declines), an increase

in budget deficit compels the government to borrow from the central bank, leading to an increase in the monetary base.

The second channel is the impact of oil prices on stock prices through the exchange rate channel (Kumar et al., 2023; Beckmann et al., 2020; Morley and Pentecost, 2000). Some studies have concluded that there is a greater correlation between crude oil prices and exchange rates in oil-exporting countries than in oil-importing countries (Reboredo, 2012; Yang et al., 2017). The exchange rate as one of the economic indicators has always been directly affected by crude oil fluctuations and in Iran, most exchange rate fluctuations are related to crude oil shocks. This shows the vulnerability of the Iranian economy to crude oil price changes, much of which is due to the passive role of foreign exchange policies. The main reason for these fluctuations is the various exchange rate policies adopted in Iran. The fall in crude oil prices in the past has caused the value of the domestic currency to rise in the short run due to misguided exchange rate policies.

The third channel is the impact of oil prices on stock prices through the expectations effect (Byrne et al., 2019). Theoretically, variations in oil prices can affect the formation of expectations in the capital market and, consequently, the stock price index of the active companies on the stock exchange market through various channels. The result of these impacts is associated with the extent to which the companies are dependent on global oil market volatilities (Wu, 2023; Basher et al., 2012). With an increase in oil prices and revenues in oil-exporting countries, optimistic expectations are formed about the boom and raising the level of economic activities. Therefore, the increased profitability of companies active in the stock exchange and, consequently, a rise in the stock index is expected (Lu et al., 2001).

Revenue effect is the fourth channel through which global oil prices affect stock prices. Indeed, higher oil prices mean the wealth transfer from the oil-importing countries to the oil-exporting ones. The effect of these changes in prices depends on the performance of the government in dealing with the revenue increase. If the revenue increase is in line with the purchase of domestic goods and services, it can lead to an increase in public wealth (Sayadi and Khosroshahi, 2020). With an increase in the demand for labor and capital, many trading and investment opportunities have been created, affecting the future cash flows of the firms and the increase in profitability.

The fifth channel is the impact of oil prices on stock prices in oil-exporting countries through the recursive effect. Oil price increase leads to an increment in total costs of goods produced by industrial countries, causing a rise in the monetary

value of imports for oil-based countries and negative impact on future cash flows of their firms and, consequently, a decrease in stock prices (Arouri and Rault, 2010). The net effect of oil price volatility on stock price in oil-exporting countries depends on the resultant of positive and negative impacts related to the channels mentioned.

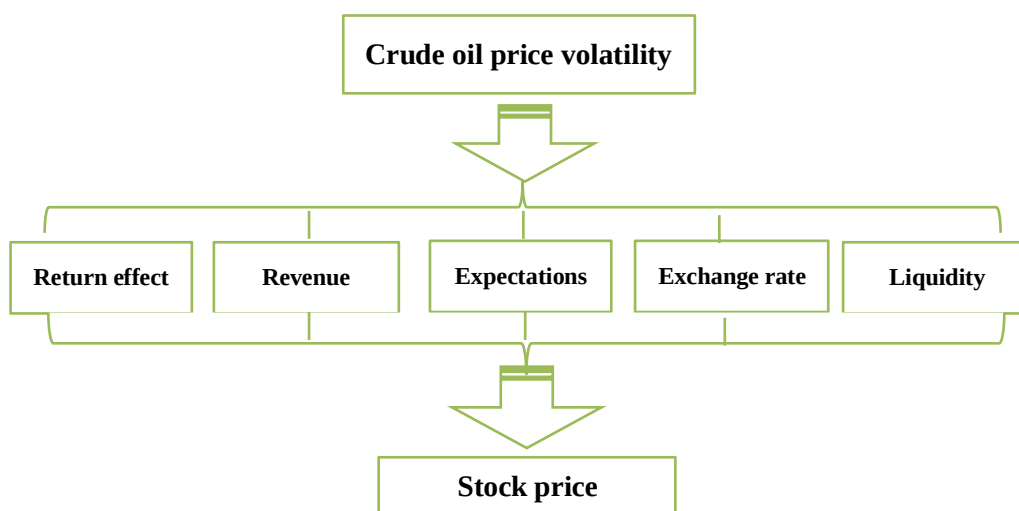


Figure 1. Crude Oil Price Volatility Impact Channels on Stock Price Volatility

Source: Research finding.

The stock price index is the most important factor influencing investors' decisions in the stock market. Therefore, accurate forecasting of stock price index movements is very important for investors. the crude oil price pass-through, which is equivalent to the effect of the percentage change in crude oil price change on the percentage change in domestic price, is examined in this study (Shioji and Uchino, 2011). Therefore, it is important to study the effect of crude oil price pass-through on the stock price index.

3. Literature Review

Table 1 presents a summary of some main features of the relevant studies, which have conducted to investigation the relationship of the oil market and stock market.

Table 1. Main Features of the Relevant Studies

Author(s)	Object(s)	Method(s)	Case Study	Result(s)
(Angelidis et al., 2015)	stock market regimes and crude oil price shock	Regime switching model	USA	The crude oil price shock has great power in predicting the stock market situation.
(Balcilar et al., 2015)	crude oil price regime model change and stock market	Regime switching model	USA	The highly fluctuating regime existed before the Great Depression and after the 1973 crude oil price shock under the influence of the OPEC
(Ghosh and Kanjilal, 2016)	Correlation between international crude oil price and Indian stock market	threshold cointegration	India	No significant relationship found between the crude oil price and the Indian stock market in the long-term equilibrium.
(Zhu et al., 2016)	Heterogeneous correlation between crude oil price changes and China industry stock market	Quantile regression	China	The market response to crude oil is significantly heterogeneous in the conditional distribution of industry stock returns.
(Diaz et al., 2016)	Crude oil price fluctuations and stock returns	Vector autoregressive (VAR) model	G7 economies	- Negative response from G7 stock markets to rising crude oil price fluctuations. - Global crude oil price fluctuations are generally greater for stock markets than crude oil price fluctuations.
(Nusair and Al-Khasawneh, 2018)	Oil price shocks and stock market returns	quantile regression analysis	GCC countries	Positive shocks to aggregate demand and specific demand for crude oil are associated with negative effects on changes in stock returns.
(Delgado et al., 2018)	The relationship between oil prices, the stock market, and the exchange rate	Vector Autoregressive Model (VAR)	Mexico	- the exchange rate has a negative and statistically significant effect on the stock market index - The consumer price index has a positive effect on the exchange rate and a negative effect on the stock market index. - Oil prices are statistically significant against the exchange rate, concluding that an increase in oil prices creates an appreciation of the exchange rate.
(Kelikume and Muritala, 2019)	The Effect of Crude Oil Price Changes on Market Shares	dynamic panel analysis	Africa	- Economic growth has a positive effect on stock returns in Africa - Relationship between the stock market and the crude oil price in this region is significant.

(Kocaarslan and Soytaş, 2019)	Asymmetric pass-through between oil prices and the stock prices of clean energy firms	nonlinear auto-regressive distributed lag (NARDL)	clean energy stocks	• Significant asymmetric effects among the variables of oil prices, interest rates, and the stock prices of clean energy and technology firms. • The increased investments in clean energy stocks appear to be due to speculative attacks along with an increase in oil prices in the short-run., • In the long-run, the increased oil price has a negative impact on clean energy stock prices and this impact is asymmetric
(de Jesus et al., 2020)	The non-linear relationship between oil prices and stock prices.	Dynamic Ordinary Least Squares model	oil-importing and oil-exporting countries	• A positive long-term relationship was found between oil and stock prices. • the wealth effect prevailed for oil-exporting countries • Oil-importing countries with emerging economies have experienced a positive sign in the long-term relationship • The United States has seen asymmetric adjustments in the long-term relationship between oil and stock prices.
(Xiao and Wang, 2020)	Dynamic complexity and causality of crude oil and major stock markets	the Kernel method Granger Causality	major stock markets	• Nonlinear bidirectional causal relationships are found between oil and stock. • The WTI and the Brent crude oil prices are not playing identical roles in their interactions with multiple stock markets.
(Chang et al., 2020)	The asymmetric effects of oil price on sectoral Islamic stocks	Quantile-on-Quantile (QQ) approach	Islamic stock indices	• Lower (upper) quantiles of oil prices negatively affect the upper (lower) quantiles of the DJ Islamic index. • Upper or lower quantiles of both markets indicate a positive relationship.
(Amiri et al., 2021)	Oil price shock and macroeconomic outcome	DSGE	Iran	• Upward oil price shocks will weaken real exchange rates. • Upward oil price shocks will lead to a loss in economic competitiveness. • Upward oil shocks will increase the liquidity.

(Olayungbo and Ojeyinka, 2021)	asymmetric response of petroleum product prices to international crude oil prices	hidden cointegration approach	Nigeria	• Petroleum prices in Nigeria respond asymmetrically to changes in crude oil prices. • positive changes (increase) in crude oil prices produce a larger and stronger effect on petroleum prices than the effect of negative changes • Evidence to support the hypothesis of “rocket and feather” in the pass-through effect of crude oil prices on petroleum prices in Nigeria.
(Shioji, 2021)	Pass-through of oil supply shocks to domestic gasoline prices	SVAR-IV	Japan	• Pass-through is so fast: about 70% of the entire adjustment process is completed within just 18 days.
(Balcilar and Usman, 2021)	exchange rate and oil price pass-through	Diebold-Yilmaz spillover index and rolling-windows	BRICS countries	• there is strong evidence of directional spillovers across the countries • The total spillovers are low, with Russia (China) having the highest (lowest). This suggests a low pass-through across the countries • the net spillovers of oil price and exchange rate are positive in Brazil, Russia, and South Africa, while in India, they are both negative. • The spillovers exhibit significant bursts with no clear-cut evidence of trends across these countries. These findings are useful in formulating an optimal monetary policy.
(Jiménez-Rodríguez and Morales-Zumaquero, 2021)	commodity price pass-through along the pricing chain for the global commodity price index and the indices of its main categories	country-by-country VAR and Pool model	advanced and emerging countries	• Partial pass-through from commodity prices to producer prices. • The pass-through seems to be led for producer prices. • Higher prices in the four categories (agricultural raw materials only in the short-run) induce significant higher producer prices in almost all cases. • Energy prices explain the highest variability of producer and consumer prices.

(Badamvaanchig et al., 2021)	Pass-through of commodity price to stock price	NARDL	Mongolia	• The results show clear evidence of asymmetric long-run relationships between stock and the commodity prices • a positive relationship between copper price and stock price in the case of a positive shock on copper price, but no clear relationship in the case of a negative shock on copper price.
(Atif et al., 2022)	Oil price changes and stock returns	Panel VAR	oil exporting and oil importing countries	• in the period marked by the rapid outbreak of the covid-19 pandemic, causality from oil to stocks increased • both oil exporting and oil importing countries were affected in a similar way, oil price changes had a larger impact on oil exporting countries.
(Xing et al., 2023)	The impact of the Russia–Ukraine conflict on the energy subsector stocks	A network-based approach	China	• the key energy stocks in terms of volatility correlations would certainly change during the Russia–Ukraine conflict. • during the conflict, several renewable energy stocks tend to influence other stocks in the system.

Source: Mentioned Research.

In general, most studies have examined the effect of crude oil shocks on various macroeconomic variables, and some studies have been conducted on the effect of crude oil price pass-through on the stock market. On the other hand, the use of the quantile method to investigate this effect has not been done in previous studies. Therefore, in this study, we examine the effect of crude oil price pass-through on the stock market through the quantile method. Also, in addition to the direct relationship, our study examines the oil price path- through on the stock market with regard to the key role of the exchange rate (indirect oil price path-through).

3. Methodology

To better understand the concept of quantile regression, it is first necessary to explain the concept of quantile and how to obtain it. Each stochastic variable has a cumulative distribution function that can be represented as follows:

$$F(y) = P(Y \leq y) \quad (1)$$

For example, if the stochastic variable Y has a standard normal distribution, its cumulative distribution function will be in the following form. If $y=0$ then, the value of the cumulative distribution function at this point will be 0.5. This means that the probability of occurrence of values less than zero for y is equal to 50% (Davino et al., 2013).

Now for each $0 < \tau < 1$, the τ -th quantile of the distribution can be calculated as follows:

$$Q(\tau) = F^{-1}(\tau) \quad (2)$$

Figure 3 shows the inverse of the standard normal cumulative distribution function. If we want to calculate the value of the standard normal distribution of the quantile 0.5 (quantile 0.5 of the distribution is the median of the distribution and the mean for the normal distribution is equal to the median), will be zero.

If we want to define the quantile of a distribution accurately, we can use the following mathematical definition:

$$Q(\tau) = \inf\{y: F(y) \geq \tau\} \quad (3)$$

Equation (4) is a simple optimization problem that can be written in a simpler form as follows:

$$Q(\tau) = \arg \min \left\{ \sum_{i: Y_i \geq \vartheta} \tau |Y_i - \vartheta| + \sum_{i: Y_i < \vartheta} (1 - \tau) |Y_i - \vartheta| \right\} \quad (4)$$

where, I is the observation index of the variable Y that takes values of 1 to n . In fact, based on the above equation, quantile of a stochastic variable such as Y is

obtained through minimization of the weighted average of the observations larger than quantile and observations smaller than quantile. Of course, the above weighted average gives asymmetric weights to values smaller and larger than quantile. If an observation is larger than quantile, it receives weight of τ , and if it is smaller, it gains the weight of $1 - \tau$. For example, if we want to calculate the 10% quantile of the distribution, the weight of the values smaller than the quantile will be 0.9 and the weight of the larger quantile will be 0.1 (Koenker, 2005).

The idea of the calculation of quantile based on Equation (4) can also be generalized to regression analysis. As mentioned earlier, in an ordinary least squares estimator, the goal is to find a line that exceeds the conditional mean distribution of the dependent variable (EYX). In the OLS method, we determine the model coefficients so that the regression line passes the conditional mean distribution of the dependent variable. Now, if we extend this idea and want the regression line to pass through the τ -th quantile of the conditional distribution of the dependent variable instead of passing through the conditional mean distribution of the dependent variable, then the estimator would be the quantile regression estimator. The idea of quantile regression is shown in Figure 2. In this figure, the regression line coefficients have been estimated to pass the distribution quantile of 0.9. In this figure, the line passing through the center of the conditional distributions is the same regression line estimated by the OLS method. The other line that crosses the distribution sequences is the regression line of the 90% quantile (Koenker, 2005).

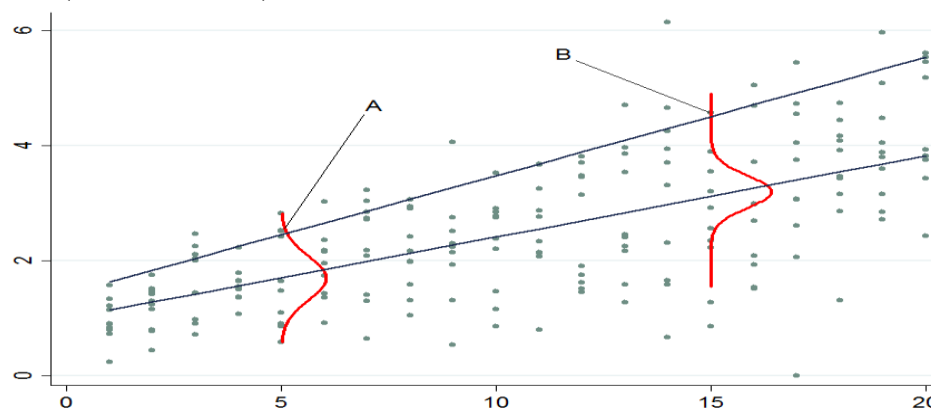


Figure 2. Comparison of the Quantile Estimator with the Ordinary Least Squares Estimator

Source: (Koenker, 2005).

Now, based on the idea of Equation (4), the problem of quantile regression optimization can be written as follows:

$$\hat{\beta}(\tau) = \arg \min \left\{ \sum_{i: Y_i \geq \hat{X}_i \hat{\beta}(\tau)} \tau |Y_i - \hat{X}_i \hat{\beta}(\tau)| + \sum_{i: Y_i < \hat{X}_i \hat{\beta}(\tau)} (1 - \tau) |Y_i - \hat{X}_i \hat{\beta}(\tau)| \right\} \quad (5)$$

If we calculate the regression coefficients at the quantile of 0.5 in Equation(5), the regression line will exceed the conditional distribution median of the dependent variable and, the quantile regression is equivalent to median regression or the least absolute deviation (LAD). Also, if, instead of the absolute value in Equation (6), we used the second power of the errors and assumed the quantile to be 0.5, Equation (6) would become the OLS estimator. Figure (6) shows the weighting differences of the errors in the three ordinary least squares regressions, least absolute deviations, and quantile regression. In this figure, $q = 0.5$ is equivalent to the regression of absolute deviations, squared error, ordinary least squares and, $q = 0.1, 0.9$ is the quantile estimator at two quantiles of 10% and 90%.

To estimate the quantile models, unlike the OLS method, which has an algebraic solution, optimization methods are used. In fact, Equation (5) is a linear programming problem that needs to be solved by one of the methods related to solving optimization problems. For example, the common simplex approach (SIMPLEX) proposed by Barrodale and Roberts (1973) and later modified by Koenker and d'Orey (1987) can be used to obtain quantile regression coefficients and solve the optimization problem. Of course, in addition to this method, any other method that exists to solve linear programming problems can be used for this purpose.

A common approach in studies related to quantile regression is to estimate the main regression of the study in different quanta. Then, using ANOVA test, they test whether the desired regression coefficients are statistically different at different quantiles. If the null hypothesis of the ANOVA test is rejected, this will mean that the regression coefficients have statistically significant differences at different quantiles; therefore, it is necessary to use quantile regression to examine the relationship between variables. Then, the regression coefficients at each quantile are calculated and analyzed according to the research subject. However, if the number of quantiles is large, graphs are usually used instead of reporting the results of the coefficients in the tables. In these graphs, in addition to the value of the coefficient of each variable at the desired quantile, the 95% confidence interval is

also given so that it is easy to comment on the significance of the coefficient at each quantile.

4. Results

4.1 Research Model

The regression pattern used in this study is as follows; it should be noted that the variables included in the following model are taken from two studies of Zhu et al. (2016) and Delgado et al. (2018).

$$RSMR_t = c^q + \beta_1^q ROILR_t + \beta_2^q REXR_t + \beta_3^q ROILRM_t * REXRM_t + \varepsilon_t^q \quad (6)$$

where, $RSMR_t$ represents the real stock market return, which has been calculated as the growth percentage of the total real price index. The total real stock market price index is obtained by dividing the total price index of the Tehran Stock Exchange by the consumer price index (base year of 2016). $ROILR_t$ in this equation also shows the percentage increase in the dollar price of crude oil, which has been adjusted by the US consumer price index. In fact, this has been done to make the crude oil dollar price real. The dollar value depreciates every year due to inflation, therefore, in order to be able to compare the price of crude oil in different years, it is necessary to adjust it with the US consumer price index. $REXR_t$ also shows the real exchange rate growth percentage.. Since revenues from oil exports have a large impact on the economies of oil-exporting countries, and in particular the stock market, the exchange rate is a key variable in modeling the economies of these countries. The exchange rate is included in the model as an interactive variable. The real exchange rate in this study has been calculated as follows:

$$REX_t = EX_t \frac{CPI_t^{US}}{CPI_t^{IR}} \quad (7)$$

where, EX_t represents the nominal exchange rate (Rials per dollar) in the informal market, CPI_t^{IR} is the Iranian consumer price index and CPI_t^{US} denotes the US consumer price index.

In this study, to investigate the role of exchange rate in the crude oil price pass-through over the stock market, (as in other studies) a new variable has been defined obtained by multiplying the variables of real exchange rate growth and real crude oil price growth. Of course, before multiplying these variables, the following changes have been applied to these variables and then the product of their multiplication has been calculated. In fact, the change applied to the variables was that their mean has been subtracted from each of the variables. This change in the variable is done to deal with the alignment problem. When, in addition to the

$ROILR_t$ and $REXR_t$ variables, the $ROILR_t * REXR_t$ variable is also included in the model. Since the probability of strong linearity between the variables is very high, one approach to solve this problem is to average the variables and then multiply the averaged variables.

$$ROILRM_t = ROILR_t - \mu_{ROILR} \quad (8)$$

$$REXRM_t = REXR_t - \mu_{REXR} \quad (9)$$

Accordingly, if the exchange rate causes a change in the direction and size of the crude oil price pass-through over the stock market, the $ROILRM_t * REXRM_t$ variable will be significant and its coefficient will show the adjustment of this relationship.

Table 2 indicates the list of variables include of variables name, description, frequency measurement, and source. $RSMR_t$, $ROILR_t$, and $REXR_t$ denote the real stock market return, real Brent crude oil spot price return, and real exchange rate return, respectively. The US PPI is used to adjust nominal prices to obtain real oil prices.

Table 2. List of Variables

Variables	Description	Frequency	Measurement	Source
$RSMR_t$	Real Stock Market Return	monthly	%	Tehran Stock Exchange
$ROILR_t$	Real Brent Crude Oil Spot Price Return	monthly	%	https://tradingeconomics.com/
$REXR_t$	Real Exchange Rate Return	monthly	%	Central Bank of Iran

Source: Research finding

Statistical descriptions of the variables are summarized in Table 3 to provide more information about the data for this study. Table 3 shows the descriptive statistics (include mean, median, max, min, standard deviation, skewness, kurtosis, and Jarque-Bera criteria) of variables. The mean values are positive for all variables and standard deviations show the unconditional volatility. The skewness for $RSMR_t$ and $REXR_t$ is positive, while the skewness for $ROILR_t$ is negative. A negative skewness indicates a greater number of larger values, whereas a positive skewness indicates a greater number of smaller values. Since the skewness of the variables is either less or more than zero, series distributions are all non-normal. Based on the results of Jarque-Bera criterion, the null hypothesis (the normality of distribution) for all variables be rejected. Moreover, kurtosis of all variables are positive and more than 2. It can be noted that, A positive value for the kurtosis

indicates a distribution more peaked than normal. In contrast, a negative kurtosis indicates a shape flatter than normal. Analogous to the skewness, the general guideline is that if the kurtosis is greater than +2, the distribution is too peaked. Likewise, a kurtosis of less than -2 indicates a distribution that is too flat.

Table 3. Descriptive Statistics

Variables	Mean	Median	Max	Min	St. Dev	Skewness	Kurtosis	Jarque-Bera (Prob)
RSMR _t	0.70	-0.22	26.10	-13.37	5.76	0.83	4.50	45.22 (0.000)
ROILR _t	0.60	1.52	20.09	-26.42	8.08	-0.67	3.82	22.26 (0.000)
REXR _t	0.22	-0.64	29.55	-21.49	4.81	1.95	14.33	1293.41 (0.000)

Source: Research finding.

4.2 Results

Before estimating the main research model using quantile regression, in order to compare, the model has been first estimated using the ordinary least squares method and the results have been reported in Table 4.

Table 4. Results from the OLS Method

Variable	Coefficient	T Test	P value
C	*0.70	1.83	0.069
ROILR	**0.11	2.22	0.027
REXR	0.11	1.34	0.183
ROILR*REXR	***-0.03	-2.74	0.007

Source: Research finding.

Note: *, **, *** denotes significance levels at the 10%, 5%, and 1%, respectively.

