Int. J. Nonlinear Anal. Appl. 15 (2024) 10, 91–105
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/ijnaa.2023.31340.4614

The effects of health and treatment expenses on business cycles of Iran's economy

Elham Shokrolahi Shirazi, Jalil Khodaparast*, Hashem Zare, Mehrzad Ebrahimi

Department of Economics, Shiraz Branch, Islamic Azad University, Shiraz, Iran

(Communicated by Ehsan Kozegar)

Abstract

After 2020 and the spread of the coronavirus, the importance of government spending on health and treatment became more apparent than before. Countries that had a higher ratio of health and medical expenses were less vulnerable to the negative effects of the pandemic. This article examines the effects of government spending, separating the effects of health care spending and other government spending on Iran's business cycles in the framework of a Bayesian stochastic dynamic general equilibrium model in two scenarios. In the first scenario, the effects of total government spending on business cycles have been investigated, and in the second scenario, total government spending is explained by separating health and treatment spending and other government spending. According to the results of the final logarithm of the model based on the Laplace approximation, the second scenario is closer to the features and data structure of the Iranian economy. In the present research, healthcare expenditure is defined as a shock, which is explained as a first-order autoregression process, and on the other hand, it is a part of the total government expenditure. To investigate the effects of this shock on the business cycles of the Iranian economy, two tools of variance analysis and instantaneous reaction functions have been used. According to the results of the analysis of variance, the health care expenditure shock explains more than 14% of product fluctuations, more than 11% of consumption fluctuations and more than 10% of investment fluctuations for the Iranian economy. Also, based on the results of instantaneous reaction functions of the variables, in response to the shock, health and treatment expenses, production, consumption, total government expenses and employment increase, while investment and wages decrease.

Keywords: government healthcare expenditure, DSGE model, business cycles
2020 MSC: 37N40, 62P20, 91B02

1 Introduction

The world is full of complexity and human societies have always been at risk of natural disasters such as floods, earthquakes or various epidemic diseases such as Covid-19. The evidence shows that in contrast to the shock of the pandemic, the countries that had higher healthcare expenses experienced less vulnerability in the face of this shock. In this way, in the current research, the role of government spending is examined and analyzed, with emphasis on the effects of healthcare spending in different scenarios on the variables of the country's economy. A Bayesian Dynamic Stochastic General Equilibrium (DSGE) model has been developed for Iran's economy and is estimated using the

*Corresponding author
Email addresses: jkshirazi@iaushiraz.ac.ir (Jalil Khodaparast), hzare@iaushiraz.ac.ir (Hashem Zare), ebrahimi@iaushiraz.ac.ir (Mehrzad Ebrahimi)

Received: July 2023 *Accepted:* October 2023

Bayesian method. The continuation of this article is as follows: The second part describes the research problem. The third part is dedicated to the importance and necessity of research. The fourth part describes the subject literature in the form of previous studies. In the fifth part, the research model and the theoretical foundations of the relationships between the variables are explained. The sixth section is dedicated to statistical data, calibration and Bayesian estimation of parameters. In the seventh section, the results of the research are presented, and the last section is dedicated to summarizing and presenting some policy recommendations.

2 Statement of the problem

Economic growth and development is considered the most important goal at the macroeconomic level. Before the theory of human capital, physical investment was known as the only way to increase the economic growth of societies. However, in the early 1960s, the concept of human capital, along with physical capital, was proposed as a factor in increasing economic growth, and its role gradually became more prominent. Today, economists believe that what ultimately determines the economic and social development process of a country is the human resources of that country. Studies show that investing in human capital will increase productivity in production and ultimately increase economic growth and improve the status of macro variables such as private consumption, capital stock and employment. Human capital was first introduced with concepts such as skilled and trained workforce and increasing the level of education of the workforce. But very soon, health and hygiene were placed next to education in the realm of human capital, to the extent that nowadays improving the level of health and the health of the workforce is one of the main ways to improve human capital. The theory of vicious cycles of poverty directly refers to the reduction of labor force productivity due to the poverty of health and treatment. So that in this theory, the labor force faces a decrease in productivity due to the low level of health and treatment, and as a result, it will have less income and savings, and thus this vicious circle continues. Usually, the investment and cost of healthcare is done by the governments and it forms a part of the governments' general budget every year. However, the effects of public health and medical expenses are hidden on economic variables, and most studies have investigated the effect of the government's financial and spending policies on the macroeconomic structure. In an overview, different macroeconomic models have obtained conflicting results regarding the reaction of private consumption and gross domestic product, etc., to government spending shocks. Articles by Baxter and King [4], Ambler and Paquet [1], Linnemann and Schabert [14], Forni et al. [10], Leeper et al. [13], Enders et al. [9], Coenen et al. [8], Kormilitsina and Zubairy [12], Beidas and Lorusso [5] are examples of these articles. The contradiction in the impact of government spending on economic variables is not limited to total public spending and includes its constituent components such as military spending, education spending, and healthcare spending. Studies by Üçler [23], Lorusso and Pieroni [15], a sample of foreign articles and studies by Hosni Sadrabadi and colleagues [11], Panahi and Al-Imran [19] are part of internal studies in this field. Nevertheless, the relationship between the government's public expenditures and its constituent components - including health and treatment - with macroeconomic variables has always been an important debate in economic circles. On the other hand, public spending on health and treatment will increase productivity by increasing the mental and physical strength of the workforce, and by improving life expectancy and longevity, it will have positive effects on savings, investment, and economic growth. It also increases private consumption following income growth. On the other hand, due to the limited sources of growth of health and treatment expenses, it will increase the final yield of financial resources in other sectors. This effect, which is known as external crowding, will cause a decrease in investment and as a result, output, through an increase in interest rates.

On the other hand, after the spread of Covid-19 in the world and the formation of a pandemic, on the one hand, the production due to the reduction of the productivity of a part of the human force due to the disease, the half-shutdown of production enterprises due to the restrictions announced by the health headquarters and Treatment decreased. In this situation, the price of oil in the future market even fell to zero. Businesses related to transportation fell sharply and commodity prices fell. On the other hand, due to such a shock, government expenditures in the health and treatment sector increased in order to prevent further losses caused by the pandemic, and also due to the loss of a large part of jobs and activities, governments around the world are trying to compensate for the losses. Entering the economic situation of the society, they raised their expenses. So that this increase in government spending led to the budget deficit and the growth of liquidity, as well as the growth of the general level of prices in the world. Central banks in most countries, including the United States, started increasing interest rates with the aim of controlling inflation caused by this liquidity growth. The evidence shows that in contrast to the shock of the pandemic, the countries that had higher healthcare expenses experienced less vulnerability in the face of this shock. The comparison of Italy and Germany in Europe is a remarkable example of this issue.

