



Analyzing the Dimensions and Components of the Effects of Government Military Expenditures on Iran's Business Cycles

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Abstract

The current research has investigated the effects of the government's military expenditures on Iran's business cycles within the framework of a DSGE model in the period from 1370 to 1400. The DSGE model has been performed in three scenarios. In the first scenario, there is no differentiation in government expenditures and a standard DSGE model is estimated. In the second scenario, government expenditures are separated into military and civilian expenditures, and in the third scenario, a war shock is included in the model. According to the results of the final logarithm of the Laplace approximation, the second model has a higher explanation for Iran's economy. The results of variance analysis of the model show that the government military expenditure shock is 15.52% of product fluctuations, 12.45% of consumption fluctuations, 11.91% of investment fluctuations, 12.83% of government expenditure fluctuations, 05/05 It explains 11% of employment fluctuations and 6.53% of wage fluctuations. According to the results of instantaneous response functions, a shock to government military expenditures has a negative effect on investment and wages and a positive effect on output, consumption, government expenditures, and employment.

Key words: government military expenditures, DSGE model, business cycles

JEL classification: H51, E32, F42

1- Introduction

The history of war between countries is not limited to the current time period, but it will exist in the past and since the beginning of mankind and probably in the future. The conflict of economic interests, international agreements, demarcation, ideological beliefs, etc. have caused differences between countries and even between regions. In addition to differences between countries, there is always potential insecurity within countries. In the new ranking of countries' military power, in addition to the number of military equipment such as tanks, fighter jets, etc., the amount of military budget, GDP and population also have a high impact. Therefore, the



economic power of the countries is one of the examples of military power. Historical experience in Iran and other countries that are involved in war is a story of fluctuations in economic variables, especially the government budget. Therefore, the military budget and its effects on creating fluctuations in economic variables are of great importance. In this way, in the current research, the effects of the government's military expenditures on the variables of the country's economy are examined and analyzed. For this purpose, a Bayesian Dynamic Stochastic General Equilibrium (DSGE) model compatible with the conditions of Iran's economy is used. The continuation of this article is as follows:

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

2- Statement of the problem

The effects of fiscal policy is a fundamental issue in macroeconomics. In this regard, 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 (1993), Ambler and Paquette (1996), Linnemann and Schabert (2006), Forney et al. (2009), Leeper et al. (2010), Enders et al. (2011), Koenen et al. (2012), Kormilitsina and Zubiri (2018), Bidas and Lorosso (2019) are examples of these articles. The contradiction in the impact of government spending on economic variables is not exclusive to total spending, and its constituent components are also included in the two general classifications of military and civilian spending. Studies by Pardahan (2010), Dan and Nicolaidou (2012), Dada (2013), Eukler (2016), Lorosso and Pironi (2019), Shaba Saba and Engpa (2019), Abdul Khaliq et al. (2019) are some examples of foreign articles. and the studies of Hosni Sadrabadi and Azizinjad (2006), Hosni Sadrabadi and Kashmiri (2007), Golkhandan (2013), Karimi Patanlar and Bajlan (2013), Abbasian et al. This is the field. Nevertheless, the relationship between government spending and its constituent components with macroeconomic variables has always been an important discussion in economic circles. On the other hand, security is a public good and its provision will have positive effects on investment, economic growth and private consumption following the growth of society's income. On the other hand, due to the limited sources of government expenditure growth, especially in the defense sector, it will increase the final yield of financial resources in other sectors. This effect, which is known as external crowding, will decrease consumption, investment, and as a result, output through an increase in interest rates.

In this way, Iran's economy and especially the consequences of the effects of the military and civilian components of government spending 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 do military and



civilian expenditures affect the fluctuations of the product and its components? How is the dynamics of private consumption of households in response to changes in the components of government expenditures? Are nominal interest rates and inflation rates 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 military and civilian components of the government expenses as one of the drivers of the country's business cycles is addressed. 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 military budget. The total government expenditure shock, the government military expenditure shock and the civilian expenditure shock are the set of the mentioned shocks. The effect of introduced shocks in the form of different patterns on production and private consumption are analyzed in the space of business cycles.

The DSGE model of this research has features that make it possible to be close to the real world. Similar to Pironi et al.'s (2008) study, in line with the so-called "Military Keynesianism", it is assumed that decision-making for two different components of the government budget are independent. According to the proponents of this view, defense spending has two special conditions: First, military spending is financed independently of other categories of public spending (such as education and health). Second, decisions about the defense sector are taken by institutions and organizations that are independent from other government sectors (the General Staff of the Armed Forces, the Ministry of Defense, etc.).

Since the early 1980s, the transmission and impact of fiscal policy shocks on economic variables, especially private consumption, have changed in many economies (Fattas and Mihoff (2001), Blanchard and Protti (2002), Protti (2005) and Galli and colleagues (2007)). Such a change is related to the increase in the participation of households in the asset markets (Bibaei et al. (2008)). Iran's economy is no exception to this rule. During the 1350s and 1360s, due to many restrictions, a large part of the households did not have access to the financial markets. From the 1370s onwards, financial liberalization expanded private access to financial markets. These structural changes have had an important effect on the response of private consumption to government spending shocks. In this research, the DSGE model tries to describe the possible sources of internal/external crowding of consumption expenditures following government expenditure shocks. To do this, as in the studies of Galli et al. (2007) and Lorosso and Pironi (2017 and 2019), households are considered heterogeneous. Some of the households do not have access to the financial market and consume their current income in every period of history. On the other hand, some households have access to financial markets and adjust their consumption in a desired way.



