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Original Research Article

The Impacts of Monetary, Fiscal and Technology Shocks on the Healthcare Sector in Iran: A Dynamic Stochastic General Equilibrium Model Approach

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The healthcare system holds a significance role in economic growth and development of any country. For assessing and evaluating the healthcare system, the relative prices of this sector are one of the crucial indicator. This study employs a stochastic dynamic general equilibrium model to examine the impacts of monetary, fiscal and technology shocks on the healthcare sector in the Iranian economy. The results indicate that positive monetary shock has direct impact on general inflation but tends to be reduced the relative prices of the health sector. Thus, the positive impact of this shock on the production of non-health goods is greater than the health sector. Also, positive shocks related to oil income, government health sector expenditures, and technology increase the production of health and non-health goods and have an inverse effect on inflation of this sector.

Keywords: Healthcare Sector, DSGE Model, Monetary and Fiscal Shocks
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1 Introduction

The healthcare system and healthcare services play a crucial role in improving the health status of a country's population. However, rising costs and inflation in the healthcare sector have become a concern for individuals and governments worldwide (Folland et al, 2006). Nevertheless, the healthcare sector, due to its specific characteristics, experiences higher inflation compared to the general inflation rate. The inflation pattern in the healthcare sector indicates that the prices of goods and services in this sector have grown at a faster rate than the consumer price index (CPI) (Sherman et al, 2003).

Following studies like Newhouse (1977), the determinants of healthcare costs (and consequently, inflation in this sector) have been categorized into economic and non-economic factors. Some of the economic factors that affect healthcare expenditures and costs include per capita Gross Domestic Product (GDP), liquidity, inflation, unemployment, trade, and more. Non-economic variables include factors like population, education, and lifestyle (Badulescu et al, 2019).

Recent studies have shown that one of the influential factors in the healthcare sector, which are closely related to the overall economy, are monetary and fiscal shocks. There is limited research that explores the interaction between healthcare sector inflation and policy shocks. Some studies that have examined the impact of monetary policies on the healthcare sector include Yagihashi and Du (2015) and Ayilldiz and Yildiz (2020).

Therefore, this study aims to investigate the impact of monetary and fiscal shocks on inflation in the healthcare sector of the Iranian economy using a dynamic stochastic general equilibrium (DSGE) model, building upon the findings of these previous studies.

The study is structured as follows: In Section 2, a new keynesian DSGE model for the Iranian economy is introduced, incorporating the healthcare sector. In Section 3, the process of obtaining a steady state model, estimating parameters, and calibrating them will be presented. Section 4 will present the results of the analysis and a comparison of the impulse response functions in the steady state. Finally, in Section 5, the study concludes with a summary of the findings.

2 The New Keynesian Model for The Iranian Economy

The proposed model is a modified version of the model presented by Yagihashi and Du (2015) that takes into account the oil sector. This model includes households that supply labor, purchase goods (including healthcare and non-healthcare goods) for consumption, hold money and bond, and

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receive their wages from firms producing goods. Production is carried out by a producer of the final goods in a competitive market based on the Dixit and Stiglitz model (1977) and is introduced as a heterogeneous similar model, similar to the work of Barsky et al (2007) and Erceg and Levin (2006). The government sector is used exogenously in the model, and the central bank formulates monetary policy through the base money growth rate instrument.

2.1 Household

Households utility function closely follows the Hall (1988). Utility increases monotonically with regular goods consumption (C), health status (X), and real money balances ($\frac{M_t}{P_t}$). Specifically, expected lifetime utility of households maximization follow:

$$max \quad E_t \sum_{j=0}^{\infty} \beta^j \, exp(\, e_{X,t+j}) \left[\frac{C_{t+j}^{1-\gamma_C}}{1-\gamma_C} + \frac{\eta_X X_{t+j}^{1-\gamma_X}}{1-\gamma_X} + \frac{\eta_m}{1-b_m} \left(\frac{M_t}{P_t} \right)^{1-b_m} \right] \tag{1}$$

