Iranian Journal of Economic Studies, 11(1) 2022, 169-190

Shiraz University

Iranian Journal of Economic Studies

Journal homepage: ijes.shirazu.ac.ir

Analyzing the Effects of Change in State Budget Components on Macroeconomic Variables

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Article History

Received date: 19 June 2022
Revised date: 27 December 2022
Accepted date: 08 January 2023
Available online: 19 March 2024

JEL Classification

H25
H31
H32
H53
H68

Keyword

Fiscal policy
Government expenditure
Government budget
Government funding expenditure

Abstract

This study is designed to investigate the effects and consequences of government methods of financing on macroeconomic variables. To have a comprehensive analysis of this goal, a dynamic model with rational expectation including household (Ricardian and non- Ricardian), firms, government, and the central bank is designed in which we try to keep characteristics of Iranian economy. In the fiscal sector, government expenditures have been divided into three parts: merit goods expenditures, public goods expenditures and construction expenditures; moreover, government tax revenues as fiscal instruments are divided into three categories: consumption tax rate, capital tax rate and wage tax rate. The structural parameters of the model were estimated using seasonal data of 2004 – 2020. The results of the model simulation show that an increase of tax rate in order to finance government expenditures depends on the nature of government spending (current or construction): if the goal is to provide the current expenditure and the government is willing to has minimum effects on consumption and production, then it is necessary to increase the tax rate on consumption or the tax rate on investment.

Highlights

- This study uses a general equilibrium model to analyze effects different tax rates.
- We compare the effects of consumption tax, capital tax and wage tax on a set of macro variables.
- We show that based on government objectives, different tax policies should implement.

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DOI: 10.22099/ijes.2023.43756.1840

1. Introduction

The effects and consequences of changes in government fiscal variables on macroeconomic variables is one of the main subjects that have a long history in the literature of macroeconomics, however, there is no generally accepted consensus about it and still is an open subject in both theoretical and applied works. Studies on the consequences of implementing a fiscal policy have been done in both micro and macro levels; while some studies merely consider the effects of government expenditures on the economy, some other studies have attempted to clarify separately the two components of government budget in terms of its components and then evaluate the effects and consequences of them. Therefore, the later approach is more appropriate for a better understanding of the conditions and mechanisms of fiscal policy making and its relation to monetary policy can be expressed in a nutshell. Therefore, new studies in this field try to focus on the components of fiscal policy in order to explain the effects and consequences of fiscal policy (Kutra et. al, 2018). Accordingly, regarding the priority of fiscal policy in Iran, the use of this approach can be a useful tool to study the impact of this policy on macroeconomic variables and economic conditions of the country.

Since 2018, the government of Iran is facing a deficit due to decline in its revenues and the rise in expenditure, thus increasing the government's debts. The unprecedented increase in the government budget deficit in the year 2019 led to the Central Bank of Iran to hold a weekly auction of government Islamic fiscal papers and sell it to banks and credit institutions, thus compensate a big part of the government budget deficit through real and legal entities. The above transformation indicates that the Iranian government in the coming years requires a radical change in budgeting structure, which necessitates a review of policies and institutions concerned with income headlines and spending document that will be a challenge to implement them. Therefore, considering the challenges facing the government in operating the budget structure, it is necessary, at first, to evaluate the effects and consequences of change in each budget element on macroeconomic variables to meet the consequences of each policy and then act towards the implementation of that policy.[1]

according to this consideration, in this study, it is tried to develop and design a structure that evaluates various parts of the government budget in terms of its components. On this basis, the income part of the budget constraint is separated into three categories: taxes, sale of non - financial assets and sale of financial assets. The tax income includes three types of taxes on consumption, taxes on wages and taxes on capital revenues. The sale of non - financial assets includes income from oil , gas and condensates and the sale of financial assets is the sale of Islamic financial securities. The government expenditures section includes three parts: current spending, owning of non - financial assets and owning of

[1] In addition, the aforementioned papers have the capacity to sell and sell through real people, investment funds and subscription.

financial assets. In this model, the current expenditures include the cost of providing government goods and payments to households. the acquisition of non -financial assets includes construction costs (government investment expenditures) and the acquisition of financial assets, including repayment of the principal and the benefit of Islamic financial securities.

After separating the government expenditures in the form mentioned above, the mechanism of the economy of the country is designed and modeled so that in addition to analyzing the behavior of each economic agent of the society, the general equilibrium of the entire economic sectors is determined. In this structure, the relationship between government fiscal behavior and other economic agents of the country is explained and therefore it is possible to evaluate the effects and consequences of any changes in government fiscal plan on different economic sectors of the country by simulation of change in different parts of government budget (revenue and cost). However, in the modeling process, two key points must be considered in order to evaluate the effects and consequences of government fiscal decisions accurately and with a biased approach. The first item to be considered in the study of fiscal policy is the relationship between government spending and private sector spending which have appeared as a puzzle in the literature of Macroeconomics: although based on standard patterns of public balance, some other studies, such as Parvati - Parvati (2002), suggest that the causality of these two variables is positive and direct.

Therefore, studies which use public balance models to investigate the behavior of fiscal policy in order to eliminate these defects and solve this problem , have been three important adjustments in their modeling structure: First, in view of non - Ricardian households facing liquidity constraint (Gali et al., 2007), second, specifying the rules for government spending that includes a Fixed function and third, in terms of the relation of complementary between private consumption and government expenditures (fu et al., 2013). In addition to the three mentioned points, to solve this puzzle, the separation of government expenditures to different parts can also solve the aforementioned puzzle as it is expected that some of government expenditure items have negative relationship with private consumption and others have positive relation.[1][2][3][4][5]

The second point to be considered in this structure is the relationship of fiscal policy and monetary policy. Different parts of government budget include tax revenue, owning of financial assets, current expenses and ownership of financial and non - financial assets are all affected by monetary base growth and bank interest rates. These two variables are the most important components of the country 's monetary policy. Accordingly, it can be said that the government 's behavior in determining fiscal policy will be completely dependent on how the

[1] Blanchard & Perotti
[2] Gali et.al
[3] Stabilization function
[4] Corsetti et.al
[5] Feve et.al

monetary policy is implemented. From this perspective, fiscal policy is divided into active and passive policy categories (Lipper, 1991). The active fiscal policy of the policy is a policy of high sensitivity to the budget deficit and the sum of debt of the state to determine the level of tax and expenditures and on the other hand, tax revenue has a high sensitivity and elasticity to government debt. Accordingly, in the case of an active financial policy that does not have high sensitivity, the government will compensate for its deficit by means of borrowing from the central bank and suppression of interest rates, but in the case of passive fiscal policy, the government is forced to cover its deficit through taxes (Walsh, 2010). According to this feature, it is necessary to determine the parameters of fiscal policy according to the economic characteristics of the country under study. However, due to the dominant behavior of fiscal policy in Iran, in this study monetary and fiscal policies are modeled based on this feature.[1][2][3]

The organization of the present paper is that the second part is devoted to examining the literature review. The third and fourth sections of the paper, respectively, include the definition of the model structure and its estimation, and finally in Section 5, the results of the study are expressed.

