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Household portfolio channel of credit shocks transmission: The Case of Iran

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Abstract

In this study, we use a Dynamic Stochastic General Equilibrium (DSGE) model to investigate the household portfolio channel of monetary and credit shocks transmission in Iran. In this regard, we developed a canonical New Keynesian DSGE model with financial and banking sectors. The model is estimated by Bayesian method for the period 1990-2012. The result showed that the current and expected prices of financial and physical assets affected their optimal proportions in household portfolio. Second, banking sector had a significant impact on the household portfolio composition and also on the real sector variables. More specifically, a positive deposit rate shock reduced the proportions of financial and physical assets in household portfolio and increased marginal cost and inflation. This shock decreased investment and output. Third, a positive shock on stock price had negative effects on demand for other assets in household portfolio but these effects were discharged rapidly. Moreover, the housing price shock had similar effects on demand for mentioned assets but the effects were discharged slowly. The results emphasized the role of credit, banking and assets markets sectors in financial fluctuation, business cycles and monetary transmission in Iran.

Keywords: Household Portfolio, Monetary Transmission, Banking Sector, DSGE Model, Financial Sector, Iran.
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1. Introduction

The central stage of discussion about how to promote sustainable economic growth and low inflation in the economy is the monetary and credit policies. Both economists and politicians advocate that the stabilization of output and inflation be left to monetary and credit policies. Indeed, in the recent years, central bank of Iran has pursued rising interest rate in order to prevent inflation increasing. In order to be successful in such a policy, the monetary authorities must have an accurate assessment of the effects of their policies on the economy, which require the understanding of the mechanisms that credit and monetary policies as the key variables of the economy.

One of the channels of monetary transmission is the household balance sheet which is presented in previous literature (Brainard and Tobin, 1968, Tobin, 1969, Mishkin, 1978, Mishkin, 1996, Collins and Anderson, 1998, Blake, 2004). The credit channel should apply to consumer who spends equally as business firm; particularly, credit shocks transmitted to economy from consumer investment and are spent on financial and physical assets such as stock, gold and housing.

The household balance sheet channel is very important in Iran, because the economy of Iran has a high level of liquidity based on last official statistics published by the central bank of Iran. On the other hand, in this economy households face a broad array of options for investment. Saving can be allocated to a wide range of assets, from deposits to real estate, gold, exchange and stocks and these financial and physical assets markets have experienced high volatility and fluctuation in recent decade particularly in 2011. On the other hand, credits are available by banks and other credit institutions so, banks play a main role in financing system of Iran. Consequently, in this study we wanted to answer the following questions in order to investigate the household balance sheet channel of monetary transmission to the economy of Iran using a Dynamic Stochastic General Equilibrium (DSGE) model with financial and banking sectors.

What are the dynamic effects of credit shocks on household portfolio allocation? What is the role of deposit rate in financial and physical assets demand equilibrium? Does deposit rate change the household portfolio composition and their investment decisions in physical and financial assets? What kind of interaction exists among durables and financial assets in the Iranian household portfolio? Due to the favorable features of DSGE models, this study employed a New Keynesian based DSGE Model in order to answer the above equations. The novelty of the paper is entering financial assets consist of stock, gold, housing and deposit in household utility maximization and inter-temporal household budget constraint and their costs which follow a random walk process. We also clarified consolidated budget constraint for government and central bank combination in Iran. Moreover, we specified financial friction and banking sectors in DSGE framework following the Christensen and Dib (2008), Gerali and et al. (2010), Cristiano and et al (2010), Zanetti (2012), Hammersland and Traee (2014) and Hollander and Liu (2016) based on the first idea of Bernanke and et al. (1999) study. In the designed model, banking sectors specified in a suitable and consistent framework for the economy of Iran.

The rest of the paper is organized as follows. Section 2 is devoted to literature review. In section 3, we have anatomized the designed DSGE model for Iran. Section 4 has presented the empirical results of model calibration and Bayesian estimation results of model and impulse responses analysis and section 5 is the conclusion.

2. Theoretical Background

A most important view of mechanism of monetary transmission is the portfolio balance sheet channel that introduced by Friedman and Schwartz (1963) and Friedman (1974) and also Friedman and Schwartz (1982) and Mishkin (1996). According to these theoretical studies, monetary policy is transmitted through the effects of household balance sheet. After the positive monetary shocks, individuals are seeking to adjust their portfolios and are looking to buy higher returns with lower obligations securities. So, the prices of financial assets are bid up and become expensive relative to physical assets and there is an incentive for individuals to acquire physical assets. At the same time, the rises in the prices of physical assets tend to raise wealth and demand curve for services. Therefore, the monetary stimulus is spread from financial markets to goods and services markets. In reality, economic agent’s portfolio re-allocation cause to changes in relative prices, output and inflation.

On the other hand, the Limited Participation model of Lucas (1990) and Fuerst (1992) stated that some of agents have limited information sets than others. Therefore, the ability of these agents is limited to adjust their portfolios. For example due to a positive monetary shock, some agents hold a higher amount of real assets. Therefore, the real effect of monetary policy is the result of the reallocation of household portfolios. On the other hand, monetary policy generates distributional effects within Limited Participation model (Andres and et al., 2004). For example, the addition of population growth to this model creates a distributional effect on money growth resulting in a real balance effect thereby eliminating the liquidity trap.

Base on the New Keynesian framework, the monetary policy effects on inter-temporal consumption decisions via change in inflation expectation. Accordingly, it is predicted that monetary and credit shocks can affect household portfolio from expectation channel (Barasinska and et al, 2012, Apergis, 2015). These shocks influence the future path of nominal variables and households response via portfolio adjustment and reallocation (Addoum, 2012, 2013). For example, an expansionary monetary policy increase inflation and inflation expectation and household adjust portfolio in order to cover the effects of inflation (Barasinska and et al, 2012). In this condition, households prefer assets with higher yields and liquidity (Mishkin, 1996, Thornton, 2012, Beck-Worth and Hendrickson, 2014).

Finally, Bernanke (2010) argued that large scale asset purchased by Federal Reserve should reduce duration risk of private sector portfolio and thus causes risk premiums and yields to a long term securities decline. This needs a rebalancing of portfolios.

3. The Model

The model consists of five main sectors. Household, intermediate and final good producers, banking sector, government and central bank sectors. The household sector maximizes its expected discount utility function subject to inter-temporal budget constraint. The intermediate goods producers face the constraint that they can change prices following the Calvo’s rule in a monopolist competition framework. The final good produced by a final good producer. The banking sector that pay interest to household’s deposits and provides loan for household and intermediate and also firms which maximize their expected net profits. Finally, there are government and central bank as fiscal and monetary authorities with a consolidated constraint which is consistent with the condition of Iran’s economy and with focusing on the balance sheet of the central bank and the government spending function. We have also specified the role of money and credit assembly in deposit rate specification in Iran and also we have determined the monetary policy in the channels of monetary based resources and bank reserves rate channel as an indirect monetary policy instrument.