In this DSGE model, there are companies that produce different goods and make decisions about labor input, and according to Calvo's (1983) model, they will determine the price level. The financial policy authority buys consumer goods, which are divided into military and civilian sectors, and uses the lump-sum (uniform) big tax, income tax and oil revenues to cover these expenses. provides financing. In this way, the way of financing government expenditures and its components will be close to the structure of Iran's economy.

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 the target inflation and reducing the deviation of production from potential production. Also, according to Ahmadian (1400), it is assumed that the central bank does not have any explicit inflation targeting to be 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. In this way, it is possible to analyze the impact of higher nominal interest rates with a more aggressive monetary policy in relation to strengthening the motivations of households to postpone consumption and the negative impact on production. The forward research model is estimated with Bayesian techniques using data from Iran's macroeconomics. The main contribution of the upcoming research, according to the previous literature, consists of two parts:

First, this research incorporates the disaggregated components of civilian and military expenditures into a DSGE theoretical framework. This allows us to evaluate the effects of these two components of public spending on several macroeconomic variables, especially on private consumption and gross domestic product (GDP). Secondly, this research uses the Bayesian method to evaluate the impact of fiscal policy shocks on the economy. This allows us to avoid the known shortcomings in the identification of military shocks that are associated with the neoclassical literature.

3- The importance and necessity of conducting research

Iran is located in a sensitive and strategic region of the world, where a large part of the Middle East region is involved in war, and the most important problem of many countries in this region is the lack of security; For this reason, it is important to pay attention to the military budget. 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 entire government budget and its provision are discussed, and the effect of military expenditures on economic variables is very important.

During the past years, many studies have been conducted in different regions of the world about the effect of government spending and its military component on economic variables. These



studies have resulted in different results and there is no consensus regarding the impact of the military and defense budget on economic variables. While some studies have evaluated the impact of military spending on economic growth as positive, the results of other studies indicate the negative impact of military spending 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 Dynamic Stochastic General Equilibrium (DSGE) model is set up and estimated for Iran's economy, which includes two different components of government expenses, i.e. civilian and military expenses. 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 effect of military spending on a small number of variables such as economic growth and private consumption within the framework of a single The regression equation has been examined and many variables affected by military expenditures such as nominal interest rate, inflation, wage level and employment, which themselves drive demand and production, have been excluded 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 (1976) (Paetz and Gupta, 2014). 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 military expenditures on economic variables, the structural feature of the DSGE model makes it possible to analyze the effects of the military budget on Iran's economy with It also provides the consideration of oil income shock. Fourth, the structural feature of the DSGE model of this research provides the role of monetary policies, with the stimulus of the nominal interest rate, in creating fluctuations in the variables of Iran's economy.

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

In the first step, the relative importance of shocks in creating fluctuations in the variables of Iran's macroeconomics is examined. For this purpose, in an estimate, the analysis of the variance of the prediction error of model variables including GDP, private consumption, employment, nominal interest rate and inflation rate compared to The occurrence of government spending shocks and military and civilian components and other structural shocks are measured. The mentioned operations will be carried out in three scenarios: In the first scenario, the entire government expenditure will be considered without any separation. In the second scenario, the basic research model is followed by dividing the total government expenditure into two components of military and civilian expenses. In the third scenario, it is



assumed that other government expenditures and government military expenditures depend on their previous period amount and on the other hand, they will be an inverse function of the negative productivity shock of war or insecurity, in the sense that due to a negative interest shock, Otherwise (such as war or insecurity), other government and military expenditures will increase. In this scenario, assuming the fact that at the time of the occurrence of a phenomenon such as, on the one hand, the production due to the decrease in the productivity of a part of the human force caused by the transfer from production activity to non-production activity, the half-shutdown of some production enterprises due to The announced restrictions are reduced in special conditions, the productivity variable is modeled with a negative coefficient in the production function, and on the other hand, according to historical evidence, due to such a shock, the government spends in the military sector in order to prevent further losses. It increases due to war and insecurity, and due to the loss of a large part of jobs and activities, the government increases its expenses in order to compensate for the damages caused to the economic situation of the society. The comparison of the first and second scenarios is based on the logarithm of the final likelihood based on the Laplace approximation and also on the comparison of the moments simulated from these two models with the moments of the Iranian economy variables. If, as expected, the separation of government expenditures into military and civilian expenditures has a higher explanation in the key variables of the economy, the effect of an insecurity or war shock can explain the reaction of the government's military expenditures and the consequences of such a shock.

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 of the variables of the model can be observed and analyzed in response to the occurrence of structural shocks in the model, especially military expenditures.

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 military expenditures on one of the macroeconomic variables. A group of studies investigated the effects of military expenditures on economic growth, and some studies considered the effects of military expenditures on variables such as consumption and investment. In addition, rarely articles in economics have investigated the effects of insecurity or war as an unforeseen shock on economic variables.

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 expenditure 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 1370 to 1400 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 Bibai et al. (2008) and Lorso and Pironi (2019).