2. A Review of the Related Literature

Gurdal et al. (2021) studied the relationship between tax revenues, government spending and economic growth for the G - 7 and in the period 2016 - 2016. for this purpose, the authors have investigated two types of causality in this study; based on the first causality, there is a reciprocal causality relationship between economic growth and government expenditure and, on second test, a reciprocal causality relationship between tax revenue and government expenditure is established. There is also no link between economic growth and tax revenue.[4][5]

Vegh (2015) in their study point out that although various scientific findings point out that government spending in developing countries has a cyclical behavior in the developed countries, but there are no diverse and diverse studies regarding tax behavior, accordingly , in this paper, the authors have investigated tax rates of 62 countries during the period 1960 - 2013, including taxes on corporate income, individuals income and value added .the findings of this study show that tax policy in industrialized countries has not a certain periodic relationship, but in developing countries, it has been generally adopted.[6]

Emadi et. al (2019) study the simultaneous effect of monetary and monetary policies on economic growth in Iran. The effect of monetary policies through variables such as currency, time deposit – saving deposits interest rates and

[1] Active and passive fiscal policies
[2] Leeper
[3] Walsh
[4] Gurdal et.al
[5] The G - 7 countries include Canada, France, Germany, Italy, Japan, United Kingdom and the United States.
[6] Vegh et.al

monetary policy are surveyed through variables such as public revenues and government public expenditure on the growth of nominal and nominal GDP for the period of 2000 - 2016. The results show that in the short term and long term, both monetary and financial policies affect economic growth.

Khodaei et al. (2018) evaluate the effects of financial policies on the economic growth of Iran. The results of the study show that the effect of financial policy on the economic growth of Iran over the period studied is positive and the increase in investment is a prerequisite for increasing economic growth rate. Also, the positive effects of monetary policies on the rate of unofficial exchange have increased over time. In addition, the effect of monetary policy on inflation in the Iranian economy is positive, so that the effects of the above are higher in economic growth periods.

Akbarpour et al. (2018) analyzed the effects of tax policies on underground economy, by using a DSGE approach. The paper reveals that the range of implicit working labor in sum of working labor at the time period is equal to 18 percent. The range of un-paid tax of consumption, level of trade and labor wage is about equal to 17.8 percent of total government tax revenue. By comparison of the impacts of four tax terms on implicit economy reveals that the firm net flow tax shock has the biggest effect on economic structure, and then is trade tax rate. The main difference between our paper and above paper is that we compare the effects of various tax rates on macro variables, instead on underground economy and that we formulate tax rate in separated models.

3. The Study Model

the model used in this study is based on the Kutra & Sakai model (2017) where government expenditures are divided into two sectors of expenditure (current costs) and investment expenditure (construction costs). It also includes two sectors of public goods and merit goods. Similar to Smith &Waters (2007) and Hiroz (2012), we assume that the tax system includes tax on consumption, tax on equity and tax on capital revenues.

The most important goal of this research is to formulating a specific model for each of tax rates and then driving their impact on macro variables; doing this in fact help policy makers to understand the effects of tax rates and then making policy by comparing the effects. By the way, our main question is that among consumption tax rate, wage tax rate and capital tax rate, which one has the most effects on macro variables, e.g., consumption and production.

The main innovation of this study, compared with other domestic studies, is that we not only formulate different tax rates but also decompose government consumption into different categories, which help us to ask and answer this question that in response to a rises in different types of consumption, raising which tax rate has the minimum effect on economy.

3.1. Households

Household sector is the first part of the structure of the present study which is known as the private sector of demand part. In this model, it is assumed that households have infinite lifetime and their number is unlimited but Countable, and is considered equal to one for normalization. Due to the heterogeneity of households, the households are divided into two categories: Ricardian and non - Ricardian. The Ricardian household owns a set of assets and is based on determining optimal consumption over time. On the other hand, the household is non - Ricardo, facing liquidity constraint and consumes all of its income at any time. If we represent the Ricardian household with symbol R and non-Ricardian household with symbol N, then we assume that the families of households are equal to the sum of Ricardian and non-Ricardian households. It can be represented as a collection of these households. Accordingly, the utility function of Ricardian households is defined as:

$$E_0 \sum_{t=0}^{\infty} \beta^t e^{z_t^b} \left\{ \frac{(C_t^e(h) - \theta C_{t-1}^e(h))^{1-\sigma}}{1-\sigma} - \frac{Z_t^{1-\sigma} e^{z_t^l} l_t(h)^{1+\chi}}{1+\chi} + V_{gm}(G_t^m) + V_{gp}(G_t^p) \right\} \quad (1)$$

The parameters suggest the discount factor (β), the consumption habit parameter (h), the reverse of the substitution between the intertemporal consumption (σ) and the reverse pull of the work force supply (χ). The shocks to model are the work force supply shock ($e^{z_t^l}$) and the preferences shock ($e^{z_t^b}$). The productivity level ($Z_t^{1-\sigma}$) has the following random sampling process:

$$\log(Z_t) = \log(Z_{t-1}) + \log(z) + z_t^z \quad (2)$$

The efficient consumption of Ricardian households is:

$$C_t^e(h) = C_t^R(h) + v^{gm} G_t^m + v^{gp} G_t^p \quad (3)$$

Similar to the case study Iwata (2013) and Kutra & sakaei (2017), it is considered to be a supplementary attribute of the kind of between the consumption of the public sector (including merit goods (G_t^m) and public goods (G_t^p)) and the consumption of the private sector. In this case, if negative (positive) then the relationship between merit state goods and consumption of Ricardian households is complementary (substitutionary).

The budget constraint of the Ricardian household is assumed as follows:

$$(1+\tau_t^c) C_t^R(h) + I_t^R(h) + B_t^R(h) = (1-\tau_t^w) W_t(h) l_t(h) + \frac{R_{t-1}^n}{\pi_t} B_{t-1}^R(h) + \left(1-\tau_t^k\right)\left(R_t^k u_t(h) K_{t-1}^R(h) + D_t^R(h)\right) + T_t^R \quad (4)$$

In this regard, I_t^R, B_t^R, R_t^k, and K_{t-1}^R are private investment, public bonds, the rate of capital, the volume of capital held at the beginning of the period. Moreover, D_t^R and T_t^R are the profit of the firm and the net deferred income to the household. In addition, π_t ،W_t ،R_t^k ،R_{t-1}^n ،τ_t^c ،τ_t^w و τ_t^k are the gross inflation rate, the real wage, the gross rate of capital, the nominal gross gain rate of the bond papers, the labor income tax rate and the tax rate on capital revenues. Accordingly, the first - order optimal condition is:

$$(1+\tau_t^c)\Lambda_t = e^{z_t^b}(C_t^e - \theta C_{t-1}^e)^{-\sigma} - \beta\theta E_t e^{z_{t+1}^b}(C_{t+1}^e - \theta C_t^e)^{-\sigma} \quad (5)$$

$$\Lambda_t = \beta E_t \Lambda_{t+1} \frac{R_t^n}{\pi_{t+1}} \quad (6)$$

Which $\Lambda_t t$ corresponds to the Lagrange budget constraint at any time.