Where β, η_X, $e_{X,t} \sim N(0, \sigma_X^2)$, γ_C , γ_X and b_m are the subjective discount factor, the utility weight on health status, the exogenous health shock., and the inverse of the intertemporal elasticities of substitution for regular goods spending, health status and interest rate elasticity of money demand. The accumulation equation governing health status X is as follows:

$$X_t = I_t^X + (1 - \delta_X) X_{t-1} \tag{2}$$

where I_t^X , δ_X are health investment and the depreciation rate of health. Health investment is evaluated through the combined analysis of health spending and leisure as outlined below:

$$I_t^X = exp(\, e_{X,t})(H_t)^{k_H}(1 - N_t)^{k_L} \tag{3}$$

where H, $1 - N$, are health spending and leisure hours defined as total hours minus hours spent working. k_H and k_L represent the elasticity of health investment with respect to "inputs" H and $1 - N$. Household budget constraint is as follows::

$$\frac{P_{R,t}}{P_t} C_t + \frac{P_{H,t}}{P_t} H_t + \frac{M_t}{P_t} + \frac{D_t}{P_t} = \frac{W_t}{P_t} N_t + \frac{R_{t-1}^n}{P_t} D_{t-1} + \frac{M_{t-1}}{P_t} + profit_t \tag{4}$$

The real expenditures of households include of consumption of health and non-health goods (H: the index of health goods and R: the index of non-health goods), Money and bond holdings. The real income of households are

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received wages, returns on held bonds, the remaining cash balance from the previous period's received wages, and the total real returns (income) collected from firms. Here, D_t is a one-period nominal coupon bond maturing at time t+1 that pays a gross nominal interest rate of t+1 and pays a nominal gross interest rate. W_t Nominal wages are determined in a competitive labor market, P_t the general price index of the economy, $P_{R,t}$ and $P_{H,t}$ the prices of non-health and health goods, and $profit_t$ is the profits of firms.

Let λ_X and $\lambda_D$are the Lagrange multiplier on the health accumulation equation (Equation (2)) and the Lagrange multiplier on the budget constraint (Equation (4)). The optimization's first-order conditions result in the following expressions for the marginal rates of substitution and intertemporal efficiency conditions:

$$\frac{MU_{H,t}}{MU_{C,t}} = \frac{k_H \lambda_{X,t} \frac{I_t^X}{H_t}}{exp(e_{X,t}) C_t^{-\gamma_C}} = \frac{P_{H,t}}{P_{R,t}} \quad (5)$$

$$\frac{MU_{1-N,t}}{MU_{C,t}} = \frac{k_L \lambda_{X,t} \frac{I_t^X}{1-N_t}}{exp(e_{X,t}) C_t^{-\gamma_C}} = \frac{W_t}{P_{R,t}} \quad (6)$$

$$\frac{MU_{1-N,t}}{MU_{H,t}} = \frac{k_L}{k_H} \frac{H_t}{1-N_t} = \frac{W_t}{P_{H,t}} \quad (7)$$

$$\lambda_{D,t} = \beta R_t^n E_t \left[\frac{\lambda_{D,t+1}}{\prod_{t+1}} \right] \quad (8)$$

$$\lambda_{X,t} = \eta_X \ exp(e_{x,t}) X_t^{-\gamma_X} + \beta(1-\delta_X) E_t [\lambda_{X,t+1}] \quad (9)$$

$$\frac{MU_{m,t}}{MU_{C,t}} = \frac{R_t^n - 1}{R_t^n} \quad (10)$$

Where $MU_i (i = C, H, 1-N, m)$ is the marginal utility of regular goods spending, health spending, and leisure, and $\prod_{t+1} = P_{t+1}/P_t$and $m_t = \frac{M_t}{P_t}$ are the gross inflation and money demand. marginal utility of health status ($MU_X \equiv \lambda_X$) and the marginal product of each input with respect to health investment ($MP_H \equiv k_H \frac{I^X}{H}$, $MP_L \equiv k_L \frac{I^X}{1-N}$).