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. The households that keep assets are a fraction of the total households and are considered as α -1. They exchange risk-free bonds for a period and own shares of companies. In this model, the fraction of households that do not keep assets is denoted by α . 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:

(1)

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

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, consumption, free time and nominal bond holding amount for this category of households in each period. The inter-period budget limit of households holding assets is explained as follows:

$$R_t^{-1} B_{A,t+1} + P_t C_{A,t} + P_t T_t = B_{A,t} + (1 - \tau)(W_t N_{A,t} + P_t D_{A,t}) \quad (2)$$

where τ represents the income tax rate, which is assumed to be fixed, and T_t are the lump-sum taxes, which are set according to a predetermined rule. In addition, R_t expresses the gross nominal yield on 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 interperiod decision problem:

(3)

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

And their budget limit will be as follows:

$$P_t C_{N,t} = (1 - \tau) W_t N_{N,t} - P_t T_t \quad (4)$$

Where $C_{N,t}$ and $N_{N,t}$ show consumption and working hours for households without assets, respectively. Equation (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:

$$Y_t^j = (u_t^j K_t^j)^\alpha (A_t N_t^j)^{1-\alpha} \quad (5)$$

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 , $K_t^j = K_0$ is considered. Technology shock follows the following stochastic process:

$$\ln A_t = \rho_a \ln A_{t-1} + \epsilon_t^A \quad (6)$$

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 σ_a^2 . It is assumed that according to picture (1), a negative productivity shock such as a military war lowers the level of production.

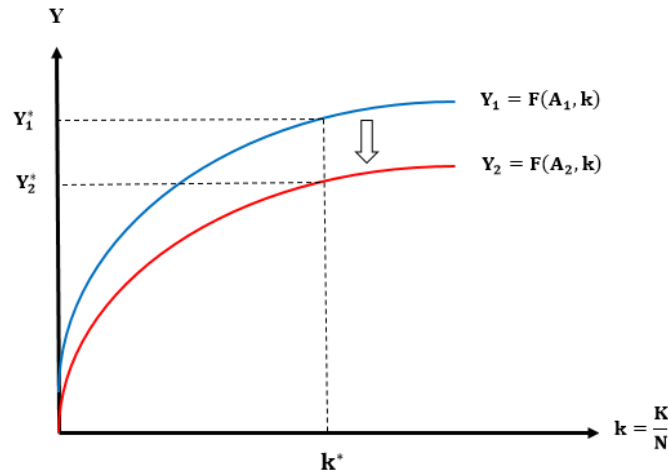


Figure 1: The effect of a negative productivity shock on the level of production following military insecurity

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:

$$K_{t+1}^j = (1 - \delta_t^j)K_t^j + \varepsilon_t^j I_t^j \quad (7)$$

Where I_t^j refers to investment and ε_t^j measures investment efficiency. It is assumed that ε_t^j of the company is IID and it is obtained from cumulative distribution Φ as $[\varepsilon_{\min}, \varepsilon_{\max}] \subset (0, \infty)$ with mean 1 and probability density function ϕ . This shock induces the heterogeneity of the company in this model.

In the following, it is assumed that the decision on capacity utilization is made before observing the investment efficiency shock ε_t^j . As a result, the optimal capacity utilization does not depend on the specific shock ε_t^j . Considering the wage rate W_t and the capacity utilization rate u_t^j , this company chooses the optimal labor demand by solving the following problem:

$$R_t u_t^j K_t^j = \max_{N_t^j} (u_t^j K_t^j)^\alpha (A_t N_t^j)^{1-\alpha} - W_t N_t^j \quad (8)$$

So that the optimal labor demand is equal to:

$$N_t^j = \left[\frac{(1-\alpha)A_t^{1-\alpha}}{W_t} \right]^{\frac{1}{\alpha}} u_t^j K_t^j \quad (9)$$

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



$$R_t = \alpha \left[\frac{(1-\alpha)A_t}{w_t} \right]^{\frac{1-\alpha}{\alpha}} \quad (10)$$

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:

$$R_t^{-1}B_{t+1} = B_t + P_t[G_t - \tau Y_t - T_t - OIL_t] \quad (11)$$

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-term discounted bonds and $[OIL]_t$ indicates oil income.

In the upcoming research, three different scenarios are analyzed: in the first scenario, the model with total government expenditures is focused on; While in the second scenario, the government's public expenditures are divided into two components: military public expenditures and other public expenditures. Finally, in the third scenario, the government's military expenditures are an inverse function of the negative productivity shock (military insecurity).

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 military 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.

$$\log(G_t) = \rho^G \log(G_{t-1}) + \epsilon_t^G \quad (12)$$

where

$$\epsilon_t^G \sim N(0, \sigma_G^2)$$

In this regard, ρ^G shows the durability parameter of the shock of the total public expenditure of the government and ϵ_t^G expresses the exogenous shock of this variable, which is distributed in the form of I.I.D.

5-3-2- Military public expenditures and other public expenditures (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 government expenditure is divided into two parts: military expenditure M_t , and other public expenditure NM_t .

$$G_t = NM_t + M_t \quad (13)$$

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

$$\log(NM_t) = \rho^{NM} \log(NM_{t-1}) + \epsilon_t^{NM} \quad (14)$$

$$\epsilon_t^{NM} \sim N(0, \sigma_{NM}^2)$$

$$\log(M_t) = \rho^M \log(M_{t-1}) + \epsilon_t^M$$

$$\epsilon_t^M \sim N(0, \sigma_M^2)$$

where ρ^{NM} and ρ^M respectively show the shock durability parameters of other military expenditures; 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- The government's military expenditures are an inverse function of the negative shock of military productivity or nominal (third scenario)

