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RESEARCH PAPER

The Effect of Government Fiscal Responses on the Dynamics of Macroeconomic Variables under Pandemic Disease Conditions

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Abstract

The pandemic nature of the Coronavirus requires effective measures. Public health measures to control the spread of the disease and support vulnerable businesses are among the most important measures in this regard. On the other hand, restrictions on movement and economic activity have created challenges in the response of governments against this pandemic, which in turn has affected the role and performance of the government. In the present study, a dynamic stochastic general equilibrium model has been used to analyze the role of government under these conditions. The results of the survey of hands-on policy scenarios compared to the state of hands-off policy indicate that the shocks of government health expenditures have caused the faster convergence of macroeconomic variables to steady-state conditions. Therefore, as a proposed policy, it is recommended that the government play a stabilizing role under pandemic disease conditions.

Keywords: Bayesian Estimation, Dynamic Stochastic General Equilibrium, Health Status, Pandemic Outbreak.
JEL Classification: E32, H30, I18, D58.

1. Introduction

Health is one of the fundamental components of human capital, which promotes labor productivity by enhancing mental abilities and physical capacity. Besides, increasing life expectancy leads to incentives to invest in physical capital, innovation, and education. Hence, the economic development and growth of societies depend heavily on human health (Bloom et al., 2019). However, the last decade has seen the spread of epidemics of diseases such as Severe Acute Respiratory Syndrome (SARS), Swine influenza, and Ebola, which have had significant economic and social effects through social interactions and economic transaction reduction. But the world experienced an unprecedented shock with the outbreak of COVID-19 disease that was found in China in December 2019 (Harjoto et al., 2021). The disease is caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) and threatened public health, in turn leading to international humanitarian, social, and economic concerns and crises (Ferrannini et al., 2021; Sharma et al., 2020; Wang and Zhang, 2021). COVID-19 disease was recognized by the World Health Organization (WHO) as a serious pandemic in March 2020. Figure 1 and Figure ***2*** show the severity of cases and deaths in countries infected with the virus, respectively. According to the International Monetary Fund (IMF), the consequences of the pandemic are even worse than the 2008 financial crisis, which have pushed the global economy into recession (Zhang, 2021).

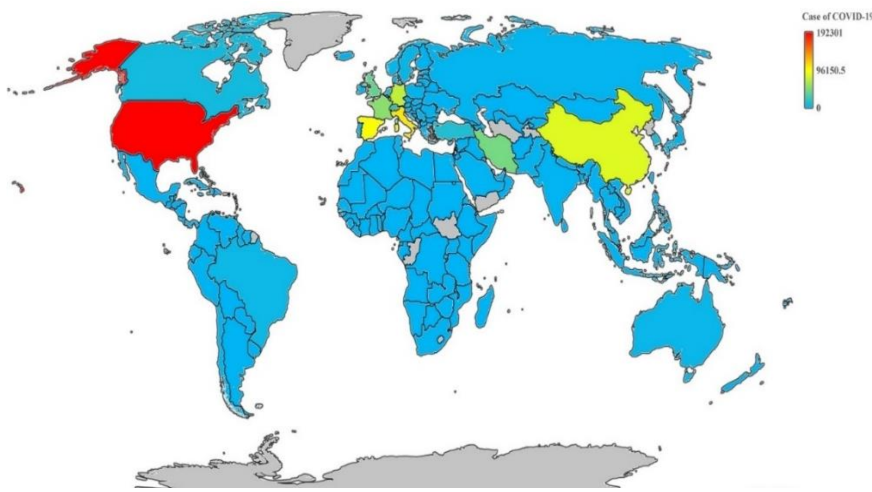

Figure 1. COVID-19 Total Cases in March 2020
Source: WHO (2021).

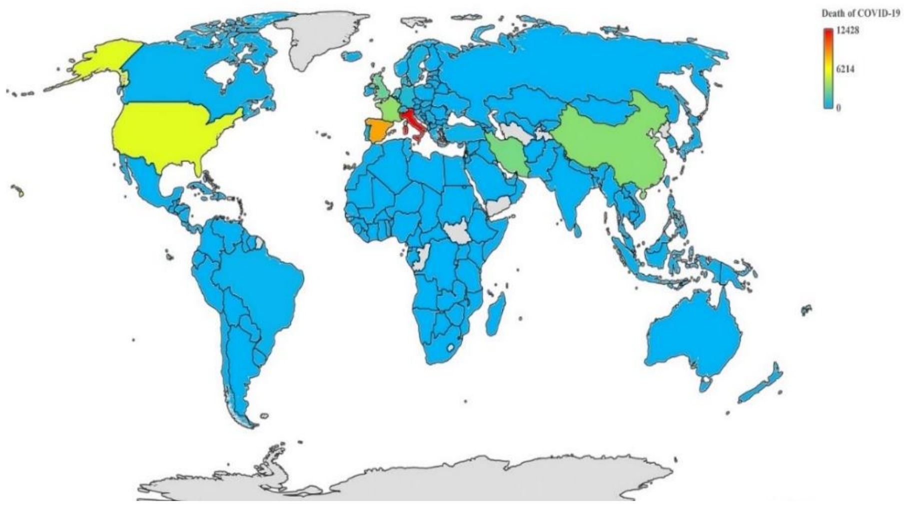

Figure 2. COVID-19 Total Deaths in March 2020
Source: WHO (2021).

The COVID-19 disease is highly contagious and has forced governments to adopt measures and policies that can control and curb the spread of the disease. Measures taken by most governments in this regard include the closure of schools, institutions, and public facilities, social distance imposition, travel restrictions, personal isolation at home, quarantine, and lockdown of the country, which in turn have had adverse consequences on the economies of countries (Dev and Sengupta, 2020; Wang and Zhang, 2021). Consequently, the economies of countries at the micro and macro levels are directly and indirectly affected by the outbreak of COVID-19 disease. At the micro-level, household health expenditures enhanced following the outbreak of the disease. On the other hand, poor health leads to lower levels of education, working hours, and consequently lower incomes. Therefore, the outbreak of the disease had dire consequences on the consumption facilities and the impoverishment of households. The disease has disrupted the performance of companies and the government by reducing leisure time and the inability of people to perform daily activities. Furthermore, the disease will lead to lower rates of return on investment and lower levels of domestic and foreign investment. In addition, aggregate demand is reduced through business closures and household budget constraints, which directly affects countries' economic growth and has destructive impacts on the macroeconomic level. Figure 3 typically shows the effects of the disease on micro and macro levels based on WHO (2009) statements.