2.2 Firms

On the supply side, we incorporate sector heterogeneity in line with Barsky et al. (2007) and Erceg et al. (2006). Our model features two sectors: the non-health goods sector (k = R) and the healthcare sector (k = H)Final good producers in both sectors purchase differentiated goods$Y_k(z)$ from their respective intermediate goods producers. These purchased goods are then

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aggregated into the sectoral good Y_k following the approach of Dixit and Stiglitz (1977).

$$Y_{k,t} = \left(\int_0^1 Y_{k,t}(z)^{\frac{\varepsilon_k - 1}{\varepsilon_k}} dz \right)^{\frac{\varepsilon_k}{\varepsilon_k - 1}} \tag{11}$$

let ε_k denote the elasticity of substitution across varieties of intermediate goods. Given the prices $P_{k,t}(z)$ and solving the cost minimization problem subject to equation (10) yields the following demand curve:

$$Y_{k,t}(z) = \left(\frac{P_{k,t}(z)}{P_{k,t}} \right)^{-\varepsilon_k} Y_{k,t} \tag{12}$$

The price index is defined as follows:

$$P_{k,t} = \left(\int_0^1 P_{k,t}(z)^{1-\varepsilon_k} dz \right)^{\frac{1}{1-\varepsilon_k}} \tag{13}$$

The sectoral final goods $Y_{R,t}$ and $Y_{H,t}$ are allocated to either private consumption or government expenditure. Thus, the following relationship holds:

$$Y_{R,t} = C_t + G_{C,t} \tag{14}$$
$$Y_{H,t} = H_t + G_{H,t} \tag{15}$$

In which: C_t is private sector expenditures on non-health goods, $G_{C,t}$ is government expenditures on non-health goods, H_t is private sector expenditures on health goods, and $G_{H,t}$ is government expenditures on health goods are included. The aggregate output, measured in both nominal and real terms, is defined in accordance with GDP

$$P_t Y_t = P_{R,t} Y_{R,t} + P_{H,t} Y_{H,t} \tag{16}$$
$$Y_t = \frac{\overline{P_R}}{\overline{P}} Y_{R,t} + \frac{\overline{P_H}}{\overline{P}} Y_{H,t} \tag{17}$$

here $\frac{\overline{P_R}}{\overline{P}}$ and $\frac{\overline{P_H}}{\overline{P}}$ represent the steady-state relative prices of the two goods. The aggregate price index P_t is implicitly defined in terms of GDP through equations (16) and (17).

Consistent with the New Keynesian framework outlined by Gali (2002), we assume that each intermediate firm zzz in both sectors hires labor N_t from

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a competitive nationwide labor market to produce intermediate goods. The firm's production constraint is expressed as follows:

$$Y_{k,t}(z) = A^{s}_{k,t}\left(N_{k,t}(z)\right)^{\mu_N}(X_t)^{\mu_X} \tag{18}$$

Where μ_N labor's share in production μ_X demonstrates the impact of health status on labor productivity. The sectoral productivity shock $A^{s}_{k,t}$ is defined as follows:

$$A^{s}_{k,t} = \left(A^{s}_{k,t-1}\right)^{\rho^{s}_{k}} exp\left(e^{s}_{k,t}\right), \qquad e^{s}_{k,t} \sim N(0,(\sigma^{s}_{k})) \tag{19}$$

Labor demand is derived by solving the cost minimization problem subject to equation (18), assuming the nationwide real wage $w_t \equiv \frac{W_t}{P_t}$ and the health status are given. The first-order condition for optimality yields the following result:

$$MC_{k,t} = \frac{1}{\mu_N A^{s}_{k,t}} w_t\left(N_{k,t}\right)^{1-\mu_N}(X_t)^{-\mu_X} \tag{20}$$