In this scenario, government expenditures and government military expenditures follow the equations below. In these equations, it is assumed that other government expenditures and military expenditures of the government depend on the amount of their previous period and on the other hand, they will be an inverse function of the negative productivity shock of military insecurity, in the sense that as a result of a negative productivity shock (such as war or insecurity) other government expenses and military expenses increase. In this scenario, assuming the fact that during the occurrence of such a phenomenon, on the one hand, due to the decrease in the productivity of a part of the human force due to the transfer from production activity to non-production activity, the half-shutdown of some production enterprises due to The declared restrictions are reduced in special conditions, the productivity variable is modeled with a negative coefficient in the production function (Equations (5) and (6)) and on the other hand, according to historical evidence, due to such a shock, government expenditures In the military sector, it increases in order to prevent more losses caused by war and insecurity, and also due to the loss of a large part of jobs and activities, the government increases its expenses in order to compensate for the losses caused to the economic situation of the society. Equations (15) and (16) are also stated in such a way that following a nominal shock, the government's expenditures will increase both in the military sector and in other sectors.

$$\log(NM_t) = \rho_{nm} \log(NM_{t-1}) + A_t \quad (15)$$



$$\log(M_t) = \rho_m \log(M_{t-1}) + A_t \quad (16)$$

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

$$D_t = G_t - \tau Y_t - T_t \quad (17)$$

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 (18) is considered in the system of DSGE equations of research:

$$D_t = G_t - \tau Y_t - T_t - OIL_t \quad (18)$$

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

$$\log(OIL_t) = \rho^{OIL} \log(OIL_{t-1}) + \epsilon_t^{OIL} \quad (19)$$

$$\epsilon_t^{OIL} \sim N(0, \sigma_{OIL}^2)$$

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 (17) and (18) 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 resulting from the deviation of output from its steady state value (Y).) is adjusted:

$$D_{t,s} = D_t - \tau(Y_t - Y) = G_t - T_t - \tau Y_t \quad (20)$$

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

$$d_{s,t} = \eta d_{s,t-1} + \phi_g G_Y g_t \quad (21)$$

This rule is in line with the studies of Bohn (1998) and Gali and Perotti (2003). The parameter η makes it possible for budget decisions to be autocorrelated. The parameters ϕ_g also measure 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, according to Ahmadian (1400), 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.

$$r_t = \rho^R r_{t-1} + (1 - \rho^R) \{ \bar{\pi}_t + r_\pi (\pi_{t-1} - \bar{\pi}_t) + r_y (y_t - y) \} \quad (22)$$

where ρ^R is the smoothed parameter of the interest rate and π_t refers to the inflation rate. Equation (19) 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 state (Rabanal and Rabio-Ramirez, 2001).

5-5- General balance and consolidation

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

$$Y_t = C_t + I_t + G_t \quad (23)$$

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:

$$C_t = \lambda C_{N,t} + (1 - \lambda) C_{A,t} \quad (24)$$

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

$$N_t = \lambda N_{N,t} + (1 - \lambda) N_{A,t} \quad (25)$$

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 stock market of companies (companies) will be in the form of relation (26):

$$B_{t+1} = (1 - \lambda) B_{A,t+1} \quad (26)$$

This means that the households have all their preferred shares and all the government's debt is settled by the property owners.

Finally, considering that working hours data are not available for Iran, employment data is used in this research. According to Smith and Waters (2003), Zagaglia (2009) and Esadi et al. (2018), it is assumed that in response to macroeconomic shocks, employment data relative to working hours due to the existence of stickiness and Contracts have less volatility, 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:

$$\widehat{EMP}_t = \beta \widehat{EMP}_{t+1} + \frac{(1-\beta\xi_e)(1-\xi_e)}{\xi_e} (\hat{N}_t - \widehat{EMP}_t) \quad (27)$$

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 and treatment components and other public expenditures along with other shocks introduced through instantaneous reaction functions and The analysis of variance on macro 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 4:1357-1400:4. All the data are seasonally adjusted and after logarithmization, they have been detrended using Hodrick-Prescott filter ($\lambda=677$).

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 lead to a unique horse saddle solution.

Table 3: Research data between 1357 and 1400

Source	symbol	variable
World Bank	Y	gross domestic product
World Bank	C	private consumption



World Bank
World Bank
World Bank
Statistics Center
Central Bank

I Formation of fixed gross capital
G Government expenditure
M Government military spending
EMP working population
OIL Oil revenue

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 DSGE model parameters in this research is divided into three categories:

The first group of parameters, which are shown in table (4), are obtained from two quantification methods based on previous studies as well as 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

amount	source	description	parameter
0/096	Research calculations	Tax rate	τ
0/412	Asadi et al. (2018)	Capital's share of production	α
0/042	Shahmoradi and Ebrahimi (1389)	Capital depreciation rate	δ
0/82	Qoli-zadeh and Nurzinejad (2018)	Autocorrelation coefficient of government budget deficit	η
0/26	Research calculations	The ratio of budget deficit to total government expenditure	ϕ_g
0/985	Zamanzadeh (1391)	Mental download rate	β
0/46	Taifeh and colleagues (1401)	Reverse elasticity of labor supply	φ
1/63	Salehian and Erfani (2017)	The inverse of interperiod substitution elasticity	σ
0/28	Asadi et al. (2018)	Working hours in stable condition	N
1/09	Bayat (2015)	The weight of inflation in the monetary base	r_π
0/04	Bayat (2015)	Product weight in monetary terms	r_y
0/50	Bayat (2015)	Autocorrelation coefficient of interest rate in monetary policy	ρ_r
0/52	Taifeh and colleagues (1401)	Non-Ricardian household share	λ
0/7	Asadi et al. (2018)	A fraction of companies that can adjust their workforce	ξ_e