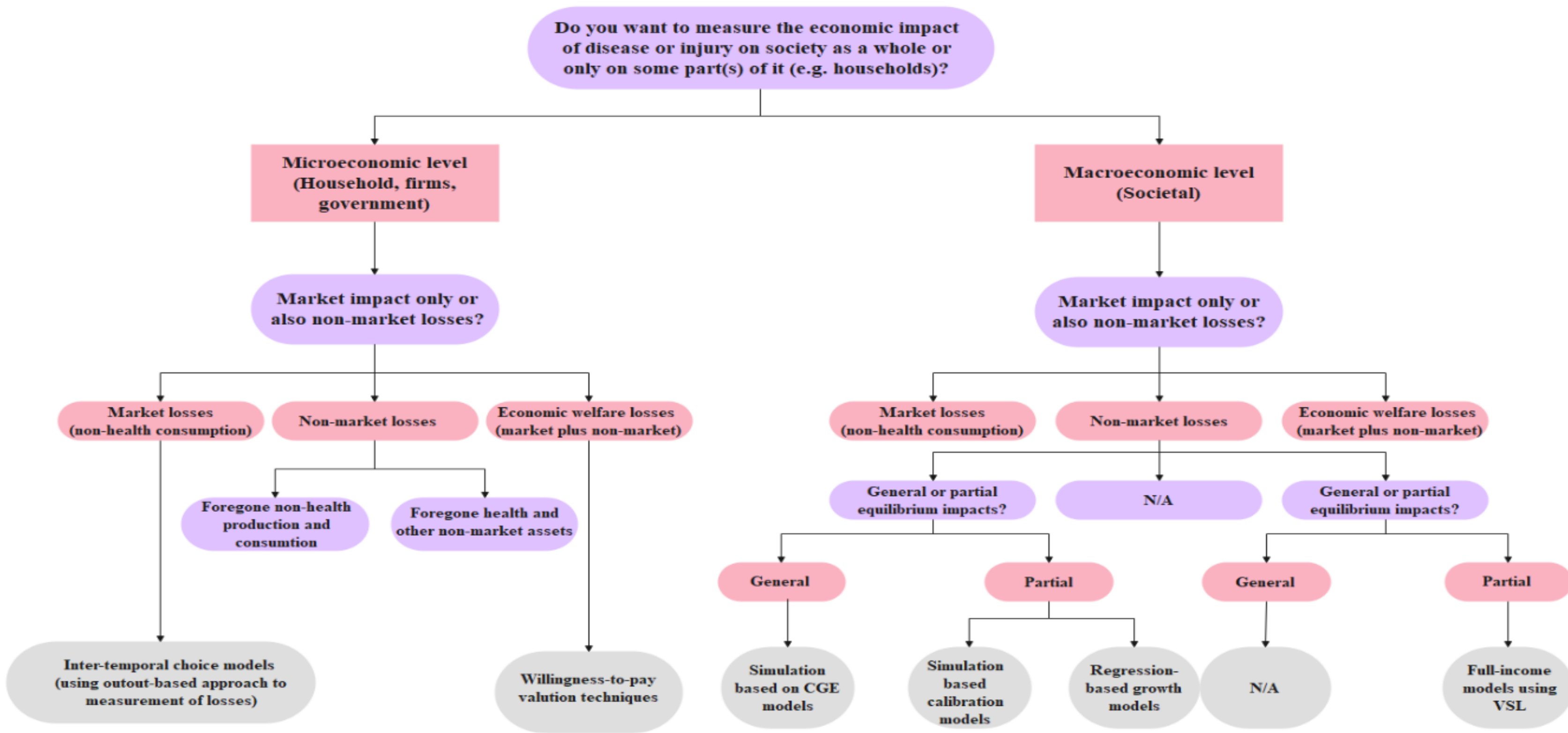

Figure 3. Algorithm of Determining the Methodological Approach in Studying the Economic Impacts of Health
Source: WHO (2009).

This crisis, which is also considered a war, has increased the role of governments in the economies of countries and the speed of economic recovery. So that the improvement of the economies of countries during the epidemic and after it depends heavily on government policies. Monetary and fiscal policies are among the tools of governments through which they can guide the economy. Fiscal policies can stabilize demand and protect countries' economies in times of crisis by supporting households and institutions (Chakraborty and Thomas, 2020). Besides, measures are taken to support businesses to facilitate a safe and assured return to jobs after the epidemic and accelerate the recovery of the economy. Meanwhile, after the pandemic, fiscal policies are critical to motivating healthcare system improvements, public investment, and digital and physical infrastructure (Fendel et al., 2020; Padhan and Prabheesh, 2021). Therefore, fiscal policies to support vulnerable businesses and households during the epidemic and improve the economic growth of countries after the disease reduction process are very effective and crucial (Siddik, 2020).

Iran is a country that contracted Coronavirus disease on 19 February 2020 and is one of the countries where the prevalence of this disease is high. The damage to the Iranian economy due to the outbreak of the disease is far greater than in other countries. Due to oil dependence, international sanctions, negative economic growth, and a high inflation rate, Iran's economy experienced multiple consequences along with the COVID-19 outbreak (Ahmadi et al., 2020). However, in response to this crisis, the Iranian government has pursued fiscal policies to support people's livelihoods and health: (1) Support for the unemployment insurance fund equivalent to 0.3% of GDP; (2) Excess funding for the sector of health equivalent to 2% of GDP; (3) Subsidized facilities for vulnerable households and affected businesses equivalent to 4.7% of GDP; (4) Cash subsidies to vulnerable households equivalent to 0.5% of GDP. It is worth noting that this budget was financed through the National Development Fund, Sukuk bonds, and revenue from privatization proceeds (IMF, 2021).

As stated above, the purpose of this study is to analyze the effect of government fiscal responses on the dynamics of macroeconomic variables in the condition of an outbreak of pandemic disease, using the Dynamic Stochastic General Equilibrium (DSGE) model in different scenarios. Unlike computable general equilibrium models, DSGE models can be calculated in a stochastic environment (Blake et al., 2003). Since the duration of the spread and impact of the virus on the economy is not identified, it is more proper to use these models (Yang et al., 2020). In this line, Section 2 discusses the literature review. In Section 3, a DSGE model appropriate to the crisis outbreak conditions for the Iranian economy is specified. Section 4 determines the input values of the model and Section 5 analysis the model results and the dynamics of macroeconomic variables in response to shocks of health and fiscal policy. Finally, the study concludes with the conclusion and policy implications presented in Section6.

2. Literature Review

Severe global crises and shocks have always caused many disruptions for various economies. The unprecedented crisis following the outbreak of the COVID-19 pandemic, which is considered a major threat to human health, has affected all aspects of social and economic life. It is worth noting that COVID-19 disease can have fundamental impacts on the economics of countries from many micro and macro channels, and governments, policymakers, and stakeholders must pursue effective measures, solutions, and policies to improve their economies as soon as possible. Thus, new literature on the economic effects of COVID-19 is emerging to identify the destructive consequences of COVID-19 and to propose appropriate policies during the disease and after its pandemic reduction. Accordingly, we review a number of these studies that have addressed the effects of health shocks on the economies of countries in line with the objectives of this study.

Vasilev (2017) examined real business cycles and their impact on labor productivity in the US economy by incorporating health status into the household utility function. To this end, the partial-equilibrium framework of Grossman (1999) with endogenous health status was considered in a standard RBC model. The results indicated that health status did not create business cycles.

Yang et al. (2020) examined the state of tourism in the Chinese economy under the spread of infectious diseases using a DSGE model in different scenarios. They concluded that the prevalence of COVID-19 disease hinders the consumption of goods and tourism services, and with the deterioration of health, welfare also decreases.

Burriel Llombart, Checherita-Westphal, Jacquinot, Schön, and Stähler (2020) simulated the risk of economics associated with high public debt regimes using the DSGE model. Generally, economies that experience higher debt are more vulnerable to such crises. As the disease has dramatically enhanced public debt, it has detrimental impacts on the economies of countries.

McKibbin and Fernando (2020) examined the effects of COVID-19 evolution on financial markets and macroeconomics using a DSGE/CGE model in seven scenarios. The main purpose of this study is to determine the range of COVID-19 disease economic costs. The results indicated that the epidemic has dramatic and significant impacts on the global economy. Therefore, a wide range of policy responses is required to overcome the consequences of the disease. The central bank's policy is probably to lower interest rates. However, it is worth noting that this shock is not just a problem of demand management and requires appropriate monetary, fiscal, and health policies.

Fornaro and Wolf (2020) have analyzed coronavirus disease and its possible economic effects in the world. They concluded that the coronavirus would hurt the global economy by forcing factories to close and disrupting global supply chains. Based on the results of this study, the pandemic may put the global economy in recession by slowing growth and increasing unemployment due to pessimistic expectations. Consequently, expansionary fiscal policy interventions are needed to pull the global economy out of recession.