Where $MC_{k,t}$ denotes the sector-specific real marginal cost. Total labor demand must satisfy the following constraint:

$$N_t = N_{R,t} + N_{H,t} \tag{21}$$

The total labor force demand comprises two components: non-health labor force and healthy labor force. We assume that a randomly assigned fraction ρ_k of intermediate goods firms is constrained from adjusting their prices in each period. Firms unable to adjust their prices in each period base their price adjustments on the inflation rate from the previous period, taking into account the inflation indexing. The last assumption is made because the inflation rate in steady state is considered not to be equal to one, as in the Iranian economy, the stable inflation rate is greater than one.

$$P_{k,t} = (\Pi_{t-1})^{\tau_k} P_{k,t-1} \tag{22}$$

Where, $0 \leq \tau_k \leq 1$ the parameter represents the inflation indexing. If this parameter is less than one, the inflation rate in steady state will be greater than one.

Within each sector, the profit maximization problem for firms that are able to adjust their prices can be expressed as follows:

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$$\max_{P_{k,t}(z)} E_t \sum_{j=0}^{\infty} \rho_k^j \Delta_{k,j,t+j} \left[\prod_{h=0}^{j-1} (\Pi_{t+h})^{\tau_k} \frac{P_{k,t}(z)}{P_{t+j}} - MC_{k,t+j}\right] Y_{k,t+j} \quad s.t. Y_{k,t+j}(z) = \left(\prod_{h=0}^{j-1} (\Pi_{t+h})^{\tau_k} \frac{P_{k,t}(z)}{P_{k,t}}\right)^{-\varepsilon_k} Y_{k,t+j}$$

where $\Delta_{k,j,t+j}$ represents the j-period-ahead stochastic discount factor for firms in sector k. The necessary first-order condition for the optimal price is given by:

$$P_{k,t}^{*} = \frac{\varepsilon_k}{\varepsilon_k - 1} \frac{E_t \sum_{j=0}^{\infty} \rho_k^j \Delta_{k,j,t+j} MC_{k,t+j} \left(\prod_{h=0}^{j-1} \frac{(\Pi_{k,t+h})^{\tau_k}}{\Pi_{t+h+1}}\right)^{\varepsilon_k} Y_{k,t+j}}{E_t \sum_{j=0}^{\infty} \rho_k^j \Delta_{k,j,t+j} \left(\prod_{h=0}^{j-1} \frac{(\Pi_{k,t+h})^{\tau_k}}{\Pi_{t+h+1}}\right)^{\varepsilon_k - 1} Y_{k,t+j}} \tag{23}$$

Where $P_{k,t}^{*}$ denotes the optimal price set by the firms that adjust their prices. The sectoral price index can be reformulated in a fixed-distributed lag form as follows:

$$P_{k,t} = \left[\int_0^1 P_{k,t}(z)^{1-\varepsilon_k} dz\right]^{\frac{1}{1-\varepsilon_k}} = \left[(1-\rho_k)(P_{k,t}^{*})^{1-\varepsilon_k} + \rho_k ((\Pi_{k,t-1})^{\tau_k} P_{k,t-1})^{1-\varepsilon_k}\right]^{\frac{1}{1-\varepsilon_k}} \tag{24}$$

After logarithmic-linear transformation, the Phillips curve is obtained in two segments as follows:

$$\hat{\pi}_{k,t} = \frac{\beta}{1+\beta\tau_k} E_t \hat{\pi}_{k,t+1} + \frac{\tau_k}{1+\beta\tau_k} \hat{\pi}_{k,t-1} + \frac{(1-\rho_k)(1-\beta\rho_k)}{\rho_k(1+\beta\tau_k)} m\hat{c}_{k,t} + \varepsilon_{k,t} \tag{25}$$

2.3 Government and Central Bank

It is assumed that fiscal policies are determined exogenously and in the form of an autoregressive process as follows:

$$G_{j,t} = \left(G_{j,t-1}\right)^{\rho_j^d} \exp\left(e_{G,t}\right), \qquad e_{G,t} \sim N(0, \sigma_G^2) \tag{26}$$