In this way, Iran's economy and especially the consequences of the effects of public health and medical expenses and other government expenses in the business cycles of the country are less understood and have not been investigated in great depth. Therefore, there are many uncertainties regarding the effects of financial policy on Iran's economy. How does health care expenditure affect the volatility of the product and its components? How is the dynamics of private consumption of households in response to the change in the components of the government's expenditures to the separation of health and treatment expenditures and other government expenditures? Are employment levels and wages affected by government spending? And in general, can the shocks caused by government spending components affect the business cycle in Iran's economy? With this description, in the upcoming research, the role of the shocks of the health and treatment components and other government expenses as one of the drivers of the business cycles of the country is discussed. For this purpose, a Dynamic Stochastic General Equilibrium (DSGE) model has been developed for Iran's economy and estimated using the Bayesian method. In this model, shocks are introduced which are expected to justify a significant part of the business cycles of Iran's economy with an emphasis on the effects of the public health budget.

3 The importance and necessity of conducting research

In the last two years, the economies of countries have been severely affected by the epidemic of Covid-19. In addition to affecting the health and medical sector, this disease has also disrupted the economic situation of countries and international trade. Therefore, the governments have taken extensive measures to reduce the economic damage caused by it. Also, every year, influenza threatens the lives of many people as a dangerous disease. Two decades ago, Sars was introduced as a contagious and dangerous disease, and in the distant past, cholera, plague, etc. were deadly diseases. In such a situation, governments pay more attention to healthcare expenses than usual. However, by reviewing the global statistics related to the deaths and patients of the corona disease in 2020, it became clear that countries such as Germany and Australia, which have a higher quality healthcare system and spent more in this sector, were less affected by this issue. For this reason, it is important to pay attention to the budget of the healthcare sector. On the other hand, in addition to internal structural problems, Iran's economy is facing additional problems with the formation of sanctions; Therefore, in such a situation, both the government's general budget and its provision are discussed, and the impact of health and treatment expenses on economic variables is very important.

During the past years, many studies have been conducted in different regions of the world regarding the impact of government spending and the health care component on economic variables. These studies have resulted in different results and in them there is no consensus regarding the impact of healthcare expenses on economic variables. While some studies have evaluated the positive effect of health and treatment expenses on economic growth, the results of other studies indicate the negative impact of health and treatment expenses on economic growth and other key macroeconomic variables. It is obvious that the analysis of the results of each study depends on the conditions governing that area, its own time period and the model and assumptions used in data analysis, which in turn provides the basis for further studies. In order to fill the void of previous research, in the upcoming research, a Bayesian Dynamic Stochastic General Equilibrium (DSGE) model for Iran's economy is set up and estimated in three scenarios, which includes two different components of the government's general expenses, i.e. health expenses. and treatment and other public expenses of the government. The reason for using the DSGE method to conduct this research is that despite the efforts made in previous studies, they can still be completed in some cases, and the use of this method reduces the problems of previous research to a large extent:

First, the model used in the conducted research, especially domestic research, includes only a few variables and tends to be general, in other words, only the impact of health and treatment expenditures on a small number of variables such as economic growth and private consumption in the framework A single regression equation has been examined and many variables affected by health and treatment expenses such as nominal interest rate, investment, consumption, inflation, wage level and employment, which are the drivers of demand and production, have been removed from economic studies. Second, they have a non-structural nature, and especially in the case of estimating models with fixed coefficients, they are criticized by Lucas [17]. In other words, they lose their credibility over time and only explain the period under investigation. Third, Iran's economy is an oil economy. Unlike many studies in which the role of oil revenues and the resulting shocks are ignored in studies related to the effects of health and treatment expenditures on economic variables, the structural feature of the DSGE model allows the analysis of the effects of health and treatment budgets on economic variables. It also provides Iran's economy with the shock of oil income. Fourth, the structural feature of the DSGE model provides conditions through which the impact of the pandemic shock on the macroeconomic variables of Iran can be analyzed.

In this way, the designed pattern is challenged in different situations mentioned below:

In the first step, the relative importance of shocks in creating fluctuations in the variables of the Iranian macroeconomics is examined. For this purpose, in an estimate, the analysis of the variance of the prediction error of the model variables including product, private consumption, investment, government expenditure, employment and wages in relation to the occurrence of the shock of the total government expenditure, the shock of the government expenditure to the separation of health and treatment components and other government expenditures, productivity shock and oil income shock are measured. The mentioned operations will be carried out in two scenarios: in the first scenario, the entire government expenditure will be considered without any separation. In the second scenario, the basic model of the research is followed by dividing the total government expenditures into two components of health and treatment expenditures and other government expenditures. The comparison of these two scenarios is based on the logarithm of the final probability based on the Laplace approximation and also on the comparison of the simulated moments. From these two models, it is done with the torques of the variables of Iran's economy. In the second step, the instantaneous reaction functions of the variables obtained from the model will be estimated in relation to the occurrence of structural shocks. In this way, the dynamics and prediction of each model variable can be checked in response to the structural shocks of the model.

4 Subject literature

Most of the studies carried out in domestic and foreign researches were based on a single equation and estimated the effects of health and treatment expenses on one of the macroeconomic variables. A group of researchers investigated the effects of health and treatment expenses on economic growth, and some researches have considered the effects of health and treatment expenses on intermediary variables that affect the economy, such as human capital.

With this introduction, in this section, previous studies are presented separately from internal and external studies, with the priority of internal studies in tables 1 and 2:

Table 1: Summary of internal studies

No.	Researcher	Year	Method	Result
1	[5]	2018	Panel data regression	The results indicate that a one percent increase in each of the variables of government health expenditure, life expectancy and gross fixed capital formation has caused an increase of 0.02, 0.02 and 0.31 percent in the economic growth of these countries, respectively. Also, a one percent increase in population growth rate variable has reduced their economic growth by 0.01 percent.
2	[20]	2010	Accumulation	The direct effect of government health expenditure on economic growth is positive and significant, and the indirect effect of health expenditure on private consumption expenditure is negative.

Table 2: Summary of foreign studies

No.	Researcher	Year	Method	Result
1	[13]	2013	ECM	Education, health and social security expenses have an internal crowding effect (positive effect through interest rate reduction) on private consumption, while other government expenses such as administrative expenses, construction, agriculture and transportation through external crowding (The negative impact through the increase in interest rates) has reduced private consumption.
2	[11]	2006	Menkiw and Romer equilibrium model and time series regression	In relation to economic growth and the rule of optimality, more than 15 countries studied by the OECD have had excessive health costs during the last two decades.

5 Research model

The current research method is correlation-causal and based on the analysis of visible and invisible time series data of Iran's economy. In this research, the effects of government spending shocks on the dynamics of business cycles are analyzed using a DSGE dynamic stochastic general equilibrium model. For this purpose, seasonal data will be used in the period of 1373 to 1398 in the space of business cycles, and the relationship between the research variables will be evaluated using Bayesian econometric methods. In this section, a DSGE model is designed for Iran's economy, which includes households, firms, and the government, by adapting Bilbiie et al. [6] and Lorusso and Pieroni [15].