Under the monopoly conditions, households provide a variety of work force, which is by assuming to be demand by intermediary firms. In this case, as in the Gali et al., (2007) study, the Producer firms provide an integrated demand function for the work force of two types of households. The demand for work force type is expressed as ($i \in [0,1]$):

$$l_t(i) = \left(\frac{W_t(i)}{W_t}\right)^{-\theta_t^w} l_t \quad (7)$$

The total demand is work force and is defined in the form of the following collective function (l_t):

$$l_t = \left(\int_0^1 l_t(i)^{(\theta_t^w - 1)/\theta_t^w} di\right)^{\theta_t^w/(\theta_t^w - 1)} \quad (8)$$

which is the attraction of succession among different types of work force. The average wage indicator is defined as:

$$W_t = \left(\int_0^1 W_t(i)^{(1-\theta_t^w)} di\right)^{1/(1-\theta_t^w)} \quad (9)$$

According to Calvo modeling (1983), Ricardian households determine their optimal wage. Accordingly, at any time with probability of households they can determine their optimal wage, whose optimal relationship is determined by the maximization of objective function (10) relative to Eq. (8):

$$E_t \sum_{j=0}^{\infty} (\beta \xi^w)^j \left[\Lambda_{t+j}(1 - \tau_{t+j}^w) l_{t+j}(i) z^j W_t(i) \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^w} \frac{\pi}{\pi_{t+k-1}}\right\} - \frac{e^{z_{t+j}^b} e^{z_{t+j}^l} Z_{t+j}^{1-\sigma} l_{t+j}(i)^{1+\chi}}{1+\chi}\right] \quad (10)$$

If we show the optimal wage by W_t^*, then the first - order optimal equation for the work force wage is:

$$E_t \sum_{j=0}^{\infty} (\beta \xi^w)^j \frac{\Lambda_{t+j} l_{t+j}}{\lambda_{t+j}^w} \left[\frac{z^j W_t^*}{W_{t+j}} \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^w} \frac{\pi}{\pi_{t+k-1}}\right\}\right]^{-\frac{1+\lambda_{t+j}^w}{\lambda_{t+j}^w}} \left[z^j \left(1 - \tau_{t+j}^w\right) W_t^* \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^w} \frac{\pi}{\pi_{t+k-1}}\right\} - \left(1 + \lambda_{t+j}^w\right) \frac{e^{z_{t+j}^b} e^{z_{t+j}^l} Z_{t+j}^{1-\sigma}}{\Lambda_{t+j}} \left(l_{t+j} \left[\frac{z^j W_t^*}{W_{t+j}} \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^w} \frac{\pi}{\pi_{t+k}}\right\}\right]^{-\frac{1+\lambda_{t+j}^w}{\lambda_{t+j}^w}}\right)^{\chi}\right] = 0 \quad (11)$$

In this regard, $\lambda_t^w = \left(\frac{1}{\theta_t^w - 1}\right)$ wage- markup. Furthermore, the equation (9) can be shown as follows:

$$W_t^{-1/\lambda_t^w} = (1-\xi^w)\left((W_t^*)^{-\frac{1}{\lambda_t^w}} + \sum_{j=1}^{\infty}(\xi^w)^j\left[z^j W_{t-j}^* \prod_{k=1}^{j}\left\{\left(\frac{\pi_{t-k}}{\pi}\right)^{\gamma^w}\frac{\pi}{\pi_{t-k+1}}\right\}\right]^{-\frac{1}{\lambda_t^w}}\right) \quad (12)$$

$\xi^w$is the probability of not re-determination optimal wage by Ricardian households. In the absence of optimal wages, they choose their nominal wage based on a gross growth rate (z) and a weighted average of pre - equilibrium inflation (π)). Accordingly, the nominal wage rule will be as follows:

$$P_t W_t(h) = z\pi_{t-1}^{\gamma^w}\pi^{1-\gamma^w}P_{t-1}W_{t-1}(h), \quad \gamma^w \in [0,1] \quad (13)$$

$$K_t^R(h) = \left(1-\delta\left(u_t(h)\right)\right)K_{t-1}^R(h) + \left(1 - S\left(\frac{I_t^R(h)}{I_{t-1}^R(h)}\frac{e^{z_t^i}}{z}\right)\right)I_t^R(h) \quad (14)$$

The optimal value of u_t determines the optimal value of I_t^R and K_t^R. The rate of capital depreciation is $\delta(.)$ and follows the following conditions:

$$\delta' > 0, \delta'' > 0, \delta(1) = \delta \in (0,1), \frac{\delta'(1)}{\delta''(1)} = \mu \quad (15)$$

thus, with increasing the rate of capital use, the depletion of capital is increased. The function represents the cost of adjustment of investment that is defined as. Also, the shock is entering the investment adjustment function. The first - order optimal conditions are:

$$\left(1-\tau_t^k\right)R_t^k = q_t\delta'(u_t) \quad (16)$$

$$q_t\left\{1 - S\left(\frac{I_t^R}{I_{t-1}^R}\frac{e^{z_t^i}}{z}\right) - S'\left(\frac{I_t^R}{I_{t-1}^R}\frac{e^{z_t^i}}{z}\right)\frac{I_t^R}{I_{t-1}^R}\frac{e^{z_t^i}}{z}\right\} + \beta E_t\frac{\Lambda_{t+1}}{\Lambda_t}q_{t+1}S'\left(\frac{I_{t+1}^R}{I_t^R}\frac{e^{z_{t+1}^i}}{z}\right)\left(\frac{I_{t+1}^R}{I_t^R}\right)^2\frac{e^{z_{t+1}^i}}{z} = 1 \quad (17)$$

$$q_t = \beta E_t\frac{\Lambda_{t+1}}{\Lambda_t}\left\{\left(1-\tau_{t+1}^k\right)R_{t+1}^k u_{t+1} + q_{t+1}(1-\delta(u_{t+1}))\right\} \quad (18)$$

In this regard, the coefficient of Lagrange multiplier is $q_t = \frac{\Lambda_t^k}{\Lambda_t}q\Lambda_t$.

A proportion of households are non - Ricardo, which do not have assets because of the risk of liquidity and hence their budget constraints are expressed as:

$$(1+\tau_t^c)C_t^{NR} = (1-\tau_t^w)W_t l_t + T_t^{NR} \quad (19)$$

Thus, it indicates the private consumption and net income of the household as mentioned above, as all no Ricardian households are providing labor, the total of their products are received, so the consumption and income of the labor are equal. In other words, it is possible to see Ricardian households as homogeneous households that have no decision making. Since the households of non-Ricardian consume every increase of temporary income resulting from an expansionary fiscal policy, the more their share in the total households, the more the effect of fiscal policy. It is also assumed that the net income between the Ricardian and non – Ricardian households is equal: $T_t^R = T_t^{NR} = T_t$

3.2. Firms

The final commodity market is fully competitive and the final commodity manufacturer of the production function with constant return to scale is:

$$Y_t = \left(\int_0^1 Y_t(f)^{(\theta_t^p-1)/\theta_t^p} df\right)^{\theta_t^p/(\theta_t^p-1)} \quad (20)$$

Which Y_t is the final product and is applicable to both the utilities and investment, $Y_t(f)$ is the finished intermediary goods produced by an intermediate firm. $\theta_t^p > 1$ is the elasticity between intermediary commodities. As a result, to maximize the profit problem of the final, the demand function for each of the generated intermediates is achieved:

$$Y_t(f) = \left(\frac{P_t(f)}{P_t}\right)^{-\theta_t^P} Y_t \quad (21)$$

And so, the relationship between the price of the final commodity and the price of intermediary commodities can be expressed as follows:

$$\left(\int_0^1 \left(\frac{P_t(f)}{P_t}\right)^{1-\theta_t^P} df\right)^{1/(1-\theta_t^P)} = 1 \quad (22)$$