Where $j = C, H$. Monetary policy follows the modified Taylor rule with partial adjustment:

$$\dot{M}_t = (\dot{M}_t)^{\rho_M} [(\prod_t)^{\rho_\Pi} (Y_t)^{\rho_Y}]^{1-\rho_M} S_{M,t} \tag{27}$$

Where ρ_M is the money growth lag coefficient, $\rho_Y$is the output gap coefficient in the central bank reaction function and $S_{M,t}$ is monetary policy

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shock. The nominal money growth rate is determined based on realized inflation, the output gap, the previous period's interest rate, and the monetary policy shock. The monetary policy shock $S_{M,t}$ is defined as

$$S_{M,t} = \left(S_{M,t-1}\right)^{\rho_M} exp(\,e_{M,t}), \qquad e_{M,t} \sim N(0, \sigma_M^2) \tag{28}$$

2.4 Oil Sector

Following the approach of Ghiaie,et al(2020), it is assumed that the oil produced in the international market is sold at a real price without any frictions. The oil production function is specified as a Cobb-Douglas function that utilizes capital and labor for the extraction of oil. The issue pertaining to the oil sector can be described as follows:

$$max\Pi_t^O = (1 - b_o)P_{Ot}Y_{Ot} - w_tN_{Ot}$$
$$s.t.Y_{Ot} = a_{Ot}(k_{Ot-1})^{\alpha_o}(N_{Ot})^{1-\alpha_o}$$
$$k_{Ot} = (1 - \delta_o)k_{Ot-1} + b_oP_{Ot}Y_{Ot}$$

In each period, the government allocates a proportion b_o of its oil income towards capital investment in the oil sector, with the aim of replenishing the depreciated capital (δ_O is the depreciation rate in the oil sector). This assumption aligns with the cyclical nature of Iran's economy and its close connection to the oil industry. Consequently, the oil sector maximizes its profits through decisions related to its workforce, and these profits are then channeled into government coffers. The first-order condition for this scenario can be stated as follows:

$$N_{Ot} = (1 - b_o)(1 - \alpha_o)\frac{P_{Ot}Y_{Ot}}{w_t} \tag{29}$$

Real oil prices (ε_t^{Po}) and technological (ε_t^{ao}) shocks in this sector follow an autoregressive process as outlined below:

$$log(P_{Ot}) = (1 - \rho_{P_O})log(\bar{P}_O) + \rho_{P_O}\,log(\,P_{Ot-1}) + \varepsilon_t^{P^O}, \quad \varepsilon_{Ot} \sim N(0,1) \tag{30}$$
$$log(a_{Ot}) = (1 - \rho_{a_O})log(\bar{a}_O) + \rho_{a_O}\,log(\,a_{Ot-1}) + \varepsilon_t^{a_O}, \quad \varepsilon_t^{a_O} \sim N(0,1) \tag{31}$$

3 Model Solution

The initial step in solving general equilibrium models involves extracting the optimization equations related to the decision-making of economic agents under the model's assumptions, as discussed in the previous section. The next step is the numerical solution of the model. To calculate the equilibrium values

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of the variables, we need to incorporate the stochastic element into the model. For the purpose of stationarization, we detrend the variables in the model and then make them stationary.

The final equations consist of:

$$\dot{m}_t = \rho_n \dot{m}_{t-1} + (1-\rho_n)\left(\rho_\pi \pi_t + \rho_y\left({y^T}_t - {y^T}_{t-1}\right)\right) + {s^M}_t \tag{32}$$

$$rp_{R,t} - rp_{R,t-1} = \pi_{R,t} - \pi_t \tag{33}$$

$$rp_{H,t} - rp_{H,t-1} = \pi_{H,t} - \pi_t \tag{34}$$

$$y_{R,t} = \left(1 - \frac{\bar{G}_C}{\bar{Y}_R}\right)\ c_t + \frac{\bar{G}_C}{\bar{Y}_R} g_{c,t} \tag{35}$$

$$y_{H,t} = \left(1 - \frac{\bar{G}_H}{\bar{Y}_H}\right)\ h_t + \frac{\bar{G}_H}{\bar{Y}_H} g_{H,t} \tag{36}$$

