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RESEARCH ARTICLE **Open Access**

Investigation of Markov-Switching Dynamic Stochastic General Equilibrium (MS-DSGE) Model in order to Develop Iran's Monetary-Economic System

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Abstract
Iran has experienced major structural and economic changes over the past four decades. In the major experimental literature, researchers believe that these changes have manifested themselves as changes in the dynamics of macroeconomic variables, so that a number of articles have focused on documenting these changes. Understanding what lies behind it and the consequences of these changes is clearly important for monetary policy. This study empirically examines how the behavior of monetary policy in Iran has changed in response to various structural shocks, which is done using the Markov switching model of dynamic random equilibrium. In this study, the Markov-Switching Dynamic Stochastic General Equilibrium (MS-DSGE) Model is estimated, which causes changes in the coefficients of the monetary policy law as well as shock fluctuations with Iranian data from 1350 to 1396. We find that regime change, both in monetary policy legislation and in shock fluctuations, is a fundamental adjustment in improving the fit of the model. Our results show that structural shock fluctuations have also changed over time. Hence, the highest instability impulse of real output is due to the monetary policy index impulse and the least impact is due to the imposition of financial liberalization. Among all the factors, the greatest impact is due to the impulse of revolution and war. The least impact belongs to the shock of oil revenues on the shocks of the monetary policy index with coefficient.
Keywords. *Macroeconomic Dynamics, Economic Impulses, Stochastic Dynamic General Equilibrium Model - Markov Switching (MS-DSGE)*

Introduction

Over the past decades, the economy has had a long period of inflation, in order to get rid of this inflation, monetary and financial authorities have tried to control the economy to reduce inflation (Perla et al, 2021: 84). As a result, we are witnessing significant changes in monetary and fiscal policies. For example, in order to overcome inflation in this situation, they try to increase bank interest rates and implement a kind of monetary contractionary policy, but the implementation of this policy itself brings limitations to the economy (Veldhoen & Simas, 2021: 139). At the same time, financial positions through reduction financial costs to control the economy and inflation have been accompanied by shortcomings. Deteriorating financial positions, in turn, have created more

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uncertainty and constraints on the economy and the risks associated with financial imbalances (Benigno, 2021:261). These developments have led to renewed attention to the sensitivity of the economy to change and uncertainty in the composition of monetary and fiscal policies. Stochastic dynamic equilibrium, or DSGE for short, is a branch of general equilibrium theory that seeks to explain all economic phenomena such as recession, business cycles, and the effects of monetary and fiscal policies based on macroeconomic models (Airaudo, 2021: 153). Structure of DSGE models Describing the behavior of the whole economy and applying the analysis of micro-decision interactions is built at different levels. The decisions made in DSGE models relate to the macro quantities studied in economics (Karimi er al., 2020: 221). Theoretically, new features have been added to DSGE models, including exchange rates, global trade, nominal and real price stickiness, wages, and several shocks (Ghiasi et al., 2022: 38). This has led to more detailed analyzes of the relationship between total variables and the effect of economic policies (Mensch, 2020: 730). In practice, the empirical and theoretical process of DSGE models has aroused the interest of central banks because monetary executives need the means by which to make the right decisions (Kheilnejad et al., 2020:154). Obviously, parameters related to central banks' reactions to key macro variables such as inflation, output, or, for example, exchange rates may fluctuate over time (Ramey, 2020: 22). In order to closely monitor and monitor these fluctuations and possible changes in the desired parameters, one can use Markov switching models. However, the use of Markov models is limited to structural models of form. Thus, the combination of both methods Markov switching and DSGE has created a set of macroeconomic analyzes that allow parameters to change over time in a more complex model. In the international literature, several studies have used MS-DSGE models. Discussions started after uncertainties about the parameters of micro-models and finally developed with the introduction of Markov switching to DSGE models. Based on these historical periods, an MS-DSGE model of a small open economy for Iran was formed, following Gali and Monacelli (2005) and Justiniano and Preston (2010), to identify changes in major shocks just like monetary policy responses. MS-DSGE allows regime changes in monetary policy coefficients just like fluctuations in shock. Here, the algorithm used in Farmer et al. (2011) is used to solve the MS-DSGE model and the model is estimated using Bayesian methods based on Iranian data.

Literature Review

-Dziewulski (2022) in article with title" Markov distributional equilibrium dynamics in games with complementarities and no aggregate risk" conclued that provide numerous applications of our results including: dynamic models of growth with status concerns, social distance, and paternalistic bequests with endogenous preferences for consumption.

-Xin et al (2022) in article with title" A More Realistic Markov Process Model for Explaining the Disjunction Effect in One-Shot Prisoner’s Dilemma Game" showed that how that the disjunction effect can be well predicted by a more realistic Markov model. Model comparison suggests the superiority of the proposed Markov model over the quantum BAE model in terms of absolute model performance, relative model performance, and model flexibility. Therefore, we suggest that the key to successfully explaining the disjunction effect is to consider the underlying cognitive mechanism properly.

-Foerster & Matthes (2021) in article with title" Learning about Regime Change" conclued that total factor productivity (TFP) and investment specific technology (IST) growth both exhibit regime-switching behavior, but the regime at any given time is difficult to infer. We build a rational expectations real business cycle model where the underlying TFP and IST regimes are unobserved. We develop a general perturbation solution algorithm for a wide class of models with unobserved regime-switching. Using our method, we show learning about regime-switching fits the data, affects the responses to regime shifts and intra-regime shocks, increases asymmetries in the responses, generates forecast error bias even with rational agents, and raises the welfare cost of fluctuations.

-Fathi Vajargah et al (2021) in article with title" Oil Price estimating Under Dynamic Economic Models Using Markov Chain Monte Carlo Simulation Approach" showed that this model is more efficient than the others are, as it provides a significantly better fit to the data, and therefore, corrects the shortcomings of the previous models and that it is closer to the actual market prices. Therefore, our estimating model under the Monte Carlo simulation allows an analysis on oil prices during certain times in the periods of tension and shock in the oil market.

-Tavakolian (2021) in article with title" Dynamic Stochastic General Equilibrium Models in Iran: Deterministic or Stochastic Steady State? "Showed that the level of consumption, private investment and GDP in the stochastic steady state is less than the deterministic steady state, while the government consumption and investment in the stochastic state are higher than the deterministic steady state. The impulse response function also show that the response of economic variables to different shocks in the stochastic steady state is less than that of deterministic steady state.

Introduction of Markov regimes

The Markov switching model was first introduced by Quandt (1972), Goldfeld and Quandt (1973) and then developed by Hamilton (1989) to derive business cycles (Gyamerah and Ngare, 2018: 106). Unlike other nonlinear methods, such as ANN and STAR, in which the transition from one regime to another is gradual, in Markov switching model the transfer is done quickly. Also, in examining the relationships between economic variables, the vector autoregression method is one of the common methods, but one of the disadvantages of this method is that it assumes that all variables considered in the model are stable and can not be used for unstable variables. Unlike the autoregression method, the Markov switching model enters less preliminary information. Also, the transfer function in the Markov switching model is easily estimated endogenously by the data. To describe the method, the relations related to an AR model (1) for the variable y_t, under two regimes $S_t = 1$ and St= 2 can be written as follows: (Ann et al., 2019: 190):

$$y_t = \begin{cases} \varphi_{0,1} + \varphi_{1,2} y_{t-1} + \varepsilon_t & s_t = 1 \\ \phi_{0,2} + \phi_{1,2} y_{t-1} + \varepsilon_t & s_t = 2 \end{cases}$$

If the variable y_t follows the autoregressive process of the order P variable and has a different regime m, the above relation can be rewritten for a more general case.

$$y_t = \sum_{i=1}^{m} \left(\sum_{i=1}^{p} (\beta i_j y_{t-j}) + u_{it} \right) I_i(s_t = i)$$
$$I_i(s_t = i) = \begin{Bmatrix} s_t = i \rightarrow 1 \\ s_t \neq i \rightarrow 0 \end{Bmatrix}$$

In the above relation, the probability of transferring the situation from one regime to another can be calculated in the form of conditional probabilities. For example, in the above model, P_{ij}, which indicates the transition from regime i to regime j, is defined as follows

$$P_{ij} = P(s_{t+1} = j | s_t = i); \sum_{i=1}^{m} P_{ij} = 1, (i, j) \in (1, 2, \ldots, m)$$

That (u_t ~N (0, σ^2 is and S_t is the result of a Markov chain with N regimes and also S_t is independent of u_t for all t. Time series equations can be extracted in two ways: in the first method, the researcher deduces from economic theory and based on his opinion, models and performs statistical tests to correctly identify the model and the estimated parameters. But the problems of this method are the lack of structural parameters and the lack of identification of shocks and specification error. In order to solve this problem, a number of principles based on economic theory are used, including microeconomic theory. From it, optimization is determined in relation to a series of constraints.

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Specify and estimate the model
Households

It is assumed that the economy consists of a large number of homogeneous households. The present value of the benefits that the representative household acquires during its lifetime is as follows:

$$U_t = E_t \sum_{t=0}^{\infty} \beta^t \, e_t^c \left\{ \frac{(C_t - hC_{t-1})^{1-\sigma c}}{1-\sigma c} + \frac{1}{1-\sigma md} \cdot \frac{(\frac{M_t}{P_t})^{1-\sigma md}}{e_t^{md}} - \frac{e_t^l (l_t)^{1+\sigma l}}{1+\sigma l} \right\}$$

This utility function reflects the external habits (eye-to-eye behavior) of consumer behavior, which depend on the average per capita consumption of the economy. Therefore, each household represented in the economy at time t, when its consumption is greater than h percent of the average per capita consumption of the economy in period t-1, acquires a positive benefit from more consumption, in which h indicates how much the consumer is willing. To smooth its consumption level compared to the average per capita consumption of the past. The higher the h, the higher the degree of dependence on the consumption habit (Laeven and Valencia, 2018: 77). In the Et utility function of expectation operators, β is the discount factor, σc is the inverse elasticity of time between consumption (relative risk aversion coefficient), σmd is the inverse of the demand for real money, and σl is the inverse of the supply of labor, and lt is the supply of labor.