Busato et al. (2020) claimed that COVID-19 disease has become a global economic and health crisis. The results of the DSGE model reveal that COVID-19 has major effects on macroeconomics. Furthermore, effective measures must be taken to address the recession after the policies are implemented to diminish the virus pandemic.

Asoyan et al. (2020) developed a New Keynesian DSGE model for a closed economy to model the impact of health shocks on the Armenian economy. The result revealed that the decision of people to deduct working hours and consumption following the health crisis reduced the spread of COVID-19 but led to an economic recession. Moreover, the expansionary monetary policy diminishes the rate of decline in GDP.

Peeri et al. (2020) extracted and compared information on symptoms, transmission and protection methods, diagnosis and treatment, and risk factors for Middle East Respiratory Syndrome (MERS), COVID-19, and SARS. The results indicate that skimp risk assessment of the urgency of the situation as well as incomplete reports led to the spread of COVID-19. Furthermore, the coronavirus is spreading faster than SARS and MERS, which could be due to its increasing globalization and epidemic.

Berger et al. (2020) developed the Sensitive-Exposed-Infected-Recovered (SEIR) base model to examine the role of testing and quarantine policy in the United States. The results show that further testing and targeted quarantine policies reduce the economic impact of the Corona epidemic.

Evidence and results of studies indicate the profound effects of pandemics such as the COVID-19 disease on the economies of countries. In most studies, epidemiology models have been used to predict the outbreak of the disease. But they do have a fundamental defect; Because they do not consider the interaction between economic decisions and rates of infection (Eichenbaum et al., 2020). Therefore, the main motivation of the present study is to understand the severity of the effect of health shock on Iran's oil economy and to analyze the role of government under these conditions using a DSGE model. These models, being developed following the critique of Lucas (1976), might show the precise interactions between market decision-makers in the context of general equilibrium. On the other hand, most time series models, unlike DSGE models, are not based on economic theory and mathematical optimization. Moreover, DSGE models are computable in a random environment. Since the duration of the virus outbreak and its effect on the economy is not known, it is more appropriate to use these models.

3. Model Design

3.1 Description of the Model

The present study, by combining and expanding the models of Grossman (1999), Vasilev (2017), Yang et al. (2020), and Asoyan et al. (2020) has investigated the impact of a pandemic infectious disease on macroeconomic variables in Iran. In this regard, the target economy consists of households with unlimited planning horizons, perfectly competitive firms, the government, and the oil sector.

3.2 Households

To maximize the discounted total utilities of the planning horizon (expected discounted utility) of its lifetime is the purpose of the sample household. In this utility function, household preferences include a sequence of consumption, leisure, health status, and money holding. Accordingly, each household follows the maximization of the expected utility of its lifetime:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ lnC_t + \psi_l lnL_t + \psi_s lnS_t + \psi_m ln\frac{M_t}{P_t} \right\} \tag{1}$$

where E_0 indicates the expected value of the operator and S_t shows the stock of good health. In Equation 1, C_t, $L_{t,}$ and $\frac{M_t}{P_t}$ represent the consumption, leisure, and real money balances in period t, respectively. Also, $0 < \beta < 1$ is a discount factor of the utility function, ψ_l, $\psi_{s,}$ and ψ_m are preference parameters for leisure, health status, and keeping money, respectively.

The household allocates each period (t) to work H_t^w, quarantine hours H_t^q, and leisure L_t, which time is normalized to 1 in Equation 2.

$$H_t^w + H_t^q + L_t = 1 \tag{2}$$

The amount of wages received by each household per working hour isW_t, as a result, the income of $W_t.H_t^w$ is acquired.

Health is depreciated over time at a rate of δ^s, and I_t^s investment shall be made to maintain health. The law of motion for health is introduced as follows:

$$S_{t+1} = [I_t^s + (1-\delta^s)S_t] - (Z_t\,.\omega) \tag{3}$$

where Z_t demonstrates the health disaster risk, and is a first-order autoregressive process. ω exhibits the deterioration rate of health capital arising from disease outbreak or size of the crisis, and I_t^s displays an investment in health and is a function of health expenditures ($P_tX_t^s$) and dedicating quarantine hours ($W_tH_t^q$):

$$I_t^s = (P_tX_t^s)^{\phi}(W_tH_t^q)^{1-\phi} \tag{4}$$

where $0 < \phi < 1$ and $1-\phi$ are the elasticity of health investment regarding health expenditures and quarantine hours, respectively. In addition, health expenditures include household's health expenditures ($P_tX_t^{sp}$) and government health expenditures ($P_tX_t^{sg}$).

$$P_tX_t^s = P_tX_t^{sp} + P_tX_t^{sg} \tag{5}$$

Finally, each household invests in physical capital, and by renting, the capital to the firm receives interest income $R_t.K_t$ as an owner of the capital. Where R_t depicts the return on capital and K_t performs the capital stock of period t. Moreover, households own businesses and receive nominal profit ($P_t.D_t$) in the form of dividends. The physical capital of the household is developed according to the law of motion:

$$K_{t+1} = I_t^k + (1-\delta^k)K_t \tag{6}$$

where δ^k displays the depreciation rate of physical capital. Each household faces the following budget constraints:

$$P_tC_t + P_t.oop.X_t^s + P_tK_{t+1} + M_t + P_t.T_t \leq W_t.H_t^w + R_t.K_t + P_t.(1-\delta^k)K_t + M_{t-1} + P_t.D_t \tag{7}$$

In Equation 7, oop is the share of out-of-pocket medical expenditures, P_t is the aggregate price level, T_t is the lump-sum tax payment of households.

Dividing both sides of the budget constraint by the price level, it can be rewritten as follows in terms of real variables:

$$C_t + oop.X_t^s + K_{t+1} + m_t + T_t \leq w_t.H_t^w + r_t.K_t + (1-\delta^k)K_t + {m_{t-1}}/{\Pi_t} + D_t \tag{8}$$

In Equation 8, $m_t.w_t.r_t$ and Π_t are real money balance, real wage, real interest rate, and gross inflation rate, respectively.

Maximizing the utility Function (1) for the budget constraint (8) would lead to household optimization conditions (Appendix).

3.3 Firms

The firm produces a homogeneous final product using Cobb Douglas's production function that requires physical capital and labor:

$$Y_t = A_t K_t^{\alpha} (S_t H_t^w)^{1-\alpha} \quad (9)$$

where A_t indicates the level of technology (Hicks neutral) available to the economy in period t.

$0 < \alpha . (1-\alpha) < 1$ is the productivity of labor and capital.

In each period, the firm pursues maximizing profits:

$$\mathrm{D}_t = A_t K_t^{\alpha} (S_t H_t^w)^{1-\alpha} - r_t . K_t - w_t . H_t^w \quad (10)$$

In equilibrium (long-term), firms' profits are zero, and each factor of production will receive as much revenue as its final output:

$$w_t = (1-\alpha) \frac{Y_t}{H_t^w} \quad (11)$$

$$r_t = \alpha \frac{Y_t}{K_t} \quad (12)$$

3.4 Oil Sector

There are several ways to integrate the oil sector with the model. In some studies, this sector being considered like the enterprise sector seeks to maximize profits for the oil sector. In contrast, an exogenous process has been used to model this section in some other studies. It is worth noting that, in the current study, this section has attempted to maximize revenue. Like most state-owned companies, the National Iranian Oil Company, known as the source of oil sales, does not pursue the goal of maximizing profits (Mohammad Sayadi and Khosroshahi, 2020). The change in oil revenues can be due to a change in the number of oil exports EXP_t^{oil}or a change in the price of oil P_t^{oil} or a change in the exchange rate e_t, or a combination of them, which in the present study, these shocks are gathered into stochastic shocks of oil revenues ε_t^{Roil}.

$$R_t^{oil} = e_t . EXP_t^{oil} . P_t^{oil} \quad (13)$$

3.5 Government

The government consumes an exogenous amount of resources in each period. Government expenditures are financed by seignior age and taxes; therefore, the dynamic government budget constraint would be as follows:

$$p_t G_t + (1-oop) p_t X_t^s = p_t . T_t + M_t - M_{t-1} \quad (14)$$

It can be rewritten in terms of real variables via dividing both sides of the budget constraint by the price level, as follows:

$$G_t + (1-oop) X_t^s = T_t + m_t - \frac{m_{t-1}}{\Pi_t} \quad (15)$$

Where G_t and $(m_t - \frac{m_{t-1}}{\Pi_t})$ denote real government expenditures and seigniorage, respectively.