5.1 Households

A range of heterogeneous households with unlimited lifetimes are considered, which are divided into two parts: households that participate in the asset market and households that do not participate in the asset market. Households that keep assets are a fraction of all households and are considered as -1. They exchange risk-free bonds for a period and own share of companies. In this model, the fraction of households that do not keep assets is identified by They do not participate in asset markets and are the only consumers of their limited income.

5.1.1 Households keeping property

These households face the following inter-period decision making problem:

$$\max_{\{C_{A,t},L_{A,t},B_{A,t+1}\}} E^t \sum_{t=0}^{\infty} \beta^t \frac{(C_{A,t}, \varphi_{A,t}, 1-\sigma)}{1-\sigma} \tag{5.1}$$

where $\beta \in (0,1)$ represents the subjective discount rate. φ represents the inverse of Frisch tension and σ is the inverse of interperiod substitution tension. In addition, $C_{A,t}, L_{A,t}$ and $B_{A,t+1}$ are respectively the consumption, leisure and holding amount of nominal bonds for this category of households in each period. The inter-period budget limit of households holding assets is explained as follows:

$$r_t^{-1} B_{A,t+1} + P_t C_{A,t} + P_t T_t = B_{A,t} + (1-\tau)(W_t N_{A,t} + P_t D_{A,t}) \tag{5.2}$$

where τ represents the income tax rate, which is assumed to be fixed, and T_t are the lamp-sam taxes, which are set according to a predetermined rule. In addition, r_t expresses the gross nominal return on Islamic treasury bonds purchased in period t, where P_t is the price level, W_t is the nominal wage and $D_{A,t}$ is the real dividend payment to households that are in companies (Firms) show that they have monopolistic competition. Finally, $N_{A,t}$ is the labor hours for households holding the asset. It is assumed that the total available time is normalized based on the number one, so $N_{A,t} = 1 - L_{A,t}$.

5.1.2 Households without assets

In each period such as t, these households face the following inter-period decision problem:

$$\max_{\{C_{N,t},L_{N,t}\}} \frac{(C_{N,t} L_{N,t}^{\varphi}, 1-\sigma)}{1-\sigma}. \tag{5.3}$$

And their budget limit will be as follows:

$$P_t C_{N,t} = (1-\tau) W_t N_{N,t} - P_t T_t \tag{5.4}$$

where $C_{N,t}$ and $N_{N,t}$ show consumption and working hours for households without assets, respectively. Equation (5.4) states that the consumption of households without assets is equal to their net income.

5.2 Companies

A range of companies producing final goods is considered homogeneous. The hypothetical firm $j \in [0,1]$ combines capital K_t^j and labor N_t^j to produce final goods Y_t^j using the following production function:

$$Y_t^j = (u_t^j K_t^j)^{\alpha} (A_t N_t^j)^{1-\alpha} \tag{5.5}$$

where $\alpha \in (0,1)$ refers to the share of capital in production, u_t^j is the capacity utilization rate and A_t indicates the technology shock. Also, according to the Cobb-Douglas production function, A_t may be referred to as a total productivity shock (TFP). For a new company entering at time t, $K_t^j = K_{0t}$ is considered. Technology shock follows the following stochastic process:

$$\ln A_t = \rho_a \ln A_{t-1} + \epsilon_t^A. \tag{5.6}$$

The parameter $\rho_a \in (-1,1)$ measures the degree of durability of the shock. Also, ϵ_t^A is a natural IID variable with zero mean and given variance a. It is assumed that the amount of capital depreciation between period t and t+1 is given by the relation $\delta_t^j = \delta(u_t^j)$, where δ is a second-order differential function and a positive number as [0,1] show.

For the sake of simplicity, the capacity utilization rate in a stable state is considered a constant value equal to 1. In this case, capital accumulation will be as follows:

$$K^j_{t+1} = (1-\delta^j_t)K^j_t + \varepsilon^j_t I^j_t \tag{5.7}$$

where I^j_t refers to investment and ε^j_t measures investment efficiency. It is assumed that ε^j_t of the company is IID and it is obtained from cumulative distribution Φ as $[\varepsilon_{\min}, \varepsilon_{\max}]c(0,\infty)$ with mean 1 and probability density function $\emptyset$. This shock induces the heterogeneity of the company in this pattern. In the following, it is assumed that the decision on capacity utilization is made before observing the investment efficiency shock ε^j_t. As a result, the optimal capacity utilization does not depend on the specific shock ε^j_t. Considering the wage rate W_t and the capacity utilization rate u^j_t, this company chooses the optimal labor demand by solving the following problem:

$$r_t u^j_t K^j_t = \max_{N^j_t} (u^j_t K^j_t)^{\alpha} (A_t N^j_t)^{1-\alpha} - W_t N^j_t. \tag{5.8}$$

So that the optimal labor demand is equal to:

$$N^j_t = \frac{(1-\alpha)A_t 1 - \alpha^{\frac{1}{\alpha}}}{W_t} u^j_t K^j_t. \tag{5.9}$$

And the capital rental rate can also be obtained from the following relationship:

$$r_t = \alpha \frac{(1-\alpha)A_t^{\frac{1-\alpha}{\alpha}}}{W_t}. \tag{5.10}$$

In any period like t, company j can make investment by buying investment goods from capital producers at the price of P_t.

5.3 Government and financial policy

In the desired DSGE model, the government budget limit will be as follows:

$$r_t^{-1} B_{t+1} = B_t + P_t[G_t - \tau Y_t - T_t - OIL_t] \tag{5.11}$$

where τ and T_t represent the tax depending on the volume of the product and the uniform tax (Lamp-Sam) respectively. Also, B_t shows one-period discounted treasury bonds and OIL_t indicates oil income. In the upcoming research, two different scenarios are analyzed: in the first scenario, the model with total government expenditures is focused on; While in the second scenario, the public expenditures of the government are divided into two components: public health and treatment expenditures and other public expenditures.

5.3.1 The total public expenditure of the government (first scenario)

In the first scenario of the research, the total public expenditure of the government is considered as an exogenous AR(1) process, in this case the health and treatment expenditure is a part of the total government budget and the separation of the components of the government budget is not considered. In this case, the effect of government expenditure shock is investigated in the form of a standard DSGE model.

$$\log(G_t) = \rho_g \log(G_{t-1}) + \epsilon^G_t \tag{5.12}$$

where

$$\epsilon^G_t \sim N(0, \sigma^2_G)$$

in this regard, ρ_g shows the durability parameter of the shock of the total public expenditure of the government and ϵ^G_t expresses the exogenous shock of this variable, which is distributed in the form of I.I.D.