The results of the normality test of the above regression error terms (Table3) show that the estimated model error terms are not normal (Table5). As mentioned earlier, the ordinary least squares method is not a suitable method for estimating model parameters in such cases. On the other hand, the presence of outliers in the real stock market return variable also causes the estimator results to be biased at least ordinary squares. Accordingly, quantile regression is used, which is robust for both of the above problems.

Table 5. Result of Testing Normality

J-B Statistic	Probability
55/55	0/000

Source: Research finding.

In order to be able to provide a convincing reason for using quantile regression, we first need to test whether the regression coefficients at different quantiles are significantly different. For this purpose, the ANOVA test is used, which tests the equality of the means of several groups (in the present application, the means of the groups are the same as the coefficients of the model) simultaneously. As shown in Table 6, regression coefficients have significant differences at different quantiles. Null hypothesis of this test represents the equality of coefficients at quantiles and the opposite hypothesis is the inequality of coefficients. According to the obtained results, the null hypothesis of the test has been rejected at the level of one percent. It should be noted that this test was performed for quantiles of 0.05 to 0.95 (with an increase of 0.05 in each step).

Table 6. Results from ANOVA Test

F Statistic	D.F of the Numerator	D.F of the Denominator	Probability
1.986	54	4050	0/000

Source: Research finding.

Figure 3 shows the coefficients of the model variables at different quantiles of the real stock market return variable. There are several major differences between the results of quantile estimation using the ordinary least squares method. First, the real exchange rate growth rate variable in the OLS method was insignificant; however, this variable is not insignificant at all quantiles, and at the end of the distribution, where the stock market records high returns, this variable has a significant effect on the stock market. Of course, it should be noted that this effect is related to the pure impact of this variable on the stock market. Because a part of the effect of the exchange rate variable, which is due to crude oil price changes, has been included in the model as another variable and, so the coefficient estimated for the exchange rate variable is different from the effect that the real exchange rate has on the stock market as a result of crude oil price changes. The second difference between the results of quantile regression and the results of the OLS method is that the real yield variable of crude oil price does not have a significant effect on the stock market at all quantities of real stock market returns (although it means a direct effect). A decrease (or increase) in the price of crude oil is more effective at the lower quantities of the stock market, i.e., where the stock

market is in a recession. In other words, if the market is declining and the crude oil price falls, the crude oil price pass-through over the stock market will deepen the stock market recession. Of course, in order to be able to make a final statement about the price of crude oil, we must also consider its indirect effect.

According to Figure 3, the indirect crude oil price reduction pass-through works in the opposite direction. In other words, lowering the price of crude oil, by increasing the real exchange rate, neutralizes a part of its negative effect. In other words, if we assume that crude oil price growth will decline, it will directly reduce real stock market returns. But on the other hand, lower crude oil prices will increase the nominal exchange rate and the real exchange rate will increase. The occurrence of two currency shocks as a result of sanctions confirms such a relationship between crude oil revenues and the foreign exchange market. Decreasing the price of crude oil will reduce crude oil revenues and reducing crude oil revenues will reduce the supply of currency. Since crude oil revenues are an important part of the foreign exchange supply in Iran, the decrease in foreign exchange supply will be accompanied by an increase in the nominal exchange rate. Since the nominal exchange rate pass-through on the consumer price index is not complete (the exchange rate pass-through in Iran is between 20 and 30% according to calculations), the nominal exchange rate in the real exchange rate formula will increase, but the denominator of the deduction, which is the domestic consumer price index, will not increase accordingly. As a result, the real exchange rate will increase. An increase in the real exchange rate will also increase the competitiveness and profitability of Stock Export Companies; as a result, a part of the reduction in stock market returns will be neutralized in this way.

The reason for the difference between the results of quantile regression and the ordinary least squares method for indirect crude oil price changes pass-through is that the coefficient of this variable in quantile regression is higher with the increase in real stock market return (higher quantiles of the real stock market return variable). In other words, when we are at high quantiles of the stock market or during the boom of this market, the pass-through of the crude oil price reduction to the stock market is not only negative, but rather, it is done indirectly, positively, to the stock market. This result is very important and is consistent with empirical evidence. Crude oil revenues fell sharply in the last two sanctions, but the stock market experienced a growing trend. One of the main reasons was the increase in the exchange rate as a result of the decrease in crude oil revenues, which made export companies profitable and neutralized the effect of lower crude oil prices.

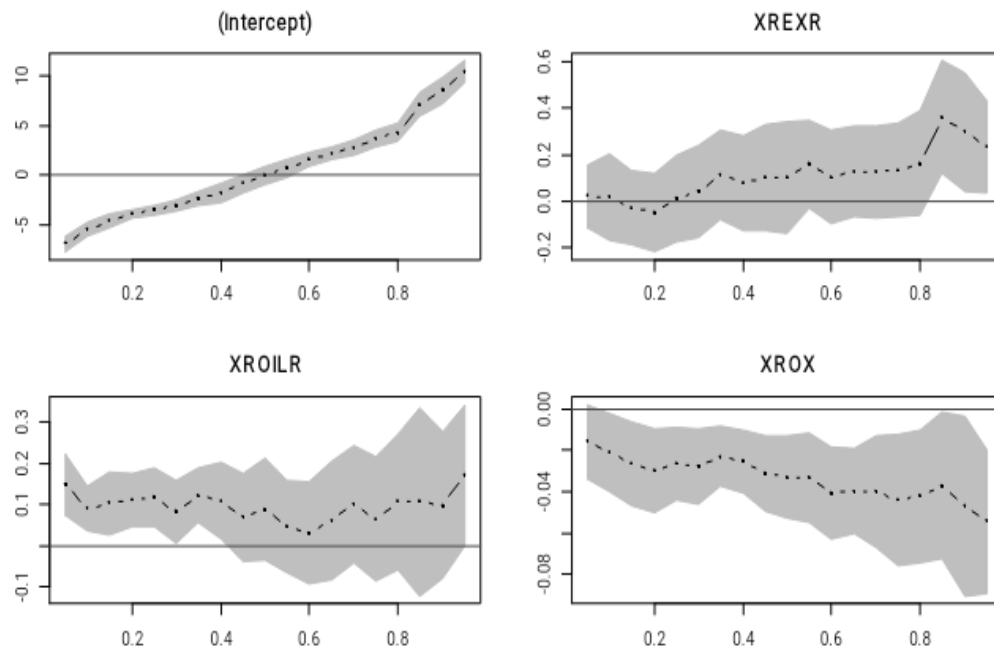


Figure 3. The Coefficients of Variables in Different Quantiles of $RSMR_t$

Source: Research finding

This research aims to test the hypothesis that there is a positive and significant relationship between oil prices and the stock market in different quantiles. Table 7 shows the values of the coefficients at different quantiles as well as their significance. In fact, these results are the same as those presented in Figure 3; but here we have tried to provide more details. As observed, the value of the real crude oil price return coefficient at the first four quantiles (ten percent quantile) is statistically significant. In other words, the crude oil price pass-through to the stock market up to the fourth quantile (quantile of 40%) occurs both directly and indirectly (due to the significance of the indirect channel at all quantiles). But from the fourth to the ninth quantile (90% quantile), the effect of changes in the real crude oil price return on the stock market, or in other words, the crude oil price pass-through on the stock market, is indirect. In fact, when the stock market is booming, a drop in crude oil prices not only does not reduce the stock market's real return, but it has a positive effect on the stock market through the exchange rate channel; the value of this positive effect is maximized at the ninth quantile or where the stock market is in full bloom. The coefficient of the real price variable of crude oil in this quantile is statistically insignificant or in other words, it is equal to zero. Also, the value of the $ROILR * REXR$ variable coefficient at this quantile is

significant and higher than the previous quantiles (in terms of absolute value). In addition, the real exchange rate is significant at this quantile, and in addition to the mediating effect through the ROILR*REXR variable, it also has a direct positive effect on stock market returns.

If the data distribution is normal, the median will match the mean and, it is expected that the results of quantile regression at the quantile of 50% (or the median) are equal to the results of ordinary least squares regression. When the distribution of data is not normal, the expectation of the equality of results will not matter. Comparison of the results obtained in Table 5 for the 50% quantile with the results of the OLS estimator reported in Table 2 shows that the results are different. Of course, there is no significant difference between the results. The only difference is the slight reduction of the real exchange rate coefficients and the real crude oil return, as well as the insignificance of the real crude oil return coefficient in the quantitative regression (at the quantile of 50%). ANOVA test was used to evaluate the equality (symmetry) of OLS regression coefficients with quantile regression at 50%. The results of this test have been reported in Table 8. As can be seen in this table, the null hypothesis of the test is rejected, and it can be concluded that the coefficients of these two regressions are different.

Table 7. The Coefficients of Variables in Different Quantiles of $RSMR_t$

Variable	q.10	q.20	q.30	q.40	q.50	q.60	q.70	q.80	q.90
C	***-5.45	***-3.85	***-3.03	***-1.74	***0.03	***1.58	***2.79	***4.32	***8.58
REXR	0.01	-0.05	0.04	0.08	0.10	0.10	0.13	0.16	*0.30
ROILR	***0.09	***0.11	**0.08	*0.11	0.09	0.03	0.10	0.11	0.10
ROILR*REXR	*-0.02	** -0.03	***-0.03	** -0.03	***-0.03	***-0.04	***-0.04	** -0.04	** -0.05

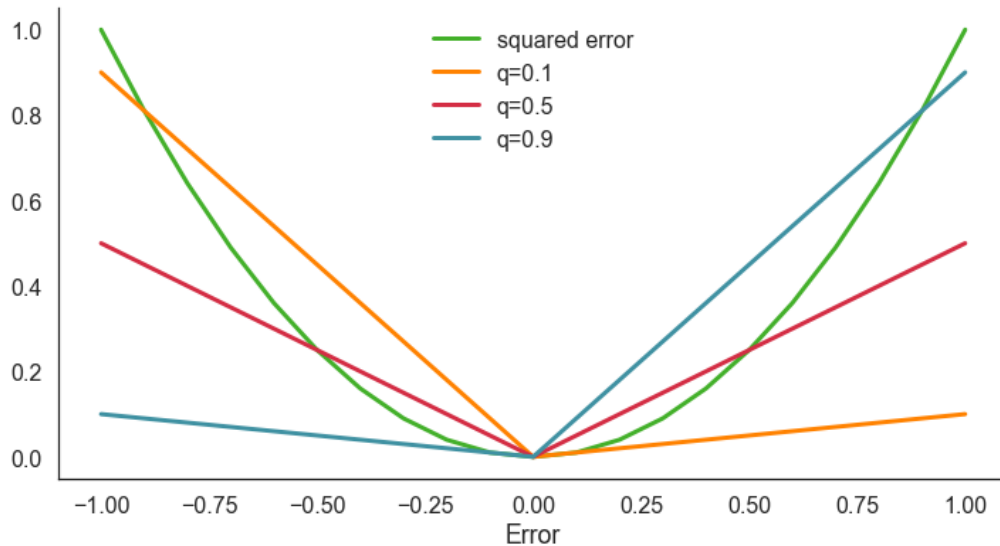
Source: Research finding.

Note: *, **, *** denotes significance levels at 10%, 5%, and 1% , respectively.

Table 8. Results of Equality Test for OLS Coefficients in the 50% Quantiles

F Statistic	D.F of the Numerator	D.F of the Denominator	Probability
2.854	3	429	0.049

Source: Research finding.

**Figure 4.** Weighted Errors in OLS, Absolute Least Deviations, and Quantile Regressions

Source: Research finding.

5. Conclusion and Discussion

Examination of the research data, using descriptive statistics, showed that the real stock market return data does not follow the normal distribution and has broader sequences than the normal distribution, and most likely, this variable follows the standard distribution t , which is suitable for financial markets. It was also shown in this section that the real stock market return variable has some outliers, which of course can be another reason for the abnormal data of this variable. The existence of outliers as well as, the abnormality of the distribution of real stock market returns provided evidence based on the inefficiency of the ordinary squares estimator. Estimating the model using the OLS method also confirmed the evidence provided and the error terms of this model were abnormal. The abnormality of the error terms of this model is the primary motivation for using the quantile regression method, but to ensure that this method is suitable for the relationships we intend to examine, we must use the ANOVA test.

The results of this test showed that the quantile regression method is a more appropriate method to examine the main research model. The estimation of the

main research model using the quantile regression method indicated that the crude oil price pass-through on the stock market, in addition to the direct path, is also indirect and through the exchange rate channel. So that at the higher quantities, that is, when the stock market is booming, the changes in the crude oil price return on the stock market, pass only indirectly and through the exchange rate channel and, a drop in the price of crude oil (or oil revenues), as in the two periods of sanctions improve the stock market by increasing the exchange rate. Our findings in the line with Abdallah (2013) for stock market of South Africa, and Ajibola et al. (2021) for stock market of Nigeria, and with Wuryandani (2011) for stock market of Indonesia, in which focus on exchange rate channel when investigating of a positive oil price pass-through on stock market. On the other hand, this finding is not consistent with Kilian and Park (2009) found that oil price increases have a negative impact on the US stock market as a net oil-importing country. They argue that higher oil prices increase production costs for firms, which leads to lower profits and subsequently lower stock prices. Similarly, Hooker (1999) analyzed the impact of oil price shocks on the stock market and found that the effect is asymmetrical, with negative shocks having a larger impact than positive shocks.

Their relationship has been studied thoroughly, and many theories have been proposed to explain the correlation between them. The oil price and stock market correlation is not straightforward, and it is influenced by various factors. A positive correlation between oil prices and the stock market means that as oil prices rise, the stock market goes up, and as oil prices fall, the stock market goes down. One of the main reasons for the correlation between oil prices and the stock market is that energy companies are a significant part of the stock market. When the price of oil goes up, energy companies' profits increase, and their stock prices rise. Conversely, when the price of oil goes down, energy companies' profits decrease, and their stock prices fall. Another reason for the correlation is that the price of oil affects the cost of production for many companies. As the price of oil rises, the cost of production increases, which leads to lower profits for non-energy companies. This, in turn, leads to a decrease in their stock prices. However, some studies have shown that there are periods where the correlation between oil prices and the stock market is weak or even negative. This may be due to factors such as changes in consumer behavior, technological advancements, and geopolitical events.

The relationship between oil prices and the stock market has significant policy implications for both policymakers and investors. The paper concludes that the oil price has a significant impact on the stock market, and the pass-through

effect varies depending on the economic circumstances of the period and exchange rate variable. Indeed, the oil price and stock market has an interaction specifically from the exchange rate variations in Iran. So, according to the results of this study, one of the recommendations to policymakers in this field can be to reduce dependence on oil revenues or in other words, increase income diversity for oil-exporting countries. In this way, besides trying to increase the market depth, Capital market traders are advised to take into account the risk spillovers of foreign exchange and oil markets to the stock market. Moreover, investors are better off allocating their portfolio in the stock market more carefully, especially when the volatilities in the two markets (exchange and crude oil) are high. Moreover, when the economic sanctions against Iran's economy are lifted, as massive capital inflows might also transform into sudden capital reversal, so this study suggests authority to maintain exchange rate stability.

For further studies, it is suggested to use copula models to evaluate different aspects of the dynamic relationship between two markets, using different variables and for a longer period of time (limitations of the present research).

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A Response of Food and Non-Food Price Changes to Global Oil Structural Shocks: Evidence from SVAR to the Economy of Iran

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Abstract

This article empirically analyzed the relationship between oil structural shocks and Iran's food and non-food inflation. The study was conducted within the SVAR model framework using monthly data from April 2004 to March 2018. However, the choice of the starting and ending dates was based on the availability of the time series data. The impulse response analysis suggested that oil-specific demand shocks caused by supply disruptions positively affected food and non-food prices in Iran. In addition, the results indicated that in the post-sanction period, one standard deviation of oil-specific demand shock led to an immediate increase in food prices compared to pre-sanction years. This also revealed that oil price volatility shocks played a more pronounced role in food price variability than oil price change. Moreover, given Iran's economic features, we found that the exchange rate disruptions positively impacted the change in food and nonfood prices. Finally, based on this evidence, the findings offer critical implications for Iran's policymakers.

Keywords: Food Price, Iran Economy, Non-Food Price, Oil Structural Shock, SVAR.

JEL Classification: C01, O53, Q18, Q41.

1. Introduction

Crude oil dominates energy markets. Its price and volatility affect the price dynamics of other commodities (Kilian, 2008; Sadorsky, 2001). Crude oil is considered a vital energy source that affects economic development. It is a significant financial asset. Investors use it to cover risks (Yang et al., 2021). Investigating the fluctuations in the price of this natural resource is essential. This is especially true in recent decades because oil prices have experienced dramatic fluctuations. These are due to crude oil supply shocks (SSs), aggregate demand

shocks (DSs), and oil-specific demand shocks (OSs) (Kilian, 2014). Other studies confirmed that oil price fluctuations significantly impacted macroeconomic activities, inequality, financial markets, and other commodity markets (Nademi, 2018; Mo et al., 2019; Meng et al., 2020; Najarzadeh et al., 2021).

Securing access to quality food has many benefits for countries and nations. It boosts economic growth, reduces poverty, and creates jobs. It also increases trade opportunities, enhances global security and stability, and improves health status (Abdul and Ismail, 2019). Over the last decades, the international community has faced many challenges to food security. The most prominent of these could be the sharp upturn in prices (Zmami and Ben-Salha, 2019). More recent data suggest that about 124 million people across 51 countries faced food insecurity in 2017 (Food Security Information Network, 2018). According to the Food and Agriculture Organization of the United Nations (FAO, 2009), the international prices of essential foods reached their highest levels for 30 years in June 2008. In Iran, a developing country, food is essential in households' consumption portfolio (Mahmoudinia, 2021). So, in the late modification, especially in recent times, the food crop prices have been on the high side. The prices of food crops such as rice, wheat, and cassava have been progressively high (Olayungbo, 2021). Rising food prices threaten the macroeconomic stability in countries with poor resources. The fluctuation of petroleum prices makes oil-rich countries more vulnerable to economic shocks (Devesh and Affendi, 2021).

Therefore, researchers have focused on investigating the relationship between the fluctuations of these variables: crude oil price and food price. In recent years, there has been worldwide concern about food and oil price fluctuations (Olayungbo, 2021). The co-movement of crude oil and food commodity prices has significant changes over time. Several measures of time-varying unconditional price change correlations were negative in the 1990s. During the early 2000s, they shifted into positive territory. After 2010, they decreased again (Peersman et al., 2021). The literature shows that fast motility in oil and food prices will hurt the world economy (Hakro and Omezzine, 2010; Alom, 2011; Karakotsios et al., 2021;).

Recent studies highlight that energy price is considered a key variable. It can explain the dynamics of food prices worldwide (Saghaian, 2010; Pal and Mitra, 2020). The increase in food prices has pressured oil-producing countries that import food. This is especially true for developing oil-exporting countries. If economic sanctions target this group of countries, poverty and inequality will spread (Salem et al., 2023, Heydari and Keikha, 2023). For instance, a country like

Egypt is the world's largest wheat importer. On average, it imports 11 million tons of wheat annually (Food and Agriculture Organization (FAOSTAT, 2016). This is followed by Yemen, which imports almost 2 million metric tons of wheat annually (World Bank, 2013). Iran imported 1.18 and 1.1 million tons of wheat and rice in 2020, respectively. Countries like these are more vulnerable to higher food prices. Their food imports mostly rely on unpredictable oil revenues. Unexpected changes in global oil prices influence these revenues.

Another interesting point is that there is a novel transmission channel between crude oil prices and food prices. Since the early 2000s, biofuel production has transformed agricultural commodities into energy carriers. It allows their use as feedstocks for ethanol and biodiesel (e.g., De Gorter and Just, 2009; Serra and Zilberman, 2013). Since then, fuel has been an input and an agricultural production output. It has also become a new way for crude oil prices to affect food prices in industrialized countries (Wang et al., 2013). However, technological progress needs to catch up in developing countries. Biofuels are not available there yet. Thus, the link between crude oil and food needs to be better understood (Nazlioglu and Soytaş, 2011). Many scholars attribute the rise in food prices to the increased cost of oil. Oil is an input to food production (Carpio, 2019; Taghizadeh-Hesary et al., 2019). Some studies have also examined the role of transportation costs on food prices (Gholamian and Taghizadeh, 2017; Shemshadi, 2021).

In general, this study innovates in several ways compared to others. First, previous studies have yet to consider the possible dynamic linkages between oil and food prices in oil-exporting developing countries like Iran. Iran is not only oil-dependent but also a net food importer. This present study, therefore, filled this gap. This gap in the literature is particularly striking as populations in developing countries are much more vulnerable to food crises than those in developed ones (Dalheimer et al., 2021). Second, international sanctions have significantly impacted oil revenues. As a result, inputs, technology, and food imports have been affected. This factor has been the main characteristic of Iran's economy in recent years. Investigating its effect is considered another innovation. This is a distinction from previous studies such as Kohansal and Hezareh (2017) and Jafari Samimi and Farajzadeh (2019). Third, our study has not just focused on a few commodities. For example, we looked not only at agricultural or energy commodities, as done in Shahzad et al. (2018). Instead, we used a food price and nonfood price index in Iran. Finally, we added the effect of exchange rate and money supply shocks to develop other structural equations. These equations model the Inflation of food and

nonfood. As far as authors know, no comprehensive work is dedicated to these objectives.

This article is organized into several parts. The second part discusses the theoretical foundations of the relationship between oil and food prices and the research background. The third section analyses the food, nonfood, and oil price data related to Iran's economy. In the fourth section, we consider the methodology and data description. Next, we estimate the model, analyse the results, and link them to the characteristics of Iran's economy. Finally, we present conclusions and suggestions.

2. Literature Review

Oil price shocks significantly affect all economic activities of developing countries (Bala and Chin, 2020). Theoretically, different mechanisms explain how oil price shocks affect different commodities. First, price shocks can affect energy and non-energy goods differently. In the case of agricultural products, oil is an essential complementary commodity. It also plays a vital role in their production function as an input (raw material) (Yang, 2019). Carpio (2019) used a vector error correction with an exogenous variable (VECX) model. He analyzed the effects of oil prices on forecasts for ethanol, gasoline, and sugar prices. The results showed that the forecasts for ethanol and gasoline prices were more sensitive to changes in future oil prices. This was compared to the sugar price forecast. Rising oil prices lead to cost-side Inflation through the effect on corporate output and citizen consumption (Wu et al., 2013). This leads to the devaluation of the domestic currency of oil-importing countries. It does so by deteriorating international payment balances.

The second case, the substitution effect, is related to biofuel production. It leads to changes in oil prices, directly impacting ethanol and biodiesel prices. This has been intensified, especially after the advent of biofuel production in the mid-2000s. Biofuels made it possible to produce fuel through substandard grains and vegetable oils. Therefore, crude oil and some agricultural grains were considered substitutes for fuel production. This leads to an increase in the positive correlation of prices between the two markets. The two commodities are highly substitutable. A shock that changes the price of one commodity will further increase the price of the substitute commodity. Bilgili et al. (2020), using continuous wavelet model estimations, found a significant linkage between biofuel production and food prices in the US for the monthly period 1981–2018. Many studies have concluded

that this is the most critical factor in oil-importing countries. However, in the case of oil-rich countries, this factor seems to be less critical.