3-1. Household

In a decision framework over life cycles of household's sector, we specified the representative agent discount expected utility function follow from Falagiarda and Saia (2013) and Hollander and Liu (2016) studies as:

$$E_t\sum_{t=0}^{\infty}\begin{array}{l}\beta^t\{[\frac{1}{1-\sigma_c}(\mathrm{C}_t)^{1-\sigma_c}-\frac{1}{1+\sigma_N}(\mathrm{N}_t)^{1+\sigma_N}+\frac{\kappa_M}{1+\sigma_M}(M_t)^{1+\sigma_M}\\ +a_{1,t}\ln(\frac{D_t}{P_t})+a_{2,t}\ln(\frac{Q_t\psi_t^p}{P_t})+a_{3,t}\ln(\frac{er_t\mathrm{X}_t}{P_t})+a_{4,t}\ln(\frac{P_t^H H_t}{P_t})+a_{5,t}\ln(\frac{P_t^G G_t}{P_t})]\}\end{array} \tag{1}$$

Household sector adopt optimal decisions on consumption (C_t), labor supply (N_t), money demand (M_t), deposit supply (D_t) with i_t^d deposit interest rate, loan demand (L_t) with i_t^l banking loan interest rate, bonds demand (B_t) and financial assets demands include stock amount (ψ_t^p) with price Q_t and foreign exchange (X_t) demand at nonofficial exchange rate of er_t, and also demand for physical and durables assets include housing (H_t) with price of equal to P_t^H and gold (G_t) demand at price of P_t^G. In equation (1), P_t is the general level of price, σ_c is the inverse elasticity of consumption, $\sigma_N \succ 0$ is the inverse elasticity of labor supply and $\sigma_M \succ 0$ is the inverse elasticity of money demand. However, in equation (1), $a_{i,t}$ for $i=1,2,...,5$, are proportions of various assets in household portfolio in the current period.[1]

In the other hand, household real budget constraint is presented as:

$$\begin{aligned}&C_t+\frac{P_t^I I_t}{P_t}+\frac{D_t}{P_t}+\frac{Q_t\psi_t^p}{P_t}+\frac{er_t\mathrm{X}_t}{P_t}+\frac{P_t^H H_t}{P_t}+\frac{P_t^G G_t}{P_t}+\frac{i_{t-1}^l L_{t-1}}{P_t}+\frac{M_t}{P_t}+\frac{B_t}{P_t}+T_t\\&=\frac{W_t N_t}{P_t}+\frac{i_{t-1}^d D_{t-1}}{P_t}+\frac{L_t}{P_t}+\frac{er_t\mathrm{X}_{t-1}}{P_t}+\frac{Q_t\psi_{t-1}^p}{P_t}\\&+\frac{P_t^H H_{t-1}}{P_t}+\frac{P_t^G G_{t-1}}{P_t}+\Pi_t+\frac{R_{t-1}^b B_{t-1}}{P_t}+\frac{M_{t-1}}{P_t}+r_t^k K_t\end{aligned} \tag{2}$$

The left side of equation (2) displays household current spending in current period and the right side shows the household income in the current period. In equation (2), I_t denotes investment spending, T_t is the tax spending in period t, i_t^l denote the banking loan interest rate and $R_t^b = (1+i_t^b)$ that i_t^b denote the bond interest rate in current period. The term $r_t^k K_t$ denotes the capital returns. The term Π_t displays the household profits of other economic activities. The borrowers face a borrowing constraint:

$$i_t^l L_t \leq \nu_t [\varphi_{1w} W_t N_t + \varphi_{2w} Q_t^s \psi_t^p + \varphi_{3w} er_t \mathrm{X}_t + \varphi_{4w} P_t^H H_t + \varphi_{5w} P_t^G G_t] \tag{3}$$

In equation (3), $0 \leq \varphi_{iw} \leq 1$ are the weights on wage and other income of financial and physical assets and ν_t shows the loan to value ratio. The household also face the following capital formation equation:

$$K_t = (1-\delta) K_{t-1} + [1 - S(\frac{I_t}{I_{t-1}})] I_t \tag{4}$$

Where δ is the depreciation rate and $S(.)$ is an adjustment cost function such that:

$$S(1) = S'(1) = 0 \quad S''(1) = \kappa^A \succ 0 \tag{5}$$

The first order conditions respect to target variables subject to (2) and (4) yield that:

$$\mathrm{C}_t^{-\sigma_c} = \lambda_t \tag{6}$$

$$-\mathrm{N}_t^{\sigma_N} + \lambda_t \frac{W_t}{P_t} = 0 \tag{7}$$

$$\kappa_M \frac{1}{P_t} (\frac{M_t}{P_t})^{-\sigma_M} - \frac{\lambda_t}{P_t} + E_t \beta \lambda_{t+1} \frac{1}{P_{t+1}} = 0 \tag{8}$$

$$-\frac{\lambda_t}{P_t} + \beta E_t \lambda_{t+1} \frac{R_t^b}{P_{t+1}} = 0 \tag{9}$$

$$a_{1,t} \frac{1}{D_t} - \frac{\lambda_t}{P_t} + E_t (\frac{\lambda_{t+1} i_t^d \beta}{P_{t+1}}) = 0 \tag{10}$$

$$\frac{\lambda_t}{P_t} - E_t\left(\frac{\lambda_{t+1} i_t^l \beta}{P_{t+1}}\right) = 0 \tag{11}$$

$$a_{2,t}\frac{1}{\psi_t^p} - \frac{\lambda_t Q_t}{P_t} + E_t\left(\frac{\lambda_{t+1} Q_{t+1} \beta}{P_{t+1}}\right) = 0 \tag{12}$$

$$a_{3,t}\frac{1}{X_t} - \frac{\lambda_t er_t}{P_t} + E_t\left(\frac{\lambda_{t+1} er_{t+1} \beta}{P_{t+1}}\right) = 0 \tag{13}$$

$$a_{4,t}\frac{1}{H_t} - \frac{\lambda_t P_t^H}{P_t} + E_t\left(\frac{\lambda_{t+1} P_{t+1}^H \beta}{P_{t+1}}\right) = 0 \tag{14}$$

$$a_{5,t}\frac{1}{G_t} - \frac{\lambda_t P_t^G}{P_t} + E_t\left(\frac{\lambda_{t+1} P_{t+1}^G \beta}{P_{t+1}}\right) = 0 \tag{15}$$

$$-\lambda_t \frac{P_t^I}{P_t} + \gamma_t\left[1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}\right] + \beta E_t\left\{\gamma_{t+1} S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2\right] = 0 \tag{16}$$

$$E_t\{\beta\lambda_{t+1}R_{t+1}^k\} - \gamma_t + E_t\{\beta\gamma_{t+1}(1-\delta)\} = 0 \tag{17}$$

In the above F.O.C equations, λ_t presents the Lagrangian multiplier respect to (2) and γ_t displays the Lagrangian multiplier respect to (4). Combining the equations (6) and (9) yields the Euler equation. The equation (7) displays the household labor supply and the equation (8) presents the dynamics of household money demand. Equations (10) until (15) present the optimal dynamic proportions of various financial and physical assets in household portfolio. These equations indicate that the optimal proportions of various assets positively depend on their prices expectation and negatively depend on their current prices. Indeed, households sell their assets when current price is rising and keep financial assets when price expectation is rising. We simplified supply sides of assets as their prices dynamics. In this regard, we assumed that the prices of assets consisted of stock price, housing price, gold price and exchange rate based on the following vector autoregressive framework:

$$\log Q_t^s = \alpha_{11}\log Q_{t-1}^s + \alpha_{12}\log P_t^H + \alpha_{13}\log P_t^G + \alpha_{14}\log(\mathrm{er}_t) + \varepsilon_t^{Q_t^s} \tag{18}$$

$$\log P_t^H = \alpha_{21}\log Q_t^s + \alpha_{22}\log P_{t-1}^H + \alpha_{23}\log P_t^G + \alpha_{24}\log(\mathrm{er}_t) + \varepsilon_t^{P_t^H} \tag{19}$$

$$\log P_t^G = \alpha_{31}\log Q_t^s + \alpha_{32}\log P_t^H + \alpha_{33}\log P_{t-1}^G + \alpha_{34}\log(\mathrm{er}_t) + \varepsilon_t^{P_t^G} \tag{20}$$

$$\log(\mathrm{er}_t) = \alpha_{41} \log Q_t^s + \alpha_{42} \log P_t^H + \alpha_{43} \log P_t^G + \alpha_{44} \log(\mathrm{er}_{t-1}) + \alpha_{45} \log(ner_{t-1}) + \varepsilon_t^{er_t} \quad (21)$$

In equations (18) to (21), it is assumed that assets prices. In equations (18) to (21), $\varepsilon_t^{Q_t^s}$, $\varepsilon_t^{P_t^H}$, $\varepsilon_t^{P_t^G}$ and $\varepsilon_t^{er_t}$ present stock price shock, housing price shock, gold price shock and non-official exchange rate shock, respectively. In the equation (21), it is assumed that the nominal-official exchange rate (ner_t) influences the non-official exchange rate in free market based on the economic conditions of Iran.