5.3.2 Public expenditure on healthcare and other public expenditure (second scenario)

In the model with decomposed public expenditures, the collectibility principle is used; Where the total expenses of the government can be considered as the sum of its different components. Therefore, the total expenditure of the government is divided into two parts: health sector expenditure M_t, and other public expenditure NM_t.

$$G_t = NM_t + M_t. \tag{5.13}$$

It is assumed that the levels of public expenditures of the healthcare sector and other public expenditures of the government will be independent of each other. Other government expenditures are defined as AR(1) exogenous process:

$$\log(NM_t) = \rho_{nm}\log(NM_{t-1}) + \epsilon_t^{NM}, \qquad \epsilon_t^{NM} \sim N(0, \sigma_{NM}^2) \tag{5.14}$$

$$\log(M_t) = \rho_m \log(M_{t-1}) + \epsilon_t^{M}, \qquad \epsilon_t^{M} \sim N(0, \sigma_{M}^2) \tag{5.15}$$

where ρ_{nm} and ρ_m show the shock durability parameters of other public expenditures and healthcare expenditures, respectively; While ϵ_t^{NM} and ϵ_t^{M} express the exogenous shock of these variables, which are distributed randomly and I.I.D.

5.3.3 Financing mechanism of public expenses

The government's primary budget deficit is defined as follows:

$$D_t = G_t - \tau Y_t - T_t. \tag{5.16}$$

According to the conditions of Iran's economy and the financing of a part of the budget through oil revenues, the above equation is changed as follows, and therefore equation (5.17) is considered in the system of DSGE equations of research:

$$D_t = Gt - \tau Y_t - T_t - OIL_t \tag{5.17}$$

where OIL_t represents oil income and exogenously follows the following AR(1) stochastic process:

$$\log(OIL_t) = \rho_{oil}\log(OIL_{t-1}) + \epsilon_t^{OIL}, \qquad \epsilon_t^{OIL} \sim N(0, \sigma_{OIL}^2) \tag{5.18}$$

in this regard, ρ_{oil} shows the durability parameter of the oil income shock and ϵ_t^{OIL} expresses the exogenous shock of this variable which is distributed as I.I.D. Equations (5.16) and (5.17) show that the total primary budget deficit of the government is created from the difference between total expenditures and total revenues. In addition, it is assumed that the government incurs a structural deficit, $D_{s,t}$, which is caused by the change in the initial deficit, by the automatic responses of tax revenues caused by the deviation of output from its steady state value (Y) is adjusted:

$$D_{t,s} = D_t - \tau(Y_t - Y) = G_t - T_t - \tau Y_t. \tag{5.19}$$

It is assumed that the structural budget deficit will be adjusted based on the following logarithmic-linear transformation:

$$d_{s,t} = \eta d_{s,t-1} + \emptyset_g G_Y g_t. \tag{5.20}$$

This rule is in line with the studies of Bohn [7]. The parameter η makes it possible for budget decisions to be autocorrelated. The parameters g also measure $\emptyset$ the response of the structural budget deficit to changes in government spending.

5.4 Central bank and monetary policy

In this research, the central bank is the monetary policy authority. In Iran, the central bank has various policy-making tools, one of which is the interest rate. It is assumed that the policy maker adjusts the interest rate of bonds with full discretion in order to achieve the two goals of reducing the deviation of inflation from target inflation and reducing the deviation of production from potential production. Also, it is assumed that the central bank does not have any explicit target for inflation that is announced to the general public. However, due to the existence of targeting in development programs, policy makers always try to pursue an implicit goal. In this way, it is assumed that the monetary policy maker adjusts the nominal interest rate based on the reaction function of the monetary policy and in the form of the following logarithmic-linear equation.

$$r_t = \rho^R r_{t-1} + (1-\rho^R)\{\bar{\pi}_t + r_\pi(\pi_{t-1} - \bar{\pi}_t) + r_y(y_t - y)\} \tag{5.21}$$

where ρ^R is the smoothed parameter of the interest rate and π_t refers to the inflation rate. Equation (5.21) shows that the central bank responds to inflation deviations with a break from implicit inflation and output gap. The production gap in this model is defined as the difference between the actual product and the product in a stable.

5.5 General balance and consolidation

The final goods market settlement condition is expressed as the following equation:

$$Y_t = C_t + I_t + G_t. \tag{5.22}$$

The above relationship shows that the total production is equal to the total demand and the total demand is obtained from the sum of consumption expenses of households, investment expenses and total public expenses of the government.

In this model, the total consumption is explained as follows:

$$C_t = \lambda C_{N,t} + (1-\lambda)C_{A,t}. \tag{5.23}$$

The balance in the labor market is also expressed as the following relationship:

$$N_t = \lambda N_{N,t} + (1-\lambda)N_{A,t} \tag{5.24}$$

in the above relationship, the amount of wages is such that the demand of companies for labor is equal to the supply of all labor. Finally, the balance in the debt market will be in the form of equation (5.25):

$$B_{t+1} = (1-\lambda)B_{A,t+1}. \tag{5.25}$$

This means that the households own all the assets and all the government's debt is settled by the asset owners. Finally, due to the fact that working hours data are not available for Iran, employment data is used in this research. According to Smets and Wouters [21, 22], and Asadi et al. [2, 3], it is assumed that in response to macroeconomic shocks, employment data relative to working hours due to the existence of stickiness and Contracts are less volatile, however, it is assumed that only a fraction of companies can adjust their workforce in each period. In this way, the following equation is added exogenously to the system of logarithmic-linear equations of the research model:

$$\widehat{EMP}_t = \beta \widehat{EMP}_{t+1} + \frac{(1-\beta\xi_e)(1-\xi_e)(\hat{N}_t)}{\widehat{EMP}_t} \tag{5.26}$$

where $\hat{N}_t$ is the working hours and $\widehat{EMP}_t$ is the number of employees. ξ_e is also a fraction of companies that can adjust their workforce. Since ξ_e has a beta distribution and its value is between zero and one, the above equation guarantees that the fluctuations of working hours will be more than the fluctuations of employment.

In the process of DSGE patterns, the objective functions of each department and economic agents are optimized according to their constraints. Also, normally, the equations obtained from the first order conditions and market settlement constraints are converted into logarithmic-linear equations using mathematical methods. The linear-logarithmic equations resulting from the DSGE model are estimated by Bayesian econometric methods and the effect of the shocks of the government's public expenditures and health care components and other public expenditures along with other shocks introduced through instantaneous reaction functions. And the analysis of variance on the macroeconomic variables of Iran's economy is investigated. It is obvious that according to the characteristics of Iran's economy, the mentioned functions and equations may face changes. The approach of this research regarding the parameters is to estimate them, but in the conditions that their estimation is accompanied by many limitations or a large volume of operations that deviates the main path of the research, from the quantification or calibration method based on the consensus of the major studies. The previous one will be used.