In the above relation θ_1, the elasticity of substitution between tradable and $C_{N,t}$ non-tradable goods is the consumption of non-tradable goods $C_{T,t}$ and the consumption of tradable goods. And γ1 is the weight of non-tradable consumer goods in total consumption. In general, the issue of household decision-making can be examined in two stages: In the first stage, the household decides what combination of consumer goods to choose so that the cost of obtaining a certain level of consumption of mixed goods is minimized. This stage selects the amount of tradable and non-tradable goods in a way that minimizes the cost of purchasing the combined consumption. Household expenses, which are a combination of tradable and non-tradable goods, can be written as follows:

$$P_{T,t} C_{T,t} + P_{N,t} C_{N,t} = P_t C_t$$

That the $P_{T,t}$ price index of tradable goods is the price $P_{N,t}$ index of non-tradable goods and P_t the total price index of the consumer. Therefore, households solve the following problem to choose the optimal combination of tradable and non-tradable goods:

$$P_{T,t}C_{T,t} + P_{N,t}C_{N,t} \underset{\{C_{T,t},C_{N,t}\}}{Min}$$
$$S.t$$
$$\left[(1-\gamma 1)^{\frac{1}{\theta 1}} C_{T,t}^{\frac{(\theta 1-1)}{\theta 1}} + \gamma 1^{\frac{1}{\theta 1}} C_{N,t}^{\frac{(\theta 1-1)}{\theta 1}}\right]^{\frac{\theta 1}{(\theta 1-1)}} \leq C_t$$

From solving the conditions of the first order of the above relation, the total consumer price index, which is a combination of the price index of tradable and non-tradable goods, is obtained as follows:

$$P_t = \left[(1-\gamma 1)\,\mathrm{P}_{T,t}^{\ 1-\theta 1} + \gamma 1 P_{N,t}^{\ 1-\theta 1}\right]^{\frac{1}{(1-\theta 1)}}$$

Which $P_{N,t}$ is the price index of non-tradable goods and $P_{T,t}$ the price index of tradable goods.

The following CES form also shows the tradable consumer goods produced domestically or abroad:

$$C_{T,t} = \left[(1-\gamma 2)^{\frac{1}{\theta 2}} \mathrm{C}_{\mathrm{H},t}^{\frac{(\theta 2-1)}{\alpha 2}} + \gamma 2^{\frac{1}{\theta 2}} C_{F,t}^{\frac{(\theta 2-1)}{\theta 2}}\right]^{\frac{\theta 2}{(\theta 2-1)}}$$

In the above relation, $C_{T,t}, \mathrm{C}_{\mathrm{H},t}, C_{F,t}$, the tradable consumer goods of domestic production, respectively, represent the foreign production of the lawyer, and θ2 indicates the elasticity of substitution between them. The marketable consumption expenditures of households, which are a combination of imported and domestically produced goods, can be written as follows:

$$P_{\mathrm{H},t}C_{\mathrm{H},t} + P_{\mathrm{F},t}C_{\mathrm{F},t} = P_{T,t}C_{T,t}$$

That the $P_{T,t}$ total price index of tradable goods, $P_{\mathrm{F},t}$ is the price index of imported consumer goods and $P_{\mathrm{H},t}$ the price index of domestically produced goods. Therefore, households solve the following problem to choose the optimal combination of domestically produced and imported goods:

$$P_{\mathrm{H},t}C_{\mathrm{H},t} + P_{\mathrm{F},t}C_{\mathrm{F},t}\ S.t \underset{\{C_{\mathrm{H},t},C_{\mathrm{F},t}\}}{Min}$$

$$\left[(1-\gamma 2)^{\frac{1}{\theta 2}} \mathrm{C}_{\mathrm{H},t}^{\frac{(\theta 2-1)}{\alpha 2}} + \gamma 2^{\frac{1}{\theta 2}} C_{F,t}^{\frac{(\theta 2-1)}{\theta 2}}\right]^{\frac{\theta 2}{(\theta 2-1)}} \leq C_{T,t}$$

By solving this problem, the optimal demand for them is obtained as follows:

$$C_{\mathrm{H},t} = (1-\gamma 2)\left(\frac{P_{\mathrm{H},t}}{P_{T,t}}\right)^{-\theta 2} C_{T,t}$$

$$C_{\mathrm{F},t} = \gamma 2\left(\frac{P_{\mathrm{F},t}}{P_{T,t}}\right)^{-\theta 2} C_{T,t}$$

Therefore, the price index of tradable consumer goods is a combination of the price index of domestic and foreign exchange goods and is defined as follows:

$$P_{T,t} = \left[(1-\gamma 2)\,\mathrm{P}_{\mathrm{H},t}^{\ 1-\theta 2} + \gamma 2 P_{\mathrm{F},t}^{\ 1-\theta 2}\right]^{\frac{1}{(1-\theta 2)}}$$

In the second stage, after determining the optimal composition of goods in the previous stage, the household goal is to maximize its utility according to its budget constraint. The actual household income and budget are specified in the following relationships:

$$\left\{(1+i^*_{t-1})er_t.\mathrm{D}^*_{t-1} - \frac{Tax_t}{P_t} + (1+i_{(t-1)})\left(\frac{B_{t-1}}{P_t}\right) + \frac{D_t}{P_t} + \frac{W_t}{P_t}L_t + \frac{M_{t-1}}{P_t} + r_t^k U_t(j) - \psi(U_t(j))\right\}$$

$$\left\{C_t + I_t + \frac{M_t}{\mathrm{P_t}} + \frac{\mathrm{B_t}}{\mathrm{P_t}} + \mathrm{er}.\frac{\mathrm{D^*_t}}{\mathrm{P_t}}\right\}$$

In the above relationships, I_t investment, $\frac{Tax_t}{P_t}$ household taxes, $\mathrm{B_t}$ nominal value of domestic bonds, $\frac{\mathrm{D^*_t}}{\mathrm{P_t}}$ foreign bonds (foreign assets), $(1+i_{(t-1)})$ interest rates on domestic bonds, $(1+i^*_{t-1})$ interest rates on foreign bonds, $\frac{M_t}{\mathrm{P_t}}$ real money, $\frac{W_t}{P_t}$ real wages, er exchange rates, r_t^k real rates $U_t(j)$ Capital rent is the amount of capital utilization, C_t consumer goods, $\psi(U_t(j)$ the cost of capital utilization. Regarding the cost of capital utilization, it is assumed that if the capital is fully used, this cost will be zero, and in case of exploitation less than the potential capacity, there will be an operating cost, and for this cost, the following relation is considered:

$$\psi(U_t(j)) = \begin{cases} \psi(1)=0 \\ \psi^{\bullet}(U_t(j)) \succ 0 \end{cases}$$

We also assume that the household invests some of its income and generates new income from these investments. In each period, the investment, despite the costs of adjusting the investment, in the next period, I_t the capital stock. k_{t+1} Increases the economy in the following ways:

$$k_{t+1} = (1-\delta)\mathrm{k}_t + \left(1-\Phi_I\left(\frac{\mathrm{e}^{\mathrm{I}}_{t.\mathrm{I}_t}}{\mathrm{I}_{t-1}}\right)\mathrm{I}_t\right)$$

In the above equation, δ the rate of capital depreciation I_t is a private sector investment and $\Phi_I\left(\frac{\mathrm{e}^{\mathrm{I}}_{t.\mathrm{I}_t}}{\mathrm{I}_{t-1}}\right)$ a function of investment adjustment costs, which is a positive function of changes in investment. $\mathrm{e}^{\mathrm{I}}_t$ Technology shock means investment. Here's the investment shock process as follows:

$$\varepsilon^I_t \sim N(0,\sigma^2_I)$$

$$\log \mathrm{e}^{\mathrm{I}}_t = \rho_I \log \mathrm{e}^{\mathrm{I}}_{t-1} + \varepsilon^I_t$$

It is assumed that household investment in each period is a combination of domestic and imported capital goods:

$$I_t \equiv [(1-\gamma\mathrm{i})^{\frac{1}{\eta\mathrm{i}}} \mathrm{I}_{H,t}^{\frac{\eta i-1}{\eta i}} + \gamma\mathrm{i}^{\frac{1}{\eta\mathrm{i}}} \mathrm{I}_{F,t}^{\frac{\eta i-1}{\eta i}}]^{\frac{\eta\mathrm{i}}{\eta\mathrm{i}-1}}$$

In the above relation, $I_{F,t}, I_{H,t}$ representing domestic and imported capital goods, respectively, i$\boldsymbol{\eta}$ measures the substitution elasticity between these two types of goods and shows the share of imported capital goods in the total investment portfolio. The demand function for domestic and imported capital goods will also be as follows:

$$I_{H,t} = (1-\gamma i)(\frac{P_{H,t}}{P_t})^{-\eta i}\ \mathrm{I}_t$$

$$I_{\mathrm{F},t} = \gamma i\,(\frac{P_{\mathrm{F},t}}{P_t})^{-\eta i}\ \mathrm{I}_t$$

$$\ell_t = \mathrm{E}_t \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{l} \mathrm{e}^c_t \left\{ \frac{(C_t - hC_{t-1})^{1-\sigma c}}{1-\sigma c} + \frac{1}{1-\sigma md} \cdot \frac{(\frac{M_t}{P_t})^{1-\sigma md}}{e^{md}_t} - \frac{e^l_t (l_t)^{1+\sigma l}}{1+\sigma l} \right\} \\ +\lambda_t \left\{ \begin{array}{l} (1+i^*_{t-1}) er_t . \mathrm{D}^*_{t-1} - \frac{Tax_t}{P_t} + (1+i_{(t-1)})(\frac{B_{t-1}}{P_t}) + \frac{D_t}{P_t} + \frac{W_t}{P_t} L_t \\ + \frac{M_{t-1}}{P_t} + r^k_t U_t(j) - \psi(U_t(j)) - C_t - I_t - \frac{M_t}{\mathrm{P}_t} - \frac{\mathrm{B}_t}{\mathrm{P}_t} \text{-er.} \frac{\mathrm{D}^*_t}{\mathrm{P}_t} \end{array} \right\} \\ +Q_t \left\{ (1-\delta)\mathrm{k}_t + \left(1-\Phi_I\left(\frac{\mathrm{e}^{\mathrm{I}}_{t.\mathrm{I}_t}}{\mathrm{I}_{t-1}}\right)\mathrm{I}_t\right) - k_{t+1} \right\} \end{array}\right]$$