The third is the cost of transportation for both agricultural inputs and market products. It is affected by fuel prices and, consequently, crude oil. Transportation costs are crucial in increasing agricultural prices in developing countries like Iran. This is because these countries need more rail and maritime transport infrastructure. They rely mainly on costly road transport (Barzelaghi et al., 2012). Gholamian and Taghazadeh (2017) propose an integrated wheat supply chain planning model. They use different transportation modes in a case study of Iran. This illustrates a significant reduction in transportation costs.

The fourth case is the effect of oil revenues, specific to oil-rich countries. Oil exports comprise many of these countries' revenues (Olayungbo, 2019; Farzanegan, 2011). Therefore, oil shocks significantly affect foreign exchange inflows. This, in turn, affects food imports and related input, resulting in food prices in these countries (Samadi, and Behpour 2013). For example, Najarzadeh et al. (2021) found that a positive oil revenue shock significantly increases the consumption of Iranian households with low education levels. It also reduces consumption inequality among consumers.

Oil, as the most important source of income (Wang et al., 2013), is a very decisive variable in the price changes of food and nonfood goods for these countries (Chen et al., 2020). These countries are more vulnerable to higher food prices. Unpredictable oil revenues primarily finance their food imports. These revenues are affected by unexpected changes in global oil prices (Olayungbo, 2021).

In recent years, supply and demand shocks caused oil prices to fluctuate significantly. This affected economic activities, financial markets, and commodity markets (Kilian, 2014; Latunde et al., 2020). On the other hand, these developing countries have different market characteristics. This is due to imperfect competition between manufacturers and retailers. There is also imperfect substitution between domestic and imported goods (Dillon and Barrett, 2015). Thus, the reaction of the food market to the oil market, in addition to the volume of oil exports or imports, probably depends on the degree of development of an economy and economic sanctions (Shirazi et al., 2016; Adeli et al., 2022).

Figure 1 shows the theoretical relationship between food and crude oil prices. The left part of the chart shows the classified aspect of the crude oil market. It includes three sources for fundamental shocks. Kilian et al. (2009) showed that oil shocks had distinct effects on oil market dynamics. However, few studies have

examined the various dimensions of these shocks. Wang et al. (2014), for example, used structural models to test the effects of these oil shock mechanisms on the food market. Expanding the model of Kilian et al. (2009), these researchers found that after 2006, food prices were solely affected by specific oil demand shocks.

In connection with input cost, both the mineral fertilizers used on farms and the fuel consumption of machinery as inputs for agricultural production can be an integral part of farmers' production costs. It, therefore, affects food supply and product prices (Dillon and Barrett, 2015; Serra and Zilberman, 2013; Wang et al., 2014). Input costs describe the traditional relationship between energy prices and food prices. However, this cost type generally plays a minor role in explaining the parallel movement of oil and food prices (Serra and Zilberman, 2013; Kristoufek et al., 2012).

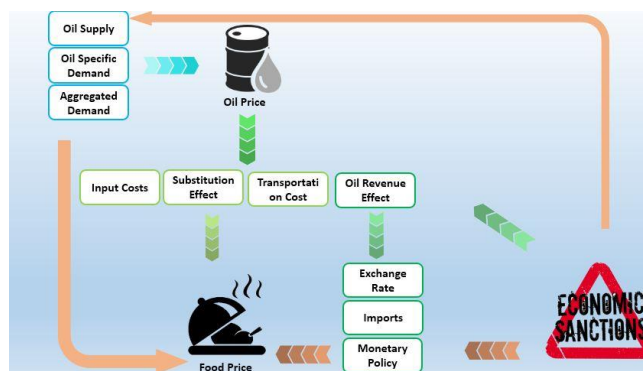


Figure 1. Conceptual Model of the Relationship between Oil Structural Shocks and Food Prices

Source: Research finding.

Currency fluctuations can also be regarded as another important issue affecting food prices. Exchange rate fluctuations and currency crises significantly influence food prices. Various studies have investigated this issue (Reboredo and Ugando, 2014). Many developing countries need help to produce agricultural products (Iddrisu and Alagidede, 2020). Consequently, they spend nearly 41.5% of their total consumption on food. Also, the government allocates subsidies to these products. This is to prevent food price increases and reduce pressure on poor families. Therefore, the government's use of monetary policies for this purpose is inevitable (Kaur, 2021).

The effect of the exchange rate on the price of food can be analysed in two ways. First, an increase in the exchange rate leads to higher prices for imported inputs like seeds, fertilizers, pesticides, and chemicals. This increases the cost of

agricultural products (Awan and Imran, 2015). Some products, like rice and wheat, make up many of developing countries' imports, especially in Iran. The increased exchange rate leads to higher import prices for these products. On the other hand, an increase in the exchange rate enhances the cost of energy and fuel. This causes an increase in the cost of transportation and, therefore, food.

Some studies have empirically examined the relationship between oil prices, monetary policy, imports, and exchange rates. For example, Mahmoudinia (2021) used quantile regression analysis to examine the effects of monetary policy, currency crises, and oil prices on food inflation in Iran. Economic sanctions in Iran strongly linked the response of food prices to the price of oil and food inflation. Iddrisu and Alagidede (2020) also found the positive impact of monetary policy, exchange rates, and world food prices on food prices.

3. Empirical Facts of Iran's Economy

According to Figure 2, during the years studied, the Inflation of food products has been higher than that of nonfood products in Iran's economy. Also, the trend of the figures shows that Inflation reached its highest level between 2010 and 2013, which was affected by various issues, including the increase in oil prices during this period.

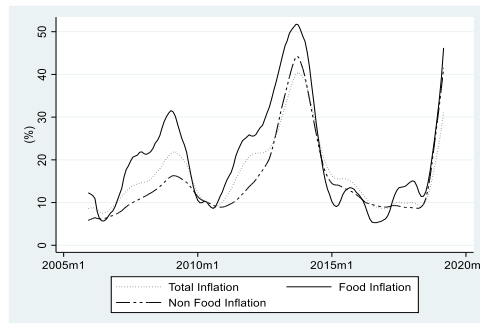


Figure 2. food, Non-Food and Total Inflation

Source: Research finding.

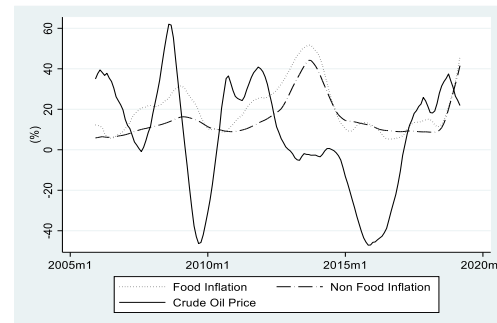


Figure 3. Food, Nonfood Inflation and Crude Oil Change

Source: Research finding.

As can be observed from figure 2, from 2005 to 2013, food inflation was higher than total Inflation; from 2014 to 2016, this trend changed, and the total Inflation exceeded food inflation. The reason for such a change may be the proximity to the presidential elections 2016. A similar thing happened from 2006 to 2007 and from 2010 to 2011. Such manipulations are likely to occur in

governments with oil budgets. After that, the food inflation rate again exceeded the total Inflation.

The intensity of Inflation gradually increases. An increase in liquidity, the enhanced severity of sanctions, and a decrease in foreign exchange reserves are the common causes of such a situation. This process is palpable in developing countries that export oil and rely on oil revenues. This is because the increase in food prices exerts much pressure on oil-producing countries that import food.

Iran is not exempted from the rule of oil price fluctuations and has always experienced shocks due to political and economic reasons. Due to the sensitive geopolitical situation of the country and some political issues, Iran's economy has constantly been subjected to cruel sanctions, and this has shown its effects in different dimensions. In addition to impeding financial mechanisms related to getting currency for the sale of oil and its entry into the country, sanctions have also affected its energy infrastructure. On the other hand, as the inflow of foreign currency is restricted, its supply side has faced a shortage, and finally, the exchange rate has increased.

Figure 3 indicates that oil price fluctuations are much higher than food and nonfood price ones; however, the trends of these two sectors are similar, with a lag of almost one year. When the global price of crude oil reached its highest level in July 2008, food prices in Iran were still rising. Also, food prices declined when they hit their lowest point in January 2009. The reason for the low volatility of food products, compared to the fluctuations in oil prices, is the government's supportive policies as a result of the dollars saved during the boom in oil revenues. Similarly, in 2012, the price of oil decreased, and this downward trend continued until 2016. Despite the long period of this period, food prices in Iran did not decrease significantly. The JCPOA agreement, the removal of sanctions during this period, and the increase in Iran's oil production did not increase the government's income much due to the low oil price. The third jump in oil prices coincided with the JCPOA's cancellation and the sanctions' return to Iran's economy.

Figure 4 represents the contribution of different sectors of the household budget, clearly showing that a significant part of Iranian household income is spent on housing, followed by food. In the last decades, the housing sector has experienced a significant price increase; finally, the amount of the rent paid by households has also increased.

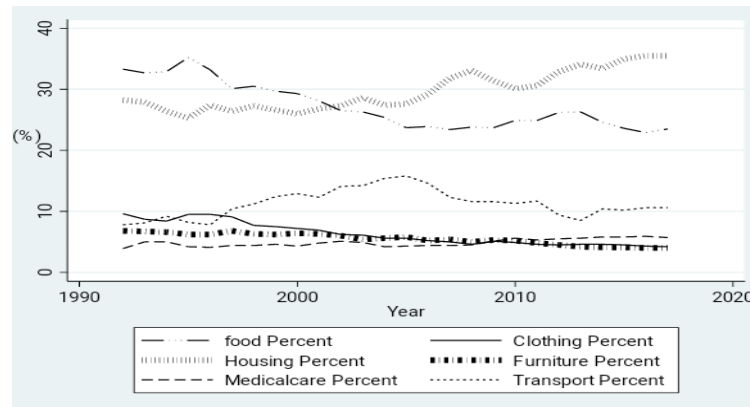


Figure 4. The Contribution of Different Sectors to the Household Budget

Source: Research finding.

4. Methodology and Data Description

4.1 Methodology

In the current study, we employed a structural vector autoregression (SVAR) model for Iran, in line with Kilian (2009), Baumeister and Kilian (2014), and Ahmad Bhat et al. (2018), to analyze the interdependence between oil structure shocks and food and nonfood price changes. In his seminal study, Killian (2009) separated three different oil price shocks based on the framework of the linear structural vector autoregression (SVAR) model; after that, this method was significantly used to study the relationship between oil price fluctuations and macroeconomic variables. Based on that, in the oil market, fluctuations in the actual price of oil can be under the influence of three structural shocks: 1) Oil supply shocks as shocks to the global supply of crude oil, 2) Aggregate demand shocks as shocks to the global demand for all industrial commodities driven by global actual economic activity, and 3) Other oil-specific demand shocks as shock in crude oil prices, which can be modeled, following Kilian (2009), to identify the changes in the precautionary demand for crude oil in response to the increased uncertainty about future oil supply shortages.

Analyzing the reaction of food and nonfood prices to these shocks can help us to find that we can separate the effects of oil factors, such as oil supply shocks and other oil-specific demand shocks, from those of the global factor, including aggregate demand shock, on the commodity market. In the two-step structural vector autoregressive (SVAR) technique, firstly, we utilize the SVAR model to consider the sources of shocks; secondly, we explore the effect of the estimated structural shocks on food and nonfood prices.

The SVAR analytical framework examines all variables and provides conditions for applying restrictions compatible with economic theory; hence, it helps us achieve more accurate, logical, and consistent findings. According to Narayan et al. (2008), the SVAR model is superior to the VAR one in that the reduced form of the latter does not consider the structural relationships between the variables. Therefore, this article will investigate the transmission of crude oil structural shocks onto food and nonfood inflation in Iran using the SVAR model with sign restrictions to know how food and nonfood prices react to structural shocks. However, the SVAR model attempts to solve the traditional identification problem. The structural VAR representation is;

$$A_0 Y_t = a + \sum_{i=1}^p B_i Y_{t-i} + \xi_t \quad (1)$$

, where Y_t is a vector of exogenous variables, B_i is the parameter coefficient matrix, P denotes the lag length, and ξ_t is a vector of orthogonal structural shocks. The reduced-form VAR is specified as:

$$Y_t = A_0^{-1} a + \sum_{i=1}^p A_0^{-1} B_i Y_{t-i} + \vartheta_t \quad (2)$$

and

$$\vartheta = A_0^{-1} \xi_t \quad (3)$$

where ϑ denotes the reduced-form VAR innovations; also, it can be expressed as the vector of estimated shocks specified by placing restrictions on the A_0^{-1} matrix. However, the covariance matrix for ϑ is specified as follows:

$$\sum_{\vartheta} = E(\xi_t \xi_t') = A_0^{-1} E(\vartheta_t \vartheta_t') A_0'^{-1} = A_0^{-1} \sum_{\xi} A_0'^{-1} \quad (4)$$

where $\sum_{\xi}$ is the covariance matrix for the shocks and E is the unconditional expectation operator. According to Kilian (2009), we do not use long-term restrictions; we only apply short-term restrictions on contemporary relationships. Based on Equation (3), it is assumed that matrix A_0^{-1} is a lower triangular matrix so that in the baseline mode, the matrix with the restrictions imposed can be seen below:

$$\vartheta \equiv \begin{bmatrix} \vartheta^{OPRO} \\ \vartheta^{GLOB} \\ \vartheta^{OPRI} \\ \vartheta^{FOOD} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \xi^{oil \text{ supply shock}} \\ \xi^{aggregate \text{ demand shock}} \\ \xi^{oil-specific \text{ demand shock}} \\ \xi^{food \text{ shock}} \end{bmatrix} \quad (5)$$

and

$$\vartheta \equiv \begin{bmatrix} \vartheta^{OPRO} \\ \vartheta^{GLOB} \\ \vartheta^{OPRI} \\ \vartheta^{NFOOD} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \xi^{oil\ supply\ shock} \\ \xi^{aggregate\ demand\ shock} \\ \xi^{oil-specific\ demand\ shock} \\ \xi^{non\ food\ shock} \end{bmatrix} \quad (6)$$

where *OPRO*, *GLOB*, *OPRI*, *FOOD*, and *NFOOD* are global oil supply, global real economic activity extracted from Kilian's index, actual crude oil price, food price index, and nonfood price index, respectively. Some identification assumptions related to the order of variables in the above equations are mentioned here. The first assumption is that global crude oil producers take at least one month to respond to all shocks, including shocks to aggregate demand, global oil prices, and food prices. This restriction is applied by setting all the first rows to zero, except the first column of matrix A_0^{-1} . Based on the second hypothesis, we argue that global economic activity responds simultaneously to oil supply and aggregate demand shocks. In contrast, its response to other shocks, including oil-specific demand shock, takes more than a month. The third row assumes that crude oil price is affected by its shock, oil supply shock, and aggregate demand shock, consistent with the commodity supply and demand principle. In the fourth row, food and nonfood prices receive simultaneous effects from all the remaining variables in the system. Following Kilian and Park (2009), the oil supply shock illustrates a negative one standard deviation shock, while the aggregate demand shock and oil-market specific demand shock display positive shocks, such that all these would tend to increase the food and nonfood prices.

In addition, we developed a structural VAR model by putting structural variables such as money supply and exchange rate as exogenous time series data, which could help us better understand the transmission mechanism of oil price shocks. The order of the variables in A_0^{-1} in equation (3) shows that reduced form innovations, ϑ , can be presented as the linear combinations of the structural innovations, ξ , as follows:

$$\vartheta \equiv \begin{bmatrix} \vartheta^{OPRO} \\ \vartheta^{GLOB} \\ \vartheta^{OPRI} \\ \vartheta^{REXR} \\ \vartheta^{MONP} \\ \vartheta^{FOOD\ (Nonfood)} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{bmatrix} \begin{bmatrix} \xi^{oil\ supply\ shock} \\ \xi^{aggregate\ demand\ shock} \\ \xi^{oil-specific\ demand\ shock} \\ \xi^{exchange\ rate\ shock} \\ \xi^{money\ supply\ shock} \\ \xi^{food\ shock\ (Nonfood)} \end{bmatrix} \quad (7)$$

where *REXR* and *MONP* are the real exchange rate and money supply. Based on this matrix, we put the real exchange rate before the money supply because the money supply responds immediately to the changes in the real exchange rate; then, the monetary policy can affect the level of Inflation in the economy, including food and nonfood items.

4.2 Data Description

This study aimed to investigate the response of food and nonfood prices to crude oil structural shocks in Iran's economy. Here, we used the sample for the empirical analysis, including 180 monthly observations made in Iran from April 2004 to March 2018. The variables under discussion in this study, based on Wang et al. (2014), Widarjono et al. (2020), Alom et al. (2011), and Baumeister and Kilian (2014), included global oil production, actual economic activity, Brent oil price, food price, nonfood price, real exchange rate, and accurate money supply. Most of the data were obtained from the Central Bank of Iran. At the same time, global crude oil production and actual economic activity index were collected from the US Energy Information Administration and Federal Reserve Bank of Dallas, respectively.

We used global oil production data as a proxy for the global oil supply and actual economic activity index constructed by Kilian (2009) to estimate the scale of global economic activity as a proxy for global demand shocks. Kilian's economic index, extracted at a monthly frequency, has an additional advantage over GDP, calculated yearly. Also, the nominal data of the Brent price index have been utilized as the proxy for world crude oil prices. In addition, we have used the food and nonfood price index calculated by the GDP deflator as the proxy for food and nonfood inflation, respectively. For further sensitivity analysis, we add money supply as the proxy for monetary policy shocks and real effective exchange rate, which can be calculated as the nominal effective exchange rate divided by a price deflator to the baseline model. The selection of the starting and ending dates was based on the availability of the data. Definitions and sources of variables used are provided in Table 1.

Table 1. Definitions and Sources of Variables

Variable	Definition	Source
<i>OPRO</i>	Global Crude Oil Production	US Energy Information Administration
<i>GLOB</i>	Real Economic Activity Index Constructed by Kilian (2009)	Federal Reserve Bank of Dallas
<i>OPRI</i>	Brent Oil Price	CBI
<i>FOOD</i>	Food Price Index	CBI
<i>NFOOD</i>	Non-Food Price Index	CBI
<i>REXR</i>	Real Exchange Rate	CBI and <i>Author calculated</i>
<i>MONP</i>	Real Money Supply	CBI
<i>VOLT</i>	Oil Price Volatility	<i>Author calculated</i>

Source: Research finding.

Moreover, the descriptive statistics of all investigated variables in the SVAR model and the distribution and variability of the data for *OPRP*, *GLOB*, *OPRI*, *FOOD*, *NFOOD*, *MONP*, and *REXR* are presented in Table 2. This study's monthly time series summary statistics revealed that all variables exhibited positive averages. As shown in Table 2, the mean values of food and nonfood prices were 57.4 and 64.9, respectively, and the standard deviation for these time series data was smaller than the mean value.

Table 2. Descriptive Statistics of All Variables

Variable	Mean	Median	Max	Min	Std.dev	Skewness	Kurtosis
<i>OPRO</i>	97.02	96.92	104.2	87.23	3.66	-0.0007	2.22
<i>GLOB</i>	14.49	-1.24	190.81	-159.4	78.55	0.35	2.29
<i>OPRI</i>	75.20	70.10	133.20	30.80	26.08	0.37	1.90
<i>FOOD</i>	57.40	36.50	226.0	10.90	45.68	1.09	3.93
<i>NFOOD</i>	64.69	44.10	197.0	33.80	36.59	1.36	4.65
<i>REXR</i>	10.58	10.57	11.57	10.24	0.22	1.56	7.42
<i>MONP</i>	15.04	14.98	16.77	13.18	1.02	-0.02	1.84
<i>Obs</i>	180	180	180	180	180	180	180

Source: Research finding.

5. Empirical Results and Discussion

5.1 Unit Root Analysis

Before we estimate the SVAR model, a preliminary analysis of the data series was performed, as it required all variables to be stationary. Hence, we utilized the augmented Dickey–Fuller (ADF), Phillips– Perron (PP), and the structural break unit root ADF test technique for all variables. The Results of the unit root tests, as

shown in Table 3, indicated that all the series (except the Kilian index) were not stationary at the $I(0)$ level, with the rejection of the null of unit root (non-stationarity); however, they were stationary at the first difference $I(1)$, which represented that modeling them in levels could lead to misleading results. Therefore, the first difference of all series, except the global economic activity index, was used to estimate the SVAR model.

Table 3. Results of the Unit Root Test

	ADF		PP		Break Test ADF	
	Level	First Difference	Level	First Difference	Level	First Difference
<i>OPRO</i>	-3.10 (0.10)	-11.32* (0.00)	-2.74 (0.21)	-11.28* (0.00)	-2.96 (0.34) [2005: 11]	-11.94* (0.01) [2011: 3]
<i>GLOB</i>	-3.89** (0.01)	-10.07* (0.00)	-3.20*** (0.09)	-10.12* (0.00)	-4.66* (0.02) [2010: 5]	-10.51* (0.01) [2009: 2]
<i>OPRI</i>	-2.59 (0.28)	-8.96* (0.00)	-2.36 (0.39)	-8.88* (0.00)	-3.33 (0.49) [2014: 6]	-9.78* (0.01) [2008: 10]
<i>FOOD</i>	-1.57 (0.80)	-5.07* (0.00)	-1.57 (0.79)	-8.51* (0.00)	-0.48 (0.99) [2018: 5]	-9.58* (0.01) [2018: 5]
<i>REXR</i>	-1.08 (0.92)	-6.56* (0.00)	-1.30 (0.88)	-11.02* (0.00)	-3.66 (0.29) [2018: 8]	-11.51* (0.01) [2018: 2]
<i>MONP</i>	-2.68 (0.24)	-4.14* (0.00)	-2.50 (0.32)	-8.07* (0.00)	-2.29 (0.98) [2011: 10]	-8.81* (0.01) [2005: 7]
<i>NFOOD</i>	-0.55 (0.98)	-5.22* (0.00)	-3.63 (0.97)	-5.27* (0.00)	-0.05 (0.99) [2017: 8]	-5.61* (0.01) [2018: 8]

Source: Research finding.

Note: (*) Denotes statistical significance at a 1% level. (**) Denotes statistical significance at the 5% level. (***) Denotes statistical significance at the 10% level. Trend and Intercept were included in all three tests.

5.2 The Baseline Model Results

In this section, to analyze the impacts of the change in oil supply, aggregate demand, and oil price on food and nonfood prices, we specified a vector of four variables as $Y = [OPRO_t, GLOB_t, OPRI_t, FOOD_t(NFOOD_t)]$. From Table 4, the optimal lag lengths selected based on the Schwarz Information Criterion (SIC), AIC, and HQ for food and nonfood models were 1. Hence, we selected $p = 1$ for the VAR model.

Table 4. VAR Lag Order Selection Criteria in Baseline Model

Lag	AIC	SC	HQ
Food Model			
0	14.1	14.2	14.1
1	11.1*	11.6*	11.3*
2	11.2	11.9	11.5
Non-Food Model			
0	13.2	13.3	13.2
1	9.76*	10.1*	9.91*
2	9.77	10.4	10.04

Source: Research finding.

Note: (*) indicates the optimal lag lengths.

In the next stage, we employed roots of the characteristic polynomial index to consider the stability of the estimated VAR model. If the vector autoregression model is unstable, the impulse-response standard errors are unreliable (Lütkepohl, 1991). Table 5 shows that the estimated VAR model in both food and nonfood models is reliable. An estimated VAR model is stable (stationary) if its root reciprocals are less than one when located in the unit circle.