$$-\gamma_C c_t + e_{X,t} = \tilde{\lambda}_{D,t} + rp_{r,t} \tag{37}$$

$$\tilde{\lambda}_{X,t} + i_t^X - h_t = \tilde{\lambda}_{D,t} + rp_{h,t} \tag{38}$$

$$\tilde{\lambda}_{X,t} + i_t^X + \frac{\bar{N}}{1-\bar{N}} n_t = \tilde{\lambda}_{D,t} + \widetilde{w}_t \tag{39}$$

$$\tilde{\lambda}_{D,t} = r_t^n - E_t \pi_{t+1} + E_t \tilde{\lambda}_{D,t+1} \tag{40}$$

$$\tilde{\lambda}_{X,t} = [1 - \beta(1-\delta_X)](-\gamma_X x_t + a_t^X) + \beta(1-\delta_X) E_t \tilde{\lambda}_{X,t+1} \tag{41}$$

$$i_t^X = e_{X,t} + k_H h_t - k_L \frac{\bar{N}}{1-\bar{N}} n_t \tag{42}$$

$$x_t = \delta_X i_t^X + (1-\delta_X) x_{t-1} \tag{43}$$

$$m_t = \frac{1}{b_m}\left(\frac{\beta\bar{\pi}}{1-\beta}\left(E_t \lambda_{D,t+1} - \pi_{t+1}\right) - \frac{\lambda_{D,t}\bar{\pi}}{1-\beta}\right) \tag{44}$$

$$y_t = \frac{\bar{Y}_R}{\bar{Y}} y_{R,t} + \frac{\bar{Y}_H}{\bar{Y}} y_{H,t} \tag{45}$$

$$y_{R,t} = a_{R,t}^s + \mu_N n_{R,t} + \mu_X x_t \tag{46}$$

$$y_{H,t} = a_{H,t}^s + \mu_N n_{H,t} + \mu_X x_t \tag{47}$$

$$n_t = \frac{\bar{N}_R}{\bar{N}} n_{R,t} + \frac{\bar{N}_H}{\bar{N}} n_{H,t} + \left(1 - \frac{\bar{N}_R}{\bar{N}} - \frac{\bar{N}_H}{\bar{N}}\right) n_{O,t} \tag{48}$$

$$\widetilde{w}_t = a_{R,t}^s + mc_{R,t} + (\mu_N - 1) n_{R,t} + \mu_X x_t \tag{49}$$

$$\widetilde{w}_t = a_{H,t}^s + mc_{H,t} + (\mu_N - 1) n_{H,t} + \mu_X x_t \tag{50}$$

$$\pi_t = \frac{\bar{Y}_R}{\bar{Y}}\left[\pi_{R,t} + rp_{R,t-1} + y_{R,t} - y_t\right] + \frac{\bar{Y}_H}{\bar{Y}}\left[\pi_{H,t} + rp_{H,t-1} + y_{H,t} - y_t\right] \tag{51}$$

$$\pi_{R,t} = \frac{\beta}{1+\beta\tau_R} E_t \pi_{R,t+1} + \frac{\tau_R}{1+\beta\tau_R} \pi_{R,t-1} + \frac{(1-\rho_R)(1-\beta\rho_R)}{\rho_R(1+\beta\tau_R)} mc_{R,t} + \varepsilon_{R,t} \tag{52}$$

$$\pi_{H,t} = \frac{\beta}{1+\beta\tau_H} E_t \pi_{H,t+1} + \frac{\tau_H}{1+\beta\tau_H} \pi_{H,t-1} + \frac{(1-\rho_H)(1-\beta\rho_H)}{\rho_H(1+\beta\tau_H)} mc_{H,t} + \varepsilon_{H,t} \tag{53}$$