That ℓ_t the Lagrangian function, λ_t and Q the Lagrangian coefficients are related to the budget constraint and capital stock. By substituting the optimization equations and eliminating the Lagrangian coefficient and writing a new equation in terms of period t consumption and its linear logarithm, the Euler equation of intermediate consumption is obtained as the following equation:

$$\hat{C}_t = \frac{h}{1+h}\hat{C}_{t-1} + \frac{1}{1+h}\hat{C}_{t+1} - \frac{1-h}{(1+h)\sigma_c}(\hat{i} - \hat{\pi}_{t+1}) + \frac{1-h}{(1+h)\sigma_c}(\hat{e}^c_t - \hat{e}^c_{t+1})$$

By placing the equations and eliminating the Lagrangian coefficient and writing a new equation according to the real money demand demand and its linear logarithm, the money demand equation is obtained as the following equation:

$$\hat{m}^{md} = \frac{1}{\sigma_{m^{md}}}\left[\frac{\sigma_c(\hat{C}_t - h\hat{C}_{t-1})}{(1-h)} - \frac{1}{(1+\bar{r})} r_t + \hat{e}^{md}_t\right]$$

By placing the equations and eliminating the Lagrange coefficient and writing a new equation in terms of labor supply and its linear logarithm, the labor supply equation is obtained as the following equation:

$$\hat{l}_t = \frac{1}{\sigma_l}\left[\hat{w}_t - \frac{\sigma_c}{(1-h)}(\hat{\mathrm{c}}_t - h\hat{c}_{t-1}) - \hat{e}^l_t\right]$$

The household investment decision equation is obtained with a linearized logarithmic form as follows:

$$\hat{I}_t = \frac{1}{1+\beta}\hat{I}_{t-1} + \frac{\beta}{1+\beta}\mathrm{E}_t\hat{I}_{t+1} + \frac{1}{(1+\beta)\varphi}\hat{q}_t + \hat{e}^I_{t+1}$$

In the above relation, $\hat{q}_t = \frac{q_t}{\lambda_t}$ the ratio of two Lagrangian coefficients or the ratio of the market value of the installed capital in terms of its replacement cost, which is called the final Tobin in the correction of q, its linear logarithmic form equation is as follows:

$$\hat{q}_t = -(\hat{i}_t - \hat{\pi}_{t+1}) + (\tfrac{1-\delta}{1-\delta+\bar{r}^k})\mathrm{E}_t\hat{q}_{t+1} + (\tfrac{\bar{r}^k}{1-\delta+\bar{r}^k})\mathrm{E}_t\hat{r}^k_{t+1} + \hat{e}^q_t$$

Taking into account $d_t = (\frac{er_t}{er_{t-1}})$ the changes in the value of the nominal exchange rate and $\pi_t = (\frac{p_t}{p_{t-1}})$ as the gross inflation rate, the equation of interest rate without coverage is obtained as follows:

$$(1+\hat{i}_t) = (1+\hat{i}^*_t) + \mathrm{e}\hat{\mathrm{r}}_{t+1} - e\hat{r}_t$$

This equation states that in equilibrium and in order to eliminate the possibility of arbitrage, assuming full mobility of capital between the domestic country and the outside world, the domestic interest rate should be equal to the foreign interest rate plus the expected changes in the nominal exchange rate.

Manufacturers

In this model, domestic products are divided into two groups of tradable and non-tradable goods. In each group, there are two types of active firms: firms producing intermediate goods and firms producing final goods. It is assumed that the producers of final goods in a competitive market and the producers of intermediate goods operate in a monopolistic competition market.

- Production of tradable goods

Behavior of final goods companies

In this model, there is a chain of traders producing intermediate goods, each of which is a $y^j_{H,t}$ unit producer of goods, which is converted by a final goods collector firm to a Y-(H, t) commodity based on a $\boldsymbol{Y_{H,t}}$Dixit-Stiglitz collector in period t.

The production function of the company producing the final product is as follows:

$$Y_{H,t} = \left[\int_0^1 (y^j_{H,t})^{\frac{1}{1+\lambda^\rho_{H,t}}} dj\right]^{1+\lambda^\rho_{H,t}}$$

That $y^j_{H,t}$ the production of tradable intermediate goods of firm j, $\boldsymbol{Y_{H,t}}$Y_ (H, t) is total tradable production and $\lambda^\rho_{H,t}$ a random process that transmits exogenous shocks to the total production function and changes the demand elasticity of intermediate goods and the amount will be marked up. It is generally interpreted as a cost-pressure shock in the inflation equation (ElFayoumi, 2018: 9). The company that produces the final product, which operates in a fully competitive market, tries to determine the amount of its purchase from these goods according to the prices of intermediate goods in such a way that its profit is maximized. Therefore, the issue of maximizing the profit of the final tradable producer can be written as follows:

$$\underset{y^j_{H,t}}{Max} \quad P_{H,t}Y_{H,t} - \int_0^1 P^j_{H,t}\, y^j_{H,t}\, dj$$

By solving this optimization problem, the demand function of the Dixit-Stiglitz standard for the tradable intermediate commodity j is represented by the following relation:

$$y^j_{H,t} = \left(\frac{P^j_{H,t}}{P_{H,t}}\right)^{\frac{-(1+\lambda^\rho_{H,t})}{\lambda^\rho_{H,t}}} y_{H,t}$$

That $P^j_{H,t}$ the price of tradable intermediate goods is j and $p_{H,t}$ the total price index of tradable goods is domestically produced, which can be expressed as follows:

$$P_{H,t} = \left(\int_0^1 (p^j_{H,t})^{\frac{-1}{\lambda^\rho_{H,t}}} dj\right)^{-\lambda^\rho_{H,t}}$$

A company that produces tradable intermediate goods

The economy consists of a chain of monopolies competing in the production of tradable intermediate goods. Each firm produces distinct goods. These firms provide their labor and capital from a fully competitive market. Since government budgets play an important role in the productivity of the private sector due to government dominance in the economy, it is necessary to build public capital to consider a type in the function of firms producing intermediate goods and the production function of these firms is as follows.

$$y_{H,t}^{j} = Z_{H,t}.(k_{H,t-1}^{j})^{\alpha_H}.(L_{H,t}^{j})^{1-\alpha_H}.(kG_{t-1})^{\alpha_G}$$

That $\alpha_H \in (0,1)$ the share of private capital and $\alpha_H \in (0,1)$ the share of public sector capital in the production of tradable goods shows domestic production. $K_{H,t-1}^{j}$ Private sector capital stock kG_{t-1} is the volume of public sector capital, $L_{H,t-1}^{j}$ labor, and $Z_{H,t}$ technology shocks that are common to all firms and are assumed to follow the following process.

$$e_t^{Z_{H,t}} \sim N(0,\sigma_{Z_H}^2)$$

$$\log Z_{H,t} = \rho_H \log Z_{H,t-1} + e_t^{Z_{H,t}}$$

The goal of a firm producing tradable intermediate goods is to minimize the cost of production relative to the limitations of its production function, whose Lagrangian function is as follows:

$$\ell = w_t l_{H,t} + r_t^k k_{H,t} + mch_t (y_{H,t} - Z_{H,t}.(k_{H,t-1})^{\alpha_H}.(L_{H,t})^{1-\alpha_H}(kG_{t-1})^{\alpha_G})$$

From solving the first-order conditions of minimizing the costs of the j-th firm according to a certain amount of production, the following relations are obtained:

Ratio of capital stock to labor force

$$\frac{k_{H,t-1}}{L_{H,t}} = \frac{\alpha_H \omega_t}{(1-\alpha_H) r_t^k}$$

And the mch_t Lagrangian coefficient as the real final cost is obtained as follows:

$$mch_t = \frac{1}{Z_{H,t}}\left(\frac{1}{kG_{t-1}}\right)^{\alpha_G}\left(\frac{1}{1-\alpha_H}\right)^{(1-\alpha_H)}\left(\frac{1}{\alpha_H}\right)^{\alpha_H}(r_t^k)^{\alpha_H} w_t^{1-\alpha_H}$$

Another issue that the commodity-producing intermediary firm faces is the issue of pricing. Since they operate in a monopoly market, they have pricing power. Here, we use the Calvo (1983) method to determine prices optimally, ie in each period, only $(1-\theta_H)$ a percentage of firms are able to adjust their prices optimally. And for the θ_H percentage of others who can not adjust their prices optimally, based on last year's inflation, they index prices in detail using the following formula:

$$P_{H,t+1}^{j} = (\pi_{H,t})^{\tau_H} P_{H,t}^{j}$$

In which $\pi_{H,t} = \frac{P_{H,t}}{P_{H,t-1}}$ the gross inflation rate of tradable goods and τ_H the parameter determines the degree of price indexing. It is done by the final producers, to maximize.