Table 5. Stability of the VAR Mode

Roots of Characteristic Polynomial	
Food Model	
Root	Modulus
0.95	0.95
0.37-0.05i	0.38
0.37+0.05i	0.38
0.17	0.17
Non-Food Model	
0.96	0.96
0.70	0.70
0.35	0.35
0.16	0.16

Source: Research finding

Note: No root lies outside the unit circle. VAR satisfies the stability condition

We now consider and compare food and nonfood price responses to a shock in oil supply, aggregate demand, and oil-specific demand using impulse response functions (IRF). We represent ten response periods for both short- and long-term effects.

According to Figure 5, among the three demand and supply shocks in the crude oil market, the shock in oil-specific demand caused by supply disruptions positively affects food and nonfood prices in Iran. So, in response to one standard deviation disruption in the oil-specific demand, food price change is gradually increased to about 0.002 index point for the first two months and begins to decline for four months. After that, it returns to its equilibrium. On the other hand, the same trend could be observed for nonfood block, but it is milder; so, the impact of an oil-specific demand shock on the price of nonfood is positive in the short and medium run. For the first two months, nonfood inflation increases to 0.001 index point; after that, it begins a smooth downward trend. This is consistent with the study done by Alom (2011), McPhail et al. (2012), and Hezareh et al. (2016). Due to the extensive energy consumption in the agricultural sector, oil price changes are directly related to the increase in agricultural goods and food prices. When the price of oil rises, the price of agricultural inputs also increases, leading to further growth in the prices of agricultural and food products. According to these outputs, it can be stated that since Iran's economy is dependent on oil and the share of oil in the government budget is high, with the increase in oil price due to other

exogenous oil-specific shocks, this share will also increase. Therefore, expansionary policies in the budget lead to more money injection in the market. Hence, the increase in price and the higher oil revenues of the country double the increase in liquidity, causing the problem of excess demand. Although excess demand in itself is not undesirable because there is no necessary movement in the production sector for a proportionate response, excess demand leads to higher food prices.

In contrast, the effects of oil supply disruptions on Iran's food and nonfood inflation are harmful in short periods and continue to be negative at a low level until the sixth and seventh months. Figure 5 indicates that a one-unit standard deviation shock to the oil supply causes a negligible change in food and nonfood by -0.0004% and -0.002 in the short run, respectively; in the long run, this impact, however, disappears. The result, in the long run, is consistent with the finding of Cunado et al. (2015), who stated that in the top oil-consuming Asian economies, oil supply shocks could have limited influence on CPI. In particular, the higher global supply of oil, along with the reduction of oil prices, can lead to a decrease in oil revenues in Iran and less injection of money into the society, which causes Inflation to decline.

More interestingly, food and nonfood prices respond differently to the unanticipated disruptions of aggregate demand driven by economic activity. As shown in Figure 5, innovations to aggregate demand have an immediate positive impact on the price of nonfood; meanwhile, we observed an almost negligible negative impact on the price of food. Following the aggregate demand shock, the price of nonfood reaches its positive maximum in the short term (around 0.008 index point), and these positive effects gradually decrease and enter the negative channel from around the third month. On the other hand, the effect of the aggregate demand hikes on food prices in Iran is minimal. It moves along its long-term equilibrium path, in which an aggregate demand disruption causes a momentary rise in food prices. We will see a smooth and continuous downward trend along the equilibrium path. This result is in line with Kilian and Park (2009) and Wang et al. (2014), who found that the increase in oil prices, caused by the increase in aggregate demand, reduced global economic activity, which partially offset the initial positive effects on food demand.

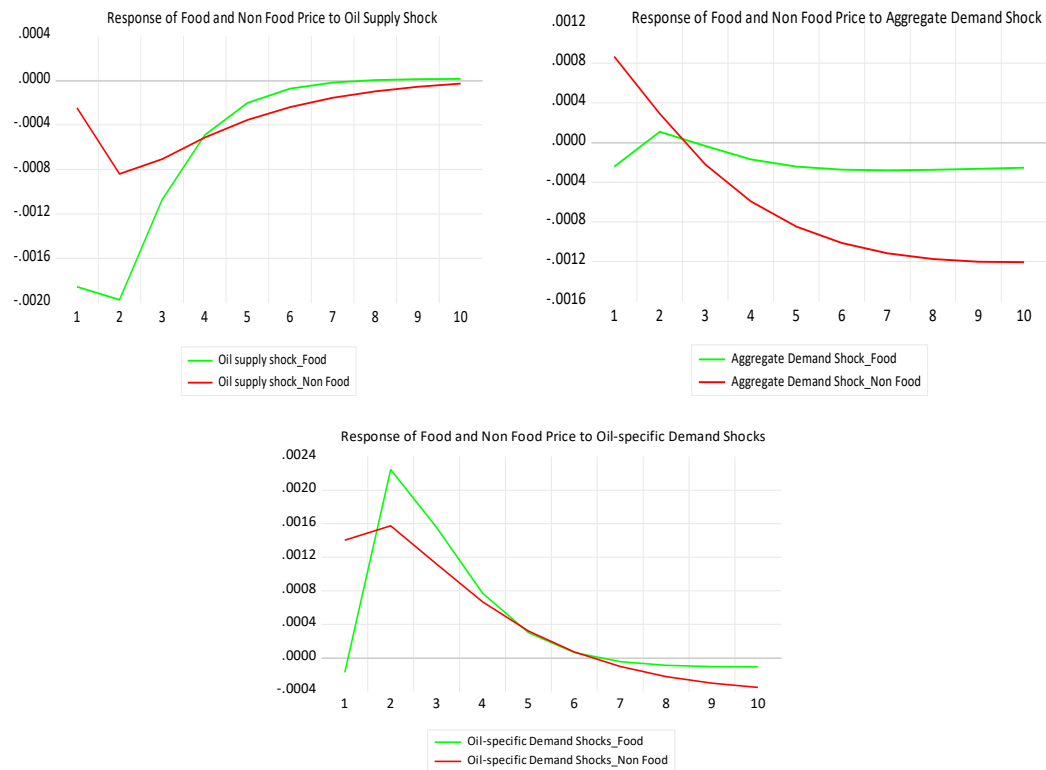


Figure 5. Impulse Response Functions of Food and Nonfood Price to Structural Shocks in the Baseline Model

Source: Research finding.

Figure 6 presents the accumulated response of food and nonfood prices. It could be observed that the oil supply shock leads to a decline in food and nonfood price changes in all periods of disruption. However, in response to the oil-specific demand shock, food and nonfood Inflation began to increase from the first month, reaching a constant level after the fifth month. The evidence presented in Figure 6 proves that the accumulated response of nonfood items in Iran to the identified shocks in aggregate demand driven by economic activity is unstable. In the short term, we see a positive impact, and this impact tends to be harmful after the fourth period. While aggregate demand surprises only have a long-lived negative impact on food prices, their response disappears in the short run.

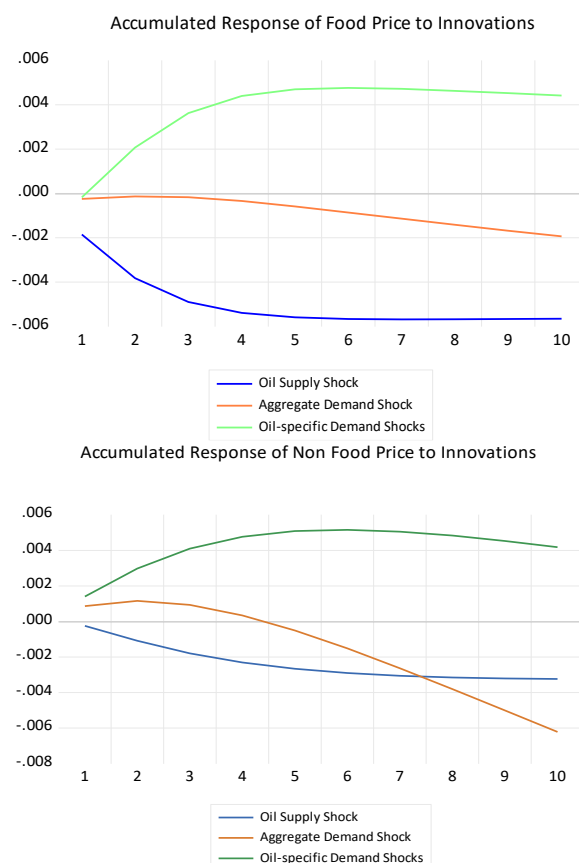


Figure 6. Accumulated Response of Food and Nonfood Prices to Innovations in the Baseline Model

Source: Research finding.

Table 6 displays the variance decomposition (VD) results at the horizons of up to 10 years for food and nonfood models. Food and nonfood blocks explain the most variation, about 97% and 96% for food-nonfood models. It is clear that, in the short run, the effect of these three shocks on food and nonfood blocks is slight. In the first period, less than 1% of the variation in the food market could be explained by the shocks extracted from the global crude oil market, while this value is about 2.3% for the nonfood price. In contrast, in the long run, the three structural shocks can account for about 3% and 6% of the variation in food and nonfood. We also found that the explanatory power of three supply and demand oil shocks for the nonfood model was more substantial than that of food prices for all periods. However, in the first period, food prices could be explained mainly by oil supply shock, and the power of oil supply for food inflation is approximately 0.6%. In

comparison, other shock rates are lower than 1%. The results indicate that in the three months, oil supply, aggregate demand, and oil-specific demand shocks could account for the movement of food prices by 1.3, 0.01, and 1.17, respectively. Further, VD results for food showed that in the tenth year, *OPRO* explained around 1.36% of the basic model, whereas *OPRI* accounted for around 1.27%. For nonfood prices, this analysis was different. In the first period, the proportion of nonfood inflation due to shock to oil supply, aggregate demand, and oil-specific was 0.05%, 0.6, and 1.6, respectively. Specifically, the shock in *OPRO* relatively had a low contribution to the nonfood price in the first year (about 0.05), but it rose to 0.55 percent in the third year and increased marginally to 0.60 percent in ten years. Over the 10-year horizon, oil-specific demand shock could explain between 1.62 and 2.25% of variation in nonfood prices. In comparison, the aggregate demand shock accounted for 0.61 to 2.93% of variations in nonfood prices from short to long periods.

Table 6. Variance Decomposition of Food and Nonfood in the Baseline Model

Food Model				
Period	<i>OPRO</i>	<i>GLOB</i>	<i>OPRI</i>	<i>FOOD</i>
1	0.6662	0.0114	0.0058	99.316
2	1.1832	0.0114	0.8181	97.987
3	1.3267	0.0113	1.1718	97.490
4	1.3568	0.0158	1.2583	97.368
5	1.3618	0.0250	1.2711	97.341
6	1.3623	0.0366	1.2714	97.329
7	1.3621	0.0488	1.2715	97.317
8	1.3619	0.0605	1.2726	97.304
9	1.3618	0.0715	1.2741	97.292
10	1.3616	0.0816	1.2757	97.280
Non-Food Model				
Period	<i>OPRO</i>	<i>GLOB</i>	<i>OPRI</i>	<i>NON – FOOD</i>
1	0.050093	0.617393	1.620312	97.71220
2	0.402642	0.437430	2.333928	96.82600
3	0.553684	0.385328	2.488399	96.57259
4	0.610100	0.492025	2.449604	96.44827
5	0.627451	0.739563	2.367005	96.26598
6	0.628923	1.093529	2.295339	95.98221
7	0.624290	1.517767	2.250239	95.60770
8	0.617724	1.981051	2.231853	95.16937
9	0.610960	2.459262	2.235084	94.69469
10	0.604660	2.935203	2.253912	94.20622

Source: Research finding.

5.3 Baseline Model Results by Monetary Policy and Exchange Rate

To further analyze the sensitivity, in this section, we will examine the effects of monetary policy and exchange rate shock on food and nonfood prices in Iran's economy based on the equation (7); the vector of exogenous variables can be written in the form of: (i.e., *OPRO*, *GLOB*, *OPRI*, *NONP*, *REXC*, *FOOD*). Figure 7 shows the impulse response of the innovations of symmetric monetary policy and exchange rate disruptions over a ten-year horizon.

To save space, we glance at the response of food and nonfood models to exchange rate and monetary policy shocks and do not focus on the response to oil structural shocks.

In the short run, one standard deviation of monetary policy shock to the food model was negative and continued to be positive in the long run. In other words, the immediate response of food inflation to the unanticipated disruption of the money supply was negative. However, this became positive after the two periods and remained stagnant from the seventh year onwards. This, thus, showed that in a medium and long-term period, the quantity theory of money was confirmed, and it was consistent with what has been proven by Mahmoudinia (2021) for Iran; therefore, the higher central bank's expansionary monetary policy, the higher the food prices.

However, this movement is different for the exchange rate uncertainty; so, in response to one standard deviation shock in the exchange rate, for the first two months, food price gradually increases up to about 0.004 index points, and it continues to decline (with a positive sign) for eight months and finally, it dies. Our result aligns with Iddrisu and Alagidede (2020) and Nazlioglu and Soytas (2012), who confirmed the positive relationship between the exchange rate and food prices.

It has been stated that exchange rate shock through the channel of devaluation and the increase in the price of primary and final imported products can lead to a push-up in the general level of prices, as well as prices in the food market. Also, this is contrary to the finding of Taghizadeh-Hesary et al. (2019), who found that, in the case of eight Asian economies, the response of food prices to any positive shock from the exchange rate was negative.

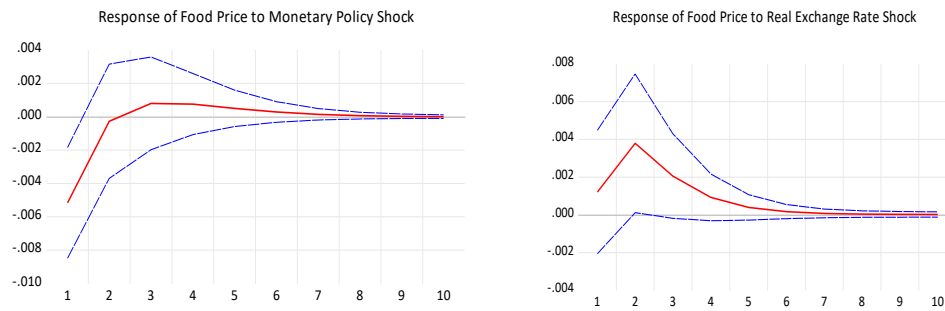


Figure 7. Impulse response functions of food price to structural shocks in the developed model

Source: Research finding

Figure 8 shows that the nonfood model responds negatively to the monetary policy shock. In the second month, it increases, slowly recovering over time and converging towards equilibrium. The response of the nonfood price to the exchange rate shock is similar to that of the food price. Nonfood inflation increased immediately after the exchange rate shock; however, after two months, this positive effect should gradually decrease and slowly die out in the long term. Thus, this analysis shows that exchange rate fluctuations directly affect food and nonfood prices in Iran.

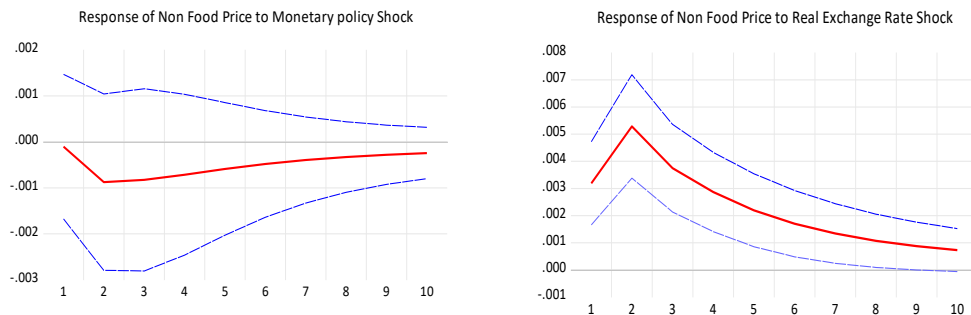


Figure 8. Impulse Response Functions of Nonfood Price to Structural Shocks in the Developed Model

Source: Research finding.

More interestingly, Figure 9 shows the accumulated response of food and nonfood items to oil structural shocks, money supply, and exchange rate disruptions. As can be seen, the exchange rate shock has the most positive effect on food and nonfood prices in Iran's economy. Also, after that, the oil-specific demand shock has the most significant impact on these two variables. On the other

hand, the oil supply and monetary policy shock have adverse and long-term sustainability effects.

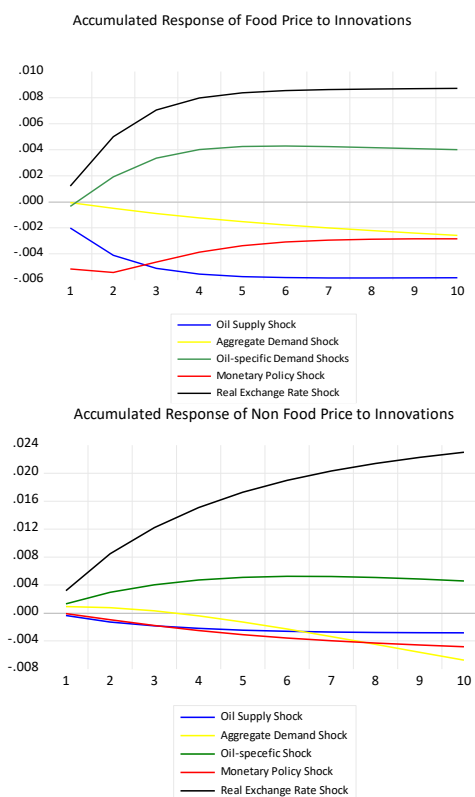


Figure 9. Accumulated Response of Food and Nonfood Prices to Innovations In The Developed Model

Source: Research finding.

Additionally, Table 7 presents the variance decomposition analysis for different periods based on Equation (7). Generally, the most variability in food and nonfood blocks in the whole period can be explained by money supply and exchange rate shocks, respectively. The results, thus, reveal that in the short run, money supply and exchange rate contribute 5% and 0.2 of the total variations in food price, respectively; meanwhile, in the long run, this proportion is about 4.3 and 3.2 percent for money supply and exchange rate, respectively. Moreover, the variation in food prices is mainly explained by monetary policy after its shocks. Table 7 indicates that, in the short and long run, only about 0.8% and 2.7% of the variation in the food price change can be explained by three crude oil shocks, respectively.

On the contrary, Table 7 reveals that money supply in the system explains the variation in nonfood inflation by 0.009 and 1.00 percent in the short and long run, respectively. Also, the variation in nonfood prices can be mainly explained by the exchange rate after its shocks. Over the 10-year horizon, the exchange rate explains between 9.04 and 24.7% of variations in the nonfood price. However, in the short and long run, only about 2.5% and 5.6% of the variation in nonfood price change can be accounted for by extracting from the crude oil market.

Table 7. Variance Decomposition of Food and Nonfood in the Developed Model

Food Model						
Period	<i>OPRO</i>	<i>GLOB</i>	<i>OPRI</i>	<i>MONP</i>	<i>REXR</i>	<i>FOOD</i>
1	0.797	0.000	0.024	5.259	0.289	93.626
2	1.363	0.031	0.852	4.307	2.549	90.896
3	1.465	0.055	1.138	4.237	3.100	90.002
4	1.483	0.072	1.196	4.290	3.206	89.751
5	1.486	0.084	1.202	4.320	3.224	89.681
6	1.486	0.094	1.202	4.331	3.227	89.658
7	1.486	0.102	1.202	4.333	3.227	89.647
8	1.485	0.108	1.203	4.334	3.227	89.640
9	1.485	0.114	1.203	4.333	3.228	89.633
10	1.485	0.119	1.204	4.333	3.228	89.628
Non-Food Model						
	<i>OPRO</i>	<i>GLOB</i>	<i>OPRI</i>	<i>MONP</i>	<i>REXR</i>	<i>NFOOD</i>
1	0.122	0.733	1.512	0.009	9.043	88.578
2	0.544	0.454	2.370	0.417	20.447	75.765
3	0.572	0.464	2.451	0.643	22.963	72.904
4	0.573	0.623	2.407	0.785	24.051	71.559
5	0.565	0.888	2.329	0.872	24.550	70.792
6	0.556	1.228	2.258	0.927	24.772	70.257
7	0.548	1.614	2.207	0.961	24.848	69.819
8	0.540	2.024	2.178	0.983	24.84	69.427
9	0.534	2.441	2.168	0.998	24.797	69.060
10	0.528	2.851	2.172	1.008	24.728	68.712

Source: Research finding.

In addition, we are interested in examining the exchange rate pass-through into food and nonfood inflation. The degree of exchange rate pass-through refers to the rate of variations of exchange rate changes to price level changes. Based on the arguments of Anh Pham (2019) and Leigh and Rossi (2002), the coefficient of pass-through is extracted by dividing price level change in response to the initial

exchange rate shock by the accumulated exchange rate change in response to its shocks. From Table 8, we can conclude that the degree of exchange rate pass-through for nonfood inflation is much higher than for food inflation. For instance, for the first period, the pass-through coefficient for food and nonfood are 0.017 and 0.04, respectively, which means that a 1 percent increase in the exchange rate will cause the price of food and nonfood by 17 and 4 percent, respectively.

Table 8. Exchange Rate Pass-Through into Food and Nonfood Inflation

	Food Model	Non-Food Model
1	0.017	0.04
2	0.04	0.06
3	0.02	0.04
4	0.10	0.03
5	0.04	0.02
6	0.01	0.019
7	0.009	0.015
8	0.004	0.012
9	0.003	0.010
10	0.002	0.008

Source: Research finding.

6. Robustness Check

6.1 The Baseline Model After and Before Economic Sanction

Given the importance of economic sanctions in the Iranian economy regarding macroeconomic variables, in this section, we divide the whole sample into the pre-sanction period (April 2004 to December 2011) and the post-sanction period (January 2012 to March 2018) to examine the effect of economic sanctions against Iran. Generally, the results illustrated that an oil structural shock could lead to differential food and nonfood price responses, depending on pre- and post-sanction times.

Figure 10 shows that one standard deviation unit of oil-specific demand shock caused by supply disruptions can lead to an immediate and more significant increase in food prices into the post-sanction period, as compared to the pre-sanction period, which is in line with Esmaeili and Shokoohi (2011), and Pal and Mitra (2018), who found a positive correlation between oil and food prices. Therefore, in oil-dependent countries, if the economy faces unexpected shocks caused by the price of export goods, including oil, it raises income and domestic demand; these, in turn, increase labor demand and wages. In this situation, the production of goods in the non-tradable sector increases, decreasing the profit of

the export sectors. Finally, the impact of the oil price impulse leads to a decrease in money supply and an increase in the real exchange rate; this, in turn, increases the total Inflation in the economy, including food and nonfood prices.

The increase in the price of crude oil affects food inflation through another channel. In recent years, the policy of some food-producing countries has been to produce biofuels from agricultural products, especially grains. With the increase in the price of crude oil, these countries reduce the supply of their products to the world markets for fuel production and increase the price of food, which can be transferred from the world markets to the Iranian market.

Additionally, it could be observed from Figure 10 that in the short run, one-unit standard deviation disruptions of the aggregate demand oil shock driven by global activity cause a change in food by -0.001% and 0.001 after and before economic sanction, respectively; in the long run, this impact disappears. Also, in pre-sanction and post-sanction periods, one standard deviation of oil supply unanticipated disruptions of food price is negative in the short run. However, the food price change response to the oil supply shock remains negative for the medium and long term in the post-sanction period, but it becomes favorable for the pre-sanction period.