3-2. Loan Demand and Deposit Supply

Following Gerali and et al. (2010) and Dib (2010), we used a Dixit-Stiglitz framework for the credit markets. In particular, we assumed that deposit supply and loan demand are a composite CES basket of differentiated products each supplied by a branch of a bank with elasticity of substitution equal to ε_t^d and ε_t^l respectively.

$$D_t = \left(\int_0^1 D_{j,t}^{\frac{1+\varepsilon_t^d}{\varepsilon_t^d}} dj\right)^{\frac{\varepsilon_t^d}{1+\varepsilon_t^d}} \quad (22)$$

$$L_t = \left(\int_0^1 L_{j,t}^{\frac{1-\varepsilon_t^l}{\varepsilon_t^l}} dj\right)^{\frac{\varepsilon_t^l}{1-\varepsilon_t^l}} \quad (23)$$

And also:

$$i_t^d = \left(\int_0^1 i_{j,t}^{d\ \ 1+\varepsilon_t^d} \mathrm{dj}\right)^{\frac{1}{1+\varepsilon_t^d}} \quad (24)$$

$$i_t^l = \left(\int_0^1 i_{j,t}^{l\ \ 1-\varepsilon_t^d} \mathrm{dj}\right)^{\frac{1}{1-\varepsilon_t^l}} \quad (25)$$

The household try to maximize deposit interest and also want to minimize loan interest. These optimization problems yield that:

$$D_{j,t} = \left(\frac{i_{j,t}^d}{i_t^d}\right)^{\varepsilon_t^d} D_t \quad (26)$$

$$L_{j,t} = \left(\frac{i_{j,t}^l}{i_t^l}\right)^{-\varepsilon_t^l} L_t \quad (27)$$

And also:

$$i_{j,t}^d = \left(\frac{D_{j,t}}{D_t}\right)^{\frac{1}{\varepsilon_t^d}} i_t^d \quad (28)$$

$$i^l_{j,t} = (\frac{L_{j,t}}{L_t})^{-\frac{1}{\varepsilon^l_t}} i^l_t \tag{29}$$

As mentioned, in equations (26) to (29), ε^d_t and ε^l_t present the elasticity of substitution among deposit rates and provide the elasticity of substitution among loan interest rates.

3-3. Firm Behavior and Price Sitting

3-3-1. The Intermediate Firms

In the New Keynesian models, entrepreneur firms are monopolist competitors and produce their goods according to the following constant returns technology:

$$Y_t = A_t (K_{t-1})^{\alpha} (\mathrm{N}_t)^{1-\alpha} - \Phi \tag{30}$$

$$A_t = A_{t-1}^{\rho_a} e^{u^a_t} \tag{31}$$

In the equation (30), K_{t-1} is physical capital, N_t is the labor supply, A_t is the technology and Φ is the firm's production fixed cost. Attendance of the fixed cost in production function helps us to specify the net profit of intermediate producers. The equation (31) presents the behavior of technology. In the equation (31), u^a_t is the technology shock. The entrepreneur firms minimize the following cost function respect to their production technology introduced in equation (30):

$$\min_{N_t, \mathrm{K}_{t-1}} \quad \frac{W_t N_t}{P_t} + r^k_t K_{t-1} \tag{32}$$

Thus the optimal demand for capital and labor is obtained from the following first order conditions:

$$r^K_t - \zeta_t A_t \alpha (K_{t-1})^{\alpha-1} (\mathrm{N}_t)^{1-\alpha} = 0 \tag{33}$$

$$\frac{W_t}{P_t} - \zeta_t A_t (1-\alpha)(K_{t-1})^{\alpha} (\mathrm{N}_t)^{-\alpha} = 0 \tag{34}$$

Where ζ_t show the real marginal cost.

Dividing (33) on (34) yields that:

$$r^K_t = \frac{\alpha}{1-\alpha} \frac{W_t}{P_t} \frac{N_t}{K_{t-1}} \tag{35}$$

And the real marginal cost can be obtained from:

$$MC_t = \frac{1}{A_t}(\frac{1}{1-\alpha})^{1-\alpha}(\frac{1}{\alpha})^{\alpha}(\frac{W_t}{P_t})^{1-\alpha}(r_t^k)^{\alpha} \tag{36}$$

The recent equation presents the optimal relationship among real marginal cost, real wage and capital returns.

3-3-2. The Final Good Producer

The final good products are produced by using intermediate good with the following production function:

$$Y_t = [\int_0^1 (Y_t^i)^{\frac{1}{1+\varepsilon_t^p}} di]^{1+\varepsilon_t^p} \tag{37}$$

Final good producers minimize the following cost function respect to (33):

$$\min_{Y_t^i} \quad \int_0^1 P_t^i Y_t^i di \tag{38}$$

This optimization problem gives:

$$Y_t^i = (\frac{P_t^i}{P_t})^{-\xi_t^p} Y_t \tag{39}$$

Where ε_t^p is the elasticity of sub situation among goods prices and:

$$P_t = [\int_0^1 (P_t^i)^{-\frac{1}{\xi_t^p}} di]^{-\xi_t^p} \tag{40}$$

Firms can just change price in Calvo's pricing rule. So in each period, they can change $1-\omega$ percent of their good price and ω is the degree of price stickiness.

3-4. Banking Sector

Banking sector chooses loans and deposits to maximize the expected discounted cash flows:

$$\max_{\{D_t, L_t, L_t^{CB}\}} E_t \sum_{t=0}^{\infty} \beta_B^t [i_t^l L_t - i_t^d D_t - i_t^{CB} L_t^{CB} - \frac{\kappa}{2}(\frac{K_t^B}{L_t} - \tau)^2 K_t^B] \tag{41}$$

Subject to the balance sheet identity (Shahhosseini and Bahrami, 2013):

$$K_t^B + D_t + L_t^{CB} = L_t + Q_t \psi_t^B + BA_t \tag{42}$$

Where, in equations (41) and (42) K_t^B is the total bank capital. In equation (41), κ presents the quadratic adjustment cost coefficient and τ displays minimum required bank capital to asset ratio or K_t^B / L_t. The term $\frac{\kappa}{2}(\frac{K_t^B}{L_t} - \tau)^2 K_t^B$ presents the adjustment cost to have minimum required bank capital to asset ratio (Hollander and Liu, 2016). In equations (41) and (42), D_t and L_t denote the deposits and loans respectively and L_t^{CB} denotes the loans of banking system from central bank at interest rate equal to i_t^{CB}. In equation (42), ψ_t^B shows the level of investment of banking sector in stock market at price Q_t and BA_t show the other banks investment in economic activities, especially in the housing market. The right side of equation (42) presents banks total assets and the left side shows the sources of these assets including bank capital, deposits and loans from central bank.