Where $P_t(f)$ is price of intermediate goods and P_t is price index. According to Baxter & King (1993) and Iwata (2013), we assume that the production function of intermediate products that operate on the monopoly market is as follows :[1]

$$Y_t(f) = Z_t^{1-\alpha-v}\left(u_t K_{t-1}(f)\right)^{\alpha} l_t(f)^{1-\alpha}(K_{t-1}^g)^v - \Phi Z_t \quad (23)$$

In which, $\alpha \in (0,1)$, $v > 0$ and $\alpha + v < 1$. K_{t-1}^g is public capital stock and $\Phi > 0$ is the fixed cost. Minimum cost problem yields:

$$mc_t = \left\{\frac{W_t}{(1-\alpha)Z_t}\right\}^{1-\alpha}\left(\frac{R_t^k}{\alpha}\right)^{\alpha}\left(\frac{K_{t-1}^g}{Z_t}\right)^{-v} \quad (24)$$

That is mc_t is the Lagrange multiplier that is related to the cost. Also, according to relations (21), (23) and (24) the total production is expressed asmc_t.

$$Y_t \int_0^1 \left(\frac{P_t(f)}{P_t}\right)^{-\theta_t^P} df = Z_t^{1-\alpha-v}(u_t K_{t-1})^{\alpha} l_t^{1-\alpha}\left(K_{t-1}^g\right)^v - \Phi Z_t \quad (25)$$

In this regard:

$$K_{t-1} = \int_0^1 K_{t-1}(f)df\,,\; l_t = \int_0^1 l_t(f)df \quad (26)$$

Based on the Calvo study (1983), it is assumed that in each period a proportion of firms $((1-\xi^P))$ determine their optimal price, thus the price is determined to maximize their expected returns according to Eq. (21):

$$E_t \sum_{j=0}^{\infty}(\xi^P)^j \left(\frac{\beta^j \Lambda_{t+j}}{\Lambda_t}\right)\left[\frac{P_t(f)}{P_{t+j}}\prod_{k=1}^{j}\left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^p}\pi\right\} - mc_{t+j}\right] Y_{t+j}(f) \quad (27)$$

If we show the optimal price with P_t^* then the first order condition for the price is:

[1] Baxter and King

$$E_t \sum_{j=0}^{\infty} (\beta \xi^P)^j \left(\frac{\Lambda_{t+j}}{\Lambda_t \lambda_{t+j}^p}\right) \left[\frac{P_t^*}{P_t} \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^p} \frac{\pi}{\pi_{t+k}}\right\}\right]^{-\frac{1+\lambda_{t+j}^P}{\lambda_{t+j}^P}} Y_{t+j} \quad (28)$$

$$\left[\frac{P_t^*}{P_t} \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t+k-1}}{\pi}\right)^{\gamma^p} \frac{\pi}{\pi_{t+k}}\right\} - (1 + \lambda_{t+j}^P) mc_{t+j}\right] = 0 \quad (29)$$

Which $\lambda_t^p = 1/(\theta_t^p - 1)$ and above equation expresses the price path of firm. Using this variable, Eq. (22) can be rewritten as:

$$(1 - \xi^p) \left(\left(\frac{P_t^*}{P_t}\right)^{-\frac{1}{\lambda_t^p}} + \sum_{j=1}^{\infty} (\xi^p)^j\right) \left[\frac{P_{t-j}^*}{P_{t-j}} \prod_{k=1}^{j} \left\{\left(\frac{\pi_{t-k}}{\pi}\right)^{\gamma^p} \frac{\pi}{\pi_{t-k+1}}\right\}\right]^{-\frac{1}{\lambda_t^P}} = 1 \quad (30)$$

The intermediate firms in which are not likely to determine the new optimal price and if they are positioned, they use the following rule to determine the new price:

$$P_t(f) = \pi_{t-1}^{\gamma^p} \pi^{1-\gamma^p} P_{t-1}(f), \ \gamma^p \in [0,1] \quad (31)$$

The earnings of intermediary goods in the form of firm revenues are shared among Ricardian households. Therefore, the total income (D_t) is expressed as:

$$D_t = \int_0^1 \left(Y_t(f) - W_t l_t(f) - R_t^k u_t(f) K_{t-1}(f)\right) df = (1 - mc_t)(Y_t \Delta_t + \Phi Z_t) - \Phi Z_t \quad (32)$$

in this regard:

$$\Delta_t = \int_0^1 \left(\frac{P_t(f)}{P_t}\right)^{1-(\frac{1}{\lambda_t^p})} df \quad (33)$$

3.3. Foreign Sector

The modeling of the country's foreign trade sector is based on the formulation of the equations relating to the export and import sectors of the country. For the economy of Iran, exports include oil and non - oil products. Oil revenues earn by exporting volumes of oil barrels to other countries where part of earned revenue belongs to government and the remaining will be allocated to national development fund and national oil company. By the way, we should model such structure for Iran volume of export.

Based on the economic structure of the country, exports are divided into two categories of oil and non - oil exports:

$$Exp_t = OilExp_t + NonoilExp_t \quad (34)$$

In equation (34), the total exports (Exp_t) are petroleum exports ($OilExp_t$) and non - petroleum exports ($NonoilExp_t$). The proceeds of the oil exports are given due to the amount of oil exports (number of barrels per day, $Yoil_t$) and the rate of exchange (S_t):

$$OilExp_t = S_t Yoil_t \quad (35)$$

In this regard, the exchange rate is nominal and the amount of oil exports is assumed to be following the following equation:

$$Yoil_t = Yoil_{t-1}^{\rho_{oil}} e^{\varepsilon_t^{oil}} \quad (36)$$

and the shock of change in the field of petroleum exports. It is also assumed that the non - petroleum exports of the country follow the equation (37):

$$NonoilExp_t = S_t Ynonoil_t \quad (37)$$

In this regard, the volume of non - petroleum exports ($Ynonoil_t$) is considered and assumed to be following the following equation:

$$Ynonoil_t = Ynonoil_{t-1}^{\rho_{nonoil}} e^{\varepsilon_t^{nonoil}} \quad (38)$$

The equation related to the nominal exchange rate and imports (imp_t) is also considered in terms of relations (39) and (40), respectively:

$$\log(S_t) = \alpha_s E_t \log(S_{t+1}) + (1-\alpha_s)\log(S_{t-1}) - \alpha_{oils}\log(OilExp_t) + \alpha_{imps}\log(imp_t) + \alpha_{\pi s}\log(\pi_t) \quad (39)$$

$$\log(Imp_t) = -\alpha_{imps}\log(S_t) + \alpha_{impx}\log(Exp_t) \quad (40)$$

3.4. Policy Rules

since 1398 the central bank in a formal announcement defined open market operations as its new policy tool and the interest rate on the interbank market as its new operational purpose. Accordingly, the central bank of Iran weekly published the report of Macroeconomics developments and measures of the central bank in which the country's Macroeconomics developments and the time path of the target variables are mentioned. Along with the report, the central bank, citing its figures and economic developments, will implement its monetary policy every week depending on the economic conditions in the form of a redemption agreement or an inverse repurchase agreement, which will be carried out at an interest rate in the central bank of the central bank. Therefore, according to this approach, the central bank monetary policy base is expressed as:

$$R_t^n = (R_{t-1}^n)^{\rho_r}(\pi_t)^{\rho_{\pi r}}(Y_t/Y_t^*)^{\rho_{yr}} e^{\varepsilon_t^r} \quad (41)$$