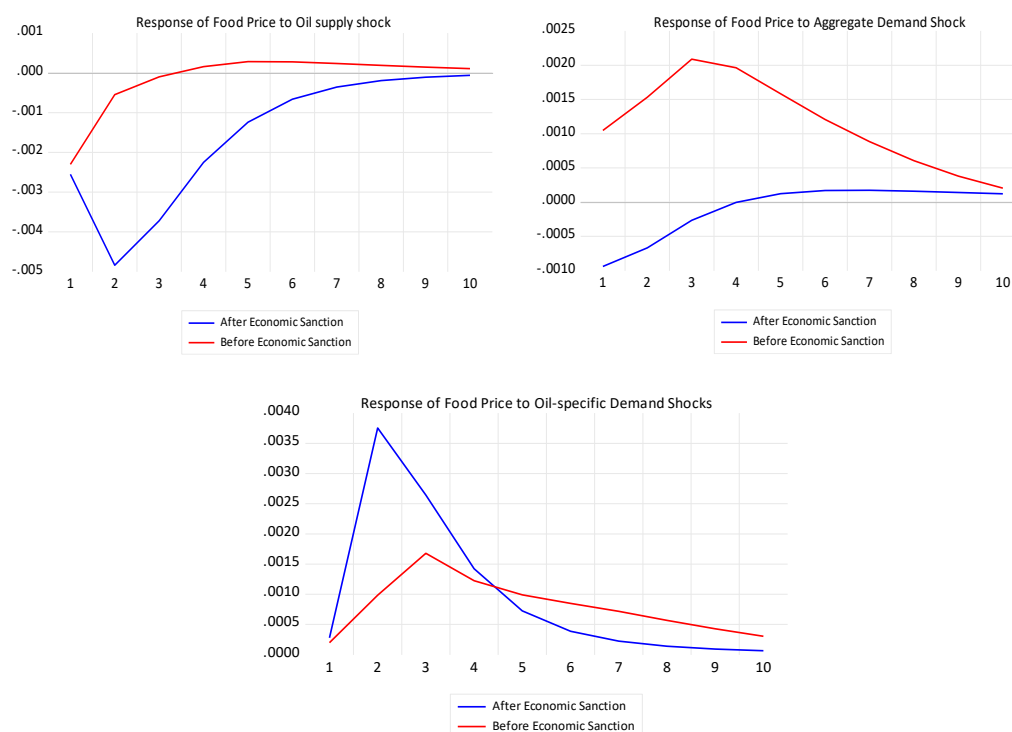


Figure 10. Impulse Response Functions of Food Price to Structural Shocks in Sanction Model

Source: Research finding.

Regarding the nonfood market, we observed that the price of nonfood items to oil supply shock declined in two months, both before and after the economic sanctions. However, these negative impacts were more for the post-sanction period. In the medium and long term, these adverse effects gradually disappear. It is evident from Figure 11 that the response of the nonfood change for the post-sanction duration to one standard deviation shock in oil-specific demand in the initial years is positive and incremental, while this trend decreases from the second month. However, before the economic sanctions, the oil-specific demand shock did not have much effect on the nonfood prices, and it was in its equilibrium almost throughout the ten periods. In addition, one standard deviation of aggregate demand shock to the nonfood price into post-sanction duration rather than pre-sanction year is positive. It continues to be positive in the long run.

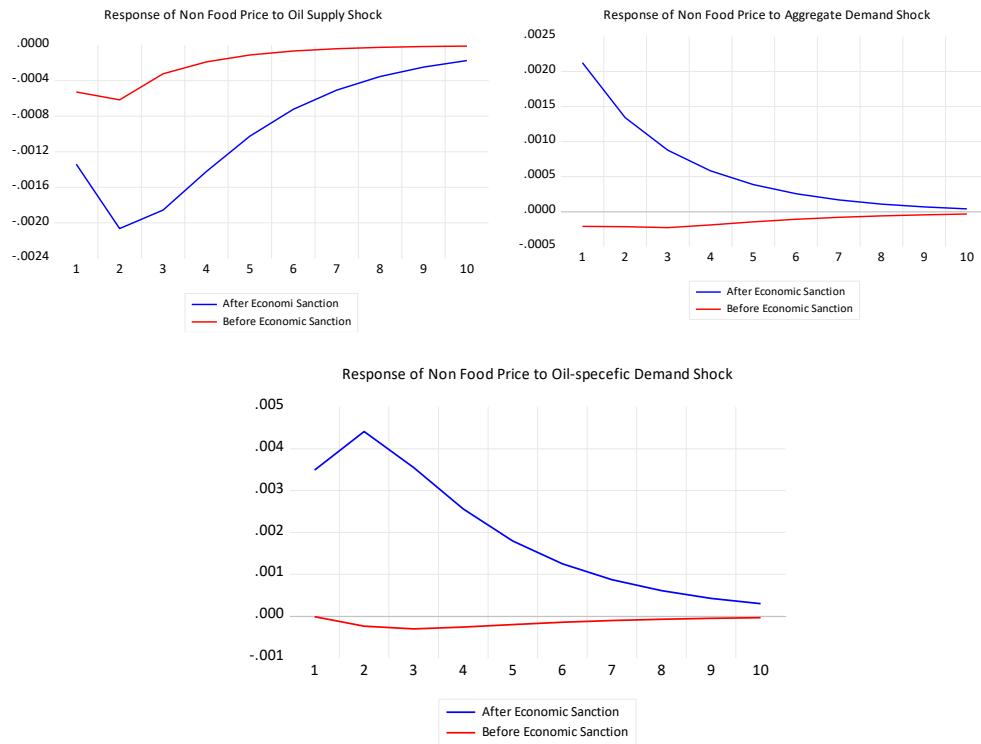


Figure 11. Impulse Response Functions of Nonfood Price to Structural Shocks in Sanction Model

Source: Research finding.

6.2 The Baseline Model by Oil Price Volatility

In the following sensitivity analysis, in line with the studies of Ahmed and Wadud (2011) and Wang et al. (2014), we have used the alternative form of oil price as volatility-adjusted oil price. Using Lee et al. (1995), the oil price volatility is calculated by the generalized autoregressive conditional heteroscedasticity (GARCH) (1,1) model of the oil price, and the AR (1) model has been used as the mean equation. The oil price volatility, based on Lee et al. (1995) in a GARCH (1, 1) framework, is presented as follows:

$$OPRI_t = \alpha + \sum_{i=1}^K \beta_i OPRI_{t-i} + u_t \quad (8)$$

$$u_t = e_t \sqrt{h_t} \sim N(0,1) \quad (9)$$

$$h_t = \theta_0 + \theta_1 u_{t-1}^2 + \theta_2 h_{t-1} \quad (10)$$

$$VOLO_t = \max\left(0, \frac{\hat{u}_t}{\sqrt{h_t}}\right) \quad (11)$$

where $u_{t\ it}$ refers to the residuals of oil price from the VAR model; h_t is the conditional variance and $VOLO_t$ shows the oil price volatility. The experimental results of volatility-adjusted oil price estimation can be seen in Table 9. However, the coefficient of AR (1) and GARCH (-1) is significant at the 5% level, while we observed that $RESID (-1)^2$ was significant at the 10% significance level.

Table 9. GARCH (1,1) for Crude Oil Price

Variable	Coefficient	z-Statistic	Prob
C	0.35	0.62	0.52
AR (1)	0.17**	1.92	0.05
Variance Equation			
C	9.894548**	1.986970	0.0469
RESID (-1) ^2	0.256325***	1.788248	0.0737
GARCH (-1)	0.463211**	2.260930	0.0238
$R^2 = 0.10$			
D.W= 1.60			

Source: Research finding.

Note: (*) Denotes statistical significance at a 1% level. (**) Denotes statistical significance at the 5% level.

(***) Denotes statistical significance at the 10% level.

According to Figure 12, the most significant fluctuations in oil price volatility occurred between 2008 and 2009 at the same time as the great depression happened.

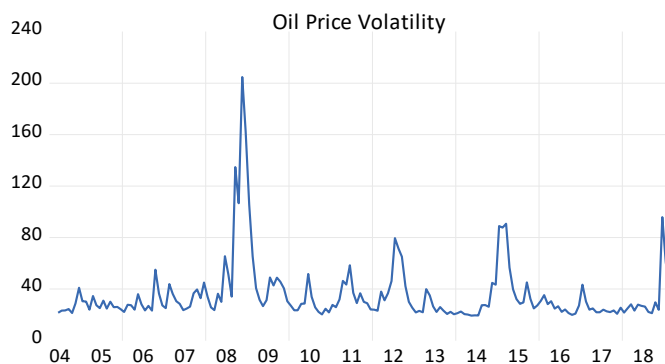


Figure 12. Oil Price Volatility

Source: Research finding

Figure 13 indicates the vector:

$Y = [OPRO_t, GLOB_t, VOLT_t, FOOD_t(NFOOD_t)]$ impulse response functions to one standard positive innovation to the three structural oil supply and demand cases. The graph of the impulse responses of the food price illustrates that one standard deviation shock to crude oil price volatility tends to increase the Inflation of food in the short run; meanwhile, after two years, a one-time positive shock to oil volatility could have a negative and persistent impact on the food price.

The story is different about the price of nonfood items. Throughout the ten years, the response of the nonfood price to one standard deviation shock in oil volatility is positive. In the short term, these positive effects are weaker; however, in the long term, they are more robust. The findings suggest that a one-time positive shock to the oil supply hurt food and nonfood prices in a short period; in the long run, this effect disappeared. In addition, the graph of the impulse responses of food and nonfood changes shows that one standard deviation disruption to the aggregate demand driven by global activity tends to reduce the food price after five periods and the nonfood price after two years.

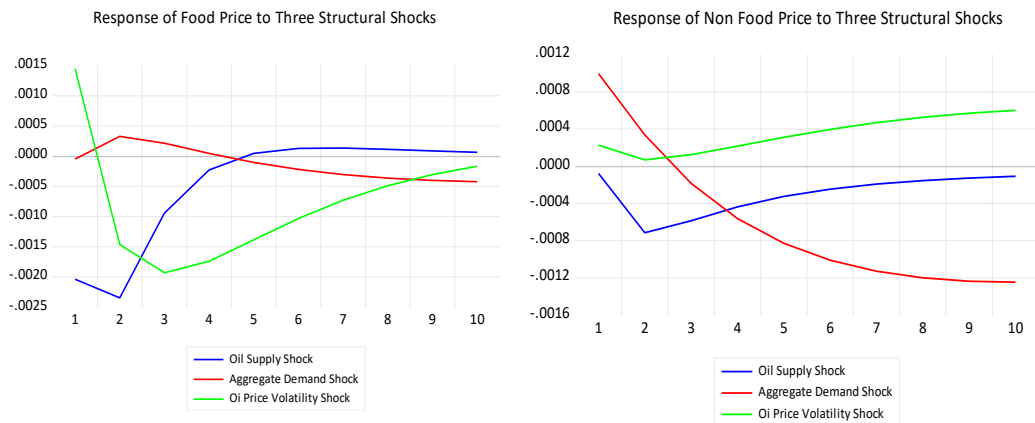


Figure 13. Impulse Response Functions of Food and Nonfood Prices to Structural Shocks in the Volatility Model

Source: Research finding.

7. Conclusion and Policy Implication

Considering the importance of food supply in the process of economic development, the issue of food security has always been discussed in developing countries, including Iran, and the variable of food prices, as a key factor affecting the supply and demand for agricultural products, has been the focus of

policymakers. In addition, food price changes are one of the most critical challenges facing policymakers because they adversely affect society's welfare, especially the poor and low-income groups. On the other hand, oil price fluctuations are one of the primary sources of economic fluctuations in oil-producing countries, in such a way that a sudden increase in oil revenues leads to an increase in foreign exchange earnings from the sale of crude oil; this, in turn, leads to the growth of wages and prices. Therefore, in this paper, we used a structural vector autoregression (SVAR) model to estimate the impact of oil structural shock on the price of food in Iran from April 2004 to March 2018. Following Kilian (2009), identified three different structural shocks: oil supply, oil demand, and oil-specific demand shocks. Also, in addition to food responses to oil structural shocks, we were looking at the effects of these disturbances on nonfood prices to compare these two groups.

The empirical evidence derived from estimating a SVAR for Iran's economy indicated that oil-specific demand disruptions positively affect food and nonfood prices in Iran; this effect could be more for food than nonfood in the short and medium term. Additionally, we found that oil supply shock hurt the food and nonfood models, especially in the short period. More interestingly, based on the variance decomposition function results, the explanatory power of three structural oil price shocks on food and nonfood blocks was small in the short run. In contrast, the explanatory power of three supply and demand oil shocks for the nonfood model was more substantial than that of food prices. Moreover, the response of food and nonfood models to one standard deviation shock in the exchange rate was strongly positive, while monetary policy shocks had a different impact. Generally, the results showed that an oil structural shock could lead to differential responses of food and nonfood prices, depending on the pre- and post-sanction times.

The findings revealed that an oil-specific demand shock had an immediate and more significant positive effect on food prices in the post-sanction period as compared to the pre-sanction period. Also, oil price volatility shocks have a much more significant influence on food price change than oil-market-specific demand shocks; meanwhile, this connection is the opposite for nonfood price change.

It is suggested that considering the adverse effects of sanctions on Iran's economy in the short term, in order to reduce the economic access to food, support policies should be used; in the long term, it is possible to allocate part of the oil resources for infrastructure investments and the use of new technologies. In the agricultural sector, it could provide the basis for sustainable and stable food production in the country. Also, consider the effect of money supply and exchange

rate on the price of food and nonfood items; therefore, controlling the fluctuations of these two critical variables has a significant impact on inflation control, which should be on the agenda of policymakers. At the level of the economy as a whole, it is possible to control the price of food through the policies of curbing the inflation rate and stabilizing the exchange rate by two independent monetary and financial policymakers, thus ensuring food security in the country. Finally, because the increase in the price of food restricts vulnerable sections of society's access to sufficient food, it is considered a severe threat to society's food security. So, policymakers should be more subtle and careful; in other words, policies should aim to reduce and eliminate dependence on oil income.

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The Effect of Macroeconomic Variables, Banking Variables, and Institutional Quality on Banking Lending Power in Iraq

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Abstract

The primary aim of this research is to examine the factors influencing the performance of banking loans in Iraq. The study utilizes unbalanced panel data over eighteen years, from 2005 to 2022, focusing on eighteen selected listed banks at the Iraq Stock Exchange (ISX) based on data availability. Data sources include annual financial reports from selected banks, the Central Bank of Iraq, and World Bank indicators (WDI) covering banking, macroeconomic, and institutional quality information. The relationship is estimated using a system generalized method of moment (SGMM) approach. The results indicate that certain banking variables such as bank assets, return on assets (ROA), and deposit-to-capital ratio have a positive and significant impact on lending power in Iraq, while the real deposit rate has a negative influence. Among macroeconomic variables, the inflation rate, real exchange rate, and liquidity growth have significant adverse effects on lending power, while economic prosperity and GDP growth yield positive effects. During economic booms, bank lending power increases, while it decreases during recessions. The study also highlights the positive and significant impact of institutional quality on bank lending power, indicating the importance of robust legal and regulatory institutions in establishing a stable and predictable financial environment, and fostering confidence among banks to engage in lending activities within the Iraqi economy.

Keywords: Banking lending power, Banking Variables, Iraq, Macroeconomic Variables, System GMM.

JEL Classification: C23, E44, G20.

1. Introduction

The economies of many countries, including Iraq, heavily rely on the banking system for various institutional and structural reasons. The banking system in these countries plays a pivotal role in providing financial resources to economic actors, facilitating the circulation of financial capital, directing liquidity towards

productive activities, and supporting economic growth. The significance of banks in the Iraqi economy lies in their crucial role as intermediaries between the supply and demand of financial resources. Any inefficiency or shortcomings in the banking sector can lead to disruptions in other economic areas.

An analysis of deposit amounts and loan balances of banks listed on the Iraq Stock Exchange reveals a declining trend in the loan-to-deposit ratio. This trend poses a significant challenge to the Iraqi economy, as it implies a reduction in the lending capacity of banks and a decrease in their ability to finance economic activities. The decline in the lending capacity of banks will have a profound impact on providing capital for existing production units and financing for new production projects in the Iraqi economy.

Since the 2008 financial crisis, there has been a renewed interest in studying the role of bank lending in the economy, particularly in the money creation process. The credit creation theory emphasizes the significant role of commercial banks in money creation, considering various constraints such as regulatory factors, credit demand, and the behavior of non-banks. Another area of literature, known as the credit channel, posits that bank lending activities are influenced by both credit demand and supply sides. Thus, maintaining and promoting the lending power of banks is essential for the country, especially in the face of economic fluctuations and challenges in the banking system.

Given the structural and institutional challenges in the banking system, the weak performance of the banking system in fulfilling its duties is a significant issue. Therefore, reforming the banking system is necessary, starting with identifying the fundamental roots of the problems and prioritizing these issues correctly for resolution.

The performance of banks in terms of receiving deposits and giving loans can be influenced by both banking and economic factors. Economic conditions, such as inflation, exchange rates, and money supply, play a crucial role in affecting banks' behavior. Additionally, internal bank factors, such as banks' assets and loan ratios, also can be effective on the banking system. Prudent lending practices are crucial for sustainable economic growth and stability, as inefficient lending practices may hinder economic progress and lead to financial instability. In addition, legal and regulatory framework, political stability, and transparency and accountability are critical for creating a favorable environment for banks to operate in. This will enable banks to assess the creditworthiness of borrowers more accurately, leading to a reduction in non-performing loans and an increase in lending power. So, it is clear that institutional quality can play a

critical role in determining the lending power of banks in Iraq. Improving institutional quality is essential for creating a favorable environment for banks to operate in, promoting economic growth and development, and increasing the confidence of investors and depositors in the banking system.

Given the limited discussions and insights within the Iraqi banking sector, and the substantial financial reforms and deregulation in recent years, this study aims to analyze the determinants affecting bank lending, with a specific focus on bank-specific characteristics, monetary policy stance, macroeconomic variables, and institutional quality. The research aims to provide valuable guidance for policymakers and regulators in Iraq.

The study is organized into five sections, beginning with a review of existing literature, followed by an explanation of the research methodology. The subsequent section presents a model estimation, summary of results and their interpretation, with the final section offering conclusions and recommendations.

2. Literature Review

The literature typically represents the supply of bank loans as a function of internal and external determinants. Internal determinants, also referred to as micro- or bank-specific determinants, pertain to factors within the control of the bank. External determinants, on the other hand, are variables unrelated to bank management that reflect the broader monetary, economic, and legal environment impacting the operations and performance of financial institutions (Latif et al., 2019). The relationship between macroeconomic factors and the lending behavior of commercial banks is a critical aspect of the overall bank lending function in an economy. The lending patterns of most banks are influenced by the signals emanating from the overall economy (Sanfilippo-Azofra et al., 2018). When banks perceive the macroeconomic environment as stable, they anticipate that borrowers across various sectors will have an enhanced capacity to repay loans. This expectation is based on the assumption that improved economic stability enables borrowers to more accurately predict their income streams throughout the loan period (Sashana, 2012). Gelen and Camilo (2011) conducted a study on the influence of business cycles on the lending power of commercial banks in developing countries, including Argentina, Brazil, Chile, Egypt, India, Indonesia, Pakistan, Peru, The Philippines, Thailand, Turkey, and Ukraine, during the period 1996-2008. The key variables considered were domestic gross product and loan interest rates, with macroeconomic variables serving as controls and factors related to commercial banks. The findings indicate that the most significant

variable affecting commercial bank lending was the growth of domestic product, with the loan interest rate being the most influential variable.

Baum et al. (2005), suggest that, given the necessity for banks to gather costly information on borrowers before extending loans to new or existing customers, uncertainty about economic conditions and the likelihood of loan default can significantly impact their lending behavior, influencing the allocation of available funds. Banks tend to issue more loans during periods of economic expansion and reduced macroeconomic uncertainty, while restricting lending during economic downturns. The economic environment serves as a systematic risk factor affecting all participants in the economy. The state of the economy is typically assessed through macroeconomic aggregates, encompassing variables such as gross domestic product (GDP), employment levels, industrial capacity utilization, inflation, money supply, and changes in the exchange rate (Talavera et al., 2006). The fluctuations in these macroeconomic factors, among others, indicate that banks adapt their lending behavior based on signals from these factors, influencing the volume of lending by commercial banks to different sectors in the economy. Fawad and Taqadus (2013) noted that when banks anticipate a positive trajectory in sector balance sheet growth due to favorable macroeconomic performance, they tend to support these sectors through increased credit growth. Historical banking crises, particularly those in Latin America (1994) and South-east Asia (1997), have revealed a close association between business cycles and the lending behavior of banks. Experimental investigations on this matter have indicated that the lending behavior of major European banks is not cyclical, whereas it tends to be cyclical in smaller banks.

The bank lending channel theory is a concept that provides insights into the relationship between monetary policy, bank lending, and the broader economy. According to this theory, changes in monetary policy, particularly those related to interest rates set by the central bank, have a direct impact on the lending behavior of commercial banks. Expansionary monetary policy, which involves lowering interest rates, typically stimulates an increase in the availability of loans from banks. This is because lower interest rates make it cheaper for banks to borrow funds, encouraging them to extend credit to businesses and individuals. On the other hand, contractionary monetary policy, which involves raising interest rates, can lead to a decrease in the amount of loans offered by banks, making it more challenging for borrowers to access funds. (Sanfilippo et al., 2018). Matemilola et al. (2015) undertook a time series investigation employing the momentum threshold autoregressive method and an asymmetric error correction model. Their

findings indicated that the lending rate of banks tended to align with a decrease in the South African money market rate. Additionally, the study observed that most commercial banks in South Africa typically adjusted lending rates downwards, while demonstrating rigidity in raising lending rates, thereby aligning with the customer reaction proposition. In a separate study, Manamba (2014) utilized co-integration technique analysis with macro-level quarterly data spanning from 1986 to 2012. The study revealed that the interest rate spread was notably influenced by the lack of intense competition among financial institutions, as well as other factors such as the presence of diseconomies of scale within the broader financial system. Furthermore, the study highlighted that an increase in the proportion of liquid assets led to a reduction in bank liquidity risk, consequently resulting in a lower interest rate spread. Krylova (2002) asserted that the implementation of a restrictive monetary policy results in a decrease in bank deposits, consequently reducing banks' lending power. The decline in bank credit availability leads to a reduction in investments, ultimately impacting real GDP negatively. In essence, a restrictive monetary policy triggers a reduction in bank deposits, which cannot be easily offset by alternative sources. Consequently, this outcome may result in some loan applicants being excluded from the process, leading to a subsequent decrease in investment and production. Gunji and Yuan (2010), conducted an analysis of bank profitability and lending behavior in China during the period 1985 to 2007. Their findings suggested that the impact of monetary policy on the lending of large banks and banks with lower cash reserves is weaker, and their responses to monetary policy in terms of finance are not distinct. Additionally, to gain a clearer understanding of the bank lending channel, they examined whether the impact of monetary policy, considering profitability, differs. The results indicated that profitable banks are less sensitive to monetary policy, as cash restrictions leading to deposit reduction result in higher financing costs for less profitable banks. Bernanke and Blinder (1988) demonstrated that a cash-restricted policy results in cost reduction by lowering loan payments, as cash restriction diminishes deposits on the debit side of the bank's balance sheet. Assuming that loans and bonds on the right side of the assets' balance sheet are imperfect substitutes, there is no inherent inclination for them to adequately compensate for the drawbacks of reduced deposits through reductions in holding bonds. Consequently, cash restriction leads to a reduction in the lending power of commercial banks.