The gross growth rate of money is as follows:

$$\gamma_t = \frac{M_t/P_t}{M_{t-1}/P_t} = \frac{M_t/P_t}{M_{t-1}/P_{t-1}}.\frac{P_t}{P_{t-1}} = \frac{m_t}{m_{t-1}}\pi_t \tag{16}$$

3.6 General Constraint of Resources

In terms of the market settlement, aggregate supply and aggregate demand are equal:

$$Y_t + R_t^{oil} = C_t + X_t^s + I_t^k + G_t \tag{17}$$

Accordingly, the total production of non-oil final goods and oil revenues spent on imports of final goods are allocated to household final consumption, household health expenditures, private sector investment in production, and government expenditures for balancing the final goods market.

3.7 Exogenous Stochastic Processes

The existing stochastic variables in the designed model include the total factor productivityA_t, the health disaster risk Z_t, oil revenues R_t^{oil}, government expenditures G_t, Government health expenditures $X_t^{sg}$and gross growth rate of money γ_t which follow a first-order autoregressive process. The autoregressive process of the total productivity of production factors is as follows:

$$\ln\left(\frac{A_t}{\bar{A}}\right) = \rho_A \ln\left(\frac{A_{t-1}}{\bar{A}}\right) + \varepsilon_t^A.\ \varepsilon_t^A \sim N(0.\sigma_a^2) \tag{18}$$

where $\bar{A} > 0$ is the steady-state level of the total factor productivity process, $0 < \rho_A < 1$ is the first-order autoregressive persistence parameter and $\varepsilon_t^A$are random shocks to the total factor productivity process.

The first-order autoregressive process of health disaster risk is:

$$\ln\left(\frac{Z_t}{\bar{Z}}\right) = \rho_z \ln(\frac{Z_{t-1}}{\bar{Z}}) + \varepsilon_t^z.\ \varepsilon_t^z \sim N(0.\sigma_z^2) \tag{19}$$

where $\bar{Z}$>0 is the steady-state level of the health disaster risk process, $0 < \rho_Z < 1$ is the persistence parameter of AR(1) and $\varepsilon_t^z$are random shocks to the health disaster risk process.

The first-order autoregressive process of oil revenues is:

$$ln\left(\frac{R_t^{oil}}{\bar{R}^{oil}}\right) = \rho_{R^{oil}} ln\left(\frac{R_{t-1}^{oil}}{\bar{R}^{oil}}\right) + \varepsilon_t^{R^{oil}}.\ \varepsilon_t^{R^{oil}} \sim N\left(0.\sigma_{R^{oil}}^2\right) \tag{20}$$

where R_t^{oil} is the oil revenue of period t and $\bar{R}^{oil}$ is the real revenue from the sale of oil in steady-state, $0 < \rho_{R^{oil}} < 1$ is the persistence parameter of AR(1), and $\varepsilon_t^{R^{oil}}$ are random shocks to the oil revenue process.

The first-order autoregressive process of government expenditures is:

$$\ln\left(\frac{G_t}{\bar{G}}\right) = \rho_G \ln\left(\frac{G_{t-1}}{\bar{G}}\right) + \varepsilon_t^G . \varepsilon_t^G \sim N(0. \sigma_G^2) \quad (21)$$

where $\bar{G}$ represents the level of government expenditures in the steady-state, and $\rho_G \epsilon (0.1)$ is the coefficient of persistence, and ε_t^G are random shocks of government expenditures.

The present study now intends to examine how the government responds when health status, deviates from its steady state. Hence, government health expenditures pursue the following fiscal rule:

$$\ln\left(\frac{X_t^{sg}}{\bar{X}^{sg}}\right) = \rho_{X^{sg}} \ln\left(\frac{X_{t-1}^{sg}}{\bar{X}^{sg}}\right) - \rho_{X^{sgz}} \ln\left(\frac{S_{t-1}}{\bar{S}}\right) + \varepsilon_t^{X^{Sg}} . \varepsilon_t^{X^{Sg}} \sim N\left(0. \sigma_{X^{Sg}}^2\right) \quad (22)$$

where $\bar{X}^{sg}$ represents the level of government health expenditures in the steady-state, $\rho_{X^{sg}} \epsilon (0.1)$ is the coefficient of persistence and $\varepsilon_t^{X^{Sg}}$ are random shocks of government health expenditures. $\rho_{X^{sgz}}$ is the government health expenditures response coefficient to the deviation of health status from the steady-state. It is worth noting that the values of this coefficient are determined according to the desired scenario.

We assume that monetary policy evolves according to the rule:

$$\gamma_t = \rho_\gamma \ln\left(\frac{\gamma_{t-1}}{\bar{\gamma}}\right) + \omega_o . \varepsilon_t^{R^{oil}} + \varepsilon_t^\gamma . \varepsilon_t^\gamma \sim N\left(0. \sigma_\gamma^2\right) \quad (23)$$

where $\bar{\gamma}$ is the steady state value of the gross growth rate of money, $\rho_\gamma \epsilon (0.1)$ is the coefficient of persistence, and ε_t^γ are random shocks of the gross growth rate of money. ω_o is the correlation coefficient of oil revenues and money growth.

3.8 Equilibrium Conditions

In equilibrium, economic factors follow similar behavior. By inserting λ_t from Equation 1 of the appendix into other equations, the system consists of 21 variables and 21 equations. This system is log-linearized using the Uhlig (1999) method[1].

4. Calibration and Model Estimation

To estimate the model indicators, the Bayesian method, and Random Walk Metropolis-Hastings algorithm were used. The data of the model's observable variables include seasonal adjusted data, gross domestic production, private

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[1]. The log-linearized form of the model equations is with the author of the article and can be provided if needed.

consumption, private investment, government expenditure and consumer price index from March of 2004 to March 2021, which underwent de-trending procedure by using Hodrick-Prescott filter. Prior to the model estimation, the indicators, which could be excluded from estimation, were identified and calibrated. Accordingly, the indicators that can be calibrated according to Iran's economy variables are presented in Table 1:

Table 1. Long-term Values of Variables Relative to Non-Oil Production

Rate	Explanation	Value
C/Y	Stable ratio of private consumption to non-oil production	0.74
G/Y	Stable ratio of private government expenditures to non-oil production	0.21
R^{oil}/Y	Stable ratio of oil revenues to non-oil production	0.2
K/Y	Stable ratio of capital to non-oil production	6.3

Source: Research finding.

Table 2 reports the calibrated values of the other parameters of the model:

Table 2. Calibrated Values of Indicators of Model

Indicator	Description	Value	Source
β	Discount factor	0.964	Fotros et al. (2015)
α	Capital productivity	0.412	Fotros et al. (2015)
δ^k	Depreciation rate of physical capital	0.028	Sayadi et al. (2015)
A	Steady-state of technology	1.00	Set
z	Steady-state of health disaster risk	0.0075	Set
ρ_A	AR(1) parameter, total factor productivity	0.75	Hosseini and Asgharpur (2021)
$\rho_{R^{oil}}$	AR(1) parameter, oil revenues	0.798	Shahhosseini and Bahrami (2013)
ρ_Y	AR(1) parameter, gross growth rate of money	0.562	Fakhrehoseini (2011)
$\rho_{X^{sgz}}$	The coefficient of response of government health expenditures to the deviation of health status from the steady-state	Scenario making	-

Making of the scenario in the adjusted model is based on $\rho_{X^{sgz}}$ (Table 3).