Where Y_t^* is targeted output and ε_t^r is the shock to monetary policy. Moreover:

$$Y_t^* = Z_t^{1-\alpha-v}(ukZ_{t-1})^{\alpha} l^{1-\alpha}(k^g Z_{t-1})^{v} - \Phi Z_t \quad (42)$$

Regarding the government expenditure, it should be noted that in this model we have two types of expenditure for the government (merit goods and public), investment expenditure and net transfer. The expenditure will be financed by the issuance of government bonds, tax on consumption, capital tax and labor tax. Accordingly, the government budget constraint is defined as:

$$B_t = \frac{R_{t-1}^n}{\pi_t} B_{t-1} + G_t^m + G_t^p + G_t^i + T_t - \tau_t^c C_t - \tau_t^w W_t l_t - \tau_t^k (R_t^k u_t K_{t-1} + D_t) \quad (43)$$

Which B_t is the volume of government bonds, G_t^i is government investment expenditure, and G_t^p the total expenditure on private consumption. The process of accumulation of public capital is through the following equation:

$$K_t^g = (1-\delta^g)K_{t-1}^g + G_t^i \quad (44)$$

That is δ^g the depreciation rate of the government capital. Also, the rules related to government spending are expressed as:

$$\log(G_t^m) = \phi^{gm}(\log(G_{t-1}^m) + \log(z)) + (1-\phi^{gm})\left(\log(Z_t g^m) + \phi_y^{gm}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{gm}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + z_t^{gm} \quad (45)$$

$$\log(G_t^p) = \phi^{gp}(\log(G_{t-1}^p) + \log(z)) + (1-\phi^{gp})\left(\log(Z_t g^p) + \phi_y^{gp}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{gp}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + z_t^{gp} \quad (46)$$

$$\log(G_t^i) = \phi^{gi}(\log(G_{t-1}^i) + \log(z)) + (1-\phi^{gi})\left(\log(Z_t g^i) + \phi_y^{gi}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{gi}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + z_t^{gi} \quad (47)$$

$$\log(T_t) = \phi^{T}(\log(T_{t-1}) + \log(z)) + (1-\phi^{T})\left(\log(Z_t\tau) + \phi_y^{T}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{T}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + z_t^{T} \quad (48)$$

The rules of government spending as above include a Smoothing component and reacts to the production gap and the deviation of the debt ratio to production from the target ratio in the previous period. Thus, if positive (negative), then it indicates that government expenditures have a long - cycle behavior. However, as discussed in the study of fu et al., (2013), if the government spending rules are estimated from the point of view of the cyclic opposite components, then the difference between government spending and private expenditures is estimated to be exceeded. Also, if the sign is negative, then it means that if the debt ratio of the government to the total production exceeds the target value, government spending will decrease

Tax revenue, is one of main channels of government earnings; along with oil revenues and issuing bonds, tax revenue received by imposing a tax rate on economic activities. By this channel, the government has this ability to raise or reduce its tax revenues by opting and changing tax rates.

Similar to the government expenditure rules, the tax rules also include a shock, save the production gap and the ratio of debt to production. In particular, the rules related to the consumption tax rates (τ_t^C), the labor tax rate (τ_t^w), and the tax rate on capital returns (τ_t^k) are expressed as follows:

$$\tau_t^C = \phi^{tc}\tau_{t-1}^C + (1-\phi^{tc})\left(\phi_y^{tc}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{tc}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + \varepsilon_t^{tc} \quad (49)$$

$$\tau_t^w = \phi^{tw}\tau_{t-1}^w + (1-\phi^{tw})\left(\phi_y^{tw}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{tw}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + \varepsilon_t^{tw} \quad (50)$$

$$\tau_t^k = \phi^{tk}\tau_{t-1}^k + (1-\phi^{tk})\left(\phi_y^{tk}\log\left(\frac{Y_{t-1}}{Y_{t-1}^*}\right) + \phi_b^{tk}\log\left(\frac{\frac{B_{t-1}}{Y_{t-1}}}{b^{tar}}\right)\right) + \varepsilon_t^{tk} \quad (51)$$

The reason that the tax rates are not only affected by the ratio of debt to production but also affected by the production gap, is that these tax rates are generally referred to as effective tax rates in Macroeconomics, which is particularly visible in models with a typical representative. In reality, the tax system is highly complex, including tax breaks and tax fines. Therefore, when this system is expressed in the form of a simple tax ratio, the tax rate can be dependent on economic conditions as well. On the other hand, some previous studies of this area stipulate the tax rules that react to the gap in the current period and the debt. However, given the temporal lag between decision making and implementation of the financial policy, the structural study is considered to be dependent on conditions of pre - economy period. It is to be mentioned that because of the political impediments to change the tax rate, shocks to the tax rate are not permanent, and therefore, contrary to other structural shocks, the Self-bound process can be defined. According to the above description, the negative sign of parameters relating to the generation gap and the debt, respectively, expresses the opposite of the cyclic behavior and the stabilization of the debt.

3.4. Market Clearing, aggregation and structural shocks

The market clear condition is:

$$Y_t = C_t + I_t + G_t^m + G_t^p + G_t^i + (Exp_t - Imp_t) + xZ_t e^{z_t^x} \quad (52)$$

which is defined as the total private consumption and private investment and are defined as follows:

$$C_t = \omega C_t^{NR} + \int_\omega^1 C_t^R(h)dh \quad (53)$$

$$I_t = \int_\omega^1 I_t^R(h)dh \quad (54)$$

which indicates the steady state value of other factors in the demand process and represents the External shock. The Collected of private capital are the profits of businesses and government papers as follows:

$$K_t = \int_\omega^1 K_t^R(h)dh \quad (55)$$

$$D_t = \int_\omega^1 D_t^R(h)dh \quad (56)$$

$$B_t = \int_\omega^1 B_t^R(h)dh \quad (57)$$

With the exception of shocks entering tax rates, each structural shocks of a first - order Self-bound process follows:

$$z_t^j = \rho^j z_{t-1}^j + \varepsilon_t^j, \quad \varepsilon_t^j \sim N(0,\sigma_j^2) \quad (58)$$

$$j \in \{b,l,z,i,x,r,gm,gp,gi,T\} \quad (59)$$

4. Model estimation

4.1. Estimation Results

In order to analyzing and evaluating different policy based on specified model, we need to assign numerical values to model parameters. Assigning

numerical values is possible with two different ways: Calibrating parameters or estimating parameters (using Bayesian estimation).

In the Bayesian approach, we used two sets of information: information from prior knowledge and information from data. Prior knowledge is past information about a parameter and constitutes prior distribution function. After that, the prior information provided for model parameters will be combined with the information obtained from the data and hence the posterior distribution function will estimate. The posterior includes point estimation of parameter plus a confidence interval. In this study we use Bayesian estimation.