By calculating the conditions of the first order and if we consider the $P_t^* = P_{jt}$ optimal price:

$$\left(\frac{P_t^*}{P_t}\right) = \frac{\theta}{(\theta-1)} \frac{E_t \sum_{i=0}^{\infty} B^i \omega^i \varphi\left(\frac{P_{t+i}}{P_t}\right)^{\theta} C_{t+i}^{1-\sigma}}{E_t \sum_{i=0}^{\infty} B^i \omega^i . C_{t+i}^{1-\sigma}\left(\frac{P_{t+i}}{P_t}\right)^{\theta-1}}$$

This pricing rule is optimal for firms that face price stickiness. Since it was assumed that in each time period some firms could set their prices optimally and the rest of the firm's index their prices based on past inflation, the total price index of tradable goods as an average the weight of these two types of firms is obtained as follows:

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$$p_t^{1-\theta} = (1-\omega)(p_t^*)^{1-\theta} + \omega p_{t-1}^{1-\theta}$$

The new Phillips-Keynesian curve for hybrid tradable goods in its linear logarithm is obtained by the following equation:

$$\hat{\pi}_{H,t} = \frac{\beta}{1+\beta\tau_H} \mathrm{E}_t \hat{\pi}_{H,t+1} + \frac{\tau_H}{1+\beta\tau_H} \hat{\pi}_{H,t-1} + \frac{1}{1+\beta\tau_H} \frac{(1-\beta\omega)(1-\omega)}{\omega} \hat{mch}_t + \hat{e}_t^H$$

Firms producing non-tradable goods

Behavior of final goods companies

In this model, there is a chain of firms producing non-tradable intermediate goods, each of which is a single producer of goods $y^j_{\mathrm{N},t}$, which is converted into a commodity in period t by the final goods producer based on a Dixit-Stiglitz collector $Y_{N,t}$. The production function of the company producing the final product is as follows:

$$Y_{N,t} = \left[\int_0^1 (y^j_{\mathrm{N},t})^{\frac{1}{1+\lambda^\rho_{\mathrm{N},t}}} dj \right]^{1+\lambda^\rho_{\mathrm{N},t}}$$

That the $y^j_{\mathrm{N},t}$ production of tradable intermediate goods of firm j, $Y_{N,t}$ is the total tradable production and $\lambda^\rho_{\mathrm{N},t}$ a random process that transmits exogenous shocks to the function of total production and will change the elasticity of demand for intermediate goods and the amount of markup. It is commonly interpreted as a cost-pressure shock in the inflation equation (Asmat and Wetter, 2003). The company that produces the final product, which operates in a fully competitive market, tries to determine the amount of its purchase from these goods according to the prices of intermediate goods in such a way that its profit is maximized. By solving this optimization problem, the demand function of the Dixit-Stiglitz standard for the non-tradable intermediate commodity j represents the following equation:

$$y^j_{N,t} = \left(\frac{P^j_{\mathrm{N},t}}{P_{\mathrm{N},t}} \right)^{\frac{-(1+\lambda^\rho_{\mathrm{N},t})}{\lambda^\rho_{\mathrm{N},t}}} y_{\mathrm{N},t}$$

That $P^j_{H,t}$ the price of non-tradable intermediate goods j, and $p_{H,t}$ the total price index of non-tradable goods is domestically produced, which can be expressed as follows:

$$P_{\mathrm{N},t} = \left(\int_0^1 (p^j_{\mathrm{N},t})^{\frac{-1}{\lambda^\rho_{\mathrm{N},t}}} dj \right)^{-\lambda^\rho_{\mathrm{N},t}}$$

A company that produces non-tradable intermediate goods

The economy consists of a chain of monopolies competing in the production of non-tradable intermediate goods. Each firm produces distinct goods. These firms provide their labor and capital from a fully competitive market. Since government budgets play an important role in the productivity of the private sector due to government dominance in the economy, it is necessary to build public capital to consider a type in the function of firms producing intermediate goods and the production function of these firms is as follows:

$$y_{N,t} = Z_{\mathrm{N},t} .(k_{N,t-1})^{\alpha_N} .(\mathrm{L}_{N,t})^{1-\alpha_N} .(kG_{t-1})^{\alpha_G}$$

That $\alpha_N \in (0,1)$ the share of private capital and $\alpha_N \in (0,1)$ the share of public sector capital in the production of non-tradable goods shows domestic production. $K^j_{\mathrm{N},t-1}$ Private sector capital stock kG_{t-1} is the volume of public sector capital, $L^j_{\mathrm{N},t-1}$ labor, and $Z_{\mathrm{N},t}$ technology shocks that are common to all firms and are assumed to follow the following process.

$$e_t^{Z_{\mathrm{N},t}} \sim N(0, \sigma^2_{Z_N})$$

$$\log Z_{\mathrm{N},t} = \rho_N \log \mathrm{Z}_{\mathrm{N},t-1} + e_t^{Z_{\mathrm{N},t}}$$

External section

Real exchange rate, exchange relationship and incomplete currency transfer channel

One of the features of the New Keynesian stochastic dynamic general equilibrium model for an open economy is to consider price deviation from the unit price law as the unit price gap (Monasi Lee, 2005: 1051). And companies importing and distributing intermediate goods have pricing power. As a result, this power will cause the price of imported goods to differ in terms of a similar currency in both domestic and foreign markets.

$$\psi = \frac{er_t P_t^*}{p_{F,t}}$$

er_t The nominal exchange rate (the amount of domestic currency in terms of one foreign currency), P_t^* the price index of the outside world, $P_{F,t}$ the price index of imported goods in terms of the national currency, and ψ the unit price law, which if established, will be equal to one. Assume the real exchange rate as the ratio of the world price index (in national currency) to the domestic price index:

$$rer_t = \frac{er_t P_t^*}{P_t}$$

Which rer_t shows the real exchange rate. The exchange relationship, which shows the competitiveness of the domestic economy against trading partners, is defined as the ratio of the price of tradable goods of domestically produced goods to the import price index in terms of the national currency:

$$V_t = \frac{P_{H,t}}{P_{F,t}}$$

Which V_t shows the exchange relationship, $P_{F,t}$ the price index of imported goods and $P_{H,t}$ the price index of domestically traded goods.

Importers

Assuming that the prices of imported goods in the domestic and foreign markets are different, this will mean that the single price law will not be in place in the country in question. That is, importers have the power to price their goods. So in the import sector, there are many companies that buy homogeneous goods at world prices from foreign markets and turn them into distinctive consumer goods using different technologies or through branding. They offer exclusive competition for their goods and can determine the price of their goods. The Calvo method (1983) is used to model the price adjustment of imported goods according to the studies of Adelfson (a2007) and Monacelli (2005). In each period, only a $(1-\theta_F)$ percentage of importing firms have the opportunity to set their prices optimally, and the rest of the firms adjust the θ_F prices of their imported goods according to the following indexing formula:

$$P_{F,t+1}^j = (\pi_{F,t})^{\tau_F} P_{F,t}^j$$

That $\pi_{F,t} = \frac{P_{F,t}}{P_{F,t-1}}$ the gross inflation rate is based on the import price index. τ_F The degree of price indexation of imported goods is between zero and one. The total price index of imported goods is calculated through the following equation:

$$P_{F,t} = \left[\int_0^1 (P_{F,t}^j)^{\frac{-1}{\lambda_{F,t}^\rho}} dj \right]^{-\lambda_{F,t}^\rho}$$

That $\lambda_{F,t}^p$ the markup shock is the mana price for import and follows an AR (1) in the form of a linear logarithm:

$$\hat{\lambda}_{F,t}^p = \rho_F \hat{\lambda}_{F,t-1}^p + \hat{e}_{F,t}^P$$

Importers convert different imported goods $c_{F,t}^{j}$ into final goods using the CES collector ($C_{F,t}$) as follows:

$$C_{F,t} = \left[\int_0^1 (c_{F,t}^{j})^{\frac{1}{1+\lambda_{F,t}^{p}}} dj \right]^{1+\lambda_{F,t}^{p}}$$

Similar to what was said in the previous sections about domestic firms, the collecting firm selects the composition of the imported goods in such a way that the cost of the imported goods is minimized $C_{F,t}$ according to a certain amount of imports ($c_{F,t}^{j}$). The following demand for imported consumer goods is obtained:

$$c_{F,t}^{j} = \left[\frac{P_{F,t}^{j}}{P_{F,t}} \right]^{-\frac{1+\lambda_{F,t}^{p}}{\lambda_{F,t}^{p}}} C_{F,t}$$

Similar to intermediate producers, firms importing maximize their expected discounted profit flow with respect to price sticking and based on the Calvo (1983) method. Finally, the relationship between imported inflation rate dynamics can be logarithm-linear stated as follows:

$$\hat{\pi}_{F,t} = \frac{\beta}{1+\beta\tau_F} E_t \hat{\pi}_{F,t+1} + \frac{\tau_F}{1+\beta\tau_F} \hat{\pi}_{F,t-1} + \frac{1}{1+\beta\tau_F} \frac{(1-\beta\omega)(1-\omega)}{\omega} mc\hat{F}_t + \hat{e}_t^{F}$$

In the above relation, $mc\hat{F}_t = \hat{P}_t^{fr} + \hat{er}_t - \hat{p}_{F,t}$ the real final cost is the importing firms.

Exporters

Exporting firms buy goods from domestically produced firms and sell them in global markets. We assume that the foreign household consumption function, which combines the following domestically produced and imported goods with the CES collector, is as follows:

$$C_t^{*} = \left[\chi_1^{\frac{1}{\kappa_1}} X_t^{\frac{\kappa_1 - 1}{\kappa_1}} + (1-\chi_1)^{\frac{1}{\kappa_1}} C_{N,t}^{*\frac{\kappa_1 - 1}{\kappa_1}} \right]^{\frac{\kappa_1}{\kappa_1 - 1}}$$

χ_1 The share of the country's exports in the consumer basket of foreign households, κ_1 is the elasticity of substitution between domestic and imported goods in global markets. Foreign households seek to minimize their consumption expenditure relative to the high collector function. By obtaining the conditions of the first order, the demand function for the export of the desired country (Iran) can be written as follows:

$$X_t = \chi_1 \left[\frac{P_t^{x}}{P_t^{*}} \right]^{-\kappa_1} C_t^{*}$$

P_t^{*} The global CPI P_t^{x} price index is the price index of the country's exports in world markets (in dollars), X_t the country's exports and C_t^{*} the total level of world consumption. If the economy of the country in question is small compared to the world economy, then the world economy is considered closed to the economy of this country because the export of the country in question constitutes a small share of the total consumption of the world. Therefore, in the following equation, C_t^{*} the world GDP can be replaced instead y_t^{*}:

$$X_t = \chi_1 \left[\frac{P_t^{x}}{P_t^{*}} \right]^{-\kappa_1} y_t^{*}$$

It is also assumed that in the market of export goods, the unit price law is established because the share of exports of the country in relation to world production is insignificant.

$$P_t^{X} = \frac{P_t^{d}}{er_t}$$

That P_t^d the price index of tradable manufactured goods and er_t the nominal exchange rate in the country in question.