The second category of parameters are a part of economic ratios that are obtained by dividing two variables in a steady state. To calculate these ratios, real data has been used in the period from 1357 to 1400. These ratios are shown in table (5):



Table 5: relative parameters

amount	symbol	parameter
0/642	Consumption to product ratio	c/y
0/117	Investment to product ratio	i/y
0/241	The ratio of government expenditure to output	g/y
0/139	The ratio of military expenditure to total government expenditure	γ_M
0/861	The ratio of non-military expenditure to total government expenditure	γ_{NM}
0/191	Ratio of military expenditure to total government expenditure (during war)	γ_M
0/809	The ratio of non-military expenditures to total government expenditures (during wartime)	γ_{NM}

Explanation: The last two symbols are considered separately in the two scenarios, in the whole period and the war period.

The parameters of the third 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 during modeling based on this distribution (Shahmoradi and Ebrahimi, 1389).

With these explanations, the posterior distribution of the model parameters in the current research has been calculated using the Metropolis-Hastings algorithm with 200,000 iterations 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 (6), (7) and (8) for the first, second and third scenarios of the research, respectively. is

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

posterior estimate	source	The mean and standard deviation of the former	description	Distribution type	parameter
0/6307	Smith and Waters (2007)	(0/2 , 0/50)	Productivity shock parameter or TFP	beta	ρ_a



0/5521	Salah Manesh et al. (2017)	(0/2 , 0/40)	Total government expenditure shock parameter	beta	ρ_g
0/6249	Salah Manesh et al. (2017)	(0/2 , 0/42)	Oil income shock parameter	beta	ρ_{oil}
0/0214	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of productivity shock or TFP	Inverse gamma	σ_A
0/0492	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of government expenditure shock	Inverse gamma	σ_G
0/0715	Research calculations	(INF , 0/01)	Standard deviation of oil income shock	Inverse gamma	σ_{OIL}

Source: research findings

Table 7: The results obtained from the Bayesian estimation for parameters related to structural shocks in the second scenario

posterior estimate	source	The mean and standard deviation of the former	description	Distribution type	parameter
0/6284	Smith and Waters (2007)	(0/2 , 0/50)	Productivity shock parameter or TFP	beta	ρ_a
0/5562	Salah Manesh et al. (2017)	(0/2 , 0/40)	The shock parameter of government military expenditure	beta	ρ_m
0/5423	Salah Manesh et al. (2017)	(0/2 , 0/40)	The shock parameter of other government expenditures	beta	ρ_{nm}
0/6195	Salah Manesh et al. (2017)	(0/2 , 0/42)	Oil income shock parameter	beta	ρ_{oil}
0/0192	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of productivity shock or TFP	Inverse gamma	σ_A
0/0475	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of government military expenditure shock		σ_M
0/0482	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of the shock of other government expenditures	Inverse gamma	σ_{NM}
0/0808	Research calculations	(INF , 0/01)	Standard deviation of oil income shock	Inverse gamma	σ_{OIL}

Source: research findings



Table 8: The results obtained from the Bayesian estimation for the parameters related to structural shocks in the third scenario

posterior estimate	source	The mean and standard deviation of the former	description	Distribution type	parameter
0/6295	Smith and Waters (2007)	(0/2 , 0/50)	Productivity shock parameter or TFP	beta	ρ_a
0/6239	Salah Manesh et al. (2017)	(0/2 , 0/42)	Oil income shock parameter	beta	ρ_{oil}
0/0228	Smith and Waters (2007)	(INF , 0/01)	Standard deviation of productivity shock or TFP	Inverse gamma	σ_A
0/0741	Research calculations	(INF , 0/01)	Standard deviation of oil income shock	Inverse gamma	σ_{OIL}

Source: research findings

7- Evaluation of estimation results

An important part of the estimation process of a model is the evaluation of its results. In the case of a DSGE model that is estimated based on the Bayesian approach, this can be done through different methods, using techniques that are common for other estimation methods, as well as techniques that are exclusive in the environment. Bayesian econometrics are used. In this research, the aspects that can be examined in order to check the quality of the estimated model are:

- 1- validation of estimation methods;
- 2- the ability of the model to adapt to the characteristics of real data;
- 3- Comparing the basic model with an alternative model or scenario.

In the following, each of these aspects is examined for the obtained estimates.

Images (2) to (4) show the posterior distribution simulated from the first to third scenarios of the research, along with the prior distribution and the view of the posterior distribution obtained from the maximum posterior kernel using Bayesian estimation. In these graphs, the horizontal axis shows the desired value in the prior and posterior distributions, and the vertical axis shows the density associated with each value.

The gray line shows the density of the prior distribution and the black line shows the density of the posterior distribution. The dotted line also represents the posterior distribution view. In the case of shocks, their standard deviation, which is symbolized by the shock SE, is shown in the graphs. The important point in the interpretation of these graphs is that the shape of the posterior distribution should be approximately normal and the density of the posterior distribution should not be multi-curved or abnormal. Also, if the prior and posterior



distributions are similar, two cases may have occurred: the first case is that the prior distribution was an accurate reflection of the information in the data, and the second case is that the desired parameter is weakly identified. The data did not provide much information to update the prior distribution (Pfeiffer, 2014). Therefore, it is better that the two charts differ from each other. The findings of the research in pictures (2) to (4) show that a significant part of the information in the data has been used in order to update the previous distributions about the model parameters.