The used data are downloaded from time series data base of the central bank of Iran1. Hence, since our model is a log – linear version of structural equations, we need to convert data to log deviation from steady state level.

The used data are downloaded from time series data base of the central bank of Iran2. Hence, since our model is a log – linear version of structural equations, we need to convert data to log deviation from steady state level. For this reason, we compute steady state level by using Hodorick - Prescott approach and then use this transformed data in estimation process. The prior distribution functions is set based on this rule that if a parameter is in range [0,1], we opt Beta p.d.f, if in range $[1, +\infty)$ opt Gamma p.d.f. and inf in range $(-\infty, +\infty)$ opt Normal p.d.f[3]. Moreover, initial values for parameters are determined by authors calculations[4]. The results are reported in Table (1).

Table 1. estimation results

Standard deviation	Prior p.d.f	upper bound	Lower bound	Posterior mode	Prior mode	Parameter
1.5	Normal	2.24	1.27	1.75	0	ν^{gm}
1.5	normal	0.73	0.39	0.56	0	ν^{gp}
0.025	beta	0.13	0.05	0.09	0.1	ν
0.1	beta - blockers.	0.17	0.03	0.1	0.025	ω
0.37	gamma	4.3	3.9	4.1	2.1	σ
0.75	gamma	4.02	1.58	2.86	2	χ
0.01	gamma	0.06	0.03	0.05	0.07	φ
0.1	beta - blockers.	0.68	0.28	0.47	0.44	ξ^{w}
0.5	Normal	0.79	-0.82	0.008-	0	ϕ_{y}^{gm}
0.5	Normal	0.82	-0.79	0.02	0	ϕ_{y}^{gp}
0.1	beta - blockers.	0.95	0.64	0.79	0.8	ϕ^{tw}
0.5	normal	0.71	-0.95	-0.11	0	ϕ_{y}^{tw}

Source: *Research computations*

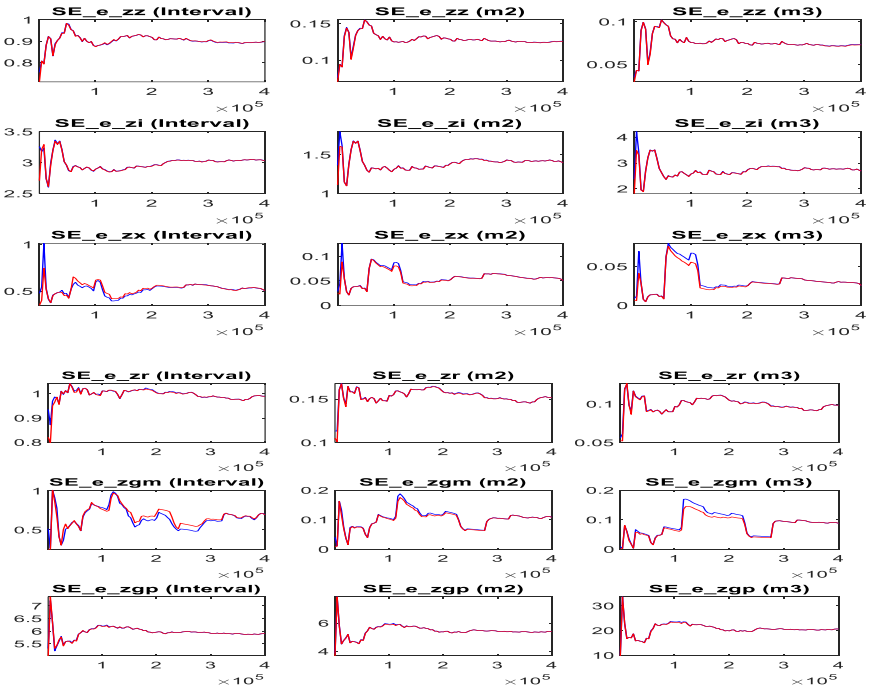
[1] https://tsd.cbi.ir
[2] https://tsd.cbi.ir
[3] Read Dynare help for this structure of assigning p.d.f. to parameters.
[4] By point estimation of each equation, and/or refer to other studies.

Then, Bayesian statistical inference statistics are used to investigate the stability and reliability of the estimated parameters.

4.1.1.Monte Carlo Markov Chain[1]

in statistics, Markov chain monte Carlo (mcmc) methods form a class of algorithms for sampling from a probability distribution. By constructing a Markov chain that has the desired distribution as its equilibrium distribution, one can obtain an example of the desired distribution by observing the chain after several stages. The more steps exist, the more the sample distribution will match the actual desired distribution. The transition from a single chain to another is usually carried out using a random walk method. In the Bayesian statistics, the recent development of monte Carlo methods is a key step in computing large hierarchical models that require the combination of unknown parameters. The important point in this statistic is the requirement for existence of Convergence between chains which could be the reason for the accuracy of the parameters.

In the Bayesian method, the statistic is presented at two levels: to verify the fitness of each of the estimated parameters and to evaluate the accuracy of the overall fitness pattern. From this perspective, it is expected to be reliable if the estimated model is reliable at both the above - mentioned levels that this property is significant in diagrams (1) and (2).



[1] Markov Chain Monte Carlo (MCMC)