6 Statistical data, quantification and estimation of parameters

The data used in this research are presented in table 3, which were collected in the period of 4:1398-1373:4. All the data are seasonally adjusted and after logarithmization, they have been detrended using Hodrick-Prescott filter (= 677). Before estimating the parameters of the model and after initializing the parameters, it is necessary to perform sensitivity analysis and identification on the previous values considered for the parameters of the model. The results of this operation indicate the existence of a unique saddle horse solution and that the parameters are known, in other words, all the parameters of the model can be identified, so it is possible to estimate all the considered parameters simultaneously Also, based on the results of sensitivity analysis, all parameters individually affect the behavior of the model, in the sense that the values selected for the prior distribution led to a unique horse saddle solution.

Table 3: Research data from 1994 to 2019

Variable	Symbol	Resource
National gross product	Y	Central bank
private consumption	C	Central bank
Formation of fixed gross capital	I	Central bank
government expenses	G	Central bank
working population	EMP	Statistics Center
Oil revenue	OIL	Central bank

Model parameters are obtained using three quantification or calibration methods based on previous studies, research calculations and Bayesian estimation. In this way, the quantification of the parameters of the DSGE model in this research is divided into two categories: the first category of parameters, which is shown in Table 4, are obtained from two quantification methods based on previous studies and also research calculations. Value based on research calculations means values of parameters that are compatible with the economic literature of DSGE models and are derived from real variables.

Table 4: Initialization of model parameters

Parameter	Description	Resource	Value
β	Mental download rate		0.967
φ	The reverse of Frisch tension		0.46
σ	The inverse of interperiod substitution elasticity		1.63
τ	Tax rate	Research calculations	0.09
α	Capital's share of production	[4]	0.412
δ	Capital depreciation rate		0.042
Y_{NM}	The share of other government expenses from the total government expenses	Research calculations	0.94
Y_M	The share of health and treatment expenses from the total government expenses	Research calculations	0.06
η	Autocorrelation coefficient of government budget deficit		0.82
$\emptyset_g$	Structural budget deficit to government expenses		0.24
λ	The percentage of people without assets		0.52
N	Working hours in stable condition	[4]	0.28
ρ_r	Autocorrelation coefficient of interest rate in monetary policy		0.50
r_π	The weight of inflation in the monetary base		1.09
r_y	Product weight in monetary terms		0.04
ξ_e	A fraction of companies that can adjust their workforce	[4]	0.7

It should be noted that among these parameters, there are some economic ratios that are obtained by dividing two variables in a stable state.

The parameters of the second category in this research are estimated using the Bayesian method. The Bayesian approach requires specifying prior information for the parameters to be estimated. Usually, in this case, previous information about model parameters and its distribution is taken from previous studies and economic literature. Previous information reflects the researcher's or modeler's opinion and guess before examining the hidden information in the sample data and actually provides additional information to estimate model parameters. The prior information is explained through the prior probability density function and the hidden information in sample observations is explained through the likelihood function. The product of these two distributions, based on Bayes' theorem, results in a new distribution, which is called the posterior probability distribution, and subsequent judgments and decisions are made based on this distribution during the modeling process with these explanations, the posterior distribution of the model parameters in the present research has been calculated using the Metropolis- Hastings algorithm with 200,000 repetitions under Diner software. The posterior distribution of the parameters along with their mean and standard deviation, which are borrowed from previous studies, are reported in Tables 5 and 6 for the first and second three research scenarios, respectively.

In the following, a set of statistics related to the real data is compared with the same set of statistics obtained with the data simulated by the model. These are usually sample moments, commonly including mean, variance, product standard deviation, product correlation, and autocorrelation coefficient. In this way, after estimating some parameters, it is necessary to use them, along with the quantified parameters, to solve and simulate the model for Iran's economy. To evaluate the performance of this model in relation to the simulation of variables, the predicted moments of the model have been compared with the moments of real variables and its summary is given in Table 7.

For this purpose, standard deviation, correlation with product and autocorrelation of product variables, consumption expenditure, investment, government expenditure and employment are compared with each other. Both simulated

Table 5: The results of Bayesian estimation for the parameters related to structural shocks in the first scenario

Parameter	**Distribution**	**Description**	**Previous Mean and SD**	**Resource**	**Next estimate**
ρ_a	beta	Productivity shock parameter or TFP	(0.2,0.72)		0.8512
ρ_g	beta	Total government expenditure shock parameter	(0.2,0.77)		0.6719
ρ_{oil}	beta	The oil income shock parameter	(0.2,0.6)		0.1822
σ_{OIL}	Inverse gamma	Standard deviation of oil income shock	(INF, 0.01)	Research calculations	0.1711

Table 6: The results obtained from the Bayesian estimation for the parameters related to structural shocks in the second scenario

Parameter	**Distribution**	**Description**	**Previous Mean and SD**	**Resource**	**Next estimate**
ρ_a	beta	Productivity shock parameter or TFP	(0.2,0.72)		0.8414
ρ_{nm}	beta	The shock parameter of other government expenditures	(0.2,0.77)		0.6651
ρ_m	beta	The shock parameter of government spending in the health sector	(0.2,0.77)		0.7421
ρ_{oil}	beta	The oil income shock parameter	(0.2,0.60)		0.9154
σ_{OIL}	Inverse gamma	Standard deviation of oil income shock	(INF, 0.01)	Research calculations	0.1743

data and real data are seasonally adjusted, logarithmic and Hodrick-Prescott filter. The results of comparing the torques in table 7 indicate the relative success of the model in simulating real data.

Table 7: Comparing the torques of the simulated variables of the model against the real data (Explanation: Symbols y, c, i, g and emp represent product, consumption, investment, investment in housing sector, immigrant population and housing price, respectively.

Data	**y**	**c**	**i**	**g**	**emp**
SD					
Real data	0.0444	0.0411	0.0951	0.0412	0.0068
Simulated data	0.0562	0.0420	0.0983	0.0463	0.0096
Data correlation with Y product					
Real data	1.000	0.8566	0.7550	0.9684	0.1735
Simulated data	1.000	0.8921	0.8024	0.9134	0.3015
First order autocorrelation coefficient					
Real data	0.3569	0.2963	0.6635	0.2982	0.9685
Simulated data	0.3822	0.3341	0.5718	0.3415	0.9026

After checking the robustness and reasonableness of the estimation results, what the experimental researcher wants to see is the ability of the estimated model to match the empirical properties of the data. In this research, the DSGE model was explained in two scenarios. In the first scenario, a standard DSGE model was defined and estimated, in which government expenditures were considered without any differentiation. In the second scenario, government expenditures were separated into two parts: government health and treatment expenditures and other government expenditures, and a random process was considered for each of these two components. Based on the results obtained from the estimation of the final likelihood of the model based on the Laplace approximation for the stated models, the DSGE model in the second scenario is more compatible with the real data. These results are shown in table 8:

Table 8: Choosing the optimal model in different scenarios based on the Laplace approximation

Scenario	**Estimation of the final likelihood of the model based on the Laplace approximation**
The first scenario (presence of government expenditure shock in the model)	909.3335
The second scenario (separation of government expenditures into healthcare expenditures and other government expenditures)	986.3549

7 Analysis of the results

After evaluating and ensuring the strength of the model compared to data simulation, it is necessary to express and analyze the results of each of them according to the definition of different shocks in the dual research scenarios. For this purpose, 2 variance analysis tools and instantaneous reaction functions, which are very common in DSGE models, will be used.