Table 3. Making of Scenario in the Adjusted Model

Hands-off Policy	Hands-on policy
$\rho_{X^{sgz}} = 0$	$\rho_{X^{sgz}} = 0.15$

Source: Research finding.

To estimate other indicators, first the distribution, prior mean values and standard deviation were determined. In the next phase, they were estimated by using the Bayesian method and Dynare plugin in MATLAB software environment. The results of the Bayesian estimation of the indicators are presented in Table 4:

Table 4. Estimating Model Indicators

Parameters	Prior mean	Prior Distribution	Reference	Posterior mean	HPD interval	Standard deviation
ψ_s	0.245	gamma	Research Assumption	0.221	0.172-0.275	0.05
ψ_m	0.057	gamma	Research Assumption	0.056	0.0001-0.158	0.05
δ^s	0.08	beta	Yang et al. (2020)	0.085	0.066-0.104	0.01
ϕ	0.27	beta	Yang et al. (2020)	0.273	0.178-0.372	0.05
oop	0.6	beta	Research Assumption	0.61	0.419-0.795	0.1
ω	0.1	beta	Yang et al. (2020)	0.1002	0.014-0.198	0.05
ω_o	0.08	beta	fakhrehoseini (2011)	0.0801	0.06-0.099	0.01
ρ_Z	0.6	beta	Yang et al. (2020)	0.59	0.408-0.794	0.1
ρ_G	0.8	beta	Research Assumption	0.862	0.796-0.926	0.1
$\rho_{X^{sg}}$	0.6	beta	Research Assumption	0.592	0.453-0.727	0.1
σ_A	0.01	invg	-	0.019	0.0164-0.023	inf
σ_Z	0.01	invg	-	0.009	0.0021-0.022	inf
$\sigma_{R^{oil}}$	0.01	invg	-	0.0908	0.075-0.106	inf
σ_G	0.01	invg	-	0.014	0.012-0.017	inf
$\sigma_{X^{sg}}$	0.01	invg	-	0.088	0.063-0.115	inf
σ_γ	0.01	invg	-	0.012	0.0019-0.051	inf

Source: Research finding.

Prior distribution and posterior distribution of estimation of model indices have been reported in Figure 4.

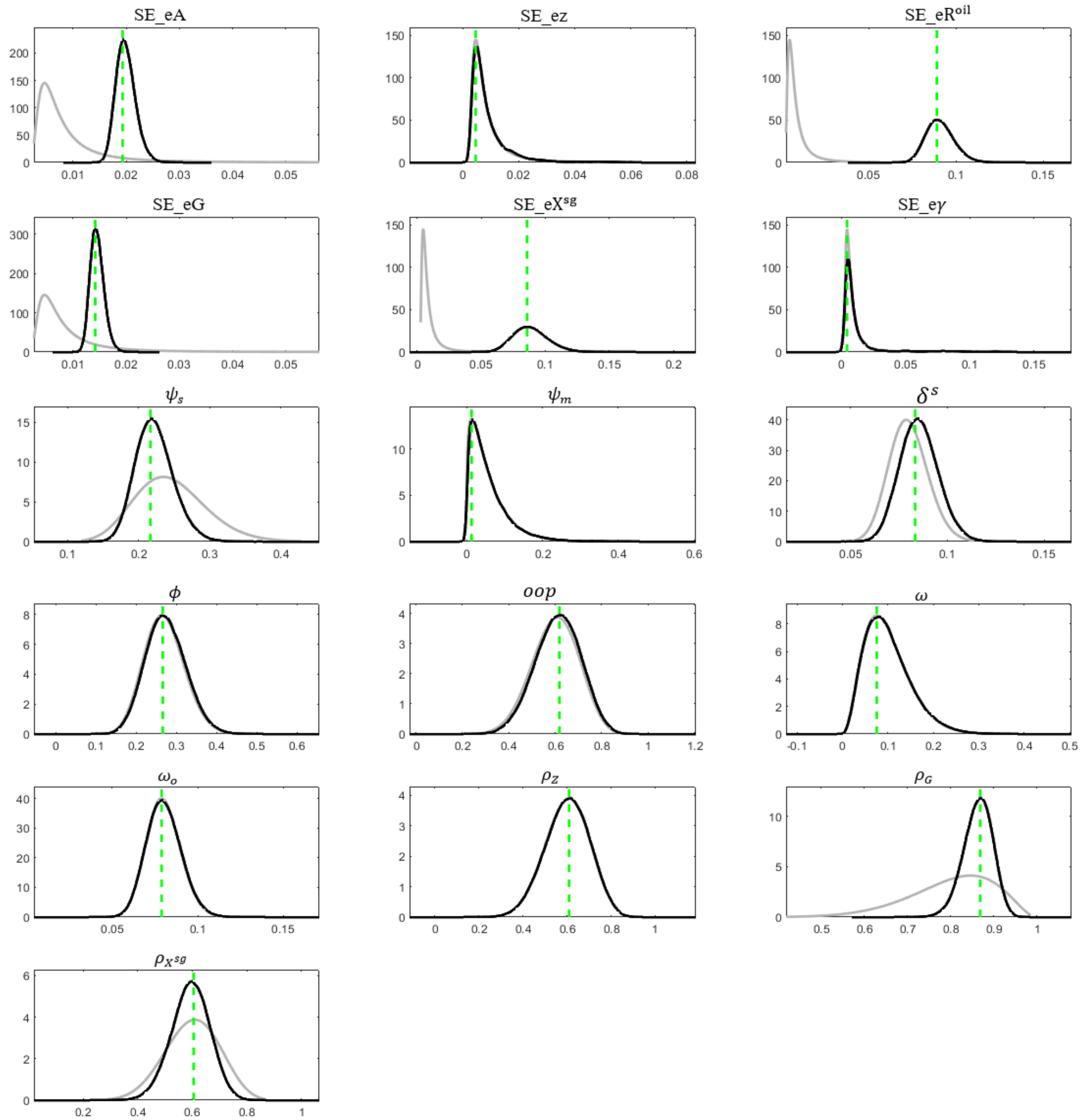

Figure 4. Prior and Posterior Distributions of Model Indicators in Bayesian Estimation
Source: Research finding.

Monte Carlo Markov Chain (MCMC) diagnostic test suggests that the index estimation is fitting and reliable (Figure 5).