On the other hand, the banking capital formation equation is:

$$K_t^B = (1-\delta)K_{t-1}^B + (Q_t - Q_{t-1})\psi_t^B + w_{B,t-1} + \Pi_t^B \tag{43}$$

In equation (43), $w_{B,t-1}$ displays non-divided banking profit and Π_t^B shows the profit of other economic activity of banking sector in the current period in the way that $\Pi_t^B = BA_t - BA_{t-1}$. The first order conditions to maximize objective function (41) respect to deposit and loans levels and subject to equations (42) and (43) are:

$$\beta_t^B\{-i_t^d + \lambda_t^B\} = 0 \tag{44}$$

$$\beta_t^B\{i_t^l - \kappa K_t^B(\frac{K_t^B}{L_t} - \tau)(-\frac{K_t^B}{L_t^2}) - \lambda_t^B\} = 0 \tag{45}$$

$$\beta_t^B\{-i_t^{CB} + \lambda_t^B\} = 0 \tag{46}$$

Composition (41) and (42) yields that:

$$i_t^d = i_t^l - \kappa(\frac{K_t^B}{L_t} - \tau)(\frac{K_t^B}{L_t})^2 \tag{47}$$

The equation (43) shows the optimal relationship between deposit and loan interest which depends on the capital to asset ratio adjustment cost. Comparing equation (44) to equation (46) yields that:

$$i_t^d = i_t^{CB} \tag{48}$$

On the other hand, banking sector keeps a part of deposits as banks legal reserves as follows:

$$R_t^L = rr_t D_t \tag{49}$$

Such that, R_t^L displays the total bank legal reserves. In equation (49), rr_t presents the bank legal reserves rate. It is assumed that the bank legal reserves rate follow a first order autoregressive process as:

$$\log rr_t = \rho_{rr} \log rr_{t-1} + \varepsilon_t^{rr} \tag{50}$$

In equation (50), ε_t^{rr} displays banks reserves rate shock as an indirect monetary policy instrument in Iran. It is assumed that banks reserves rate follow a stationary first order autoregressive model.

3-5. Government and Central Bank

In the designed model, we supposed that Iran's government spending (GO_t) function has a Cobb-Douglas form as:

$$GO_t = f(OR_t, T_t, X_t) = OR_t^{\alpha_1} \times T_t^{\alpha_2} \times OI_t^{\alpha_3} \times e^{\varepsilon_t^{go}} \tag{51}$$

In the recent equation OR_t, T_t and OI_t denote the oil revenues, tax revenues and other government incomes, respectively. Equation (51) shows that government spending in Iran depends on government income resources and any of these resources have a proportion in government spending structure. In equation (51), ε_t^{go} denotes the government spending shock as fiscal policy instrument. It is assumed that $\alpha_1 + \alpha_2 + \alpha_3 = 1$ and the oil revenues can be specifying as the following equation:

$$OR_t = ner_t \times P_t^{oil} \times Y_t^{oil} \tag{52}$$

In the recent equation, ner_t shows the nominal exchange rate, P_t^{oil} and Y_t^{oil} present oil price and oil production respectively. We specified the following processes for the oil price, oil production and nominal-official exchange rate:

$$\log P_t^{oil} = \rho_{Poil} \log P_{t-1}^{oil} + \varepsilon_t^{Poil} \tag{53}$$

$$\log Y_t^{oil} = \rho_{yoil} \log Y_{t-1}^{oil} + \varepsilon_t^{yoil} \tag{54}$$

$$\log ner_t = \rho_{ner} \log ner_{t-1} + \varepsilon_t^{ner} \tag{55}$$

In equations (53) and (54), ε_t^{poil} and ε_t^{yoil} present the oil price and the oil production shocks and ε_t^{ner} presents the shock of nominal-official exchange rate.

Moreover, the government nominal budget constraint is:

$$\frac{B_{t+1}^{P}}{(1+r_t^b)} + B_{t+1}^{CB} + T_t + \psi_{t-1}^{GO} + D_t^B = GO_t + H_t^{GO} + B_t^P + B_t^{CB} + \psi_t^{GO} + D_{t-1}^B \tag{56}$$

The left side of recent equation presents the government incomes and debts from private sector(B_{t+1}^P) and central bank(D_t^B) in the current period and the right side shows the government spending in this period include transfer payment(H_t^{GO}), repurchase private bond(B_t^P) and central bank (B_t^{CB}) bonds and also investment in stock market(ψ_t^{GO}) and debts from central bank (D_{t-1}^B) in previous period. To simplify, we assumed that the tax revenues, other income, transfer spending and government investment in stock market follow from the following autoregressive processes:

$$\log T_t = \rho_T \log Y_t + \varepsilon_t^T \tag{57}$$

$$\log OI_t = \rho_{OI} \log Y_t + \varepsilon_t^{OI} \tag{58}$$

$$\log H_t^{GO} = \rho_H \log H_{t-1}^{GO} + \varepsilon_t^{H^{GO}} \tag{59}$$

$$\log \psi_t^{GO} = \rho_{\psi^{GO}} \log \psi_{t-1}^{GO} + \varepsilon_t^{\psi_t^{GO}} \tag{60}$$

On the other hand, the central bank balance sheet is:

$$C_t^P + R_t^L = G_t^{CB} + B_t^{CB} + D_t^B + L_t^{CB} + ner_t Z_t \tag{61}$$

The right side of above equation presents money base resources include central bank gold reserves, bond and foreign assets reserves and government debts (D_t^B) and loans from banking sector(L_t^{CB}). The left side shows money base components involve reserve requirement and currency in circulation. Consolidations the government and central bank budget constraints by defining $M_t^B = G_t^{CB} + B_t^{CB} + D_t^B + L_t^{CB} + ner_t Z_t$ as the powered money or monetary based yield that:

$$\frac{B_{t+1}^P}{(1+r_t^b)} + M_{t+1}^B - G_{t+1}^{CB} - D_{t+1}^B - L_{t+1}^{CB} - ner_{t+1} Z_{t+1} + T_t + \psi_{t-1}^{GO} \tag{62}$$

$$= GO_t + H_t^{GO} + B_t^P + M_t^B - G_t^{CB} - D_t^B - L_t^{CB} - er_t Z_t + \psi_t^{GO}$$

In order to specify the real form of government and central bank consolidated budget constraints, divide the equation (62) to level price and obtain:

$$E_t \pi_{t+1} \{ \frac{B_{t+1}^P}{(1+r_t^b)} + M_{t+1}^B - G_{t+1}^{CB} - D_{t+1}^B - L_{t+1}^{CB} - ner_{t+1} Z_{t+1} \} + T_t + \frac{\psi_{t-1}^{GO}}{\pi_t} \tag{63}$$

$$= GO_t + H_t^{GO} + B_t^P + M_t^B - G_t^{CB} - D_t^B - L_t^{CB} - ner_t Z_t + \psi_t^{GO}$$

Based on the definitions, there was a relationship between money levels and monetary based as following equation:

$$M_t = m.M_t^B \qquad m = (1+k)/(k+rr) \tag{64}$$

In (64), rr present mean of banks reserves rate and k equal to currency deposits ratio.