7.1 Fluctuation of model variables in different scenarios in response to structural shocks

In this part, the results of analysis of the variance of the prediction error for the variables regarding the occurrence of each of the structural shocks in each of the two scenarios of the research are presented. The results of this operation are shown in tables 9 and 10:

Table 9: Variance analysis of model variables in relation to structural shocks in the first scenario

shock	**y**	**c**	**i**	**g**	**emp**	**w**
TFP productivity shock	25.21	22.17	18.74	3.05	48.87	46.27
Total government spending shock	38.93	50.38	41.93	77.14	29.39	25.94
Oil income shock	35.86	27.45	39.33	19.81	21.74	27.79

According to the results of variance analysis of structural shocks in the first scenario, the TFP shock explains about half of the employment and wage fluctuations. Specifically, this shock explains 48.87% and 46.27% of employment and wage fluctuations. While the shock of government expenditure explains the largest share in explaining the fluctuations of output, consumption, investment and government expenditure. Half of the fluctuations in consumption fluctuates with the government expenditure shock. After the government expenditure shock, the oil income shock has a higher share in creating fluctuations in the demand components of the entire Iranian economy.

Table 10: Variance analysis of model variables in relation to structural shocks in the second

shock	**y**	**c**	**i**	**g**	**emp**	**w**
TFP productivity shock	24.23	20.17	15.74	2.03	37.14	43.29
The shock of government spending in other sectors	28.72	32.14	29.21	46.11	24.24	22.63
The shock of government spending in the health sector	14.21	11.24	10.72	14.03	9.15	7.86
Oil income shock	32.84	36.45	44.33	37.83	29.47	26.22

As mentioned in the previous sections, in the second scenario, the government expenditure was divided into two components: government expenditure in other sectors and government expenditure in the health sector, and the mechanism of the shock propagation of the government expenditure was separated from the input of these two components. The total expenditure of the government and then other economic variables were declared. According to the results of variance analysis, in this scenario, despite the disaggregated government expenditure shock, the TFP shock makes the biggest contribution to the fluctuation of employment and wages, but the values of these fluctuations are lower than in the previous scenario. In other words, in this scenario, a part of these fluctuations has been transferred to the mechanism of shocks through government spending. By analyzing government expenditures, the oil revenue shock explains a higher part of the fluctuations of product, consumption, and investment variables, although by combining the effects of the two components of government expenditures, the effects of shocks related to government expenditures are greater as in the first scenario. The shock of the government's health and treatment expenses both in comparison with the shock of other government expenses and in comparison with other shocks explains a smaller part of the fluctuations related to the variables of the macro economy of Iran. This result can be interpreted in the sense that based on the calibrated values in table 3 and equation (5.13), health and treatment expenses account for a small part of the total government expenses in Iran's economy. According to the calculations, the share of health and treatment expenses from the total government expenses is 6% in a steady state.

7.2 The results of the dynamics of the model

In order to better understand the effects of structural shocks in the form of different scenarios on the macroeconomic variables of Iran, the instantaneous reaction functions of these shocks are drawn in figures 1 to 5.

In these images, the symbols y, c, i, g, emp, and w represent product, consumption, investment, government spending, employment, and wages, respectively. The vertical axis of each of the graphs in figures 1 to 5 shows the percentage changes of the variables from their permanent state (stable state) and the horizontal axis also shows the periods (where each period is equivalent to a season).

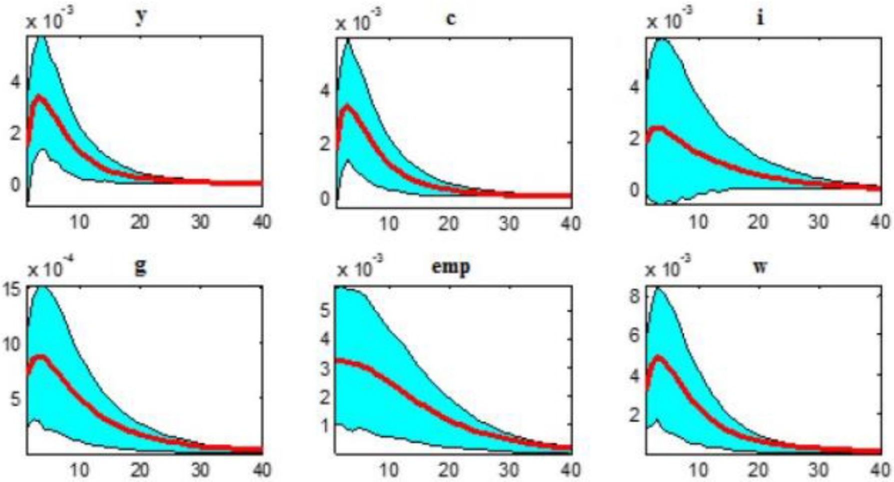

Figure 1: Instantaneous response graphs of model variables in response to TFP shock

Figure 1 shows that the reaction of macroeconomic variables including product, consumption, investment, government spending, employment and wages in response to a positive productivity shock is positive. Based on the theoretical foundations proposed in the DSGE model of this research, in response to a positive shock, production productivity or product increases. Following the increase in production, the demand for labor increases and as a result, employment increases. The increase in demand for labor force and increase in productivity will increase the level of real wages, and in this way, according to the household budget, consumption will also increase. Following the growth of production and the path taken, the dynamics of the investment model also increases, and according to the market settlement equation, government expenditures also increase. On the other hand, with the reduction of the effect of the shock - due to the fact that the parameter or autocorrelation coefficient of the shock is smaller than one in the stated model - the dynamics of the variables tend towards their equilibrium value in the stable state.