In developing countries, where bank financing is a critical source of funding for businesses and individuals, the bank lending channel plays a

significant role in influencing economic activity. The theory also emphasizes the role of bank deposits in influencing lending activities. When there are policies that result in high lending interest rates, the amount of loans offered by banks tends to decrease, impacting the overall availability of credit in the economy. Furthermore, the theory highlights the importance of bank reserves and liquidity in influencing lending activities. Studies have shown that banks with higher levels of liquidity are better able to maintain their credit supply despite changes in monetary policy. This suggests that the level of bank reserves and liquid assets can impact the ability of banks to continue lending during periods of monetary policy tightening. (Vo and Nguyen, 2014) Understanding the Bank Lending Channel Theory is crucial for policymakers, economists, and market participants as it provides valuable insights into how changes in monetary policy and banking variables can influence the lending power of banks and, consequently, the overall functioning of the economy. By considering the dynamics of the bank lending channel, policymakers can make informed decisions regarding monetary policy and its potential impact on credit availability and economic growth (Vo, 2018).

The concept of the credit channel of monetary policy was originally developed by Neo-Keynesians, positing that the transmission mechanism of monetary policy is influenced by a credit shortfall. This idea is rooted in the presence of asymmetric information and disparities in credit markets. The credit channel can impact the transmission of monetary policy through both the balance sheet and bank lending channels. According to the bank lending channel, it is presumed that bank credits serve as the primary source of funding for small and medium-sized enterprises, playing a crucial role in facilitating the flow of money and connecting the monetary, financial, and real economic sectors (Filardo et al., 2020). It is expected that a bank with higher assets is better positioned to extend loans. The levels of a bank's capital and assets play a determining role in their lending capacity. A higher volume of assets corresponds to a greater inclination to provide loans. Various regulations and constraints governing loan disbursement are associated with the size of a bank. Consistent with prior research, under restricted credit conditions, the magnitude of a bank's assets plays a critical role in determining its lending capacity. Previous studies have demonstrated that the quantity and scale of a bank's reserves significantly impact its lending capacity (Bernanke and Gertler, 1987; Kashyap and Stein, 2000). Deposits constitute the primary inflow of cash for banks. The deposit-to-assets ratio signifies the degree to which a bank relies on customer deposits. A higher deposit-to-assets ratio corresponds to an increased lending capacity for a bank.

Banks typically establish the loan-to-asset ratio within a framework stipulated by the central bank. This ratio serves as a risk-taking criterion, indicating the bank's asset level without factoring in credit risk coverage. Generally, banks with larger assets possess greater flexibility to extend more loans, particularly when not under acute pressure or financial constraints.

3. Data and Methodology

3.1 Model and Data Description

The analysis of the determinants of lending power in the Iraqi banking sector involves an examination of bank portfolio behavior across banks and over time. Employing a panel data regression model, this study utilizes data spanning an eighteen years period from 2005 to 2022, encompassing eighteen banks in Iraq. The model specification aligns with the approaches of Lee et al. (2022), Roulet (2018), Maurin and Toivanen (2010). The nexus between bank's financial position, monetary and macroeconomic variables, and its lending power can be conceptually elucidated as follows: during stable periods, banks seize perceived investment opportunities and respond more precisely to loan demand, leveraging their understanding of their balance sheet position and regulatory landscape. Conversely, in times of uncertainty where predicting returns on bank lending is challenging due to an environment lacking identifiable profitable lending opportunities, lending activity diminishes. The estimation strategy explores the interplay where lending capacity is contingent on monetary policy stance, economic activities, institutional quality, and bank-specific characteristics. Following the methodology of Adams and Amel (2005) and other mentioned literature, the lending power of bank i in period t serves as the dependent variable as follow:

$$LOA_{it} = \alpha_0 + \alpha_1 DUM_{it} + \gamma_0 Z_{it} + \delta_0 M_{it} + IQ_{it} + \varepsilon_{it} \quad (1)$$

where LOA is the dependent variable of the model and it equals to the total loan to bank's asset ratio at time t . DUM is the dummy variable and it is an indicator of economic boom (business cycle). We filter GDP by using Hodrick -Prescott Filter in order to determine business cycle. This method separates time trend element from variability element of GDP. Variability element of GDP called business cycle. It is shown in Fig.1. According to the pro-cyclicality theory of bank lending, banks tend to increase their lending due to economic prosperity.

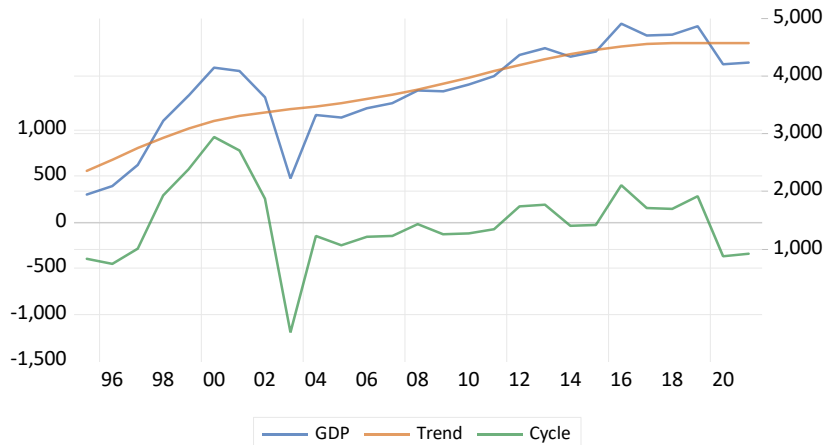


Figure 1. Hodrick-Prescott Filter

Source: Research finding; source of data: WDI.

Z_{it} is a vector of variables describing characteristics of the entire commercial banking system include, $\text{Ln}A_{it}$ is the natural logarithm of Assets for bank i at the time t , ROA_{it} is the bank's return on assets (ROA), and measured by the ratio of net income to total assets at the time t , and DOK_{it} is the bank deposit to capital ratio at the time t , R_{it} is a real interest rate on saving deposits. M_{it} is a vector of macroeconomic variables describing other dimensions of the economy over time, include: INF_{it} is the percentage of variation in consumer price index (CPI) as an inflation rate, EXR_{it} is the real exchange rate and GM_{it} is the liquidity growth. IQ_{it} , represents the institutional quality index. Institutional quality is a multi- dimensional one that cannot be measured with just one index. Therefore, in this research, in order to accurately measure this index from the six global sub-indices of the governance indices provided by the World Bank, Such as the stability of the government and its effectiveness, political stability, lack of violence, terrorism, quality of legislation, rule of law and accountability. The sub-indices used have been combined to reach one index using the PCA method (Dogan et al., 2020a). The data utilized for this research was sourced from the central Bank of Iraq, Iraq Stock Exchange (ISX) and the World Bank Indicators, encompassing a comprehensive array of indicators and indexes pertaining to the country of Iraq. The analytical framework employed panel data spanning over a period of eighteen years, from 2005 to 2022. The regression equation of the research based on all research variables of Model 1 can be written as follows:

$$\text{LOA}_{it} = \alpha_1 \text{LOA}_{it-1} + \alpha_2 \text{DOK} + \alpha_3 \text{ROA}_{it} + \alpha_4 \text{Ln}A_{it} + \alpha_5 \text{INF} + \alpha_6 \text{EXR}_{it} + \alpha_7 \text{GM}_{it} + \alpha_8 R_{it} + \alpha_9 \text{IQ}_{it} + \alpha_{10} \text{DUM}_{it} + \eta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

η_i and λ_t express individual fix effects (sectional) and time effects (virtual time variable) respectively, and ε_{it} is the disturbance term. In equation 2, η_i is sectional effects (bank) that contains unseen and immeasurable variables Which are effective on the loan to bank's asset ratio of Iraq banks. A summary of used variables and statistical references is presented in Table 1.

Table 1. Definition of Variable

Variable	Definitions	references
Banking Variables		
Loan to assets Ratio(LOA)	It is measured by the ratio of total loan to total assets of banks	ISX
Deposit to capital Ratio (DOK)	It is measured by the ratio of total Deposit to total capital of banks	ISX
Bank's Return on Assets (ROA)	It is measured by the ratio of net income to total assets	ISX
Log of Total Asset(A)	logarithm of total assets	ISX
Real Interest rate(R)	Indicates the interest rate on saving deposits is the rate paid by commercial or similar banks for demand, time, or savings deposits.	CBI
Economic Variables		
GDP	Indicates rate of growth of GDP	WDI
Liquidity Growth (GM)	Indicates the growth rate of broader measure of money supply	WDI
Inflation (INF)	Indicates the rate of inflation	WDI
Real Exchange Rate (EXR)	The exchange rate of Iraqi Dinar to Us Dollar	WDI
Institutional Variable		
Institutional quality (IQ)	The stability of the government and its effectiveness	WDI
	Political stability	
	Absence of violence	
	Terrorism	
	The quality of legislation and the governance of accountability law	

Source: Research finding.

Some of the descriptive statistics of the variables have been presented in Table 2.

Table 2. Descriptive Statistics

variable	Mean	Maximum	Minimum	Standard Deviation
Banking variable				
L (Loan)	192656	11201156	82.1	413144.5
A (Assets)	10152231	20937886	2013.7	344485
K (Capital)	16121.4	108270/7	9.1	31084.4
D (Deposit)	196401.9	1117432	729.2	306071.8
Real deposit rate	6.72	10.54	4.77	1.8011
Deposit to capital Ratio (DOK)	116.48	1968.9	.01	350.64
Bank's Return on Assets (ROA)	66.05	1068.25	6.47	192.9
Loan to assets Ratio (LOA)	0.36	0.44	0.23	0.05
Natural Logarithm of asset	11.11	16.85	7.19	2.54
Macroeconomic variable				
GDP Growth	1.57%	11.02%	-13.39%	5.32%
Liquidity Growth (GM)	25.8	41.3	6.02	8.7
Inflation (INF)	4.42%	12.82%	-0.4555%	3.345
Real Exchange Rate (EXR)	1230.19	1457.41	1166	106.93
Institutional Variable				
Institutional Quality (IQ)	-1.48	2.037490	-3.120600	1.091031

Source: Research finding.

A summary of descriptive statistics has been provided in Table 2. Based on the data presented in this Table, a significant observation pertains to the notable disparity in the standard deviation between capital and loan, as well as assets and deposits within the banking sector. On average, the banks' lending surpasses their capital reserves. The average loan to asset ratio stands at 0.36, indicating that during the research period, the banks allocated a sum equivalent to 36% of their asset to lending. This discrepancy highlights a substantial concern, suggesting that Iraqi commercial banks consistently faced challenges related to capital

intensification. The deposit rate had a minimum value of 4.77%, a maximum value of 10.54% with a mean of 6.72% and a deviation from the mean of 1.80%. Inflation rate ranged from a minimum of -0.45 % to 12.82% with a relatively low deviation from the mean of 3.345% and a mean value of 4.42%. The GDP growth rate was observed to have almost low dispersion from the mean of 5.32. it has been found to have a range of minus 13.39% to 11.02% with a mean value of 1.57.

3.2 Econometric Methodology

As stated before, the Equation 2 is used in order to investigate the effect of macroeconomic, banking and institutional variables on banking system lending power in Iraq. By assuming that ε_{it} follows a one-way disturbance term model (i.e., only one factor causes the variations between cross sections), we can then conclude that: $\varepsilon_{it} = \mu_i + v_{it}$ which $\mu_i \approx IID(0, \delta_\mu^2)$ and $v_{it} \approx IID(0, \delta_v^2)$, they are independent of one another in each section. In the estimation of panel data models, the initial consideration pertains to the nature of η_i (or section effects), whether it is fixed or random. The fundamental assumption in the random effects model posits that the section effects are unrelated to the explanatory variables. Islam (1995) contends that given the rejection of this assumption in estimation of Model 2, the utilization of the random effects method is deemed inappropriate. While the fixed effects method does not encounter issues with the relationship between section effects and explanatory variables, it is unable to address the endogeneity bias of the explanatory variables. Conversely, owing to the dynamic structure of the model, Hsiao (1986), and Arellano and Bound (1991) have demonstrated that the fixed effects method yields incompatible estimations. In line with the findings of Baltagi (2001) and Arellano and Bound (1991), the application of the Two-stage least squares (2SLS) method or the generalized method of moments (GMM) is recommended, as model (2) exhibits endogeneity of explanatory variables and dynamic structure issues. In the context of the Two-stage least squares method, the use of certain types of instruments may lead to overestimated coefficients variance and yield incompatible results. Consequently, the most suitable estimator for panel dynamic models is the generalized method of moments (GMM) estimator. Within the GMM estimation method, the bias stemming from the relationship between explanatory variables and fixed effects expression is eliminated by taking the first order of difference from equation 1, thereby omitting the fixed effects expression. To address the endogeneity issue of independent variables, their lags can be employed as instruments. Generally, the

GMM estimator is categorized into two groups: the first-order difference estimator (introduced by Arellano and Bound, 1991) and the system generalized method of moments estimator (introduced by Blundell and Bound, 1998).

Arellano and Bound (1991) originally proposed using the lag of dependent variables as instruments at the level, but subsequent studies by Blundell and Bound (1998), as well as Jaeger and Bound and Baker (1995), demonstrated that lagged variables at the level are weak instruments for the regression equation in difference. To address this issue, Blundell and Bound (1998) recommended the use of the system GMM estimator, which combines a regression in the level with a regression in differences within a system. It is important to note that the validity of results obtained from the GMM method relies on the accuracy of the underlying hypotheses. The m_j statistic is employed for testing autocorrelation in the error term, while the Sargan statistic is utilized to assess the validity of the applied instruments.

The Generalized Method of Moments (GMM) approach is widely acknowledged as a superior method for estimating economic models. In particular, due to the presence of individual fixed effects in Model 2, which are correlated with the system, the GMM approach is considered to be more efficient than other methods. Additionally, the inclusion of the dependent variable lag (LOA_{it-1}) in the model estimation can result in incompatibility. To address the issue of individual fixed effects in Model 1, a first-order difference is taken from Model 2.

$$\begin{aligned} \Delta LOA_{it} = & \alpha_1 \Delta LOA_{it-1} + \alpha_2 \Delta DOK + \alpha_3 \Delta ROA_{it} + \alpha_4 \Delta LnA_{it} + \alpha_5 \Delta INF \\ & + \alpha_6 \Delta EXR_{it} + \alpha_7 \Delta GM_{it} + \alpha_8 \Delta R_{it} + \alpha_9 \Delta IQ_{it} + \alpha_{10} \Delta DUM_{it} \\ & + \Delta \eta_{it} + \Delta \lambda_t + \Delta \varepsilon_{it} \end{aligned} \quad (3)$$

Δ represents the operator for the first-order difference in the model. Using the OLS method as an estimator for the first-order difference in the model is not appropriate, as the estimates will be incompatible and upward biased due to the correlation between the lag of the model's dependent variable (ΔSDG_{it-1}) and the individual fixed effects (Δv_{it}). modified to include the lagged dependent variable as an instrumental variable in the level equation, and the model is estimated using the GMM approach, as suggested by Arellano and Bound. This estimator is known as the first-order difference GMM estimator. However, this approach has a weakness in terms of non-stationary instrumental variables. To address this issue, Blundell and Bound (1998) proposed the system GMM estimator, which was originally introduced by Arellano and Bover (1995). This estimator employs different types of lagged dependent variables in the instrumental variables'

matrix. Based on simulation results, the system GMM estimator is more efficient when the coefficient of the lagged dependent variable is closer to 1. Therefore, the same estimator has been used in this study, with the inclusion of controlling variables. The modified general research model is as follows:

$$\begin{aligned}\Delta LOA_{it} = & \alpha_1 \Delta LOA_{it-1} + \alpha_2 \Delta DOK + \alpha_3 \Delta ROA_{it} + \alpha_4 \Delta LnA_{it} + \alpha_5 \Delta INF \\ & + \alpha_6 \Delta EXR_{it} + \alpha_7 \Delta GM_{it} + \alpha_8 \Delta R_{it} + \alpha_9 \Delta IQ_{it} + \alpha_{10} \Delta DUM_{it} \\ & + \Delta \lambda_t + \Delta v_{it}\end{aligned}\quad (4)$$

4. Empirical Result

In this section of the study, the research model will be estimated using the system GMM method. A series of pre-estimation tests and post-estimation tests will be conducted before each estimation. The results of all these diagnostic tests will be presented. The system GMM according to Roodman (2009) exploits the time series element of the data, controls for bank-specific effects, allows for the inclusion of lagged dependent variables as regressors and controls for the endogeneity of explanatory variables. As a result, diagnostic tests are conducted to check the validity of the results.

4.1 Cross-Sectional Dependence Test

Prior to estimating panel models, it is essential to assess the stationarity of variables. To select the appropriate unit-root test, a cross-section dependence test should be conducted before the panel's stationary test. Various unit-root tests, such as the Generalized Dickey Fuller (ADF), Levin, Lin and Chu (LIC), Fisher Generalized Dickey Fuller (ADFF), Phillips-Peron-Fisher (FPF), Im-Pesaran-Shin (IPS), Breitung, Haudry, and Pesaran (2003), and Pesaran Unit-Root test, are available for investigating the stationarity of panel variables. The choice of a suitable test requires an initial cross-section dependence test (Baltagi, 2005). To examine cross-section dependence, the Pesaran (2015) test, an enhanced version of Pesaran (2004) applicable to both balanced and unbalanced panels, is employed. null and alternative hypotheses for this test are:

$$\begin{aligned}H_0: \rho_{ij} = \rho_{ji} = E(u_{it}v_{it}) &= 0 & \text{for all } i \neq j \\ H_1: \rho_{ij} = \rho_{ji} = E(u_{it}v_{it}) &\neq 0 & \text{for some } i \neq j\end{aligned}$$

v_{it} and u_{it} are the error terms of the estimated model. For balanced panels, CD is calculated as following:

$$CD = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \right)$$

In which $\hat{\rho}_{ij}$ is Pearson correlational coefficients as a pair of residual terms (Pesaran, 2004). Using conventional panel unit-root tests such as Levin test, Lin and Chu (LIC), Im and Pesaran and Shin (IPS) and etc. The presence of cross-section dependence in panel data can lead to spurious unit-root test results. To address this issue, several panel unit-root tests, such as the Pesaran unit-root test, are recommended, even in the presence of cross-sectional dependence. Table 3 presents the results of the Pesaran cross-section dependence test for the research data.

Table 3. Pesaran Cross-Section Dependence Test

Variables	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)	Test Result
Real deposit rate	1.245	0.013	10.83	0.04	0.47	cross-sectional dependence
Deposit to capital Ratio (DOK)	13.613	0.000	10.19	0.30	0.30	cross-sectional dependence
Bank's Return on Assets (ROA)	-1.657	0.007	10.64	-0.06	0.35	cross-sectional dependence
Loan to assets Ratio (LOA)	1.674	0.004	10.00	0.06	0.44	cross-sectional dependence
Natural Logarithm of asset	1.782	0.005	9.80	-0.06	0.24	cross-sectional dependence
Macroeconomic variable	1.486	0.037	10.83	0.05	0.44	cross-sectional dependence
Liquidity Growth (GM)	-1.487	0.037	10.64	-0.05	0.36	cross-sectional dependence
Inflation (INF)	1.487	0.038	10.89	0.05	0.41	cross-sectional dependence
Real Exchange Rate (EXR)	7.776	0.001	10.29	0.16	0.17	cross-sectional dependence
Institutional Quality	-1.455	0.038	10.67	-0.05	0.37	cross-sectional dependence

Source: Research finding.

4.2 Panel Unit-root Test

Next step is to investigate variables stationary. in order to test the stationary of some variables in which cross section dependence is confirmed, we use a unit-root test presented by Pesaran (2003) that considers sectional dependency. This test is based on the generalized T-bar statistic of dicky fuller in each section and is aligned with the presented test by Im, Pesaran, and Shin (IPS, 2003).

Critical amounts of T-bar statistic are calculated by Pesaran¹. In this test, the null hypothesis is the existence of unit-root. The results of Pesaran unit-root test are shown in table 4. Based on these results, if the probability is less than 0.05, the null hypothesis is rejected and considered variable is stationary.

The next step involves examining the stationarity of variables, particularly those for which cross-sectional dependence has been confirmed. To test the stationarity of such variables, we will employ a unit-root test proposed by Pesaran (2003), which accounts for cross-sectional dependency. This test is based on the generalized T-bar statistic of the Dickey-Fuller test applied to each section and is in line with the test presented by Im, Pesaran, and Shin (IPS, 2003). Critical values of the T-bar statistic are calculated by Pesaran. In this test, the null hypothesis posits the existence of a unit root. The results of the Pesaran unit-root test will be presented in table 4. Based on these results, if the probability is less than 0.05, the null hypothesis will be rejected, indicating that the variable is stationary. The results indicate that some of variables are stationary at level and some of them are stationary with one difference.

Table 4. Pesaran Unit-Root Test

Variable	Z[T-bar]	P-value	Test Result
Real deposit rate	-2.716	0.003	I(0)
Deposit to capital Ratio (DOK)	-1.677	0.047	I(1)
Bank's Return on Assets (ROA)	-2.563	0.005	I(0)
Loan to assets Ratio (LOA)	-2.217	0.013	I(0)
Natural Logarithm of asset	-1.424	0.007	I(0)
GDP Growth	-1.456	0.008	I(1)
Liquidity Growth (GM)	-4.489	0.001	I(0)
Inflation (INF)	-4.524	0.000	I(1)
Real Exchange Rate (EXR)	-1.656	0.009	I(0)
Institutional Quality (IQ)	-4.867	0.002	I(1)

Source: Research finding.

¹. Pesaran (2007) recommended a test statistic to investigate the unit-root and to consider cross-section dependence by changing IPS and ADF tests, which is known as CIPS and is as follows:

$$CIPS(N, T) = \frac{1}{N} \sum_{i=1}^N \tau_j(N, T)$$

In which τ_j is CADF pattern statistic for each individual section in the panel. The value of test Statistic will be compared with calculated critical value by Pesaran and if the statistic is more than critical value, null hypothesis will be rejected and stationary of variable will be accepted. With respect to the fact that the research panel is unbalanced and CIPS is only applicable in balanced panels, therefore we use the Pesaran test (2003) in this research.

4.3 Co-integration Test

to ensure the validity of the results, it is important to assess the long-term relationship between variables, especially if some of the variables are non-stationary. There are several tests available to investigate co-integration relationships between variables in panel data, such as the Pedroni co-integration test (1999; 2004), Westerlund co-integration test (2007), and Kao co-integration test (1999). The choice of the appropriate test depends on the number of sections and time series and whether the panel is balanced or unbalanced. For instance, if the number of time series is less than the number of sections, then Pesaran's cross-section independence test would be appropriate, while the Breusch-Pagan cross-section dependence test would be suitable if the number of time series is more than the number of sections (Pesaran, 2004). In this research, since the panel data is unbalanced, the Kao co-integration test will be used to investigate the long-term relationship between variables. The Kao co-integration test is based on the Engle-Granger two-step procedure and considers the homogeneity of panel data in testing co-integration. The null hypothesis, which posits the absence of a co-integration relationship, will be tested using the ADF test in this research.