We specified indirect monetary policy tools as the following random walk equations:

$$\log D_t^B = \rho_{D^B} \log D_{t-1}^B + \varepsilon_t^{D^B} \tag{65}$$

$$\log L_t^{CB} = \rho_{L^{CB}} \log L_{t-1}^{CB} + \varepsilon_t^{L^{CB}} \tag{66}$$

We also have two behavioral equations for foreign assets of central bank and bonds of central bank as follow:

$$\log(B_t^p) = \gamma_1 \log(er_t) + \gamma_2 \log(\pi_t) + \gamma_3 \log(Y_{t-1}) + \gamma_4 \log(B_{t-1}^p) + \varepsilon_t^{B^p} \tag{67}$$

$$\log(Z_t) = \beta_1 \log(Z_{t-1}) + \beta_2 \log(er_t) + \beta_3 \log(\pi_t) + \beta_4 \log(\mathrm{OR}_{t-1}) + \varepsilon_t^z \tag{68}$$

It is also assumed that the gold resource of central bank has a simple autoregressive presentation as:

$$\log G_t^{CB} = \rho_G \log G_{t-1}^{CB} + \varepsilon_t^{G_t^{CB}} \tag{69}$$

The above equations (65) to (69) determine the monetary based resources channels of monetary policy in the Iran economy. In reality in

the economy of Iran, the monetary policy directly depends on the monetary based resources behaviors.
On the other hand, we offered the role of money and credit assembly for Iran's central bank as the following equation:

$$i_t^d = (i_{t-1}^d)^{\rho_{i^d}} [\pi_{t-1}^{\rho_\pi^i})(\frac{Y_{t-1}}{Y_t})^{\rho_y}]^{1-\rho_{i^d}} e_{i^d} \qquad e_{i^d} \sim iid(0, \sigma^2_{e_{i^d}}) \tag{70}$$

In final, the following markets clearing condition is specified:

$$Y_t = C_t + I_t + GO_t + \delta_B K_{t-1}^B \tag{70}$$

The equation (70) is the aggregate resource constraint for the economy of Iran. In this equation, $\delta_B K_{t-1}^B$ represents the bank's management cost in term of bank capital.

4. Empirical Analysis

One of the most important challenges of empirical DSGE model is the nonlinearity of equilibrium equations. In order to linearization of model, the log-linearization method has been employed (DeJong and Dave, 2007). The log-linearized model is provided in appendix sector of paper. In this section, we calibrated the structural parameters. In order to examine the choice process of values of model parameters, we simulated and compared the model simulation with the real time series of Iran for various values for model parameters several times and finally we have chosen best value for parameters. As it is displayed in Table1, we finally calibrated parameters by taking their value directly from the previous literature such as Tavakolian (2012), Moshiri and et al. (2012) and Heidari and Molabahrami (2013) or set them to match of the real quarterly time series data from Iran economy during 1991 to 2012. Then we calculated the steady state of endogenous variables of the designed DSGE model based on parameters values. Table 1 shows calibrated parameters of the designed model.

Table 1. Calibrated Parameters of Designed Model

Parameter	Explain	Value	Reference
σ_c	Inverse elasticity of inter-temporal consumption	1.571	Tavakolian(2012)
σ_N	Inverse elasticity of labor supply	2.17	Tavakolian(2012)
σ_M	Inverse elasticity of money demand	2.39	Tavakolian(2012)
δ	Depreciation rate	0.042	Motavaseli et al. (2011)
κ_M	Quadratic adjustment cost coefficient	0.2	Research calculation
β	Discount factor	0.96	Motavaseli et al. (2011)
α	Capital share in output	0.42	Tavakolian(2012)
ρ_π	Degree of price indexation	0.715	Tavakolian(2012)
$\bar{\lambda}_t^p$	Steady state level of price Mark-up	1.30	Motavaseli et al. (2011)
ω	Degree of price stickiness	0.5	Tavakolian(2012)
β_B	Banking sector discount factor	0.97	Research calculation
κ	Quadratic adjustment cost coefficient	10	Research calculation
α_1	Elasticity of government oil revenues	0.74	Research calculation
α_2	Elasticity of government tax revenues	0.16	Research calculation
α_3	Elasticity of government other revenues	0.1	Research calculation
ρ_π^i	Inflation gap coefficient in interest rate equation	0.0312	Farzinvash and et al. (2015)
ρ_y	Output gap coefficient in interest rate equation	0.968	Farzinvash and et al. (2015)
ρ_{i^d}	Degree of interest rate indexation	0.909	Farzinvash and et al. (2015)

Source: research results

We set discount factor at 0.97. The capital share was set at 0.42 and the depreciation rate at 0.042. In the good market, a value of 4 for ε_t^p in steady state, deliver a markup of 30 percent, a value that commonly used in the literature. We also set the degree of price indexation and degree of price stickiness equal to 0.715 and 0.5 following the Tavakolian (2012). For the banking parameters, no corresponding estimate was available with precision in the literature. To calibrate, we set banking sector discount factor equal to 0.97 and also the quadratic adjustment cost coefficient of banking sector equal to 10. We also calibrated elasticity of government oil revenues, tax revenues and other revenues equal to 0.74, 0.16 and 0.1 respectively according to econometrics estimation based on the quarterly time series data from Iran economy during 1991 to 2012 periods.

In order to initialize the model, in the Table2 calculated the steady-state of endogenous variables has been reported. The steady-state values are obtained from equilibrium condition in the long-run.

Table2. Steady State Values of Endogenous Variables of the Model

Variable	Value	Reference
$\bar{K}$	1.36	Research calculation
$\bar{I}$	0.08	Research calculation
$\bar{Y}$	1.91	Research calculation
$\bar{C}$	0.39	Research calculation
$\bar{M}$	1.06	Research calculation
$\bar{\Phi}$	2.48	Research calculation
$\bar{D}$	1.43	Research calculation
$\bar{L}$	1.23	Research calculation
$\bar{L}^e$	1.12	Research calculation
$\bar{L}^h$	1.45	Research calculation
$\bar{K}^b$	2.65	Research calculation
$\bar{i}^d$	0.45	Research calculation
$\bar{i}^e$	1.031	Research calculation
$\bar{GO}$	1	Research calculation
$\bar{OR}$	1	Research calculation
$\bar{T}$	1	Research calculation
$\bar{X}^{GO}$	1	Research calculation
$\bar{\psi}^{GO}$	0.56	Research calculation
$\bar{r}^k$	0.073	Research calculation
$\bar{R}^b$	1.03	Research calculation
$\bar{G}^{CB}$	1	Research calculation

Variable	Value	Reference
$\bar{Z}$	1	Research calculation
$\bar{\pi}$	1	Research calculation
$\bar{L}^{CB}$	1	Research calculation
$\bar{D}^{B}$	1	Research calculation
$\bar{\psi}$	0.56	Research calculation
$\bar{H}^{GO}$	1	Research calculation
$\bar{B}^{p}$	1	Research calculation
$e\bar{r}$	1	Research calculation

Source: research results

Here, we have employed Blanchard-Kahn method for solving the linearized model in terms of shocks. Then the solved linearized model is simulated for Iran economy. In order to assess the model, the simulated data are compared with actual quarterly time series data for main six variables of Iran economy during 1991 to 2012 by using mean and standard deviation moments. We used Hodrick-Prescott filter in order to calculate the deviation from long-term value of actual data. These results are presented in Table3.

Table3. Assessment the Model Performance Using Moments

Variable (gap)	Mean of actual data	Mean of simulated data	Standard deviation of actual data	Standard deviation of simulated data
Output	0.063	0.061	0.069	0.0655
Investment	0.024	0.032	0.077	0.068
Consumption	0.012	0.0123	0.032	0.043
Capital stock	0.045	0.049	0.057	0.065
Inflation	0.13	0.141	0.096	0.083
Money	0.039	0.041	0.049	0.0531

Source: research results

In general, based on the presented goodness of fit moments, model's ability for fitting the behavior of key macroeconomic variables of the Iran economy was acceptable.

We estimated parameters of the designed model based on the Bayesian econometrics. The quarterly time series data from Iran economy include output, inflation, investment, consumption, government spending, tax revenues, government other incomes, capital stock, money, nonofficial exchange rate, housing price index, stock price index (TEPIX), gold price index, deposit interest rate, banks deposits, loans from banking sector and official exchange rate. We first defined prior distribution for model parameters. Then we employed Bayesian Markov Chain Monte Carlo method for estimating the posterior distribution of all parameters in Dynare software. We used quarterly time series data from economy of Iran during 1991 to 2012. We used 20 observable endogenous variables as above. The Bayesian estimation results of model parameters are presented in Table4 as follows. These results include mean of prior, mean of posterior and confidence interval of parameters.