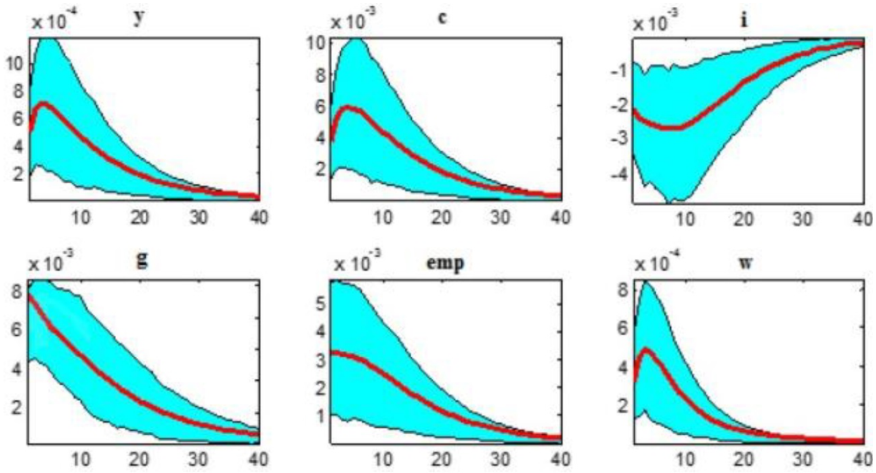

Figure 2: Instantaneous response graphs of model variables in response to government spending shocks

Figure 2 shows that as a result of a positive shock to the total government expenditure equal to one standard deviation, the initial reaction of investment is negative and other variables of Iran's macroeconomics go up, and with the reduction of the shock effect, the dynamics of the variables towards the equilibrium value tends to its steady state. Following a positive shock to government spending, investment decreases due to crowding out. This result is in accordance with the theoretical foundations of macroeconomics regarding the effect of government spending on investment. Due to the increase in government spending, the interest rate will rise, and in this way, it will have a negative effect on the demand for investment. On the other hand, the increase in government spending will lead to an increase in consumption due to the increase in bond income for asset-owning households. The increase in consumer demand, along with the increase in government spending based on the market settlement equation, will lead to an increase in total demand and as a result will increase the demand for labor, and since households without assets need more working hours to ensure their livelihood, employment will increase. He finds The increase in labor demand of companies increases wages due to consumer demand, but the percentage of wage increase is not as high as employment growth.

Figure 3 shows that a positive oil income shock has favorable effects on Iran's macroeconomic variables. An oil income shock on the one hand directly increases the national income and as a result the product and on the other hand it causes an increase in the government expenditure, therefore through the positive effects of the government expenditure mentioned in the analysis of figure 3 it has an effect on macroeconomic variables. will be. Since oil income is one of the components of financing the budget, therefore, the increase in oil income will prevent the budget deficit and thus prevent interest growth. Therefore, this lack of increase in interest rate will prevent the reduction of investment.

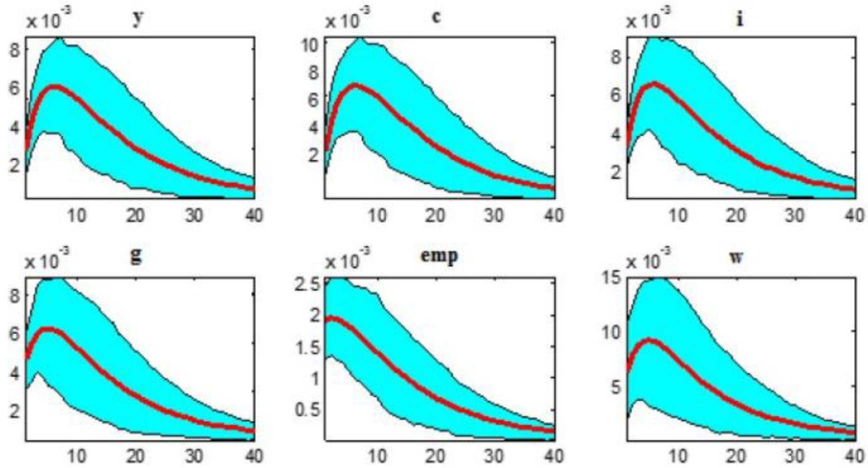

Figure 3: Instant reaction graphs of model variables in response to oil income shock

Figures 4 and 5 show the effect of two shocks of government spending in other sectors of the economy and government healthcare spending on macroeconomic variables in Iran. According to the calculations, the share of the health and treatment budget from the total government expenditures in a steady state (average of the entire period) is about 6%, and 94 other government expenditures account for about 94% of the government expenditures. The values of these two components are shown in Table 4 related to the quantification of research parameters.

Since in the modeling of the research, the total government expenditures resulting from these two components were considered, it is natural that the results related to the shock to other government expenditures are very close to the total effects of the total government expenditures. According to the results, a positive shock to other government expenditures reduces investment and has a positive effect on other economic variables. With the reduction of the shock effect due to the autocorrelation parameter of the shock, the values of each of the variables will tend towards their equilibrium value in the steady state. The shock propagation mechanism on the variables under study was explained in the explanations of Figure 2 based on the shock effects of government expenditures in a standard DSGE model.

Also, according to figure 5, a shock equal to one standard deviation in the government's health and treatment expenditures has similar results to the total government expenditures, and the direction of the fluctuations of the variables is compatible with the previous results. With the difference that due to the low share of health and treatment expenses in the total government expenses, therefore, the fluctuation of macroeconomic variables from their stable state is very small. This result is consistent with the results of variance analysis of the variables in table 10, where the share of health and treatment expenses causes a small fluctuation in macroeconomic variables in Iran due to its small share (about 6%) of the total government expenses.

8 Summary and policy suggestions

The theoretical foundations, the model structure and the results obtained from the application of research data show that government spending plays a significant role in the fluctuation of the macroeconomic variables of Iran. A part of these fluctuations comes back to the government's health and treatment expenses. Despite the fact that health and treatment expenses are effective on variables such as the formation of human capital or improve health

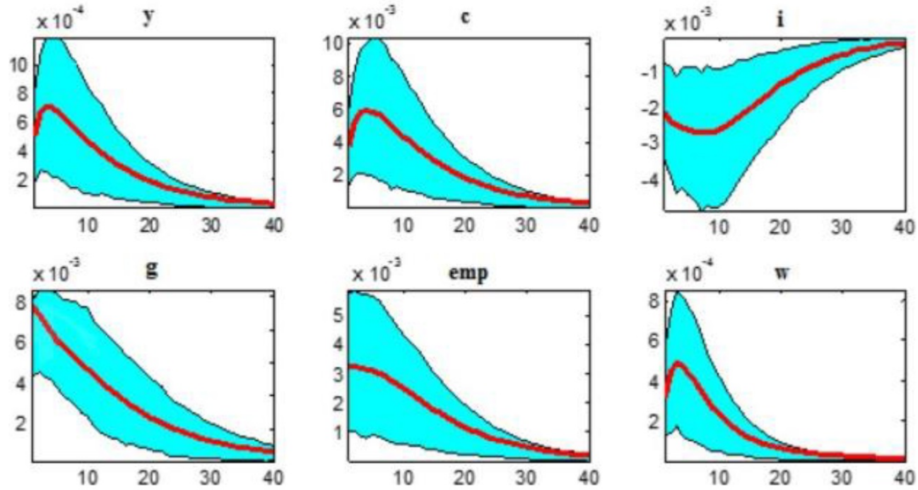

Figure 4: Instant reaction graphs of model variables in response to the shock of government spending in other sectors