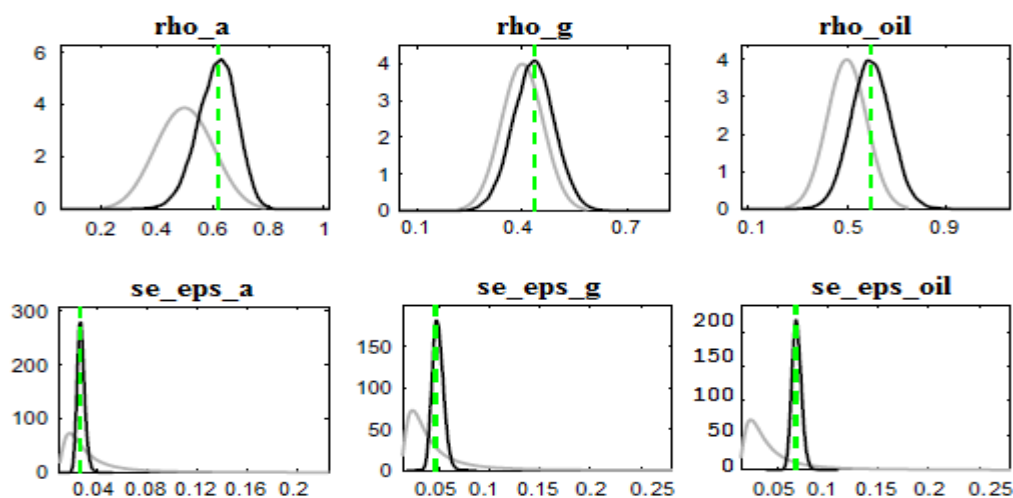
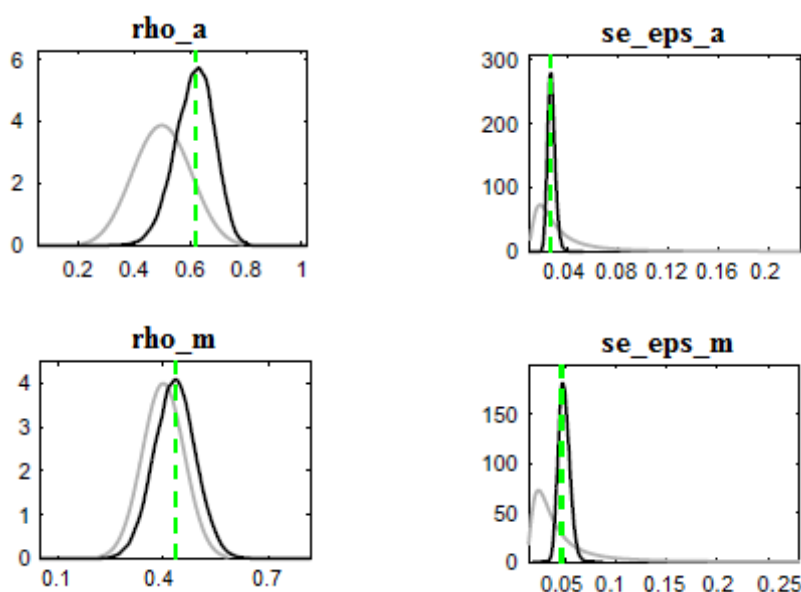


Figure 2: Prior and posterior density of estimated parameters of the model in the first scenario



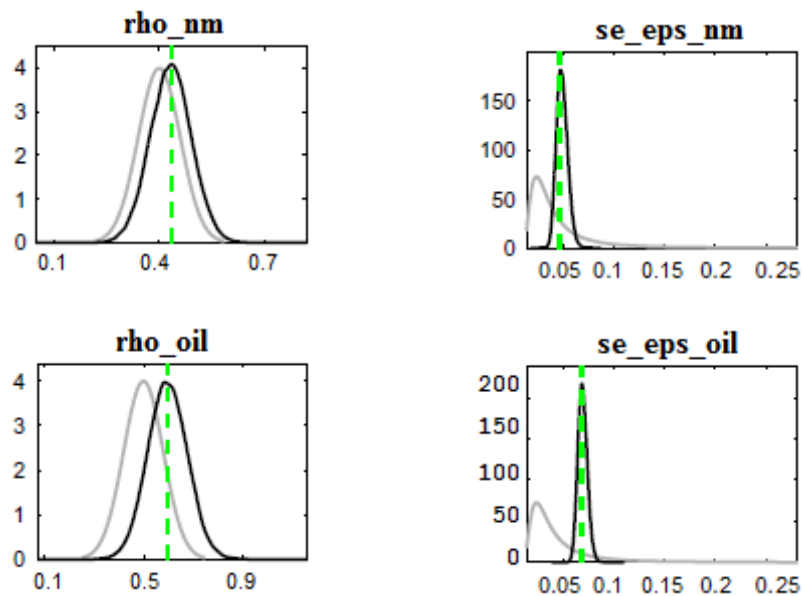
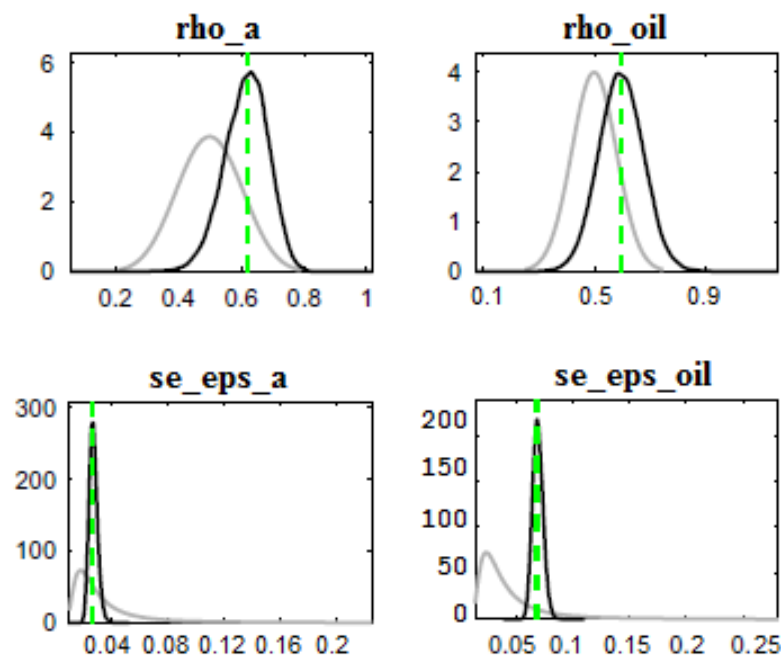