Table 4. Bayesian Estimation of Model Parameters

Parameter	Mean of prior distribution	Mean of posterior distribution	Confidence interval (90 percent)		Prior distribution
σ_c	1.571	1.45	1.41	1.47	GAMMA
σ_N	1.9	1.81	1.78	1.87	GAMMA
σ_M	2.39	2.37	2.32	2.42	GAMMA
κ_M	2.1	1.93	1.87	2.03	GAMMA
δ	0.042	0.13	0.09	0.15	NORMAL
ρ_π	0.714	0.73	0.66	0.79	NORMAL
ω	0.5	0.64	0.62	0.67	BETA
β	0.95	0.95	0.94	0.96	BETA
ρ_a	0.92	0.91	0.90	0.92	BETA
α	0.42	0.46	0.39	0.49	BETA
α_1	0.74	0.84	0.79	0.89	BETA
α_2	0.16	0.23	0.15	0.27	BETA
α_3	0.1	0.15	0.11	0.24	BETA
ρ_t	0.9	0.94	0.90	0.99	NORMAL
ρ_{poil}	0.95	0.78	0.71	0.84	NORMAL
ρ_{yoil}	0.97	0.95	0.92	1.00	NORMAL
$\rho_{\psi^{GO}}$	0.8	0.82	0.7	0.95	GAMMA

Parameter	Mean of prior distribution	Mean of posterior distribution	Confidence interval (90 percent)		Prior distribution
γ_1	0.12	0.11	0.07	0.15	NORMAL
γ_2	0.47	0.43	0.33	0.49	NORMAL
γ_3	0.39	0.41	0.37	0.46	NORMAL
γ_4	0.283	0.18	0.11	0.27	NORMAL
β_1	0.72	0.75	0.6	0.85	NORMAL
β_2	0.3	0.32	0.24	0.41	NORMAL
β_3	0.52	0.71	0.58	0.79	NORMAL
β_4	0.82	0.75	0.7	0.80	NORMAL
ρ_{OI}	0.8	0.77	0.63	0.86	GAMMA
ρ_H	0.6	0.99	0.98	1.00	GAMMA
$\rho_{G^{CB}}$	0.6	0.58	0.51	0.68	GAMMA
a_{11}	0.9	0.96	0.93	0.99	NORMAL
a_{22}	0.92	0.78	0.73	0.85	NORMAL
a_{33}	0.96	0.95	0.91	0.98	NORMAL
a_{44}	0.91	0.72	0.69	0.77	NORMAL
a_{12}	-0.22	-0.06	-0.09	-0.03	NORMAL
a_{23}	-0.12	-0.21	-0.24	-0.17	NORMAL
a_{34}	-0.34	-0.34	-0.4	-0.26	NORMAL
a_{13}	-0.2	-0.04	-0.07	0.01	NORMAL
a_{45}	0.6	0.29	0.28	0.30	NORMAL
β_B	0.96	0.98	0.97	0.99	BETA
κ_d	2.3	2.26	2.1	2.36	GAMMA
τ	0.1	0.02	0.001	0.05	BETA
ρ_i^d	0.909	0.989	0.98	1.00	BETA
$\rho^i{}_\pi$	0.031	-0.078	-0.1	-0.064	NORMAL
ρ_y	0.969	1.18	1.17	1.19	NORMAL

Source: research results

In next step of model assessment, we have divided the shocks that appeared in the designed model into three groups. First, there were macroeconomics shocks which pools shocks to production technology, inter-temporal preference, housing demand and price markup. Second, there were credit sector shocks consist of deposit rate shock. Finally there were financial and nonfinancial shocks that consist of stock price shock and housing price shock. In this part of paper, we investigated dynamic effects of these shocks on the macroeconomics and assets variation based on the impulse responses functions. The horizontal axes of these functions, present periods and vertical axes show the variable deviation from steady-state values. These figures display that how endogenous variables react to shocks and also present the adjustment process of shocks effects. Figure (1) displays the Bayesian estimated impulse response functions for deposit rate shock in thirty future periods that apply by credit and money assembly of central bank of Iran.

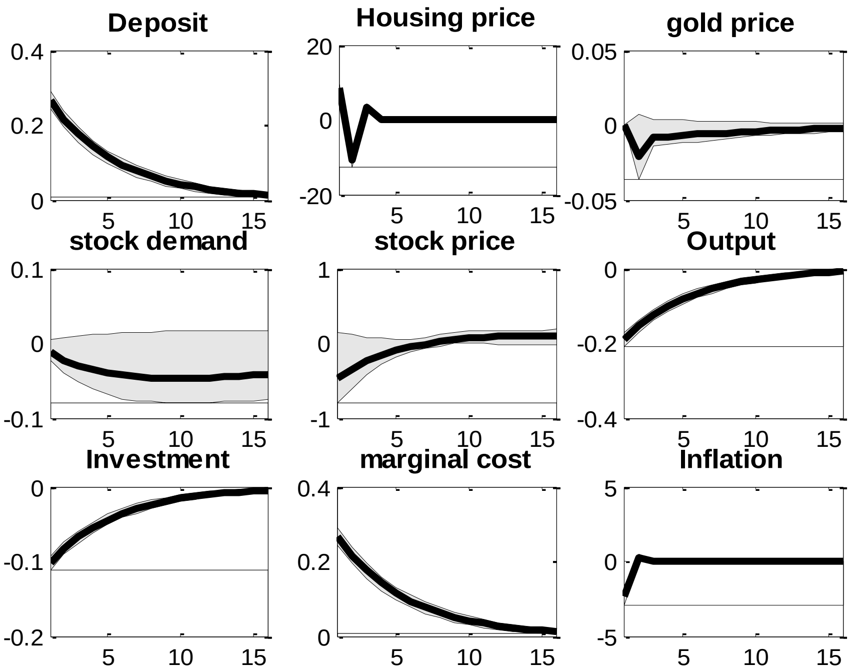

Figure 1. Bayesian Impulse Responses Functions of Positive Deposit Rate Shock

Source: research results

Based on the Figure 1, positive deposit rate shock lead to negative deviations in steady-state values of housing, gold and stock prices and adjustment process takes 5 periods for housing and gold prices. For stock price the adjustment process takes 10 periods. In reality, when a positive deposit rate occurs, investors will be more willing to bank deposits as a riskless investment option and so they bring out a part of their resources from risky assets markets to deposits in banking sector and then prices of risky assets decrease. So, banking deposit rates play a key role in boom and bust cycles of financial and physical assets markets. On the other hand, when a positive deposit rate shock occurs, bank deposits increase but inflation, investment and output decrease as results of a positive deposit interest rate. So, the MaKinnon-Show theory is rejected for Iran. In summary, a positive deposit rate decreases the value of collaterals and also increases the financing costs and financial friction and finally recession will be deeper and accordingly the financial accelerator theory is accepted for the economy of Iran. Consequently, investment, capital stock decline and finally output decreases. Based on the obtained results, deposit rate shock plays a key role in dynamic behaviors of main macro-variables of the Iran economy.

On the other hand, Figure 2 displays the Bayesian estimated impulse responses functions to a positive stock price shocks. We observed a reduction in gold price due to a sudden positive stock price shock. However, an increase in stock price has a short-run negative effect on household deposits. The impulse responses of Figure 2 indicate that the effect of a positive stock price shock on household deposits is discharged rapidly.