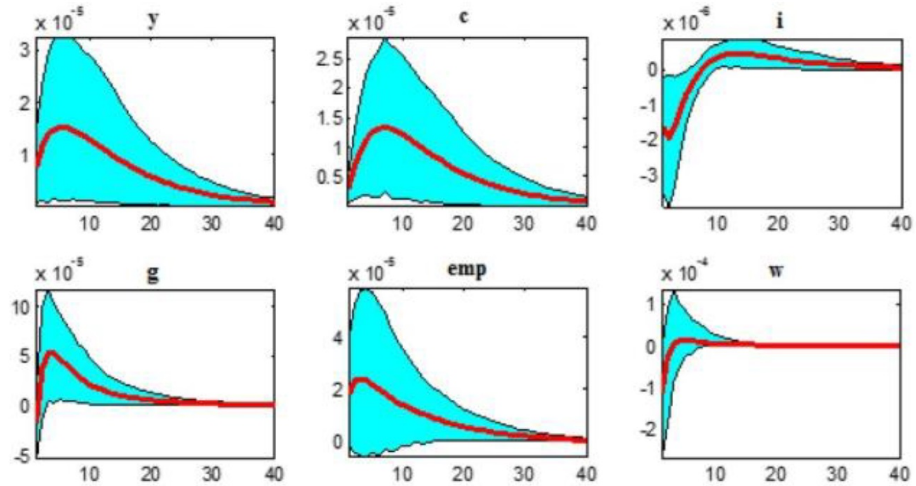

Figure 5: Instantaneous reaction graphs of model variables in response to the government expenditure shock in the health sector

indicators such as life expectancy, reducing the infant mortality rate, etc., but the effects of this shock in the DSGE model Research is by influencing the total expenditure of the government. Therefore, due to the effects it has on the government's expenses, health care expenses have an effect on the labor market, wages, products and other variables of the economy. Although the effects of government health and treatment expenditures in Iran's economy on variables such as production, consumption, investment, employment and wages are not very large, the cause of this issue can be related to the very low share of health and treatment expenditures in the total government expenditures. In a stable situation (long-term average), the share of health and treatment expenses from the total government expenses was about 6%. In this regard, the following suggestions can be listed:

1. Increasing government spending in the healthcare sector. Recent evidence shows that in response to unforeseen events such as Corona, the vulnerability of countries that had higher government health and treatment expenditures was much lower than other countries. On the other hand, the increase in health and treatment expenses will increase the productivity of the workforce by affecting the growth of human capital.
2. Paying attention to the slogan or old proverb in Iranian culture is based on prevention is better than cure.

References

[1] S. Ambler and A. Paquet, *Fiscal spending shocks, endogenous government spending, and real business cycles*, J. Econ. Dyn. Control **20** (1996), no. 1–3, 237–256.

[2] E. Asadi, H. Zare, M. Ebrahimi, and K. Pirai, *Price bubble in Tehran stock market: a stochastic dynamic general equilibrium model*, PhD dissertation in economics, Islamic Azad University, Shiraz Branch, 2018.

[3] E. Asadi, H. Zare, M. Ebrahimi and K. Piraiee, *Sentiment shock and stock price bubbles in a dynamic stochastic general equilibrium model framework: the case of Iran*, Iran. J. Econ. Stud. **7** (2018), no. 2, 115–150.

[4] M. Baxter and R.G. King, *Fiscal policy in general equilibrium*, Amer. Econ. Rev. **83** (1993), 315–334.

[5] S. Beidas-Strom and M. Lorusso, *Macroeconomic Effects of Reforms on Three Diverse Oil Exporters: Russia, Saudi Arabia, and the UK*, International Monetary Fund, 2019.

[6] F.O. Bilbiie, A. André Meier, and G.J. Müller, *What accounts for the change in US fiscal policy transmission?*, J. Money Credit Bank. **40** (2008), no. 7, 1439–1470.

[7] H. Bohn, *The behavior of US public debt and deficits*, Quart. J. Econ. **113** (1998), no. 3, 949–963.

[8] G. Coenen, R. Straub and M. Trabandt, *Fiscal policy and the great recession in the Euro area*, American Econ. Rev. 102 (2012), no. 3, 71–76.

[9] Z. Enders, G.J. Müller, and A. Scholl, *How do fiscal and technology shocks affect real exchange rates?: New evidence for the United States*, J. Int. Econ. **83** (2011), no. 1, 53–69.

[10] L. Forni, L. Monteforte and L. Sessa, *The general equilibrium effects of fiscal policy: estimates for the Euro area*, J. Public Econ. **93** (2009), no. 3–4, 559–585.

[11] M. Hasani Sadrabadi, Z. Azarpeivand and R. Firouzi, *The effect of public health expenditures on economic growth and it's indirect effects on private consumption in Iran*, J. Health Admin. **13** (2010), no. 42, 64–57.

[12] A. Kormilitsina and S. Zubairy, *Propagation mechanisms for government spending shocks: A Bayesian comparison*, J. Money Credit Bank. **50** (2018), no. 7, 1571–1616.

[13] E.M. Leeper, T.B. Walker, and S.C.S. Yang, *Government investment and fiscal stimulus*, J. Monetary Econ. **57** (2010), no. 8, 1000–1012.

[14] L. Linnemann and A. Schabert, *Productive government expenditure in monetary business cycle models*, Scott. J. Politic. Econ. **53** (2006), no. 1, 28–46.

[15] M. Lorusso and L. Pieroni, *Disentangling civilian and military spending shocks: A Bayesian DSGE approach for the US economy*, J. Risk Financ. Manag. **12** (2019), no. 3, 141.

[16] M. Lotfalipour, M.A. Falahi, and M. Borji, *The effects of health indices on economic growth in Iran*, J. Health Admin. **14** (2011), no. 46, 57–70.

[17] R.E. Lucas, *Econometric policy evaluation: A critique*, Carnegie-Rochester Conf. Ser. Public Policy. Vol. 1, North-Holland, 1976, pp. 19–46.

[18] M. Paetz and R. Gupta, *Stock price dynamics and the business cycle in an estimated DSGE model for South Africa*, University of Pretoria, and Department of Economics Working Paper Series, 2014.

[19] H. Panahi and S.A. Aleemran, *The effect of government health expenditures on economic growth in countries of D-8 organization for economic cooperation*, J. Health Dev. **4** (2015), no. 4, 336–327.

[20] A. Raispour and J. Pezhoyan, *Effects of government health spending on economic growth and productivity in Iran: a regional approach*, Plann. Budget. Mag. **18** (2013), no. 4, 43–68.

[21] F. Smets and R. Wouters, *An estimated stochastic dynamic general equilibrium model of the Euro area*, J. Eur. Econ. Assoc. **1** (2003), 1123–1175.

[22] F. Smets and R. Wouters, *Shocks and frictions in US business cycles: A Bayesian DSGE approach*, Amer. Econ. Rev. **97** (2007), 586–606.

[23] G. Üçler, *Testing the relationship between military spending and private investments: Evidence from Turkey*, Theor. Appl. Econ. **23** (2016), no. 3, 307–318.