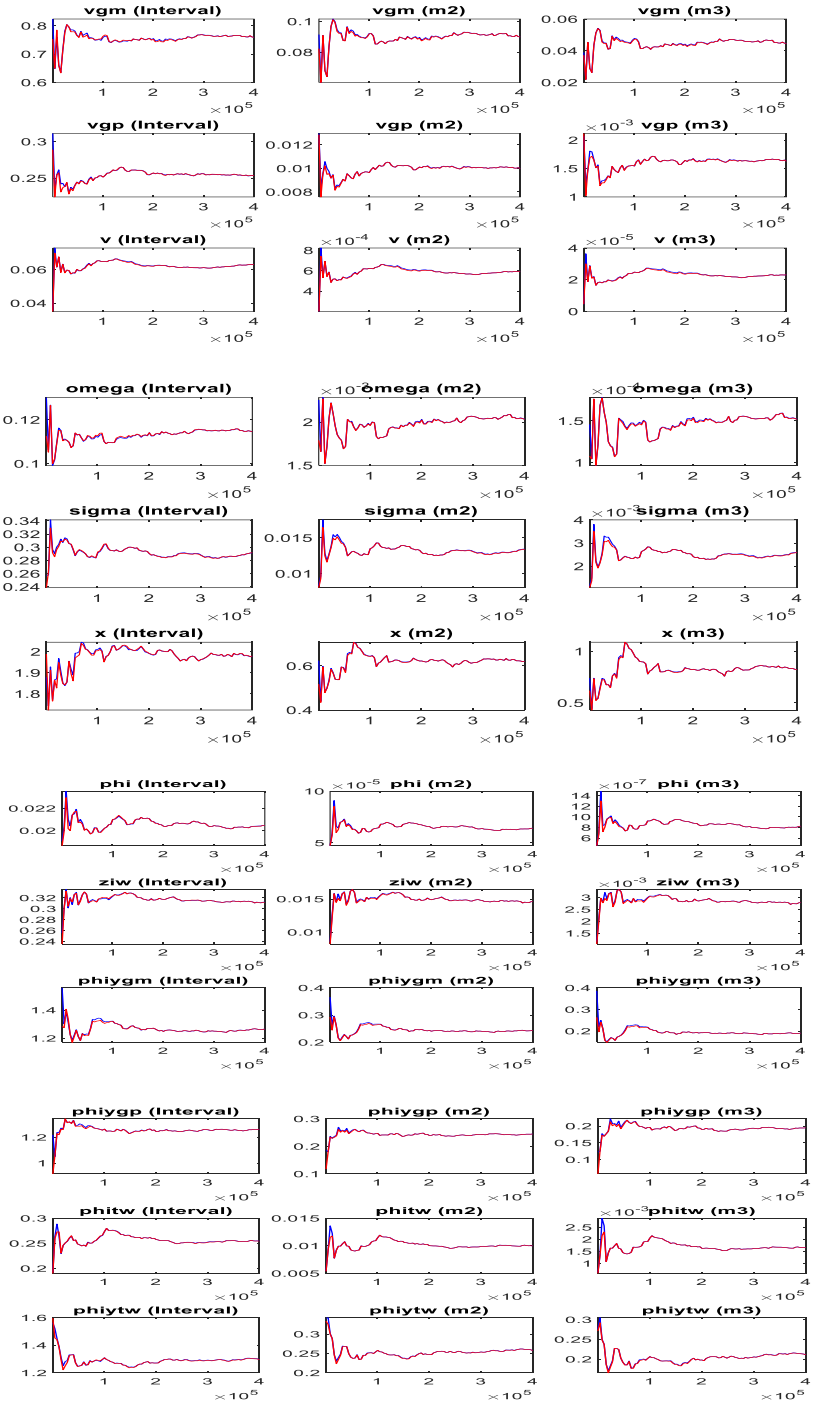

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Figure 1. Convergence of the chains for each of the estimated parameters

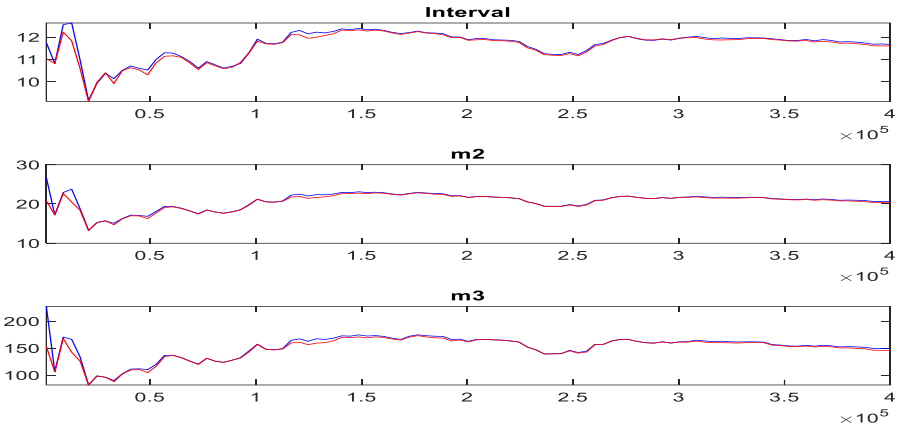

Figure 2. Convergence of the chains for the overall structure of the model

4.1.2. Comparison of the prior and posterior distribution functions

According to the data provided by the prior distribution function and sample data, it is necessary to properly stop at the peak distribution function, as well as the posterior distribution functions, which are observed in the graph (3).

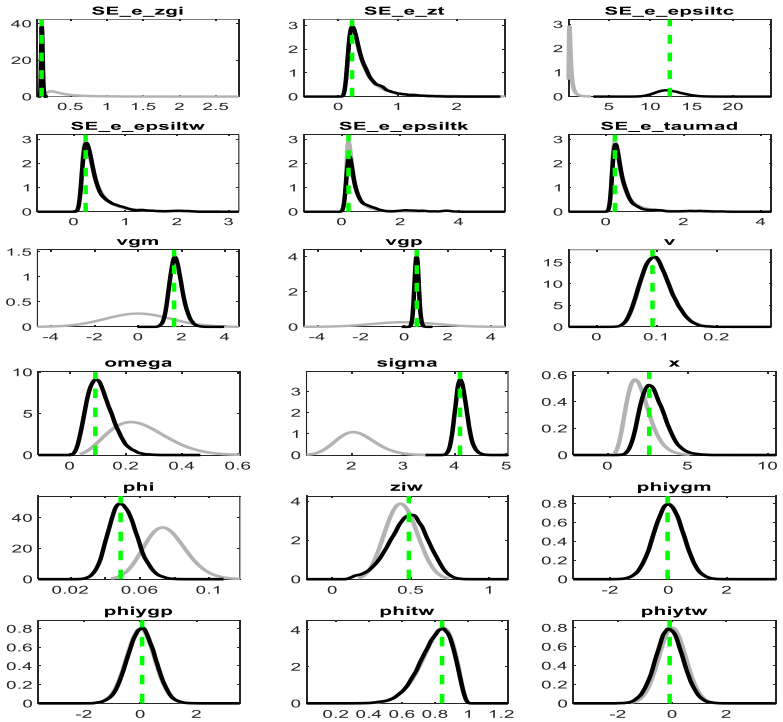

Figure 3. comparison of the later distribution functions of the estimated parameters

4.1.3. statistic for identification of the estimated parameters

One of the most important steps in investigating the accuracy of estimating the parameters of general equilibrium patterns is the analysis of the estimated parameters. In order to validate the general equilibrium patterns, the identification test is performed on the basis of the Jacobian matrix in the state of stable state and the J - rank condition, which indicates that the results of the present model show that all parameters are identified and therefore the estimates are reliable and reliable (graphs 4).

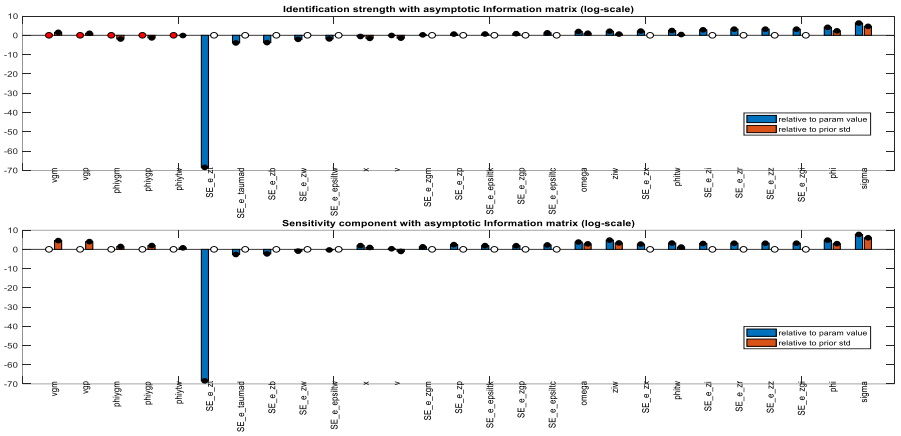

Figure 4. statistics for model parameters identification

4.2. Simulation Analysis

4.2.1. simulating of the financing public expenditure through change in tax rates.