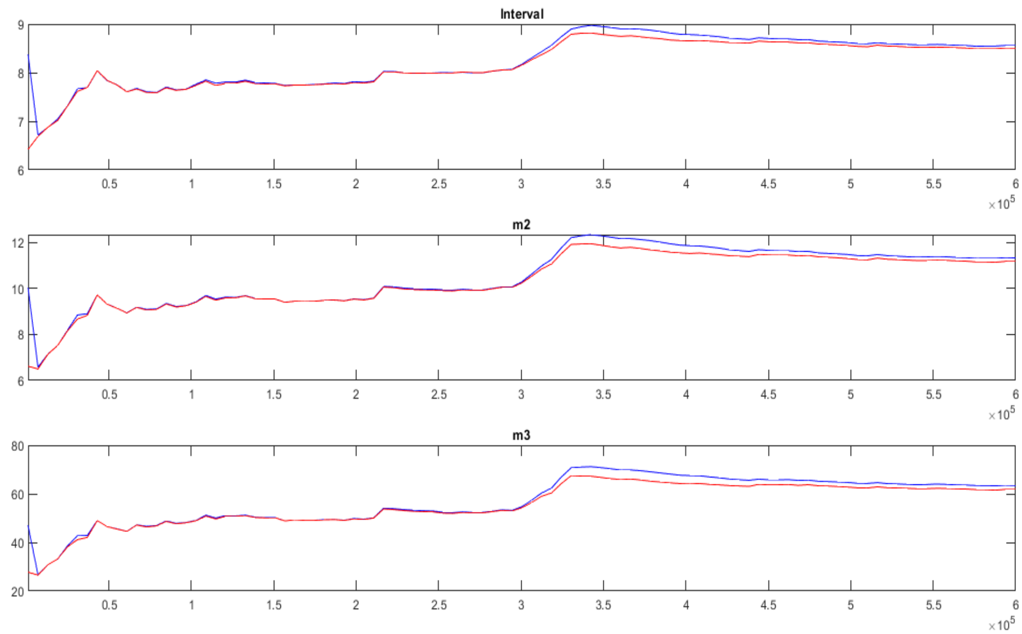

Figure 5. The MCMC Outcomes
Source: Research finding.

5. Investigating the Dynamics of Pattern Variables

5.1 Impact-Response Functions against Health Disaster Risk Shock

Figure 6 displays the impulse response functions (IRFs) to a shock of Z_t. The increased risk of health disasters, leads to deterioration of health status, by a standard deviation. Quarantine hours have been increased to improve health status, which means the health investment increase. Since the sum of working hours, leisure hours, and quarantine hours are proportional, when additional hours are assigned to quarantine, working hours will decrease, and then the marginal productivity of physical capital would fall; which is due to the complementarity of labor and capital in the production function of Cobb Douglas. In the end, labor income and capital income will decrease. Therefore, total output, consumption and physical investment would suffer a considerable fluctuation. Inflation increases due to the decrease in total production. Over time, shortages of physical capital lead to the amplification of interest rates, physical investment, and working hours; they eventually are returned to their steady-state level in a gradual way.

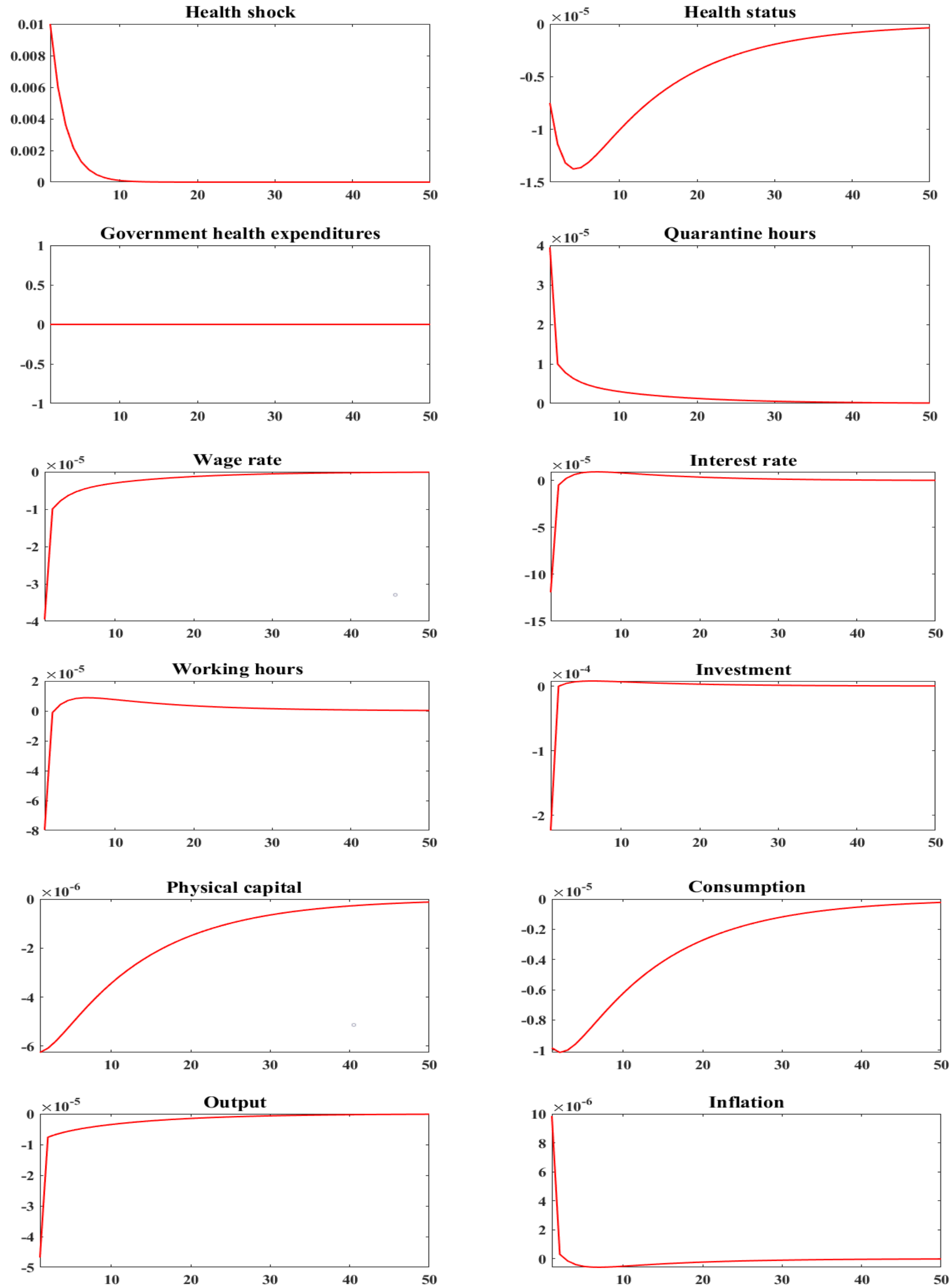

Figure 6. Effect of a 1% Increase in Health Disaster Risk on Macroeconomic Variables
Source: Research finding.

These trends represent a typical path during the outbreak of a social-wide pestilence. The time paths in Figure 3 closely resemble the comparison between COVID-19 and SARS in 2003, and Middle East Respiratory Syndrome in 2014 (Peeri et al., 2020).

5.2 Government's Impact-Response Functions against Health Disaster Risk Shock

Figure 7 indicates how the government's fiscal policy response to the pandemic affects economic variables. In the baseline scenario, it is assumed that the government has no involvement in the economy and a hands-off state is considered for it. Under these conditions, the government would not adopt a fiscal response in the face of pandemic disease (solid line in Figure 7).