Government and Central Bank

Due to the lack of central bank independence in Iran, the government and the central bank can not be modeled as two separate parts, but they should be considered in relation to each other. It is assumed that the government's goal is to keep its budget balanced, and in times of budget deficit, the central bank acts in such a way that the government achieves its main goal. Also, because the central bank's goal is to maintain price stability and increase economic growth, in addition to helping the government achieve its goal, the central bank is trying to achieve its goals through monetary policy.

Government budget constraint:

The government tries to cover its expenditures in the form of current construction expenditures through tax revenues from households, the sale of participation bonds, and borrowing from the central bank.

$$g+(1+i_{t-1})\frac{B_{t-1}}{P_t}=\frac{B_t}{P_t}+Tax_t+\frac{M_t-M_{t-1}}{P_t}.$$

Total government expenditures consist of two parts, current and development expenditures, and we have considered them as externalities that are affected by shocks to current expenditures, development expenditures and oil revenues:

$$g=gc+gi$$

$$gc=\rho_{gc}gc_{t-1}+e_t^{gc}$$

$$gi=\rho_{gi}gi_{t-1}+e_t^{gi}+e_t^{oilr}$$

The equation of accumulation of government capital is specified as follows:

$$kG_t=(1-\delta)KG_{t-1}+gi$$

Government tax revenues:

In this study, VAT is a function of total public and private spending and other taxes are a function of total national income:

$$Tax_t=taxy_t+taxva_t$$

Oil revenues:

In this study, oil production through non-modeled production companies is determined exogenously. Iran's export quota is determined through OPEC and oil prices in world markets are determined. As a result, foreign exchange earnings from oil exports are exogenous and it is assumed to follow a first-order self-regression process:

$$oilr_t=\rho_{oilr}oilr_{t-1}+e_t^{oilr}$$

Central Bank balance sheet

$$M_t=DC_t+FR_t$$

Government debt to the central bank follows the following relationship:

$$DC_t=DC_{t-1}+(g-\varpi oilr_t-Tax_t)$$

The central bank's foreign reserves follow the following relationship:

$$FR_t=FR_{t-1}+\varpi oilr_t+X_t-\frac{IM_t}{er_t}$$

Monetary policy

$$mg_t=\rho_{mg}mg_{t-1}+\lambda_\pi\pi_t+\lambda_y y_t+e_t^{mg}$$

The balance of the whole market

A four-sector pattern in macroeconomics is defined as follows:

$$Y_t=C_t+I_t+G_t+X_t-IM_t$$

In the model, since household consumption is a combination of domestically produced and imported goods, and investment also includes domestically produced and imported goods. As a result, the market settlement condition will be obtained as follows:

$$Y_t=C_{H,t}+C_{N,t}+C_{F,t}+I_{H,t}+I_{F,t}+G_t+X_t-(C_{F,t}+I_{F,t})$$

We assume that there is no cash in the economy, so the central bank balance sheet does not contain any monetary debt. The first difference of the central bank balance sheet is as follows:

$$b_t^{cb}-\frac{b_{t-1}^{cb}}{\pi_t}=(d_t^g-\frac{d_{t-1}^g}{\pi_t})-s_t(R_t^*-R_{t-1}^*)$$

R_t^* Inventory of foreign reserves. The policy of the central bank is expressed by Taylor's law:

$$i_t = \frac{1}{\beta}(\pi_t^N)^{\phi_\pi}$$

R^* The amount of reserves in the long run. The coefficient ω measures the amount of surplus oil dollars sold to the market by the central bank, ie the degree of rapid absorption out of the stable position. The central bank initially accumulates 1-ω of the increase in oil revenues as reserves, which will decrease at the rate of P_d.

The rest of the world

The rest of the world is considered exogenous. That is, the variables of foreign production, foreign inflation, and foreign interest rates are considered exogenously in the model. According to Adolfson (2005), the rest of the world is vectorized Self-regression is modeled:

$$\hat{y}^* = \rho_{y^*}\hat{y}^*_{t-1} + \varepsilon_{y^*}$$
$$\hat{r}^* = \rho_{r^*}\hat{r}^*_{t-1} + \varepsilon_{r^*}$$
$$\hat{\pi}^* = \rho_{\pi^*}\hat{\pi}^*_{t-1} + \varepsilon_{\pi^*}$$

The share of international risk

Incomplete asset substitution between domestic and foreign stocks results in a condition of apparent optimal rate parity (UIP) equal to:

$$\mathrm{E}_t\lambda_{t+1}P_{t+1}\left[\left(1+\tilde{i}_t\right)-\left(1+\tilde{i}_t^*\right)\left(\tilde{e}_{t+1}/\tilde{e}_t\right)\phi_{t+1}\right]=0$$

And the real exchange rate is defined this way: $\tilde{q}_t = \tilde{e}_t P_t^* / P_t$

Monetary policy

Monetary policymakers regulate policy based on the following

$$\frac{i_t}{\bar{i}} = \left(\frac{i_{t-1}}{\bar{i}}\right)^{\rho_i(\xi_t^P)}\left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\lambda_\pi(\xi_t^P)}\left(\frac{Y_t}{\bar{Y}}\right)^{\lambda_Y(\xi_t^P)}\left(\frac{\tilde{e}_t}{\tilde{e}_{t-1}}\right)^{\lambda_{de}(\xi_t^P)}\right]^{1-\rho_i(\xi_t^P)} \exp\left[\sigma_i\left(\xi_t^Q\right)\epsilon_{i,t}\right],$$

That λ_π, λ_y and λ_{de} policy responses to inflation, production and $\epsilon_{i,t} \sim N(0,1)$ exchange rate gap, respectively

Financial policy

The government regulates taxes according to the following law:

$$\tilde{\tau}_t = \rho_{\tau,\xi_t^{sp}}\tau_{t-1} + \left(1-\rho_{\tau,\xi_t^{sp}}\right)\left[\delta_{b,\xi_t^{sp}}\tilde{b}^m_{t-1} + \delta_e\tilde{e}_t + \delta_y(\hat{y}_t - \hat{y}_t^*)\right] + \sigma_{\tau,\xi_t^{vo}}\epsilon_{\tau,t}$$

That $\tilde{\tau}_t$ the deviation of the tax-to-GDP ratio and $\epsilon_{T,t} \sim N(0,1)$. Taxes not only react to $\delta_{b,\xi_t^{sp}}$ debt, but also to government spending δ_e and the δ_y GDP gap. Note that, like the monetary policy response parameters, the fiscal policy $\rho_{\tau,\xi_t^{sp}}$ and $\delta_{b,\xi_t^{sp}}$ response parameters can be changed.

MS-DSGE model

According to the study of Gali and Monacelli (2005) and Monacelli (2005), Justiniano and Preston (2010), the important features of DSGE models in economics, such as incomplete asset market, habit formation and price indexation in inflation were introduced. . The experimental literature uses the linear logarithm approximation of the model optimization conditions around a non-random steady state. In the following, we present the equations related to this analysis. All variables are inferred as the logarithm of the deviations of the values of the steady state. The model proposed by Justiniano and Preston (2010) is shown in the next step in accordance with the studies of Liu and Mumtaz (2011). Euler's linear logarithm equation is expressed as follows:

$$(1+h)c_t + hc_{t-1} + E_t c_t - \frac{1-h}{\sigma}(r_t - E_t\pi_{t+1}) + \frac{1-h}{\sigma}(\epsilon_{g,t} - \rho_g \epsilon_{g,t})$$

That current consumption logarithm (c_t) depends on the consumption of t-1, the expected future consumption ($E_t\pi_{t+1}$) and the real interest rate ($r_t - E_t\pi_{t+1}$). Parameter h shows the degree of habit continuity, inverse σ of the substitution tension between temporal and $\epsilon_{g,t}$ Rahjan shock. The linear logarithm approximation of market equilibrium conditions is shown as follows:

$$y_t = (1-\alpha)c_t + \alpha[\eta(s_t + q_t) + y_t^*]$$

That y_t is domestic production, s_t is business conditions, q_t is the real exchange rate, and y_t^* is foreign production. Equation (2) shows that domestic production is the sum of domestic consumption and exports, while the parameter α shows the level of economic openness and η is the substitution elasticity between domestic and imported goods. The law of one price is shown as follows:

$$\psi_{F,t} = q_t - (1-\alpha)s_t$$

Which $\psi_{F,t}$ is the deviation from the law of one value. Trading conditions are indicated by $s_t = p_{F,t} - p_{H,t}$ This conveys the concept:

$$s_t - s_{t-1} = \pi_{F,t} - \pi_{H,t}$$

Which $\pi_{F,t}$ imported inflation and $\pi_{H,t}$ domestic inflation. Thus, sustainable domestic consumption depends on domestic production and on three sources of external turmoil: trade conditions, deviations from the one-price law, and foreign production. The relationship between the real exchange rate and trading conditions can be expressed by this equation:

$$q_t = e_t + p_t^* - p_t = \psi_{F,t} + (1-\alpha)s_t \text{ یا } \Delta e_t = q_t - q_{t-1} + \pi_t - \pi_t^*$$

The Phillips curve for domestic inflation is shown by the following equation:

$$(1+\beta\delta_H)\pi_{H,t} = \delta_H\pi_{H,t+1} + \beta E_t\pi_{H,t+1} + \frac{(1-\theta_H)(1-\theta_H\beta)}{\theta_H}mc_t$$