Figure 3: Prior and posterior density of estimated parameters of the model in the second scenario



Pictures 4: Prior and posterior density of estimated parameters of the model in the third scenario



Also, to evaluate and ensure the performance of this model in relation to parameter estimation, the acceptance rate of Metropolis-Hastings algorithm and Markov chain Monte Carlo diagnostic test (MCMC) of Brooks and Gelman (1998) are also used.

The acceptance rate of the Metropolis-Hastings algorithm in the estimation process is ideally in the range of 25% to 33%. The estimation results of this research show that this value is in the ideal range in all three research scenarios in three algorithm chains. These results are shown in tables (9) to (11):

Table 9: Acceptance rate values in 3 chains of the Metropolis-Hastings algorithm in the first scenario

third chain	second chain	First chain	Metropolis-Hastings algorithm
31/8989	28/7414	26/1583	Acceptance rate

Source: research findings

Table 10: Acceptance rate values in 3 chains of the Metropolis-Hastings algorithm in the second scenario

third chain	second chain	First chain	Metropolis-Hastings algorithm
31/9083	29/3544	27/7856	Acceptance rate

Source: research findings

Table 11: Acceptance rate values in 3 chains of the Metropolis-Hastings algorithm in the third scenario

third chain	second chain	First chain	Metropolis-Hastings algorithm
32/1873	31/2390	28/4532	Acceptance rate

Source: research findings

The last criterion for evaluating the obtained estimates is the MCMC diagnostic test of Brooks and Gelman (1998). The MCMC multivariate detection chart reflects a measure of the sum of the eigenvalues of the variance-covariance matrix of all parameters. Pictures (5) to (7) show that in all three scenarios under investigation, the two curves drawn for the first to third order moments tend to each other and at the same time to a constant value, which means that the estimates of It is correct. In other words, the two curves drawn for the first to third order moments have completely converged. This result indicates the reliability of the overall estimation of the models under investigation in the designed scenarios.

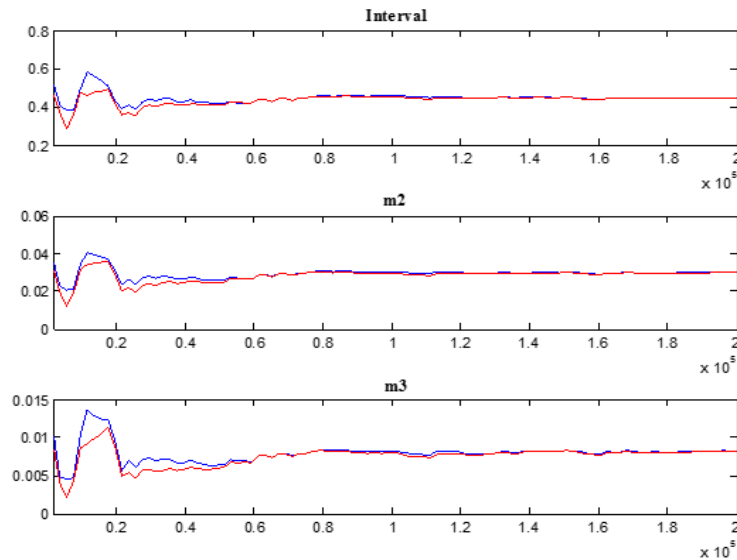


Figure 5: Brooks and Gelman (1998) multivariate MCMC convergence diagnostic test. The first scenario

(source: research findings)