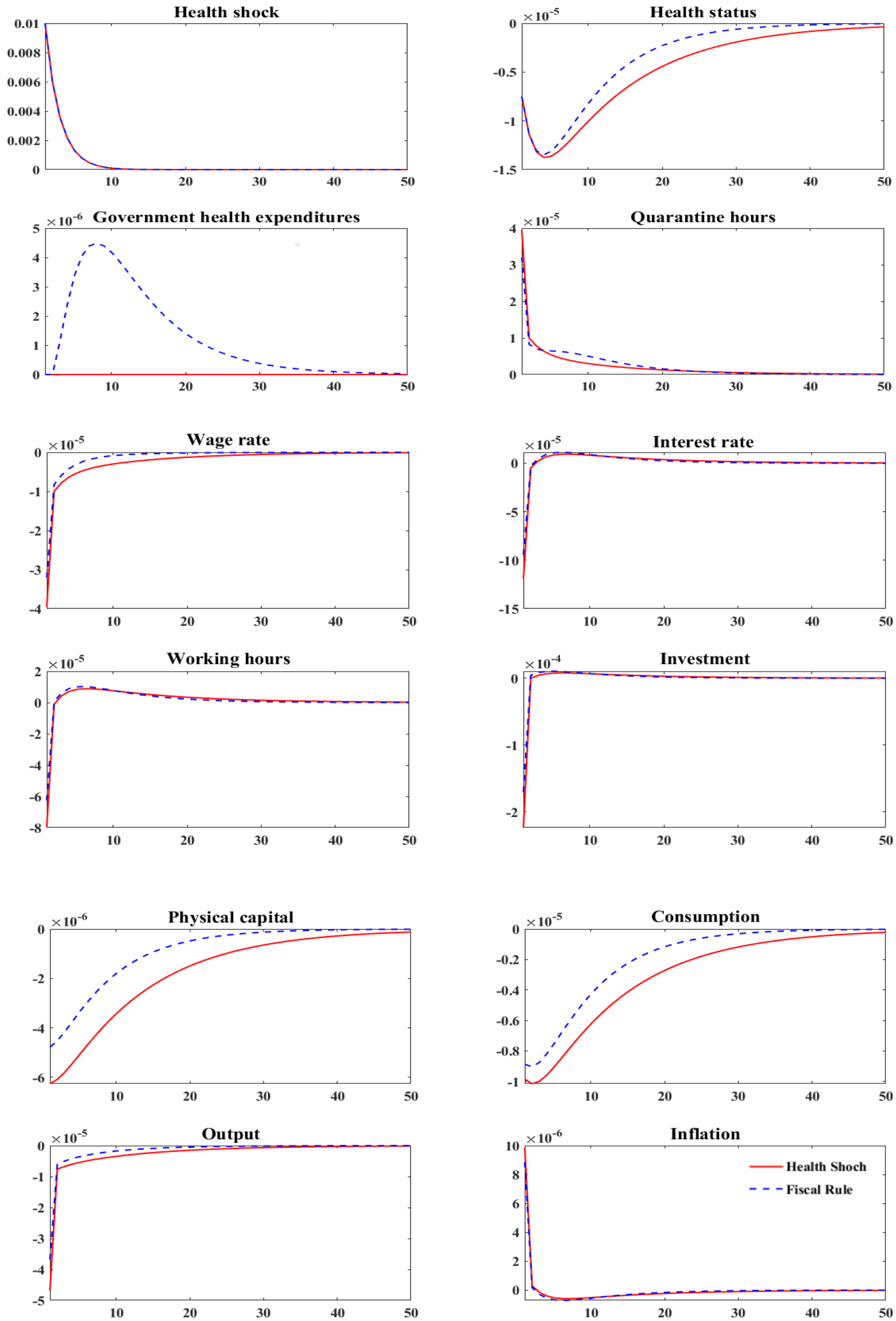

Figure 7. Hands-on Policies Scenarios Compared to the State of Hands-Off Policy

Source: Research finding.

The increase of government health spending would lead to the slight increase of quarantine hours. Therefore, employment hours would face a fewer decline. In contrast, the marginal productivity of capital increases. Under these conditions, investment, inflation, and total production experience less fluctuation (Dashed line in Figure 7).

Given Figure 7, in this study, the design of discretionary fiscal policy in the context of a pandemic outbreak has led to less fluctuation in the macroeconomic variables.

6. Conclusion

Using the experience of the real business cycle school, a dynamic stochastic general equilibrium model for an oil-exporting country is designed in this research to determine the effect of government fiscal responses on the dynamics of macroeconomic variables under pandemic disease conditions. These models, being developed following the critique of Lucas (1976), conform to the principles of microeconomics and might optimally evaluate the performance of economics in a stochastic environment. The general idea standing in the present study is how government fiscal responses to the outbreak of a pandemic disease affect the dynamics of macroeconomic variables; for this purpose, the adjusted model is simulated after calibration and estimation indicators based on the quarterly information of Iran's economy during the period 2004:03-2021:03. In the baseline scenario, it is assumed that the government has no involvement in the economy. Videlicet a state of hand-off policy is presumed for the government. In another scenario, the government's fiscal response to the outbreak of pandemic disease is simulated.

The results of the survey of hands-on policy scenarios compared to the state of hands-off policy indicate that the impact of government expending shocks on the economy under pandemic disease conditions has much less feedback on macroeconomic variables; In other words, using a dynamic stochastic general equilibrium model, it was shown that the active presence of the government and the implementation of discretionary policies under pandemic disease conditions have led to less instability.

The findings of this study are consistent with the results of the studies of Fornaro and Wolf (2020), McKibbin and Fernando (2020), and Berger et al. (2020).

Given the results of this study and also based on the fact that countries like Iran do not have the financial capacity and skills to curb the outbreak of the virus, the only effective way to deal with such a situation is social distancing. Moreover, social distancing requires the closure of educational centers, factories, shops, transportation systems, quarantine, etc. nevertheless, the establishment of various contact centers by government agencies to answer people's questions, screening, increasing the number of daily diagnostic tests and the establishment of temporary hospitals and quarantine centers, are the main affairs governments can do.

As a recommendation for future studies, the role of monetary policy in managing a health crisis can be analyzed in case the structure of the model changes according to New Keynesian assumptions and issues such as market incompleteness and price stickiness. In addition, the effect of a pandemic disease's outbreak under different regimens might be evaluated according to Markov Switching models.

References

Ahmadi, M., Sharifi, A., Dorosti, S., Jafarzadeh Ghoushchi, S., & Ghanbari, N. (2020). Investigation of effective climatology parameters on COVID-19 outbreak in Iran. *Sci Total Environ, 729*, 1-7.

Asoyan, A., Davtyan, V., Igityan, H., Kartashyan, H., & Manukyan, H. (2020). Modelling the Effects of a Health Shock on the Armenian Economy. *Russian Journal of Money and Finance, 79*(4), 18-44.

Barro, R. J., & Ursua, J. F. (2008). Consumption Disasters in the Twentieth Century. *American Economic Review, 98*(2), 58-63.

Berger, D. W., Herkenhoff, K. F., & Mongey, S. (2020). A Seir Infectious Disease Model with Testing and Conditional Quarantine. *National Bureau of Economic Research Working Paper Series, 26901*, 1-30.

Blake, A., Sinclair, M. T., & Sugiyarto, G. (2003). Quantifying the Impact of Foot and Mouth Disease on Tourism and the UK Economy. *Tourism Economics, 9*(4), 449-465.

Bloom, D., Canning, D., Kotschy, R., Prettner, K., & Schünemann, J. (2019). Health and Economic Growth: Reconciling the Micro and Macro Evidence. *NBER Working Papers, 26003*, 1-42.

Burriel Llombart, P., Checherita-Westphal, C., Jacquinot, P., Schön, M., & Stähler, N. (2020). Economic Consequences of High Public Debt: Evidence from Three Large Scale DSGE Models. *Banco de Espana Working Paper, 2029*, 1-34.

Busato, F., Chiarini, B., Cisco, G., Ferrara, M., & Marzano, E. (2020). Lockdown Policies: A Macrodynamic Perspective for COVID-19. Retrieved from https://ideas.repec.org/p/ces/ceswps/_8465.html

Chakraborty, L., & Thomas, E. (2020). Covid-19 and Macroeconomic Uncertainty: Fiscal and Monetary Policy Response. Retrieved from https://ideas.repec.org/p/npf/wpaper/20-302.html

Dev, S. M., & Sengupta, R. (2020). COVID-19: Impact on the Indian Economy. Retrieved from http://www.igidr.ac.in/pdf/publication/WP-2020-013.pdf

Eichenbaum, M. S., Rebelo, S., & Trabandt, M. (2020). The Macroeconomics Of Epidemics. *NBER Working Paper Series, 26882*, 1-53.