Which $mc_t = \varphi y_t - (1+\varphi)\epsilon_{a,t} + \alpha s_t + \sigma(1-h)^{-1}(c_t - hc_{t-1})$ is a function of the actual final cost of each company, $\epsilon_{a,t}$ shock, β intermittent discount rate, δ_H index measurement rates, θ_H is the fraction of companies that do not adjust their prices in each period, and the reverse is the elasticity of labor supply. Thus, domestic inflation depends on past inflation $\pi_{H,t-1}$ and its expectation $\pi_{H,t+1}$ for the next period and the current final cost mc_t. The Phillips Import Inflation Curve is shown as follows:

$$(1+\beta\delta_H)\pi_{F,t} = \delta_H\pi_{F,t-1} + \beta E_t\pi_{F,t+1} + \frac{(1-\theta_H)(1-\theta_F\beta)}{\theta_F}\psi_{F,t} + \epsilon_{cp,t}$$

The above equation, similar to the previous equation, according to the hypothesis of the participation of imported retailers in the monopoly competition market, records the deviations of the one-price law (Equation (3)) for imported goods. In addition, the shock due to exogenous cost pressure $\epsilon_{cp,t}$, which shows inefficient changes in price increases, is considered. Current inflation related to domestic and imported inflation is as follows:

$$\pi_t = (1-\alpha)\pi_{H,t} + \alpha\pi_{F,t}$$

The condition of equality of the uncovered interest rate with Equation (9) is shown:

$$E_t(q_{t+1} - q_{t+1}) = (r_t - E_t\pi_t) - (r_t^* - E_t\pi_{t+1}^*) + \chi a_t - \epsilon_{\phi,t}$$

Where a_t is the level of foreign assets, χ is the elasticity of debt given the interest rate and $\epsilon_{\phi,t}$ is the risk of shock. The flow of asset budget constraints can be shown as follows

$$c_t + a_t = \frac{1}{\beta} a_{t-1} - \alpha(q_t + \alpha s_t + y_t$$

Finally, monetary policy is assumed to be articulated by Taylor's law. The central bank responds to fluctuations in inflation and output through interest rates. In addition, the central bank can react to the devaluation of the exchange rate. Therefore, the interest rate law is shown as follows:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)[\lambda_1 \pi_t + \lambda_2 y_t + \lambda_3 \Delta e_t] + \sigma_m \epsilon_{m,t}$$

Equation (11) shows that nominal interest rates react to past inflation, current inflation, output, nominal exchange rate fluctuations and interest rate shocks, or monetary policy shock $\epsilon_{m,t}$ in general. Parameter $0 < \rho_r < 1$ shows the rate of interest rate smoothing and λ_1, λ_2 and $\lambda_3 \geq 0$, respectively, inflation response, production and exchange rate movement coefficients. Shock$\epsilon_{m,t}$ can be interpreted as a non-systematic component of monetary policy.

Therefore, this model contains 22 variables χ_t containing four terms about expectation. The exogenous processes of the model $\mathrm{Z_t}$ are: preference shock $\epsilon_{g,t}$; Technology shock$\epsilon_{a,t}$; Cost shock$\epsilon_{cp,t}$; Risk-only shock $\epsilon_{\phi,t}$; Monetary policy shock$\epsilon_{m,t}$; Foreign production shock$\epsilon_{y^*,t}$; External inflation shock $\epsilon_{\pi^*,t}$; And external interest rate shock $\epsilon_{r^*,t}$. All AR (1) process perturbations are assumed to be independent, except (ϵ_ (m, t)) which follows an independent process with the same distribution (i.i.d). Hence, we have:

$$\epsilon_{j,t} = \rho_j \epsilon_{j,t-1} + \sigma_j \eta_{j,i} \quad \text{for} \quad j = g, a, cp\ e\ \emptyset$$

$$v_t = \rho_v v_{j,t-1} + \sigma_v \eta_{v,i} \quad \text{for} \quad v = y^*, \pi^*, e\ r^*$$

Matrix form

By rewriting the DSGE model as a matrix, we find:

$$\Gamma_0 X_{t+1} = \Gamma_1 X_t + \psi Z_t + \Pi \eta_t$$

Which X is the vector $n \times 1$ of the endogenous variables, Z is the vector of exogenous processes $\mathrm{k} \times 1\mathrm{k}$ and η_t is the disorder $\iota \times 1$. Γ_0,Γ_1, Ψ and Π are the model parameter matrices. The representation of the model in Equation 13 remains constant in all parameters and allows it to be solved by rational expectation algorithms, such as the Genesis solution method proposed by Sims (2001). This solution will be definite (single solution) or indefinite (multiple solutions) or critical (no solution) according to some conditions in the matricesΓ_0,Γ_1, Ψ and Π. Having a single solution requires that the endogenous shock η_t be adjusted in each period to keep the system in a linear space and the solutions remain limited, and this extends to the properties of Ψ and Π matrices as well as to specific values. Γ_0, and Γ_1 depend. This method offers the following unique solution:

$$\mathrm{X_t} = \mathrm{G}\,(\Phi)\,\mathrm{X_{t-1}} + AZ_t$$

Where Φ represents the model parameters. The combination of Equation (14) with an observation equation is denoted as follows

$$\mathrm{Y_t} = \mathrm{HX_t}$$

Which the vector $\mathrm{Y_t}$ contains the observed data and the H matrix is repeatedly. In this case, the algorithm can be used to evaluate the probability performance and estimate the model parameters. However, almost all the possibility of changing certain parameters over time under the Markov regime has been considered. As shown by Liu and Mumtaz (2011), for the specification of the MS-DSGE model, the parameter vector Φ is divided into three blocks:

$$\phi = \{\phi^S; \Sigma^s; \bar{\phi}\}$$

Which ϕ^S blocks the parameters subject to regime change, Σ^s s blocks the variance in the regime change oscillations and $\bar{\phi}$ contains parameters that do not change over time. The uppercase letters S and s show two state variables. Superscript S shows the unknown regime in relation to the parameters subject to regime change and includes discrete values S = 1, 2. The superscript s is related to fluctuations and also assumes discrete values of s = 1, 2 and is independent of S. It is assumed that both S and s follow the first-order Markov chain with the following transfer matrix:

$$p = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix} \text{ و } \varrho = \begin{pmatrix} \varrho_{11} & \varrho_{12} \\ \varrho_{21} & \varrho_{22} \end{pmatrix}$$

Which $P_{ij} = p(S_t = j|S_{t-1} = i)$ and $\varrho_{ij} = p(S_t = j|S_{t-1} = i)$. P_{ij} means the probability of being in diet j at a specific time t that existed in diet i in the previous period. The same is true of Q_{ij} analysis, but it also applies to fluctuations. The MS-DSGE model for the S mode can be rewritten as follows:

$$\begin{pmatrix} \Gamma_{0,1}^{S} \\ \Gamma_{0,2}^{S} \end{pmatrix} X_{t+1} = \begin{pmatrix} \Gamma_{1,1}^{S} \\ \Gamma_{1,2}^{S} \end{pmatrix} X_t + \begin{pmatrix} \Psi_1^{S} \\ 0 \end{pmatrix} Z_t + \begin{pmatrix} 0 \\ \Pi \end{pmatrix} \eta_t$$

Model estimation

Using Bayes' theorem, the posterior density of the parameters $p(\theta|y)$ can be calculated from a combination of data $\ell(y|\theta)$ likelihood and anterior density of the parameters $p(\theta)$ as follows:

$$p(\theta|y) = \frac{\ell(y|\theta)p(\theta)}{\int \ell(y|\theta)p(\theta)d\theta}$$

That θ the vector of parameters and y is the vector of data. Assuming that the DSGE model is linear and the shocks are all i.i.d, the data validation $\ell(y|\theta)$ function can be calculated using the Kalman filter:

$$\log \ell(y|\theta) = \sum_{t=1}^{T} \left[\frac{N_y}{2} \log(2\pi) + \frac{1}{2}\log\left|\Omega_t|_{t-1}\right| + \frac{1}{2}\upsilon'\Omega_{t|t-1}\upsilon_t \right]$$

T Number of periods and N_y is the number of observations.

Which $\upsilon_t = y_t - H'x_{t|t-1}$ are the data prediction error and $\Omega_{t|t-1} = H'\Sigma_{t|t-1}H + R$ the variance matrix.

With the likelihood function, the posterior density of the parameters $\ell(y|\theta)$ can be satisfied by a simulation technique such as the MCMC algorithm.

According to Schorfeid (2000), the process follows a two-step method. In the first step, the posterior kernel is obtained through a numerical optimizer, the posterior mode and the variance-covariance matrix. In the second stage:

$$r = \min\left\{1, \frac{\ell(y|\theta_j^*)p(\theta_j^*)}{\ell(y|\theta_{j-1})p(\theta_{j-1})}\right\}$$

Finally, the mean, variance and confidence interval are estimated based on the experimental posterior density.

$$E\left[h(\theta)|y\right] = \frac{1}{N}\sum_{j=1}^{N_{sim}} h(\theta_j)\tilde{p}(\theta_j|y)$$

Which is a function of the posterior estimator of the parameters and the net number of samples.

Previous distribution of estimated parameters

The former distribution plays a very important role in estimating DSGE models. The previous distribution table shows the estimated parameters. Parameters in the range (1-0) are similar to the beta distribution usually used for them. The parameters that are positive use the gamma distribution and the standard distribution is used to deviate the shocks from the inverse gamma distribution, and the parameters that may have positive or negative values are used.

Subsequent distribution

Combining the previous distribution of the parameters with the likelihood function of the data, the posterior density function of the parameters is obtained, which of course can not be evaluated analytically. MCM methods can be used to sample them. One of the most valid MCMC methods is the Metropolis-Hastings algorithm.

Assume that the goal is to extract a sample from the distribution $P(\theta)$ in such a way that the $P(\theta)=\frac{F(\theta)}{K}$ normalizer K constant may be unknown and difficult to calculate. The Metropolis-Hastings algorithm generates a random instance of a distribution as follows:

The Metropolis-Hastings algorithm generates a random instance of a distribution as follows:

A) We start with the initial value θ_0 of the parameters.

B) Using the latter value θ, we extract the candidate point θ^* from the proposed distribution. The probability of obtaining a value $q(\theta_1,\theta_2)$ is provided that we have the latter value. $q(\theta_1,\theta_2)$ This distribution is also called the jump distribution and the candidate productive distribution θ_2. The only limitation on this distribution in the Metropolis-Hastings algorithm is that it must be symmetric θ_1.