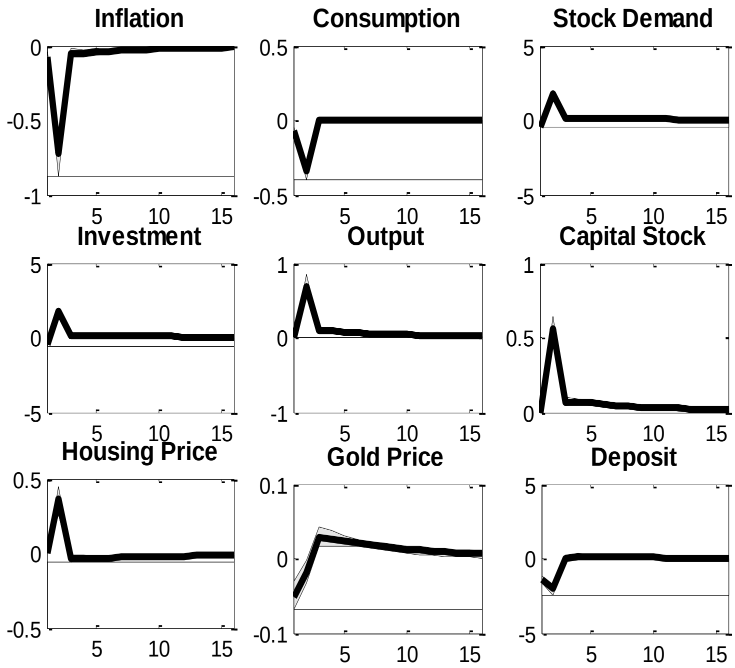

Figure2. Impulse Responses Functions to a Positive Stock Price Shock

Source: research results

The impulse responses functions of Figure 2 indicate that a sudden increase in stock price which leads to reduce the demand for other assets including gold and deposits and so composition of household portfolio changes and investors prefer to raise investment in stock markets. In general, the responses of macroeconomics variables such as investment, capital stock and finally output to a positive suddenly stock price shock are positive. But inflation increases as a result of positive random stock price shock.

In Figure 3, Bayesian estimated impulse responses functions of a positive housing price shock are presented. A housing price shock leads to the increase of housing investment demand and also leads to a general decreasing in demands for other financial and nonfinancial assets despite the stock price. These variables return to equilibrium slowly, as it is seen in Figure3. Housing and stock market positively related based on the results which are due to the positive relation among related housing industries and the stock market. On the other hand, following the positive housing price shock, the demand for banking loans increase and also investment and output are increased. On the other hand, investors prefer to decrease their banking deposits and banks deposits are decreased due to a positive housing price shock. It seems that a positive housing price could help to the recovery and revival of economy of Iran.

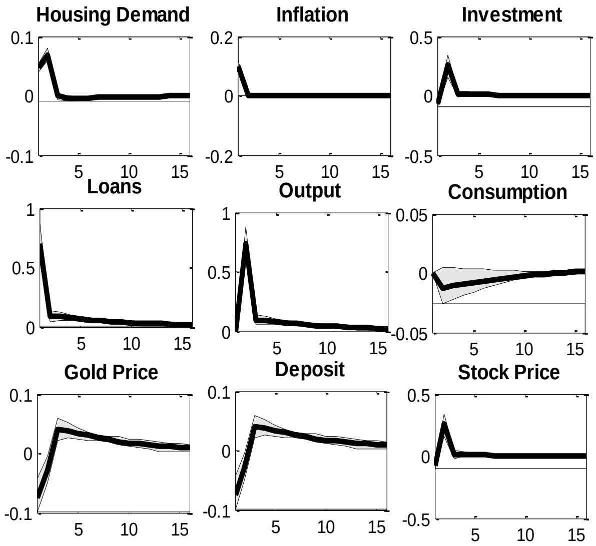

Figure 3. Impulse Responses Functions to a Positive Housing Price Shock
Source: research results

In general, a positive housing price shock changes the composition of household portfolio in such a way that household bank deposits and gold price investment is decreased. On the other hand, since housing market relates to many products and services markets, boom in this market can improve the stock market activities and also level of investment and output.

Finally, we provided Bayesian estimated impulse responses functions of oil price shock in Figure 4. As it is seen, a positive oil price shock leads to a positive deviation in steady-state values of money, inflation, investment and output. On the other hand, when oil price is increased, exchange rate deviates from its steady state value and also government spending increased. With the injection of additional oil revenues to the economy, prices in housing market as a non-tradable sector increase and subsequently stock price increases. In reality, when oil price increases, the price of petroleum and oil companies raise and in general the stock market price index is increased.

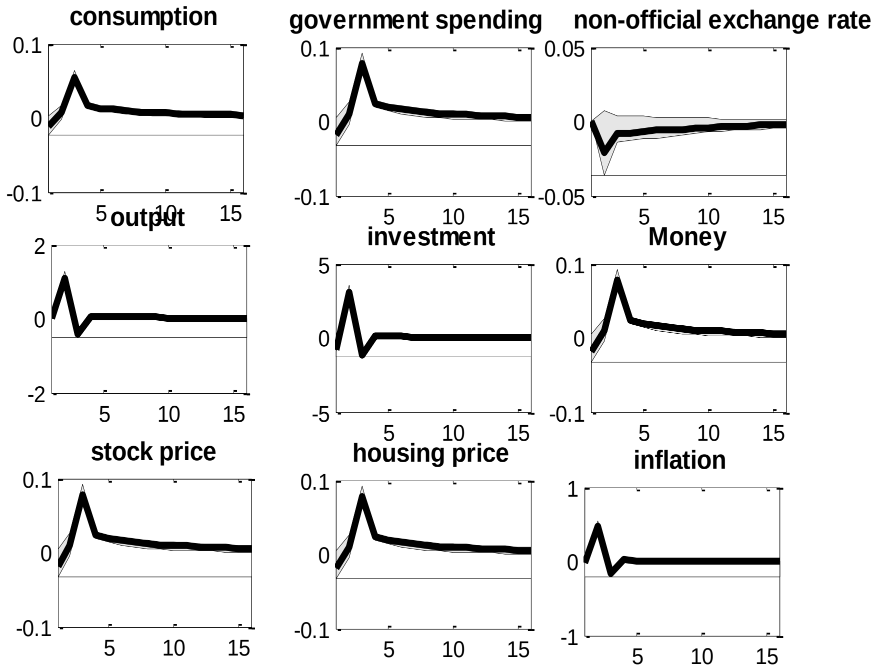

Figure 4. Impulse Responses Functions to a Positive Oil Price Shock

Source: research results

In summary, positive oil price shock increases oil revenues and government spending. When additional oil revenues are injected to the economy, housing and stock markets placed in boom cycles and exchange rate is decreased. These results indicate on the Dutch disease in the economy of Iran.

5. Conclusions

This paper provided a dynamic model of household financial decisions and their portfolio choices in Iran's economy including a DSGE model with banking sector based on the Bayesian econometrics for quarterly time series data during 1990 to 2012 periods. We observed that the proportions of various financial and physical assets in household portfolio were positively dependent on assets prices expectation and negatively related on their current prices. Initialization, calibration, simulation and finally Bayesian estimation results of model and estimated impulse responses functions indicated that banking sector has an important role in Iranian economy so a positive deposit rate shock increases inflation and marginal cost and decreases investment and output. On the other hand, when a positive deposit rate is happened, household demands for risky financial and nonfinancial assets decrease and the level of banking deposits increase significantly. Based on Bayesian estimated impulse responses functions, a positive shock to deposit rate increases the amounts of household deposits and also decreases prices of financial and nonfinancial assets in the household portfolio. In summary, a positive deposit rate decreases the value of collaterals and also increases the financing costs and finally recession would be deeper and the financial accelerator theory is accepted for the economy of Iran.