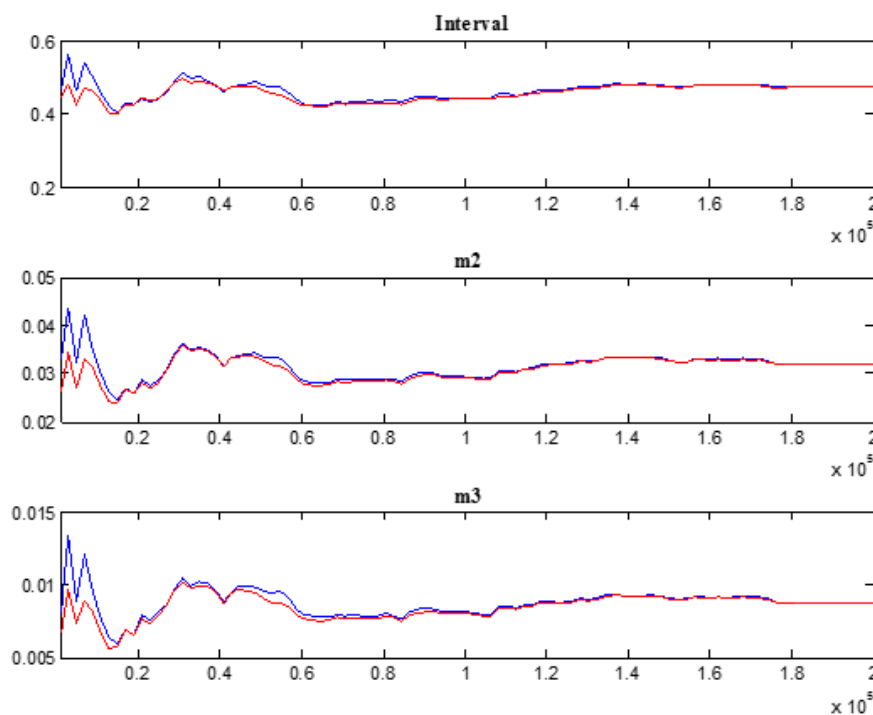
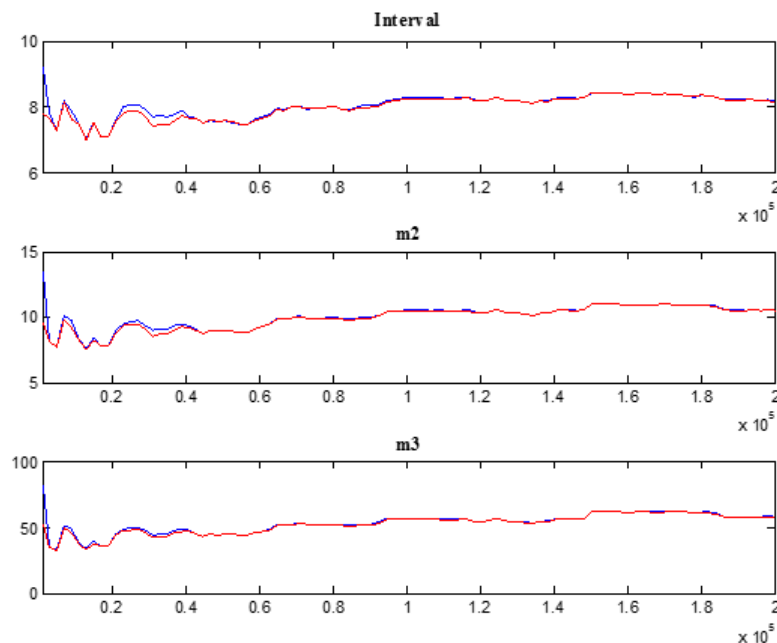


Figure 6: Multivariate MCMC convergence diagnostic test of Brooks and Gelman (1998). The second scenario

(source: research findings)



**Figure 7: Brooks and Gelman (1998) multivariate MCMC convergence diagnostic test.
The third scenario**

(source: research findings)

In a summary of the criteria of this research regarding the goodness of the DSGE model estimation, it can be seen that the estimations of the parameters have the necessary validity.

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 the current research, the DSGE model was explained in three 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: military expenditures and other government expenditures, and a random process was considered for each of these two components. In the third scenario, the government expenditures were divided into two components, military expenditures and other government expenditures, as in the second scenario, but a negative productivity shock (war or insecurity) was considered, which will cause fluctuations in the two components of government expenditures from this shock. was

Based on the results obtained in table (12) from the estimation of the final probability of the model based on the Laplace approximation for the stated models, the DSGE model in the second scenario is more consistent with the real data.



Table 12: Choosing the optimal model in different scenarios based on the Laplace approximation

Estimation of the final likelihood of the model based on the Laplace approximation	the scenario
1028/4875	The first scenario (presence of government expenditure shock in the model)
1089/2368	The second scenario (separation of government expenditures into military expenditures and other government expenditures)
909/2043	The third scenario (negative productivity shock or pandemic)

Source: research findings

8- Conclusion

The conflict of economic interests, international agreements, border demarcation, ideological beliefs, etc. have caused differences between countries and even between regions in such a way that many wars have occurred in the world from the past until now. . Evidences in Iran and in other parts of the world have told about the destructive effects of wars. In addition to casualties, a war also affects economic variables. The country of Iran is in a region that is full of conflict and strife. Afghanistan in the east, Armenia and Azerbaijan in the north, Iraq and Syria in the west of Iran have an insecure situation. The current research investigated the effects of war on economic variables with an emphasis on military and civilian expenditures of the government in the form of a DSGE model in the period from 1370 to 1400. As expected from the basics of economics, a government expenditure shock has adverse effects on investment by creating external crowding. The results indicate the negative response of economic variables such as production, consumption, investment, employment and wages in response to a war shock. As a side effect, despite the war, the government's budget increases and it can intensify the inappropriate economic effects due to the budget deficit. In addition, in the DSGE model of this research, an oil income shock was considered, which has positive effects on economic variables.

The results of this research provide the following two policy suggestions:

- 1- Increasing deterrence by maintaining the current levels of the government's military expenditures, because the effects of increasing the military budget on economic variables are less than the shock of war. In addition, at the time of war, the ratio of military expenses to the total government expenses increases and leaves inappropriate effects.
- 2- Increasing interactions through the country's foreign policies in order to create deterrence, create peace and increase oil sales.



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