C) Having a candidate point θ^*, we calculate the ratio of density at the candidate point θ^* to the most recent point θ_{t-1}, ie.

$$\alpha=\frac{f(\theta^*)}{f(\theta_{t-1})}$$

D) If it i $\alpha\rangle 1$ s, we accept θ^*, that is $\theta_t=\theta^*$, we place it and return to step 2, and if $\alpha\langle 1$, we accept θ^* the point with probability α. Otherwise we return to step 2.

Briefly: 1) That is, we calculate the following ratio:

$$\alpha=\min\left\{\frac{f(\theta^*)}{f(\theta_{t-1})},1\right\}$$

2. We accept θ^* the candidate point with probability α.

In this way, a Markov chain $(\theta_0,\theta_1,\ldots\theta_k,\ldots,\theta_n)$ is generated, the probability of which is transferred from θ_t only to θ_{t+1} and not to $(\theta_0,\theta_1,\ldots\theta_{t-1})$. After a period of fuel, for example k stage, the chain reaches its mana distribution.

Table 1

Previous and Subsequent distribution

Parameter		Previous distribution			Subsequent distribution		
		Type	Average	Standard deviation	Average	90% confidence interval	
K1	The share of utilizing government construction expenditures in the tradable sector	Beta	0.27	0.15	0.1237	0.1907	0.04
K2	The share of utilizing government construction expenditures in the non-exchange sector	Beta	0.73	0.15	0.9146	0/9734	0.8645
Ka	The share of using private capital in the products of Qa	Beta	0.53	0.15	0.447	0.56	0.3253
beta	Consumer mental discount rate	Beta	0.965	0.001	0.9657	0.96621	0.9651
delta	Depreciation rate	Beta	0.05	0.0015	0.0466	0.0487	0.0435
H	The degree of stability of habits	Beta	0.5	0.0015	0.2492	0.2503	0.2483
Rk	Capital rental rates	Beta	0.03	0.015	0.0123	0.0197	0.0061

Parameter		Previous distribution			Subsequent distribution		
		Type	Average	Standard deviation	Average	90% confidence interval	
Rho_md	Self-regression process coefficient of money demand shock	Beta	0.42	0.15	0.4499	0.5756	0.3314
Rho_c	Consumption shock autoregression process coefficient	Beta	0.62	0.15	0.1114	0.1732	0.0457
Rho_l	Labor supply shock process autoregression coefficient	Beta	0.78	0.15	0.2996	0.3998	0.1750
Rh_i	Investment specific process shock regression coefficient	Beta	0.8	0.15	0.5667	0.7114	0.436
R_tax	Income tax rate	Beta	0.058	0.15	0.1517	0.2387	0.0642
R_vat	VAT rate	Beta	0.085	0.15	0.1088	0.2607	0000
Td	The ratio of income tax to total tax	Beta	0.841	0.15	0.3103	0.4424	0.1769
Tv	Ratio of VAT to total tax	Beta	0.16	0.15	0.1064	0.2211	000
r 1	Impact coefficient of oil on central bank reserves	Beta	0.6	0.15	0.6742	0.7713	0.5747
r 2	Impact of non-oil exports on central bank reserves	Beta	0.2	0.15	0.2316	0.3235	0.1258
r 3	Impact of imports on central bank reserves	Beta	0.2	0.15	0.4557	0.5658	0.3601
San	Government share of oil revenues	Beta	0.7	0.15	0.7093	0.8173	0.6087
Rho _tax	Tax shock autoregression process coefficient	Beta	0.41	0.15	0.6273	0.7252	0.522
Rho_yfrn	Foreign production shock autoregression process coefficient	Beta	0.6	0.15	0.2358	0.2502	0.22
Bu	Self-regression coefficient of oil revenues	Beta	0.48	0.15	0.5497	0.6383	0.4648
bmb	Monetary rule autoregression process coefficient	Beta	0.35	0.15	0.2772	0.3729	0.1857
Bm	Monetary policy shock process self-regression coefficient	Beta	0.52	0.15	0.3817	0.4576	0.3010
Gama1	Share of non-tradable consumer goods in total consumption	Beta	0.34	0.15	0.4954	0.568	0.4281
Gama2	Share of imported consumer goods in total consumption	Beta	0.42	0.15	0.3514	0.4407	0.2567
tetaf	Percentage of importing firms that adjust	Beta	0.98	0.15	0.9812	0.9824	0.9801
omegaf	Degree of import price indexation	Beta	0.75	0.15	0.7063	0.8056	0.6171

Parameter		**Previous distribution**			**Subsequent distribution**		
		Type	**Average**	**Standard deviation**	**Average**	**90% confidence interval**	
tetat	Percentage of firms producing tradable goods that adjust	Beta	0.55	0.15	0.8180	0.8801	0.7692
rhozh	Coefficient of technological shock autoregression process of tradable products	Beta	0.98	0.15	0.9616	0.9699	0.9535
omegat	Degree of indexation of the price of tradable goods	Gam ma	0.715	0.15	0.9994	1	0.9993
tetan	Percentage of firms producing non-tradable goods that adjust	Beta	0.54	0.15	0.706	0/81	0.6002
omegan	Degree of price indexation of non-tradable goods	Beta	0.75	0.15	0.4337 6	0.5335	0.3339
rhozN	Coefficient of technological regression process of non-commercial production technology	Beta	0.73	0.15	0.8529	0.8964	0.7988
lamda	Impact real exchange rates	Beta	0.7	0.15	0.9884	0.999	0.9775
Va	The share of the labor force employed in tradable products of the total labor force	Beta	0.5	0.15	0.2812	0.4036	0.1554
rhoirfn	External interest rate autoregression process coefficient	Beta	0.67	0.15	0.5835	0.6772	0.4835
Rho_pfrn	Multiply the external inflation autoregression process	Beta	0.3	0.15	0.0723	0.1278	0.0096
S1	Consumption to production ratio	Beta	0.528	0.15	0.1239	0.1928	0.0499
S 2	Investment to production ratio	Beta	0.124	0.15	0.011	0.0288	0
S3	The ratio of government spending to production	Beta	0.376	0.15	0.4295	0.5503	0.2982
S4	The ratio of total exports to production	Beta	0.181	0.15	0.0175	0.0454	0
Sim3	Import to production ratio	Beta	0.21	0.15	0.3112	0.3743	0.2572
sam	The share of imported investment in the total investment	Beta	0.92	0.15	0.927	0.9483	0.9091
Rq	Tobin equation autoregression process coefficient	Beta	0.21	0.15	0.0203	0.414	0
Alfa2	Production elasticity to the capital factor	Beta	0.26	0.15	0.2346	0.3265	0.1404

Parameter		Previous distribution			Subsequent distribution		
		Type	**Average**	**Standard deviation**	**Average**	**90% confidence interval**	
Alfa1	Production elasticity to the labor force factor	Beta	0.35	0.15	0.5592	0.6583	0.4726
alfagg	Production elasticity to the factor of government development expenditures	Gamma	1.42	1	1.2184	1.2904	1.1487
Ft	Stretch the cost adjustment function of the investment	Normal	3.41	0.15	3.3825	3.4681	3.2990
Land2	The coefficient of importance of production in the monetary rule of the central bank	Normal	-5.87	0.05	-5.8473	-5.8085	-5.881
Land1	Inflation significance coefficient in the monetary rule of the central bank	Normal	-1.75	0.5	-1.75	-1.8014	-1.89
Teta1	The interval between the consumption of tradable and non-tradable goods	Gamma	1.5	0.5	3.1889	3.5577	2.8132
Teta2	Interval stretch between domestic and imported consumption	Beta	0.16	0.5	1.5597	1.7599	1.3205
Rc	Attraction of investment to domestic investment	Gamma	0.11	0.15	0.0142	0.0421	0
iteta	Photo Consumption Stretch Consumption	Normal	2.6	0.15	4.3022	4.5421	4.0455
sgmc	Photo stretch the real balance of money	Normal	4.35	0.075	4.3524	4.3752	4.3288
sigml	Photo of labor supply tension	Normal	3.1	0.075	3.0629	3.1330	2.9765
b 3	Export elasticity of foreign production	Gamma	1.5	0.15	1.6021	1.7485	1.4628
b 1	Share of domestic debt in the balance sheet of the central bank	Beta	0.81	0.15	0.4252	0.5539	0.3142
b 2	Share of foreign exchange reserves in the balance sheet of the Central Bank	Beta	0.42	0.15	0.4323	0.4924	0.3697

The above tables show the mean and confidence interval of the posterior distribution of the parameters obtained from the Metropolis-Hastings algorithm. The technology shock of the tradable sector is significant and has a positive effect on the production of tradable goods. In Bayesian estimation of model parameters, the distribution function, mean and standard deviation of the previous parameters for the parameters must be determined first. By considering the initial values for the mean and standard deviation of the parameters, the parameters can be estimated using the Bayesian method. The model is estimated in the Dynare program space under MATLAB software. For this purpose, the Monte Carlo method with Markov chain in the form of

Metropolis-Hastings algorithm with 15 blocks and 1.5 million samples per block has been used. It should be noted that the previous distribution for each parameter was selected based on the characteristics of that parameter and the characteristics of the desired distribution. Therefore, the beta distribution was used for parameters that are in the range of zero to one. Also gamma distribution is a distribution with amplitude from zero to infinity. Therefore, this distribution is used for parameters that have a positive amplitude. And the inverse gamma distribution is also used for variance parameters.