Table 5. Kao Co-Integration Test

Test statistic	Model
Modified Dickey-Fuller t	-2.0793 (0.0188)
Dickey-Fuller t	-3.7566 (0.0001)
Augmented Dickey-Fuller t	4.8529 (0.0000)
Unadjusted modified Dickey-Fuller t	-2.1794 (0.0147)
Unadjusted Dickey-Fuller t	-3.7869 (0.0001)

Source: Research finding.

Note: The probability of statistics is presented in parenthesis.

It is evident that the co-integration relationship is confirmed in all of the estimated regressions, as indicated by the probability values of the Kao statistic.

4.5 Result and Discussion

The estimation of effects of macroeconomic, banking and institutional variables on banks' lending power in Iraq was conducted with the System GMM. The results provided in Table 6.

Table 6. Long-run Relationship between Variables

Dependent variable is Loan to Asset ratio (LOA)		
Variables	Variable explanation	Coefficient (t statistics)
LoA(-1)	The lagged value of dependent variable	0.0526 (4.45)
LnA	Natural logarithm of Banks' asset	0.0516 (7.35)
ROA	Bank's Return on Assets (ROA)	0.0134 (3.25)
DOK	Deposit to capital Ratio (DOK)	0.0765 (3.21)
R	Real deposit rate	-0.056 (-3.25)
INF	Inflation rate	-0.0120 (-5.75)
EXR	real exchange rate	-0.0002 (-5.27)
GM	liquidity growth(M2)	-0.0234 (-3.77)
DUM	Dummy variable (business cycle)	0.115 (6.49)
IQ	Institutional Quality	0.056 (3.25)
C	Intercept	0.82 (1.45)
R-squared	0.6387	
Adjusted R-squared	0.5432	
Sargan test	41.128 [0.2946]	
Wald test	235.12 [0.000]	
Arellano–Bond tests	-1.37 [0.172]	

Source: Research finding.

Note: Figures in parenthesis are the t statistic for coefficients. p values for diagnostic tests (Wald, Arellano-bond and Sargan) are reported in brackets. The Sargan test for over identification restriction (which the null hypothesis is that instruments are exogenous); the Arellano–Bond tests for first and second order serial correlation in residuals (which null hypothesis is that there is no serial correlation; and the Wald test for joint significant of parameters.

Table 6 provides the results of the Arellano-Bond test, Wald test and Sargan test, which are diagnostic tests conducted subsequent to estimation. The Wald test assesses the significance of the entire regression, while the Sargan test evaluates the validity of instrumental variables in the model and tests the over-identifying restrictions. The null hypothesis for the Sargan test is the validity of instrumental variables based on the chi-square distribution. The results of this test indicate that in estimated model, instrumental variables are not correlated with model error terms. Therefore, these variables have been correctly chosen, and the model results can be trusted. The Arellano–Bond test, conducted to examine first and second-order serial correlation in residuals, yields results indicating the absence of serial correlation in the model. The null hypothesis, suggesting no serial correlation, is not rejected based on the test outcomes¹.

The results indicate the lagged dependent variable positively influences banking lending power in Iraq. Indeed, the current year banks' lending is influenced by the previous year's results. Thus, the significance of the coefficient on the lagged lending power proxy in our equations confirms the dynamic nature of the model.

Banks performance influenced by their environmental conditions, and their lending behavior is mostly subject to macroeconomic factors such as gross domestic product (GDP), employment levels, inflation, and exchange rates. Therefore, banks adjust their lending behavior in response to these economic indicators. Positive (negative) indicators encourage banks to increase (decrease) lending. Additionally, the loan portfolio of banks may be influenced by their expectations of economic performance. In accordance with the results, the boom in the Iraq's economy accompanies with increasing in the lending power of banking system and the boom dummy variable has a positive and significant effect on banking lending power. It indicates that during different economic periods in Iraq, banks systematically adjust their lending standards in the business cycle. This means that they restrict the provision of facilities during economic recessions due to the potential non-repayment risk, and conversely, facilitate it during economic expansions. During economic boom periods, the economy experiences growth and prosperity, leading to an increase in deposit

¹. In addition to the estimation of SGMM model, in order to ensure the results obtained in this research, research models were also estimated using dynamic ordinary least squares estimation (DOLS). The results of the DOLS estimation aligned with the findings of the previously estimated model, providing further support for the research's outcomes.

volumes and subsequently, an expansion in loan activities. Consequently, the velocity of money undergoes a rapid upturn. Conversely, during recessionary phases characterized by a reduction in production and transactions, there is a decrease in the demand for bank transfers and loans. In periods of economic upturn, there is a notable increase in the transfer of banking documents. Conversely, during recessions, the frequency of transfers declines, accompanied by a rise in the number of protesting documents. To elaborate, during economic booms, businesses actively seek loans and credit, but during recessions, due to constrained cash flow, the repayment of these commitments encounters difficulties. So, the relationship between real GDP and banking lending power is positively correlated, as GDP serves as a measure of the economy, commercial banks should pay close attention to the overall macroeconomic situation of the country and the factors influencing GDP. During economic booms and impressive GDP growth, banks can confidently extend credit to the economic sectors. Conversely, during economic downturns, banks may exercise caution and limit lending. The growth of liquidity (M2) has a significant negative impact on the lending power of banks in Iraq. An increase in the money supply, represented by an increase in coins, bills, and current accounts, is associated with a decrease in the real interest rate due to rising inflation. This, in turn, increases the opportunity cost of depositing money in banks. Consequently, individuals are more inclined to invest in capital assets rather than making deposits in banks. Therefore, the expansionary monetary policies that result in an increased money supply have diminished the lending power of banks in Iraq. However, the negative and significant effect of inflation on the lending power of banks can provide further evidence for the negative relationship between bank lending power and liquidity growth and fully support this conclusion. Inflation rate also has a significantly negative effect on the lending power of banking system in Iraq. These results indicate that an inflationary environment impedes financial development by constraining borrowers from seeking external financing and prompting banks to prioritize holding liquid assets over engaging in long-term financial projects (Vo, 2018). An increasing in inflation triggers an upsurge in nominal interest rates, coupled with credit rationing by banks, consequently leading to a contraction in investment. This outcome aligns with the findings of Boyd, Levine, and Smith (2001), suggesting that heightened inflation is a sign of diminished long-term financial activity. In economies grappling with high inflation, financial intermediaries tend to curtail lending and allocate capital with

less efficiency. High long-term inflation is synonymous with diminished levels of real activity and/or slower growth rates in the long run.

The exchange rate significantly and negatively influenced the lending power of banks in the examined period in Iraq. A rise in the exchange rate is associated with a diminished ability of customers to repay loans, potentially leading to increased non performing loan. Consequently, there is a reduction in funds flowing into the bank, resulting in decreased liquidity and a constrained supply of facilities. Overall, fluctuations in the exchange rate, coupled with unstable economic policies, can disrupt the market system, contributing to financial crises. Such crises may trigger panic among depositors, prompting widespread withdrawals and diminishing the bank's stable resources, consequently impeding its capacity to extend facilities.

Real deposit rate has significantly negative impact on banking lending behavior in Iraq. The negative coefficients of the deposit rate as a policy rate in Iraq confirm the existence of the bank lending channel. This suggests that when the Iraqi authorities implement a tightening monetary policy, they are successful in reducing the supply of bank loans.

Results of the model reveal a positive and significant relationship between deposit to capital Ratio and banking lending power in Iraq, aligning with the loanable fund theory, which posits that bank loans are contingent on pre-existing savings. The natural logarithm of banks' asset which is a proxy of size of the bank, represents positive and significant impact on lending behavior of banking system in Iraq economy. This supports the idea that larger banks can achieve significant economies of scale, as suggested by Barth et al. (2013), thereby augmenting their credit supply, profitability, and operational efficiency. This aligns with prior research highlighting the connection between bank size and these financial metrics (Bikker and Hu, 2002; Goddard et al., 2004).

Concerning institutional quality, the study reveals a statistically significant and positive impact on the lending power of Iraqi banks. Institutional quality plays a critical role in shaping the environment in which banks operate. Strong institutions contribute to a stable, transparent, and predictable financial system, empowering banks to lend with confidence and efficiency. The relationship between institutional quality and bank lending power underscores the importance of effective governance, legal frameworks, and regulatory environments in fostering a robust financial sector.

5. Conclusion and Policy Implication

Today, economists consider achieving sustainable economic development contingent upon economic growth and the development of the financial sector in a country. The historical experience of developed countries indicates a consistent correlation between economic growth and financial sector growth. In other words, the economic growth and development of any country require the proper allocation of surplus financial resources from savers to investors. Given the current state of the capital market in Iraq, financing various economic sectors is primarily conducted by the banking system. Due to insufficient development of the capital market in Iraq, the banking industry can play a pivotal role in the development and economic growth of Iraq due to its provision of diverse financial and credit services. It can be regarded as a driving, accelerating, and balancing force in the economy. Therefore, identifying the factors influencing the credit allocation of the banking system is of utmost importance. This study investigates the impact of macroeconomic, banking and institutional variables on bank's lending power in Iraq economy. The research utilizes unbalanced panel data spanning eighteen years, from 2005 to 2022, encompassing eighteen selected listed banks at the Iraq Stock Exchange (ISX) based on data availability. The data sources consist of annual financial reports from selected banks listed in ISX, central bank of Iraq and World Bank indicators (WDI), capturing banking, macroeconomic and institutional quality information. The estimation of the relationship employs a system generalized method of moment (SGMM) approach. The findings indicate that within the realm of banking variables, bank asset, bank's return on assets (ROA), and deposit to capital ratio exert a positive and significant influence on the lending power in Iraq. Conversely, the real deposit rate exhibits a negative impact. Among macroeconomic variables, the inflation rate, real exchange rate, and liquidity growth demonstrate significant adverse effects on lending power, whereas economic prosperity/GDP growth yield positive effects. In boom time, the lending power of banks will be increased and when the economy is in recession, it will be decreased. The positive and significant impact of institutional quality on bank lending power is evident, as evidenced by the presence of robust legal and regulatory institutions.

Given the significant positive relationship between GDP and banking credit supply, it is essential that these institutions consider the overall macroeconomic situation and the factors that impact GDP when making lending decisions. Additionally, the liquidity ratio should be carefully evaluated. If the macroeconomic situation is favorable and supportive, banking performance can

be enhanced, and prudent lending behavior can be ensured. Thus, commercial banks must exercise caution and make informed lending decisions to promote sustainable economic growth and stability. To attain their objectives, Iraqi banks must identify the factors influencing successful bank performance, formulating policies to fortify and sustain the stability of the banking sector in Iraq. The evident correlation between banking sector well-being and economic growth underscores the significance of understanding the determinants of banking lending power. This awareness is crucial for regulators and bank administrators, enabling the development of effective strategies to enhance the profitability of Iraq's banking sector.

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The Role of “Related Variety” in Regional Economic Development of Iran: Employment Growth or Economic Productivity?

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Abstract

This study, aims to examine the impact of related variety on regional economic development in Iran. The study constructed an index for the concept of related variety based on spatial productivity indicators and the production pattern in the input-output model. The findings reveal that Tehran, Bushehr, and Gilan provinces have the highest related variety indicator values. Additionally, the correlation analysis between this indicator and economic performance indicators suggests a direct, albeit not particularly strong, linear relationship between them. Furthermore, the causal relationship analysis, using the related variety indicator as the independent variable, demonstrates that related variety significantly contributes to regional employment growth. However, its impact on productivity growth in economic activities is not statistically significant. Therefore, the author recommends that regional development policies prioritize enhancing a diverse range of related activities to facilitate knowledge and experience spillover, particularly if the goal is to increase employment rates. This approach should be considered over a narrow focus on specialization policies and the creation of growth poles based solely on relative advantages.

Keywords: Agglomerative Economy, Regional Economic Growth, Related Variety, Urbanization Economy.

JEL Classification: R11, R12.

1. Introduction

In many regional development plans, economic growth is identified as a fundamental and essential goal. Key indicators, such as increased productivity and employment, are employed to gauge regional economic growth (Feser et al., 2008; Delgado et al., 2014). Strategies promoting localization and urbanization economies are introduced as effective approaches for achieving this objective (Stimson et al., 2006). However, regional disparities arising from factors like

relative advantages, central or peripheral positions, the level of welfare services, and urbanization present numerous challenges to spatial decision-makers in choosing the right development strategy.

Research has shown that urbanization and localization economies, both considered agglomerative economies (Hoover, 1937), can lead to different forms of knowledge spillover and regional production flows, each contributing to economic growth in distinct ways (Feser and Sweeney, 2000; Eberts and McMillen, 1999). Locational economies, which encourage industry specialization in specific areas, and the clustering of activities, result in knowledge spillover among similar economic sectors, thereby enhancing economic productivity. In contrast, urbanization economies signify a diversity of activities and the transfer of knowledge between different sectors (Dinc, 2015).

The concept of "related variety" emerged in 2007, raising the initial question: "Do regions benefit more from a variety of economic activities or from specialization in economic activities?" This concept underscores the importance of knowledge spillover among various activities, not limited to a single activity group. It also emphasizes the relevance of activities that facilitate this knowledge transfer. Related industries sharing common institutional and structural foundations in value-added production have a higher capacity for knowledge transfer. This dynamic flow of knowledge and innovation trade-offs leads to the creation of new combinations of knowledge and products, facilitating regional employment (Frenken et al., 2007).

Understanding this concept is crucial as it can guide policymaking for regional economic growth, especially in situations where the production industry and activity specialization are under threat. Empowering diverse and related economic activities in these regions can effectively stimulate regional economic growth. With these considerations in mind, this study aims to test this hypothesis within the economic system of urban regions in Iran. The study focuses on "urban regions" as the analytical units, defined as official political regions aligning with provincial boundaries and corresponding to spatial planning documents at this level due to the availability of organized economic and institutional data.

In the initial section, I provide a comprehensive explanation of the theoretical framework, aiming to facilitate a profound comprehension of the "related variety" concept. Subsequently, I delve into the foundational theories that support this concept. Specifically, I expound upon the agglomerative economy theory in the context of related variety and the portfolio theory concerning unrelated variety. Moving on to the following section, I lay out the methodological

framework employed to formulate the related variety indicator and detail the process by which it will be applied in the case study. Lastly, the study culminates in the presentation of analysis findings. These findings are instrumental in elucidating the role played by the related variety indicator in influencing employment and the growth rate of economic productivity in urban regions of Iran.

2. Literature Review

2.1 Regional Economic Development and the Concept of Related Variety

Numerous contemporary theories of urban economic development place significant emphasis on knowledge and innovation as the cornerstones of sustainable regional progress (Mahmoudpour and Daneshpour, 2015; Dadashpour and Yousefi, 2016; Jomehpoor et al., 2017; Sheykh Zeynaddin et al., 2014; Hedayatifard and Rozenblat, 2019). These theories underscore the pivotal role of knowledge flow in driving and sustaining regional development. The concept of "related variety" made its debut in 2007 in articles by Frenken at the University of Austria (Fitjar et al., 2017). This concept was initially introduced with the fundamental question of whether regions derive greater benefit from a diversity of economic activities or from specialization in specific economic activities (Glaeser et al., 1992; Frenken, 2007). Speculative research was undertaken to explore whether the production of a wide array of products and services significantly contributes to a region's economic vitality (Content et al., 2019; Al-Marhubi, 2000; Brenner et al., 2017; Cadot et al., 2011; Essletzbichler, 2007). Advocates of this proposition contend that variety fosters knowledge spillover among different economic activities. This concept has evolved in alignment with the contemporary growth theory, which posits that knowledge spillover transpires not only within an economic sector but also across distinct and diverse economic sectors (Frenken et al., 2007; Hausmann and Hidalgo, 2011; Hidalgo and Hausmann, 2009; Fitjar et al., 2017; Hedayatifard and Heydari, 2019). Furthermore, recognizing that knowledge spillover is geographically limited, disparities in regional growth can be attributed to qualitative distinctions in the economic landscape at the regional level.

On the flip side, a crucial consideration lies in the interconnection of various types of knowledge. Scholars contend that knowledge spillovers predominantly occur between sectors that share similar knowledge and are thus related (Hidalgo et al., 2007). To delineate this notion of relatedness, Fernandez et al. (2016) identify three distinct mechanisms. The first pertains to contingency and complementarity in the production of a commodity or activity. The second

revolves around similarity or the sharing of akin skills, while the third centers on local synergy arising from co-spatiality. All three of these mechanisms wield a significant influence on the creation or elimination of new employment opportunities.

Analytical findings reveal that in urban regions, newly emerging jobs are intricately connected with pre-existing ones, underscoring a state of interdependency (Van Dam and Frenken, 2022; Janssen and Frenken, 2019). In a similar vein, research indicates that regions exhibiting relatedness in terms of specialized sectors and complementary roles tend to experience more robust growth than areas that specialize in unrelated sectors (Frenken et al., 2007).

The concept of related variety also intertwines with the theory of the product lifecycle, which carries spatial and geographical implications. This theory posits that emerging industries characterized by high rates of innovation in the product itself tend to generate employment across diverse urban areas. In contrast, mature industries with high innovation rates in the production processes often enhance productivity in suburban and specialized regions (Content and Frenken, 2016; Neffke et al., 2011). Additionally, the concept of related variety is closely linked to the idea of the product space. Hidalgo et al. (2007) highlight that countries achieve development by diversifying their exports over time. The approach involves exporting products that are in some way related to the products they have previously exported, creating a form of product proximity value. This occurs because, when a country specializes in exporting a particular product, the institutional and infrastructural conditions necessary for producing and exporting related products are already in place (Hidalgo et al., 2007; Hausmann and Klinger, 2007). When applied to urban regions, these regions strive to establish clusters in products for which the production technology is already available. Consequently, the concept of related variety comprises two pivotal components: the "variety" of economic activities and the "relatedness" of economic activities, with each contributing uniquely to the process of economic development in urban regions.

2.2 “Related Variety” in the Regional Economic Structure

To substantiate the concept of related variety in terms of knowledge spillover, various researchers have presented supporting theories, including agglomerative economies (Frenken et al., 2007; Brachert and Kubis, 2011), theories by Jacobs (1969), MAR (an acronym for Marshall (1920), Arrow (1962), and Romer (1990)), Porter (1996), and portfolio theory (Montgomery, 1994). These theories collectively offer insights into dimensions of knowledge spillover and regional

economic growth. The MAR approach places emphasis on the specialized knowledge and skills within specific sectors, considering them as sources of innovation and economic growth. Michael Porter, on the other hand, acknowledges the role of specialized knowledge but also highlights how local competition encourages firms to innovate, positively influencing growth and firm survival. Jacobs offers a different perspective by recognizing the importance of local competition while asserting that various industrial sectors within a region provide access to diverse knowledge based on their individual industrial environments. This diversity of knowledge leads to knowledge spillover and, consequently, economic growth (Brachert and Kubis, 2011). Content and Frenken (2016) elucidate these two approaches while highlighting the dichotomy between the theories of MAR and Jacobs that underlie the concept of related variety. MAR's theoretical approach revolves around the notion of spatial economy, formed by the agglomeration of firms in an industry, which optimizes the production process and fosters increased productivity through knowledge specialization. Critics of this approach contend that while it can lead to economic development through enhanced productivity, it doesn't necessarily result in the creation of new jobs (Boschma and Iammarino, 2009). Conversely, Jacobs's approach defines innovation as the integration of various forms of knowledge in novel ways, culminating in the development of new products, services, and employment opportunities (Content and Frenken, 2016; Castaldi et al., 2015). It's worth noting that a thorough understanding of the concept of agglomerative economies and the sources of economic creation can lay the groundwork for a more comprehensive grasp of the related variety concept.

2.3 Agglomerative Economy and Related Variety

The theory of agglomerative economy centers on the fundamental concept that economic activities cluster together due to the advantages derived from the physical proximity and co-spatial presence of firms (Davids and Frenken, 2018). Within this framework, there exist four distinct sources of agglomerative economies:

The first source, Internal Scale Increases, revolves around the economic benefits that stem from the growth of firms to a larger scale, leading to reduced production costs through serving a broader market. In this context, the spatial dimension is not a primary concern, except for the fact that the presence of large firms in a particular location necessitates the concentration of local employment factors. Sectoral External Economies also, pertains to the benefits experienced by

local firms within a specific sector and is often referred to as spatial or Marshallian economies. Within an activity cluster, these external economies originate from the establishment of labor markets, the development of specialized suppliers, and the emergence of knowledge spillover among firms (McCann, 2005). Urbanization economies as the third source, represent external economies that are unrelated to specific economic sectors and result from the size and population density of a city. This form of external economy is tied to the macro-level processes of urban accumulation and is independent of the city's industrial structure. Prominent entities such as universities, industrial laboratories, business organizations, and other knowledge-producing institutions within the city act as sources of these economic benefits (O'Sullivan, 2009). And finally, Jacobs Economy denotes the economic benefits that are accessible to all firms within a given geographic area. This economy gains its name from the diversity of industries co-located in a single urban region, fostering opportunities for interactions such as replication, modification, and the recombination of ideas. Significant innovations often arise from the amalgamation of knowledge across diverse industries. The close geographic proximity of firms operating in various sectors facilitates this recombination. Functional specialization within homogeneous industries, especially when in close proximity to one another, fosters spatial interdependence, resulting in advantages for all firms located in that area. Hence, diversity in economic activities inherently amplifies knowledge and innovation spillover (Dink, 2015; McCann, 2005).

Taking into account these four sources of agglomerative economy, Frenken et al. (2007) introduced the question of whether knowledge spillover primarily arises when an area specializes in a few specific sectors (spatial economy), or when it hosts a wide array of economic sectors (the Jacobs economy), or if it predominantly results from the city itself and its population density (urbanization economy). The answer to this question is that, in fact, any form of agglomerative economy can emerge as a consequence of knowledge spillover, whether it's firms learning from other firms within the same industry (spatial economy) or from diverse firms in different industries (the Jacobs economy), or even from the concentration of various stakeholders like universities, government bodies, and consumers (Content and Frenken, 2016).

2.4 The Portfolio Theory and Unrelated Variety

The portfolio theory originated in business economics (Montgomery, 1994). So, it is used in evaluating the effect of the variety of products on the growth and

profitability of the firm. However, the principle stated in this theory, suggesting that variety reduces risk, has also been used for regional development theories. Regional variety can be a portfolio strategy to protect regional income against sudden shocks such as oil price fluctuations, commercial warfare, radical innovations in production, and so on. Even if the inter-regional immigration of labor force is high, economic shocks reduce the economic growth, because they reduce the agglomerative economy. Therefore, variety at the regional level reduces regional unemployment and increases the economic growth of the region, whereas specialization can increase the risk of unemployment and reduce the economic growth (Frenken et al., 2007; Brachert et al., 2011). The important point is that in this theory, “unrelated variety” is emphasized. Contrary to related variety (in terms of market or technology), unrelated variety is a criterion for risk confrontation, so that if unrelated variety is high in a region, occurrence of change in an economic sector will have a slight impact on the economy of the region, whereas specialization in one or more industries, or, in other words, the creation of variety, can lead to more vulnerability in the regional economy (Content and Frenken, 2016; Boschma, 2015; Diodato and Weterings, 2015). Boschma and Capone (2015) examined the institutional context of relatedness and unrelatedness, and found out that relatedness often occurs in countries where economy is the coordinated with the market, and unrelatedness exists in countries with free economies (Boschma and Capone, 2015).