In this section, on the basis of the posterior average estimated parameters, it is considered that if the government increases the percentage of public goods expenditure, then the financing of this new expenditure by increasing the different tax rates has an effect on macroeconomic variables. Accordingly, the government can provide this increase in its expenditures through tax increases, but each change in each tax rate has a different effect on macroeconomic variables. Accordingly, the effect of a unit percentage increase in tax rates on consumption, taxes on wages and tax on capital to compensate for the cost of public goods provision (figure 5). As shown from figure 5, during the long - term period, the consumption of Ricardian households ($cr_m ad$) as a result of the tax on capital is at a higher level than the other two taxes because the tax on capital decreases as a result of the tax on capital and thus the future consumption of the current consumption. On the other hand, under the imposed tax on wages, household consumption has not changed particularly, and under the tax on consumption, consumption will be reduced in the meantime, as these two taxes, savings and investment will decline.

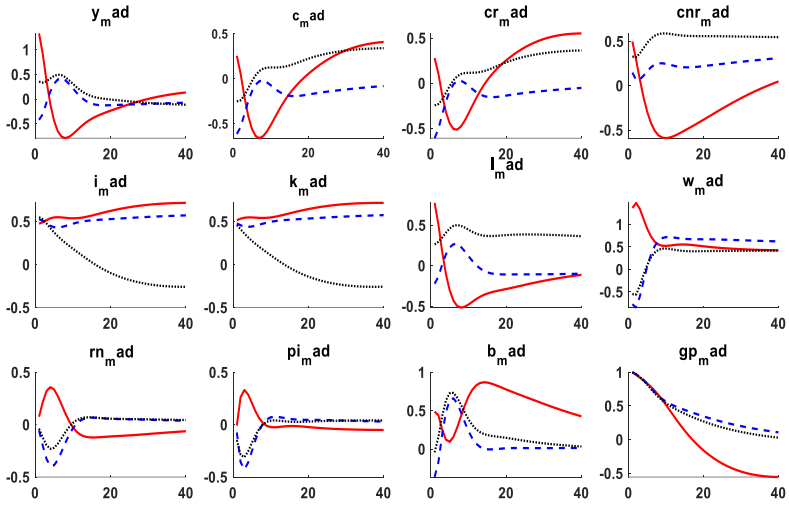

Figure 5. Impact of Tax rates on macroeconomic variables (red-line is consumption tax, dashed red-line is capital tax and dashed blue line is wage tax)

The above analysis has also been done on the consumption of non – Ricardian households ($cnr_m ad$) which causes the total consumption behavior ($c_m ad$) under the tax on investment rather than the other two taxes. The study of household consumption diagram of Ricardian household consumption and total consumption shows that the situation of each of the three taxes , causes the substitution of future consumption instead of the present , as a result of reducing savings , investment expenditures ($i_m ad$) are reduced and consequently we see that the capital level ($k_m ad$) is more severe than the other two tax rates .as for the production variable, it is obvious that in the case of capital taxes, the fluctuations in the production level ($y_m ad$) are more than two other tax rates and the production of the Smoother route will take place until the shock of the financial policy reaches zero. However, as expected, investment spending is more influenced by capital tax than two other tax rates and it will take longer time to vanished capital shock, while the effect of two other shocks on investment is almost similar.

As the result, we conclude that if the government goes to financing its expenditures without loss of reducing private consumption, it should raise capital taxes without any changes in other taxes. Raising capital tax has a more benefit that it generates less fluctuations in output level than other two taxes and therefore less business cycles will appear if government just provide its expenditures by this sort if income.

4.2.2.simulating the financing government investment through changes in tax rates

In this section, we will deal with this issue that if the government increases the percentage of investment expenditures, then financing of these new expenses

by increasing the different tax rates has an effect on macroeconomic variables. According to the diagram (6), the time trend of consumption of Ricardian and non – Ricardian in all three states of taxation on consumption, wages and capital are almost the same, and for this reason, the total consumption and volume of production in all three states of tax rates increase nearly one. However, the increase in the level of investment expenditures in the case of consumption tax is more rather than the other two policies. Considering the changes in investment expenditures under each of the three tax rates mentioned above, it is observed that the formation of fixed capital in the consumption tax is the highest level in terms of financing through two other tax rates and in the case of financing the capital through tax on capital, the formation of capital has lower level of investment than the other two tax rates.

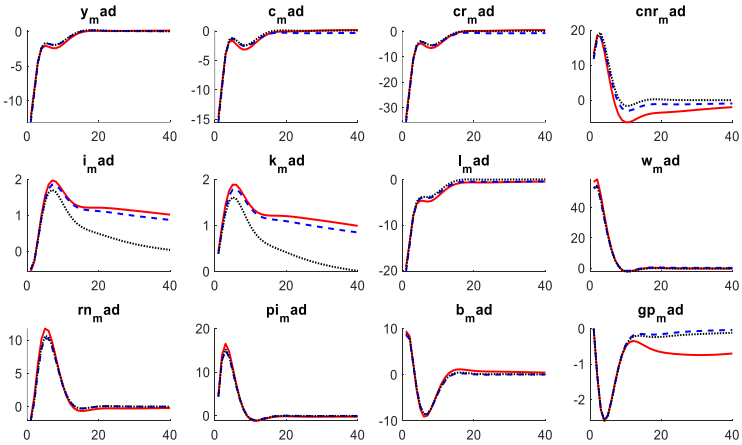

Diagram 6. Impact of Tax rates on macroeconomic variables (red-line is consumption tax, dashed red-line is capital tax and dashed blue line is wage tax)

Using above results reveal that if government concerns is keeping investment level at a specific target, it should raise consumption taxes, otherwise, it could raise capital tax that has minimum effects on other variables.

5. CONCLUSION

In this study, an open dynamic stochastic general equilibrium pattern for the Iranian economy has been designed. The aim of this model is to investigate the effects of government financing on macroeconomic variables, which is aimed at providing financial support to two categories of finance in order to provide the resources required for the current expenses and finance in order to provide the resources required for development. Therefore, in order to do this assessment, the government expenditure and income levels are divided into three categories, each corresponding to different policy instruments that the government can use in order to implement their financial policies. In addition to the tax revenues, according to the government 's auction tools, the relation to the source of financing using

financial bonds has been made clear. According to income sources as well as government expenditure, the study investigates the question that if the government is willing to finance its expenses, the use of each tax tool will affect macroeconomic variables. To be more precise, the survey was conducted in two different modes: financing for current expenditures and financing for government development expenditures.

The results of first - state review (financing for current government expenditures) indicate that if the government aims to maintain the level of private sector consumption and avoid reduction of production level, then increasing the rate of tax on capital would be a more appropriate option than the rate of tax on consumption and wage tax rate, however, the tax rate on consumption is a better option for financing projects. Furthermore, the results of the second case study (financing for government projects) show that the effect of all three tax rates on total consumption and production levels are approximately the same and that they are no different from that, but the increase in the rate of tax on capital leads to further reduction on the level of capital and investment expenditure. Therefore, in conclusion, if the goal is to achieve an economic growth rate in the long term, it is necessary to avoid a certain level of capital and therefore, independent of the type of expenditure (current or development), it would be better if the tax rate on capital would be a good option because it would affect the level of production and private consumption less.

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