Aggregate and structural instantaneous reaction function

As the cumulative shock diagram shows. Shocks are not as stable as a standard deviation to the production instability variable of any of the four variables used in the model and tend to zero after a period of 10 years, and these shocks are significant only in the first period. The shocks to the monetary policy index variable are significant throughout the period and are not stable according to the chart. The shocks to the financial liberalization index are also significant from the instability of real GDP and the monetary policy index in the first period at the level of one percent, but in the following periods at the level of 10 percent and are not significant even in year 4, which Shows GDP shocks and monetary policy on short-term fiscal liberalization. But shocks from oil revenues and exchange rates are significant at 5% in all periods. This finding is also consistent with economic reality, because the shock from production or monetary policy to the financial account and capital has a short-term effect, and the shock from exchange rate and oil revenue policies, due to the nature of these variables. It has a long-term effect and is not significant in the short term. The shocks from the model variables to the real exchange rate are significant only in terms of oil revenues and only in the first round. This finding is also consistent with the reality of Iran's economy, because real GDP shocks, monetary policy, and capital and financial accounts have less impact on the exchange rate than variables such as oil revenues and sanctions. Also, the shocks of the model variables on oil revenues are not significant in any period, because oil revenues are a completely exogenous variable, because its price in world markets and Iran's quota is also determined in OPEC. In Bayesian estimation of model parameters, the distribution function, mean and standard deviation of the previous parameters for the parameters must be determined first. By considering the initial values for the mean and standard deviation of the parameters, the parameters can be estimated using the Bayesian method. The model is estimated in the Dynare program space under MATLAB software. For this purpose, the Monte Carlo method with Markov chain in the form of Metropolis-Hastings algorithm with 15 blocks and 1.5 million samples per block has been used. It should be noted that the previous distribution for each parameter was selected based on the characteristics of that parameter and the characteristics of the desired distribution. Therefore, the beta distribution was used for parameters that are in the range of zero to one. Also gamma distribution, is a distribution with amplitude from zero to infinity. For this reason, this distribution is used for parameters that have a positive amplitude. And the inverse gamma distribution is also used for variance parameters.

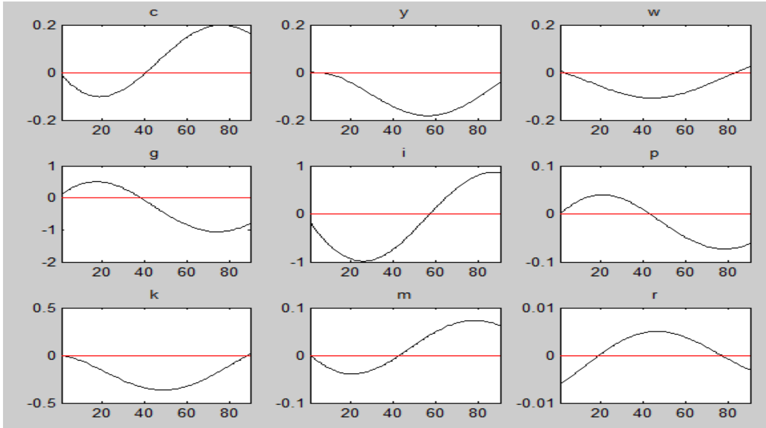

Fig 1. *Instantaneous reaction function to currency shock*

The above chart shows the currency shock to the model. In this chart, in response to the currency shock, total output first declines and in the long run the effect of the shock disappears and the economy returns to equilibrium. Exchange rate shocks have the highest value compared to other shocks. The exchange rate is one of the determinants of the price of raw materials, intermediate goods and other final goods. Thus, exchange rate fluctuations through the prices of imported goods open their way to the prices of domestic and imported products. These changes affect the value of the national currency and the general level of prices and lead to an increase in domestic prices and inflation. To what extent changes in exchange rates lead to changes in the consumer price index has always been a topic of interest for economists. In the Iranian economy, the revolution of the Islamic Republic in 1978 and the subsequent eight-year war between Iran and Iraq, the world oil crises have been factors that have increased inflation. Especially in recent years (2011), US economic sanctions and barriers to oil exports have caused significant problems in the oil-dependent economy. Also, since one of the main problems in the Iranian economy has always been high and continuous inflation and has directly imposed high costs on the welfare of consumers and producers; Consumers have faced a decline in purchasing power due to the continuous growth of prices, and producers have lost their ability to compete internationally due to the high growth of domestic prices in terms of quantity and quality. The result of this high and historic inflation has been a great social loss for Iranian society in recent years; one of the main factors in the growth of prices in the Iranian economy has always been high exchange rate changes.

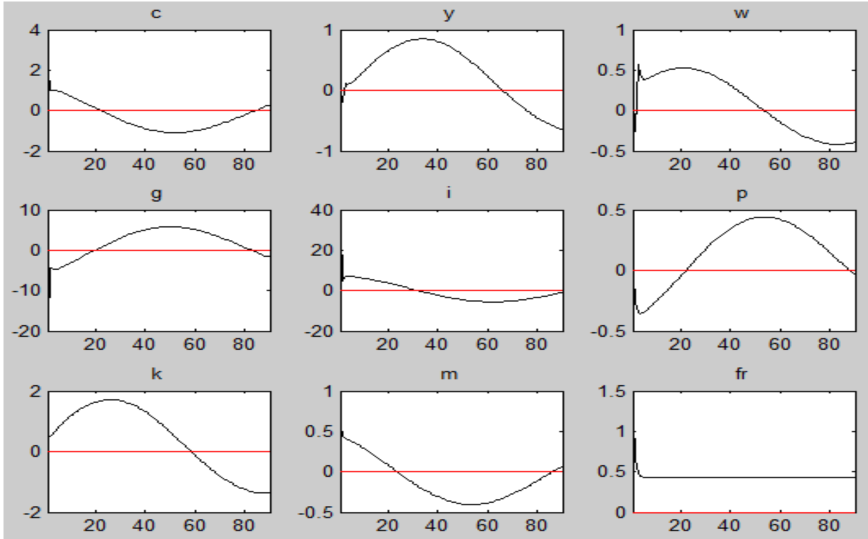

Fig 2. *Instantaneous reaction function to oil price shock*

Oil price shocks are the main source of economic fluctuations in oil exporting countries such as Iran. Also, the appropriate monetary policy rule can play an important role in reducing the adverse fluctuations of such a shock. In this section, the role of monetary, fiscal and exchange rate policies is explained by placing the results of estimating the model parameters under the influence of different scenarios. In this scenario, it is assumed that there is no National Development Fund in the Iranian economy; therefore, the omega parameter, ie the percentage of oil revenues allocated to the government, is set equal to one; In other words, all oil revenues go into the government budget and no percentage of it goes to the fund. In this model, the oil shock has entered the economy and it is assumed that the dependence on oil revenues has been reduced. In response to the oil price shock, total production initially increased and decreased in the medium term. Private consumption expenditure variables initially reacted negatively but responded positively in the medium and long term.

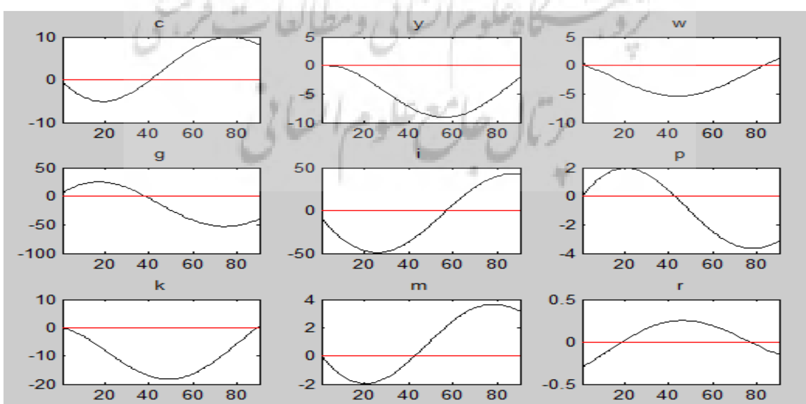

Fig 3. *Instantaneous response function to inflation shock*

Total inflation first increased and then decreased and after several periods of shock effect, it became negative. Inflation, in general, has three main sources: increasing demand, cost pressures, and structural bottlenecks. Increased money supply, expansionary fiscal policies (government budget deficit) and devaluation of money, including examples of increased demand, supply-side shocks, rising wages, declining productivity, rising prices of factors and inputs of production, especially energy carriers, including examples Inflation is caused by cost pressure. Also, the non-competitive structure of markets and the existence of monopolies are among the structural reasons for inflation. Therefore, according to the causes of inflation and its examples, the proposed solutions to combat inflation based on theories of demand gap, cost pressure and the structure of the economy, respectively, include restricting the money supply, government financial discipline, and so on. A set of factors such as the dependence of government revenues on oil revenues are among the structural factors of inflation, so that supposedly with the reduction of oil prices and non-realization of revenues from oil sales, the government faces a budget deficit and to provide this budget deficit from the banking system borrows. Borrowing from the banking system increases the amount of liquidity, which results in nothing but increasing inflation. Thus, the implementation of long-term structural reform policies, such as the development and expansion of the tax system, as well as the successful implementation of Article 44 of the Constitution, paves the way for the expansion of private sector activities in order to overcome these bottlenecks.

Conclusion

Examining the effects of fiscal policies on macroeconomic variables is of particular importance. Given this, fiscal policies can affect the total amount of output (or GDP), an important tool for managing the economy. This ability of fiscal policies to affect production by changing aggregate demand makes them a potential tool for economic stabilization. The cumulative instantaneous reaction function showed that the reciprocal shocks between the variables were not stable in the long run and tended to zero after a period of 10 years. The most important result of cumulative instantaneous reaction functions is that shocks to real GDP instability are significant only in one period and endogenous shocks have no significant effect on oil shocks. Also, the shocks on the monetary policy index are endogenous shocks. Historical analysis of structural shocks also shows that there is a high correlation between the graphs of shocks on real GDP instability and the raw data of real GDP instability, which indicates the significance of the shocks of model independent variables on real GDP instability. In the model, the instantaneous reaction function can be evaluated in addition to the Chulsky method, which measures the change of one unit of other variables in the model, the momentum of each variable relative to a structural momentum. In this research, 7 structural shocks have been used. Structural shocks, except for the shocks of virtual variables, which are not interpretable by their nature, are dormant after ten periods. Also, the results of historical analysis of structural shocks to the exchange rate show that the shocks on the exchange rate have always been significant and in the period under study, the intensity of shocks on the exchange rate has been decreasing.

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