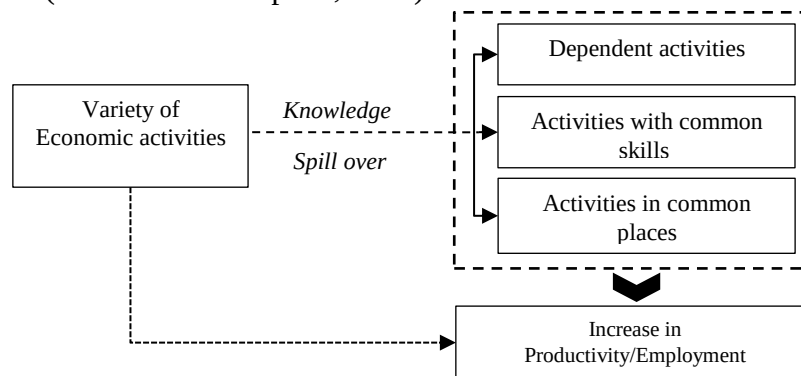


Figure 1. Analytical Model of Related Variety and its Role in Regional Economic Development

Source: Research finding.

3. Research Methodology

In order to develop a criterion for measuring related variety in urban regions, the two concepts of “economic diversity” and “relatedness” of economic sectors have

been considered. Economic diversity has been investigated through the level of specialization of activities in regions. For this purpose, the spatial coefficient indicator of economic activities in each province of Iran has been used. Also, in order to measure the level of relatedness of economic activities with one another, according to Fernon's approach (2007) the technology of value added production in economic activities was considered. Accordingly, using the input-output model, the value added production formula in an economic activity was considered with various combinations of economic activities, and then the matrix of the proximity of production technologies, or the production formulae for each of the activities, was calculated. In this approach, it is assumed that activities that have similar technology, composition and formulae in value added production, are related (Hidalgo et al., 2018). In this way, the related variety indicator for each region has been calculated through the following steps:

3.1 First Step: Developing the Related Variety Indicator

Developing the related variety indicator is formulated in the two sub-steps of calculating the location coefficient for dimension of diversity/specialization, as well as calculation of relatedness for the other aspect of this indicator:

3.1.1 Calculating the Location Coefficient

Using the location coefficient, major economic activities that are specialized are identified in urban regions. The location coefficient calculates employment in a specified activity (i) in the spatial unit — province — (m), and compares it with the corresponding ratio in the reference unit — country. The location coefficient higher than 1 reflects the specialization of the activity in the given spatial unit. The final set of specialized jobs for each spatial unit reflects common skills and relative advantage of labor force in that area.

$$A) LQ_i^{(m)} = \frac{x_i^{(m)} / \sum_i x_i^{(m)}}{\sum_m x_i^{(m)} / \sum_m \sum_i x_i^{(m)}}$$

$x_i^{(m)}$ The number of workers in job i in city m

The output of this step helps to consider only specialized activities in each urban region in calculating the related variety.

3.1.2 Calculating the Relatedness of Economic Activities

Using the input-output table, the value-added ratio of each of the economic activities used as input in the production of value added in a specific activity is

calculated. Thus, the set of value added ratios of various economic activities in a specific activity is considered to be a production formula for that activity in the form of a vector. Then, using a proximity criterion based on the calculation of correlation between the resultant production vectors, the proximity matrix is calculated. The reason for the use of correlation criterion instead of methods such as Euclidean, Minkowski, and Manhattan distance is emphasizing similarity, and not lack of similarity, in the given indicator.

$$B) V_i = \sum_{j=1}^n V_j: v_{ij} = \frac{V_j}{V_i} : P_i = \{v_{j1} \cdot v_{j2} \cdot v_{j3} \cdot v_{j4} \dots v_{jn}\}$$

v_{ij} : The share of added value of activity j in the production of activity i

P_i : The production vector of activity i

$$C) RP_{ij} = \frac{\sum_{i=1}^N (Y_i - \bar{Y})(X_i - \bar{X})}{\sqrt{\sum_{i=1}^N (Y_i - \bar{Y})^2 \sum_{i=1}^N (X_i - \bar{X})^2}}$$

$:R_{ij}$ The correlation between production vector of i and production vector of j

Then the correlation indicator of activities (i, j) for each spatial unit (m) and for specialized activities in the urban region is weighted with the help of the number of employees in each activity, and standardized by division into of the total number of employees:

$$D) RV_{ij}^{(m)} = \frac{(e_i^{(m)} + e_j^{(m)}) RP_{ij}}{2 \sum_{k=1}^n e_k^{(m)}}$$

Where m is the spatial unit of province, n^m is the number of jobs in province m and $e_i^{(m)}$ is the number of workers in activity i in province m . In this way, the related variety RV is weighted with the average number of employees in two related jobs through links, and is standardized through the total number of employees.

For each province, the sum of related variety of specialized activities is calculated and considered as the related variety indicator of the entire province.

$$E) T^{(m)} = \sum_{i < j}^{s^{(m)}} RV_{ij}^{(m)}$$

Then through the extremum standardization method, the index is normalized as specified in equations F and G:

$$F) \hat{x}_{ij} = \frac{x_{ij} - x_{jmin}}{x_{jmax} - x_{jmin}} \quad G) \hat{x}_{ij} = \frac{x_{jmax} - x_{ij}}{x_{jmax} - x_{jmin}}$$

where, i denotes the province number; j denotes the related variety number; $\hat{x}_{ij}$ refers to the normalized value of index j in province i ; x_{ij} refers to the measured

value of index j in province I ; x_{jmax} and x_{jmin} refer to the maximum and minimum measured values of index j , respectively.

3.2 Second Step: Investigating the Role of Related Variety in Productivity and Growth of Employment

In the next step, the role of related variety in productivity and employment growth are investigated through linear regression analysis.

Table 1. Data Required in Analyzing the Role of Related Variety in Regional Employment and the Productivity Rate of Economic Activities

Index	Sources of Data
Employee growth Ratio (2006-2016)	Census statistics
Productivity ratio of economic activities (2006-2016)	Census statistics Regional counting information. Statistics of central bank

$$F) PR_m = \frac{\sum_{i=1}^n L_i}{\sum_{i=1}^n V_i}$$

L_i : The number of employees in activity i

V_i : The amount of Added value of activity i

In order to improve the accuracy of the model, three control variables are considered. Infrastructure, socio-cultural index and innovation capacity are included as the independent variables. The infrastructure index also been constructed based on the level of access to infrastructure such as electricity, water and sanitation, telephone, internet, gas, roadways, and housing production units per thousand people. The social-cultural variable has also been constructed based on indices such as the share of public libraries, cultural and artistic centers, per capita sports facilities, the share of healthcare and medical centers, health houses, population growth rate, urbanization, and the level of political participation in the provinces (Sadeghi and Masoudi Nadoushan, 2018). The innovation capacity index is also constructed based on the ration of master, PhD and postdoc graduates, the number of R&D and research centers, educated employments, entrepreneurs, specialized labor and literacy rate (Hedayatifard and Heidari, 2019).

4. Finding

To investigate regional economic diversity, the location coefficient has been employed to assess the degree of specialization in regional economic activities. The examination of specialization levels in the provinces of Iran reveals that

agricultural and construction activities exhibit the highest likelihood of specialization among other activities, with a greater demand for employment in these two sectors compared to others. Education, ranking third with a 40% probability of specialization, signifies the focus of the service sector on education and learning, serving as an input for production sectors such as industry. An analysis of the spatial distribution of specialized activities among regions reveals that the provinces of Bushehr, Tehran, and Gilan host the largest number of specialized activities, indicating a diversity of activities, value-added processes, and capital production in these areas. It's worth noting that both Bushehr and Gilan are coastal provinces, benefiting from natural coastal resources that offer the potential for specialization in a wide range of economic activities, including tourism, agriculture, fisheries, transportation, and more. To examine the interrelationships between economic activities, I have considered the intermediate consumption of each economic activity using data from the input-output table. Intermediate consumption reveals how economic activities interact with one another, as different consumption combinations determine the production pattern and capital production formula for each economic activity. This approach allows us to identify each economic activity's contribution to economic production within the intermediate consumption matrix (Table 2).

As anticipated, the results highlight the primary role of wholesale and retail activities in shaping the economic production structure. Real estate and mining, on the other hand, rely on financial intermediary processes (Table 2). When we examine the table vertically, it illustrates the production vector for each major group of activities, showing how the ratios of various activities combine to create the final value added. In line with Frenken et al. (2007), one aspect of the relatedness of economic activities centers on the similarity in the structure and pattern of production. Consequently, the next step involves evaluating the level of structural similarity among economic activities through correlation analysis of the vectors representing value-added production. The findings indicate that "transport and storage" and "construction" activities exhibit the highest degrees of similarity in terms of value-added production structure. Meanwhile, educational activities involve the least input and intermediate consumption for the production of value added in economic sectors. This suggests that, due to the high level of activity specialization based on employment criteria (Table 2), a significant proportion of the labor force does not contribute to the flow of value-added production (Table3).

Table 2. Intermediate Consumption Matrix; The Ratio of Economic Activities in the Production of Major Economic Groups

Input-Output table	health and social work input	education input	public administration input	real state input	finance input	transportation and inventory input	hotel and restaurant input	wholesale and trade input	building construction input	water, electricity and gas input	industry input	mining input	agricultural input	other services input
agriculture	5.1	0.1	2.5	0.0	0.2	0.3	8.8	0.2	0.1	0.6	1.7	0.7	4.5	0.4
mining	0.0	0.1	0.0	0.7	0.0	0.1	0.1	0.1	0.4	8.7	4.1	0.3	0.2	0.1
Industry	1.1	0.1	1.2	1.4	0.5	1.2	1.2	1.4	2.1	0.9	1.8	0.5	0.9	1.6
Water, Electricity and Gas	2.2	1.4	1.0	0.7	1.9	1.1	0.4	1.0	0.3	3.2	1.0	2.0	0.6	3.1
building construction	0.4	1.4	0.6	1.3	0.1	0.6	1.6	0.8	0/8	1.2	0.1	0.3	0.2	1.2
wholesale and Trade	14.9	3.8	26.3	11.2	17.2	18.6	12.7	14.2	16.9	21.4	16.9	3.8	16.9	7.7
Hotel and restaurants	0.0	35.3	3.2	1.0	2.6	1.4	0.0	0.9	0.1	1.0	0.0	1.8	0.0	0.1
Transportation and inventory	2.4	2.0	2.4	2.4	2.3	5.2	1.9	5.0	4.1	2.3	2.4	2.9	4.6	2.3
Finance	5.2	6.6	4.6	16.1	17.3	3.4	4.7	5.7	3.3	2.0	2.8	23.5	4.5	6.1
Real state	0.4	8.2	1.5	1.3	4.3	2.3	0.2	1.3	0.2	1.5	1.8	2.8	0.7	4.1
Public administration	1.0	0.0	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.7	0.0	0.1	0.0	0.6
Education	0.3	2.5	0.4	0.3	1.9	0.4	0.0	0.5	0.0	1.0	0.2	0.1	1.1	4.3
Health and social work	3.8	4.2	1.0	0.3	1.1	0.3	0.0	0.1	0.0	0.4	0.0	0.9	0.2	0.1
other service activities	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2	0.8

Source: Research finding.

Table 3. Proximity Matrix Using the Correlation Criterion among Production Vectors in Each Group of Economic Activities, 2006-2007

the correlation criterion among production vectors	agriculture	mining	Industry	Water, Electricity and Gas	building construction	wholesale and Trade	Hotel and restaurant	Transportation and inventory	Finance	Real state	Public administration	Education	Health and social work	other service activities
agriculture	1	0.24	0.93	0.84	0.96	0.95	0.91	0.95	0.75	0.65	0.95	-0.11	0.95	0.70
mining	0.24	1	0.14	0.03	0.20	0.39	0.25	0.19	0.76	0.87	0.18	0.10	0.28	0.55
Industry	0.93	0.14	1	0.97	0.96	0.91	0.79	0.95	0.70	0.58	0.95	-0.12	0.88	0.66
Water, Electricity and Gas	0.84	0.03	0.97	1	0.89	0.82	0.67	0.88	0.60	0.48	0.89	-0.10	0.78	0.56
building construction	0.96	0.20	0.96	0.89	1	0.97	0.78	0.99	0.75	0.64	0.97	-0.08	0.90	0.70
wholesale and Trade	0.95	0.39	0.91	0.82	0.97	1	0.76	0.97	0.85	0.77	0.94	-0.02	0.88	0.79
Hotel and restaurants	0.91	0.25	0.79	0.67	0.78	0.76	1	0.76	0.64	0.58	0.82	-0.16	0.90	0.53
Transportation and inventory	0.95	0.19	0.95	0.88	0.99	0.97	0.76	1	0.75	0.62	0.97	0.00	0.88	0.72
Finance	0.75	0.76	0.70	0.60	0.75	0.85	0.64	0.75	1	0.96	0.75	0.11	0.75	0.86
Real state	0.65	0.87	0.58	0.48	0.64	0.77	0.58	0.62	0.96	1	0.62	0.03	0.65	0.77
Public administration	0.95	0.18	0.95	0.89	0.97	0.94	0.82	0.97	0.75	0.62	1	0.05	0.93	0.68
Education	-0.11	0.10	-0.12	-0.10	-0.08	-0.02	-0.16	0.00	0.11	0.03	0.05	1	-0.14	-0.11
Health and social work	0.95	0.28	0.88	0.78	0.90	0.88	0.90	0.88	0.75	0.65	0.93	-0.14	1	0.64
other service activities	0.70	0.55	0.66	0.56	0.70	0.79	0.53	0.72	0.86	0.77	0.68	-0.11	0.64	1

Source: Research finding.

The results of this matrix have been standardized using the level of employment in each of the activities in each province, and ultimately, its sum has made the level of “related variety” for urban regions (Fig. 2). Thus, the provinces of Tehran, Gilan, and Bushehr have the highest levels of related variety indicator, respectively. Also, the provinces of West Azerbaijan, Qazvin and Hamedan have the lowest level of related variety, respectively.

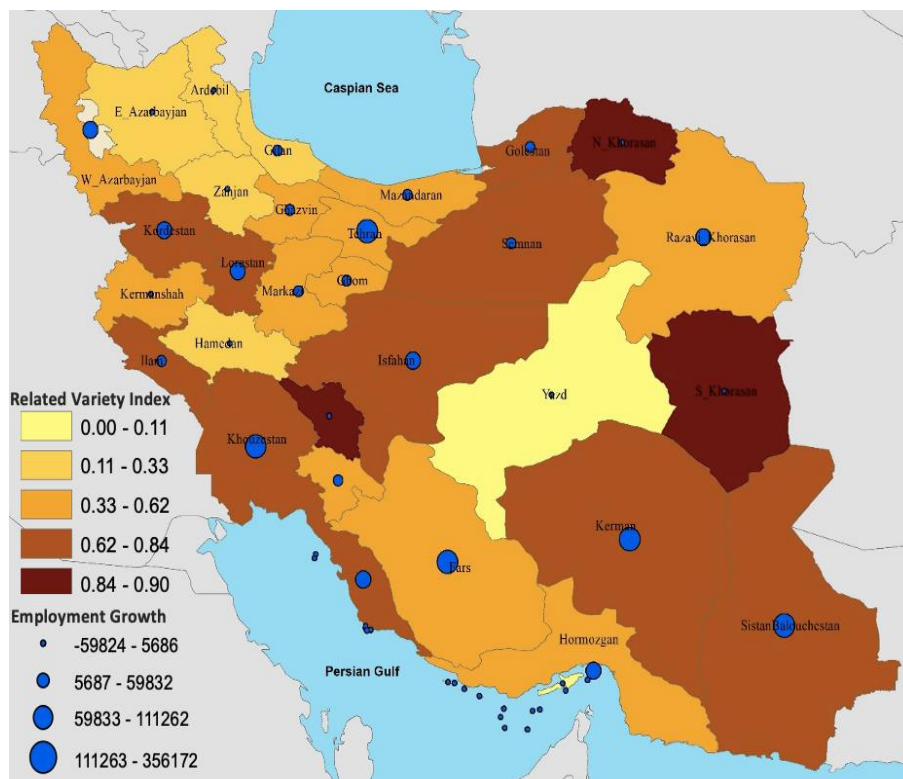


Figure 2. The Spatial distribution of Related Variety Index

Source: Research finding.

It is expected that with an increase in the diversity of interrelated economic activities, the likelihood of knowledge transfer between various economic activities would increase. As a result, potential production costs would decrease, ultimately leading to an increase in economic productivity. It is also expected that with an increase in the related variety index, the possibility of creating employment opportunities and the emergence of new jobs in provinces would increase. The analysis of the relationship between regional economic development variables, including employment growth rate and productivity growth, and the related variety index has shown that there is a significant linear relationship between employment

growth rate and related diversity. However, there is no significant linear relationship between productivity growth and related diversity. The causal relationship between the related diversity index and regional development indices was examined through two regression models. In these models, the variables of productivity growth and employment growth during the period 2006-2016 were considered as dependent variables, while the related variety index was considered as the independent variable. In order to enhance the model's accuracy, three control variables, namely infrastructure, innovation capacity, and socio-cultural status, were included. This analysis aimed to assess how the related diversity index relates to changes in productivity and employment over the specified time frame while controlling for the influence of infrastructure, education, and socio-cultural factors.

The findings indicate that while the model shows a causal relationship between the related diversity index and employment growth (Sig.=0.001), this relationship is not statistically significant for economic productivity growth in the provinces of Iran (Sig.=0.466 at 5% confidence level). In other words, the diversity of interrelated economic activities appears to have a meaningful impact on employment growth but does not have a statistically significant impact on economic productivity growth in the Iranian provinces. The obtained model suggests that regions that had diverse and interrelated economic activities in 2006 experienced significant employment growth during the ten-year period. Additionally, the control variable of technical and communication infrastructure has also been found to have a significant positive impact on employment generation. This is despite the fact that social-cultural indices and the indices related to production innovation capacity, which measure the number of research and development centers, the percentage of highly educated individuals, and the literacy rate, do not have a significant impact on employment growth in the provinces.

Table 5. ANOVA Test Results for Testing the Role of Related Variety in the Growth Rate of Economic Productivity

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	53.117	4	13.279	.924	.466 ^b
	Residual	359.379	25	14.375		
	Total	412.496	29			

a. Dependent Variable: Productivity_Growth

b. Predictors: (Constant), Related_Variety, Socio_Cultural, Infrastructure, Innovation_Capacity

Source: Research finding.

Table 6. ANOVA Test Results for Testing the Role of Related Variety in Employment Growth

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.171	4	5.293	6.391	.001 ^b
	Residual	20.703	25	.828		
	Total	41.874	29			

a. Dependent Variable: Employment_Growth

b. Predictors: (Constant), Related_Variety, Innovation_Capacity, Infrastructure, Socio_Cultural

Source: Research finding.**Table 7.** Regression Coefficients Table

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-2.829	1.177		-2.403	.024
Socio_Cultural	1.424	2.301	.096	.619	.542
Innovation_Capacity	-.556	1.021	-.085	-.545	.591
Infrastructure	8.261	2.061	.585	4.009	.000
Related_Variety	1.596	.742	.311	2.152	.041

a. Dependent Variable: Employment_Growth

Source: Research finding.

The findings of this analysis support Jacobs's criticism. According to the MAR approach, with the specialization of economic activities and the advent of locational economies, the production process is optimized by increased productivity. Meanwhile, with the existence of related variety, which is followed by the flow of a combination of various types of knowledge in the region, new combinations of products and services can be created which are necessitated by emergence of new jobs. Therefore, related variety can lead to employment increase in Iranian urban regions. This issue gains importance when regional policies aim at employment or increasing productivity in specialized production. In situations where the policy making objective is increasing regional employment the strategy of diversifying complementary and related economic activities will play an important role in achieving the desired goal and regional development.

5. Conclusion

The concept of related variety is a new concept rooted in business economics and has been introduced in the theories of regional economic development since 2007. The main challenge is how specialization and diversity of economic activities can lead to economic growth. The core of this concept is the possibility of emergence

of knowledge spill-over among various economic sectors instead of only one specialized group. This concept, on the other hand, has been supplemented by the ideas of researchers on the possibility of transferring knowledge among sections that are not similar and are diverse and yet have common contexts. The combination of these two points has led to the development of the concept of related variety as an indicator of regional economic development. Those who agree with this concept emphasize the importance of related variety in regional employment. In this view, locational economies and specialization lead to increased productivity, and thus to the regional economic development, while the related variety of economic activities leads to employment growth. This can affect a large number of urban regional policy challenges. In situations where many Iranian regional development strategies are indicative of specialization and concentration of economic activities and creation of growth poles to increase development shrinkage and locational economies, establishing the foundation for the formation of related variety in economic activities can be an effective step in increasing regional employment and achieving regional development goals. This research has attempted to examine how this hypothesis works in the economic systems of the urban regions in Iran. For this purpose, first the related variety indicator has been developed by using employment data in major activity groups and location coefficient technique in order to emphasize the diversity of economic activities in the region, and then the input-output model to emphasize the relatedness of the activities to one another. The results have shown that the provinces of Bushehr, Tehran, and Gilan, have the largest number of specialized activities, which implicitly reflects diversity in the economic structure of the region. Also, through using the input-output model to extract the production pattern, relying on intermediate consumption in each activity group, it was found that wholesale and retail activities and financial intermediaries are among the main activities effective in the value added production formula in the major activity groups. The correlation among the production formula vectors in the proximity matrix has shown that transportation-storage and constructional activities has the highest level of similarity and, on the other hand, educational activity has the lowest significance in the value added production structure. Meanwhile, the highest level of employment is accumulated in educational activities, reflecting that a high level of regional employment lays outside the production cycle. Finally, after combining these considerations, the final related-variety indicator showed that the provinces of Tehran, Bushehr, and Gilan enjoy the highest level of related variety. In the next step, investigation of the relationship between this indicator

and economic growth indicators such as productivity and employment growth rates through the linear correlation test showed a direct and positive relationship between employment growth and related variety index. The causal relationship test for these two sets of indicators for explaining the function of related variety in economic growth indicators has shown that in the Iranian urban regions, related variety is effective in regional employment growth, while, in terms of growth of productivity, the test results have not been significant. Thus, the hypothesis that related variety can be effective in increasing regional employment in a positive way is supportable in studying the regional economic system of Iran, and therefore, it can guide regional policies to increase the variety of related activities for the expansion of employment capacities and growth of economic indicators. This is especially important in situations where the production chain is faced with ambiguity and problems. Hence, in regions where production capacities and infrastructures are not fully provided and the costs of external economies is more than locational economies for specialization, the use of diversification strategies for economic activities, and in particular the identification and empowerment of related industries, will play an effective role in the regional economic growth. However, despite the expectation that the mechanism through which related diversity contributes to employment generation is the creation of new jobs via the transfer of knowledge between economic sectors, it seems that this pathway is not easily traceable in urban areas in Iran. This is because the transfer of knowledge was expected to occur through the performance of innovation-producing firms and a knowledge-based economic flow. This is in contrast to the finding that innovation capacity, driven by the performance of educated human resources and research centers, was not identified as significant factors in employment generation. Therefore, explaining how related diversity affects employment generation in urban areas of Iran appears challenging. Indeed, this topic can be further explored in future research to gain a deeper understanding of the relationship between related diversity and employment generation in urban areas of Iran. Additional studies and analyses may provide valuable insights into the mechanisms at play and shed light on the factors that influence job creation and knowledge transfer in the context of economic diversity.

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