Fakhrehoseini, F. (2011). The Dynamic Stochastic General Equilibrium Model of Monetary Business Cycle for Iran. *Journal of Economic Modeling Research, 2*(3), 1-28.

Fendel, R., Neugebauer, F., & Zimmermann, L. (2020). Reactions of Euro Area Government Yields to Covid-19 Related Policy Measure Announcements by the European Commission and the European Central Bank. *Finance Research Letters, 42*, 1-5.

Ferrannini, A., Barbieri, E., Biggeri, M., & Di Tommaso, M. R. (2021). Industrial Policy for Sustainable Human Development in The Post-Covid19 Era. *World Development, 137*, 1-16.

Fornaro, L., & Wolf, M. (2020). *Covid-19 Coronavirus and Macroeconomic Policy*. Retrieved from https://EconPapers.repec.org/RePEc:bge:wpaper:1168

Fotros, M. H., Tavakolian, H., & Maaboudi, R. (2015). Impact of Fiscal and Monetary Shocks on Macroeconomic Variables in Iran, Dynamic Stochastic General Equilibrium Approach 1961-2012. *Economic Growth and Development Research, 5*(19), 94-73.

Grossman, M. (1999). The Human Capital Model. In A. J. Culyer & J. P. Newhouse (Eds.), *Handbook of Health Economics*, 1 (347-408). New York: Elsevier.

Harjoto, M. A., Rossi, F., Lee, R., & Sergi, B. S. (2021). How do Equity Markets React to COVID-19? Evidence from Emerging and Developed Countries. *Journal of Economics and Business, 115*, 1-15.

Hosseini, N. S., & Asgharpur, H. (2021). Exchange Rate Pass-Through and the Effects of Monetary Shock in a DSGE Model. *Economic Growth and Development Research, 11*(42), 154-131.

IMF. (2021). *Policy Tracker*. Retrieved from https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#top

Lucas, R. E. (1976). Econometric Policy Evaluation: A Critique. *Carnegie-Rochester Conference Series on Public Policy, 1*, 19-46.

McKibbin, W. J., & Fernando, R. (2020). The Global Macroeconomic Impacts of COVID-19: Seven Scenarios. *CAMA Working Paper*, *19/2020*, 1-45.

Padhan, R., & Prabheesh, K. P. (2021). The Economics of COVID-19 Pandemic: A Survey. *Econ Anal Policy, 70*, 220-237.

Peeri, N. C., Shrestha, N., Rahman, M. S., Zaki, R., Tan, Z., Bibi, S., Baghbanzadeh, M., Aghamohammadi, N., Zhang, W., & Haque, U. (2020). The SARS, MERS and Novel Coronavirus (COVID-19) Epidemics, The Newest and Biggest Global Health Threats: What Lessons Have We Learned? *International Journal of Epidemiology, 49*(3), 717-726.

Sayadi, M., Daneshjafari, D., Bahrami, J., & Rafeei, m. (2015). A Framework for the Optimum Oil Revenue Allocation in Iran; Dynamic Stochastic General Equilibrium Approach. *Planning and Budgeting, 20*(2), 21-58.

Sayadi, M., & Khosroshahi, M. K. (2020). Assessing Alternative Investment Policies in a Resource-Rich Capital-Scarce Country: Results from a DSGE Analysis for Iran. *Energy Policy, 146*, 1-18.

Shahhosseini, S., & Bahrami, J. (2013). Designing a New Keynesian Dynamic Stochastic General Equilibrium Model for Iran's Economy with Banking Sector. *Iranian Journal of Economic Research, 17*(53), 55-83.

Sharma, A., Tiwari, S., Deb, M. K., & Marty, J. L. (2020). Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-Cov-2): A Global Pandemic and Treatment Strategies. *International Journal of Antimicrobial Agents, 56*(2), 1-13.

Siddik, M. N. A. (2020). Economic Stimulus for COVID-19 Pandemic and Its Determinants: Evidence from Cross-Country Analysis. *Heliyon, 6*(12), 1-10.

Uhlig, H. (1999). A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily. In R. Marimon and A. Scott (Eds.), *Computational Methods for the Study of Dynamic Economies* (30-61). Oxford: Oxford University Press.

Vasilev, A. (2017). Us Health and Aggregate Fluctuations. *Bulletin of Economic Research, 69*(2), 147-163.

Wang, Q., & Zhang, F. (2021). What does the China’s Economic Recovery After COVID-19 Pandemic Mean for the Economic Growth and Energy Consumption of Other Countries? *Journal of Cleaner Production, 295*, 1-20.

WHO. (2009). Who Guide to Identifying the Economic Consequences of Disease and Injury. Retrieved from https://iris.who.int/bitstream/handle/10665/137037/9789241598293_eng.pdf?sequence=1

Yang, Y., Zhang, H., & Chen, X. (2020). Coronavirus Pandemic and Tourism: Dynamic Stochastic General Equilibrium Modeling of Infectious Disease Outbreak. *Annals of Tourism Research, 83*(c), 1-7.

Zhang, X. (2021). Broadband and Economic Growth in China: An Empirical Study During the COVID-19 Pandemic Period. *Telematics and Informatics, 58*, 1-10.

Appendix

First-order Conditions:

$$C_t: \quad \lambda_t = \frac{1}{C_t} \tag{1}$$

$$K_{t+1}: \quad \lambda_t = \beta E_t \lambda_{t+1}[\, r_{t+1} + (1 - \delta^k)] \tag{2}$$

$$H_t^w: \quad w_t \lambda_t = \frac{\psi_l}{1 - H_t^w - H_t^q} \tag{3}$$

$$H_t^q: \quad \frac{\psi_l}{1 - H_t^w - H_t^q} = \mu_t (1-\phi) {w_t}^{(1-\phi)} (X_t^S)^{\phi} \left(H_t^q\right)^{-\phi} \tag{4}$$

$$S_{t+1}: \quad \mu_t = \beta \left\{ \frac{\psi}{S_{t+1}} + (1 - \delta^s). \mu_{t+1} \right\} \tag{5}$$

$$X_t^s: \quad \lambda_t (oop) = \mu_t (\phi) (X_t^s)^{\phi - 1}. \left(H_t^q\right)^{1-\phi} \tag{6}$$

$$m_t: \quad \lambda_t = \left(\frac{\psi_m}{m_t}\right) + \beta E_t\, \lambda_{t+1} (\frac{1}{\Pi_{t+1}}) \tag{7}$$

$$\lim_{n \to \infty} \beta^t \lambda_t K_{t+1} = 0 \tag{8}$$

$$\lim_{n \to \infty} \beta^t \lambda_t m_t = 0 \tag{9}$$

$$\lim_{n \to \infty} \beta^t \mu_t S_{t+1} = 0 \tag{10}$$

where λ_t and μ_t relate to the Lagrangian multiplier of household budget constraint and health capital motion, respectively. The first equation in the first-order condition is derived from the optimality of the marginal utility of consumption with the shadow price of wealth; the second equation is the Euler equation, which shows the optimal allocation of physical capital in two consecutive periods. Then, the working hours are chosen in such a way that the final benefit of the work equals the final cost of doing the work. Quarantine hours are also determined where the health benefits of an extra hour of quarantine are offset by the cost of utility. The next optimal condition is the inter-temporal allocation of health, where the household equates the ultimate benefit with the ultimate cost of good health. Equation 6, where health income from an additional unit of health expenditures is compensated by the utility cost, health expenditures are assigned. Equation 7 is the optimal demand for real money balance. Equations 8, 9, and 10 are transversal conditions for physical capital, real money balance, and health, respectively.

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