A positive loan interest rate shock also has a similar impact on the mentioned variables. Estimation results of the designed model showed that, stock price and housing price shock had negative effects on price of other financial and physical assets but discharging and returning to equilibrium are slower, when a housing price shock occurs. On the other hand, a positive housing price shock increased the level of investment and output from their steady-state level. The impulse responses functions also showed that a positive stock price shock can increase the level of investment, capital stock and finally output

Two important findings are worth noting here. A higher deposit rate reduces the value of collaterals and household worth which leads to credit rationing and finally reduction in investment and output. On the other hand, any positive stimulus in asset markets particularly stock market and housing market leads to an increase in investment and output. The policy makers and monetary authorities of Iran must pay attention to the negative consequences of credit policies specially deposit rates increase.

Endnote

1. It is assumed that $\sum_{i=1}^{5} a_{i,\mathrm{t}} = 1$ based on the $a_{i,\mathrm{t}}$ definition.

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Appendix: Log-Llinearized Model

$\hat{C}_t = E_t\hat{C}_{t+1} - \frac{1}{\sigma_c}(\hat{R}_t^b - E_t\hat{\pi}_{t+1})$	Euler equation
$\sigma_N \hat{N}_t = -\sigma_C \hat{\mathrm{C}}_t + \hat{\mathrm{w}}_t$	Labor supply
$\hat{\mathrm{m}}_t = \frac{\sigma_C}{\sigma_M}\hat{C}_t - \frac{\sigma_C}{\sigma_M}\frac{\hat{r}_t^b}{\overline{\mathrm{r}}^b}$	Money demand
$\hat{d}_t = \sigma_C\hat{C}_t + \frac{\overline{i}^{\,d}}{\overline{R}^b - \overline{i}^{\,d}}\hat{i}_t^d$	deposit supply
$\sigma_C\hat{C}_t = \frac{\overline{i}^{\,l}}{\overline{i}^{\,l} - \overline{R}^b}\hat{i}_t^l = \frac{\overline{i}^{\,l}}{\overline{i}^{\,l} - \overline{r}^b - 1}\hat{i}_t^l$	Loan demand
$\hat{\phi}_t^p = \sigma_C\hat{C}_t - \frac{\overline{r}^b + 1}{\overline{r}^b}\hat{Q}_t^s + \frac{1}{\overline{r}^b}E_t\hat{Q}_{t+1}^s$	Demand for Investment in stocks
$\hat{x}_t = \sigma_C\hat{C}_t - \frac{\overline{r}^b + 1}{\overline{r}^b}e\hat{r}_t + \frac{1}{\overline{r}^b}E_t e\hat{r}_{t+1}$	Demand for investment in currency
$\hat{g}_t = \sigma_C\hat{C}_t - \frac{\overline{r}^b + 1}{\overline{r}^b}\hat{p}_t^G + \frac{1}{\overline{r}^b}E_t\hat{p}_{t+1}^G$	Demand for investment in gold
$\hat{h}_t = \sigma_C\hat{C}_t - \frac{\overline{r}^b + 1}{\overline{r}^b}\hat{p}_t^H + \frac{1}{\overline{r}^b}E_t\hat{p}_{t+1}^H$	Demand for investment in housing market
$\hat{I}_t = \frac{(\hat{\gamma}_t - \hat{p}_t^I)}{\kappa^A(1+\beta)} + \frac{1}{1+\beta}\hat{I}_{t-1} + \frac{\beta}{1+\beta}E_t\hat{I}_{t+1}$	Investment function
$\hat{K}_t = (1-\delta)\hat{K}_{t-1} + \delta\hat{I}_t$	Capital formation

$\frac{\bar{Y}}{\bar{Y}+\bar{\Phi}}\hat{Y}_t = \hat{A}_t + \alpha\hat{K}_{t-1} + (1-\alpha)\hat{N}_t$	Production function
$\hat{r}_t^k = \hat{w}_t + \hat{N}_t - \hat{K}_{t-1}$	Capital optimal pricing
$MC_t = -\hat{A}_t + (1-\alpha)(\hat{\mathrm{w}}_t) + \alpha\hat{r}_t^k$	Marginal cost
$G\hat{O}_t = \alpha_1 O\hat{R}_t + \alpha_2\hat{T}_t + \alpha_3\hat{X}_t^{GO}$	Government spending function
$E_t\hat{\pi}_{t+1} + \bar{B}^p\hat{B}_{t+1}^P - \bar{R}^b\hat{R}_t^b + \bar{M}^B\hat{M}_{t+1}^B - \bar{G}^{CB}\hat{G}_{t+1}^{CB} - re\bar{r}re\hat{r}_{t+1}$ $-\bar{D}^B\hat{D}_{t+1}^B - \bar{L}^{CB}\hat{L}_{t+1}^{CB} - \bar{Z}\hat{Z}_{t+1} + \bar{T}\hat{T}_t + \bar{\psi}^{GO}\hat{\psi}_{t-1}^{GO} - \bar{\pi}\hat{\pi}_t$ $= G\bar{O}G\hat{O}_t + \bar{H}^{GO}\hat{H}^{GO} + \bar{B}^p\hat{B}_t^P + \bar{M}^B\hat{M}_t^B - \bar{G}^{CB}\hat{G}_t^{CB}$ $-\bar{D}^B\hat{D}_t^B - \bar{L}^{CB}\hat{L}_t^{CB} - e\bar{r}e\hat{r}_t - \bar{Z}\hat{Z}_t + \bar{\psi}\hat{\psi}_t^{GO}$	Government and central bank consolidated constraint
$\frac{\bar{i}^l\hat{i}_t^l}{\bar{i}^d - \bar{i}^l} = \frac{\bar{i}^d\hat{i}_t^d}{\bar{i}^d - \bar{i}^l} + (2 + \frac{1}{1-\tau})\hat{K}_t^B - (2 + \frac{1}{1-\tau})\hat{L}_t$	Banking sector equation
$\bar{K}^B\hat{K}_t^B + \bar{D}\hat{D}_t + \bar{L}^{CB}L_t^{CB} = \bar{L}\hat{L}_t + \bar{Q}\hat{Q}_t + \bar{\psi}^B\hat{\psi}_t^B + B\bar{A}B\hat{A}_t$	Balance sheet of banking sector
$\hat{Q}_t^s = \alpha_{11}\hat{Q}_{t-1}^s + \alpha_{12}\hat{P}_t^H + \alpha_{13}\hat{P}_t^G + \alpha_{14}\,\mathrm{e}\hat{\mathrm{r}}_t + \hat{\varepsilon}_t^{Q_t^s}$	Stock price dynamics
$\hat{P}_t^H = \alpha_{21}\hat{Q}_t^s + \alpha_{22}\hat{P}_{t-1}^H + \alpha_{23}\hat{P}_t^G + \alpha_{24}\,\mathrm{e}\hat{\mathrm{r}}_t + \hat{\varepsilon}_t^{P_t^H}$	Housing price dynamics
$\hat{P}_t^G = \alpha_{31}\hat{Q}_t^s + \alpha_{32}\hat{P}_t^H + \alpha_{33}\hat{P}_{t-1}^G + \alpha_{34}\,\mathrm{e}\hat{\mathrm{r}}_t + \hat{\varepsilon}_t^{P_t^G}$	Gold price dynamics
$\mathrm{e}\hat{\mathrm{r}}_t = \alpha_{41}\hat{Q}_t^s + \alpha_{42}\hat{P}_t^H + \alpha_{43}\hat{P}_t^G + \alpha_{44}\,\mathrm{e}\hat{\mathrm{r}}_{t-1} + a_{45}ne\hat{r}_{t-1}\hat{\varepsilon}_t^{er_t}$	Exchange rate dynamics
$\hat{i}_t^d = \rho_{i^d}(\hat{i}_{t-1}^d) + (1-\rho_{i^d})[\rho^i{}_\pi\hat{\pi}_{t-1}) + \rho_y\{(\hat{Y}_{t-1} - \hat{Y}_t)\}] + \hat{e}_{i^d}$	Interest rate specification by money and credit assembly