$$y_{O,t} = \alpha_o k_{O,t-1} + n_{O,t}(1-\alpha_o) + a_{O,t} \tag{54}$$

$$k_{O,t} = k_{O,t-1}(1-\delta_o) + b_o\left(y_{O,t} + p_{O,t}\right) \tag{55}$$

$$n_{O,t} = y_{O,t} + p_{O,t} - w_t \tag{56}$$

$$s_{m,t} = \rho_M s_{m,t-1} + e_{m,t} \tag{57}$$

$$g_{C,t} = \rho_C^d g_{C,t-1} + e_{G,t} \quad (58)$$
$$g_{H,t} = \rho_H^d g_{H,t-1} + e_{G,t} \quad (59)$$
$$a_{R,t}^s = \rho_R^s a_{R,t-1}^s + e_{R,t}^s \quad (60)$$
$$a_{H,t}^s = \rho_H^s a_{H,t-1}^s + e_{H,t}^s \quad (61)$$
$$a_{O,t} = \rho_o a_{O,t-1} + \varepsilon_{O,t} \quad (62)$$
$$p_{O,t} = \rho_o p_{O,t-1} + \varepsilon_t^{P_O} \quad (63)$$

3.1 Calibration and Parameter Estimation

In this section and according table 1, the model is calibrated and the parameters are estimated using data on non-oil gross domestic product, the value added in the healthcare sector, inflation rate, healthcare sector inflation rate, government healthcare expenditures, base money growth rate, oil revenue, and the life expectancy index.

Table1

The calibrated parameters

Symbol	Parameter explanation	Calibrated value
$\frac{G_c}{Y_R}$	The ratio of government non-healthcare expenditures to non-healthcare production	0.15
$\frac{G_H}{Y_H}$	The ratio of government healthcare expenditures to healthcare production	0.25
δ_X	The capital depreciation rate	0.05
π_{SS}	The steady-state inflation	1.178
r_{SS}	The steady-state interest rate	1.18
$\frac{Y_R}{Y}$	The ratio of non-healthcare production to non-oil production	0.6
$\frac{Y_H}{Y}$	The ratio of healthcare production to non-oil production	0.1
$\frac{Y}{Y_T}$	The ratio of non-oil production to total production	0.78
μ_X	The share of healthcare in total production	0

Source: Research Findings.

The estimation of the other parameters is reported in Table 2 and Appendix 1.

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Table 2
Estimating Model Parameters

Parameters	Parameter Explanation	Prior mean	Post mean	90% HPD	Interval	Prior	Pstdev
$\boldsymbol{\rho_m}$	Money growth lag coefficient in the central bank reaction function	0.8	0.7652	0.7473	0.7818	Beta	0.01
$\boldsymbol{\rho_\pi}$	Inflation lag coefficient in the central bank reaction function	-3.83	-3.8295	-3.8642	-3.7982	Normal	0.02
$\boldsymbol{\rho_y}$	Production gap lag coefficient in the central bank reaction function.	-1.21	-1.2268	-1.259	-1.1957	Normal	0.02
$\boldsymbol{\gamma_c}$	Inverse elasticity of non-healthcare goods consumptin	1.65	1.6542	1.6212	1.6878	Gamm	0.02
$\boldsymbol{\beta}$	discount factor	0.97	0.97	0.9684	0.9718	Beta	0.001
$\boldsymbol{\gamma_x}$	The inverse elasticity of healthcare goods consumptin	5.46	5.4644	5.4316	5.4963	Gamm	0.02
$\boldsymbol{\kappa_L}$	Healthcare investment elasticity of leisure.	0.15	0.1436	0.1282	0.1589	Beta	0.01
$\boldsymbol{\kappa_H}$	Healthcare investment of healthcare output	0.25	0.2643	0.249	0.2806	Beta	0.01
$\boldsymbol{b_m}$	Inverse interest elasticity of money demand.	1.5	1.4996	1.4823	1.5155	Gamm	0.01
$\boldsymbol{\mu_N}$	Share of labor force in the production.	0.67	0.6784	0.6642	0.694	Beta	0.01
$\boldsymbol{\rho_R}$	price stickiness coefficient of non-healthcare	0.5	0.5023	0.4858	0.5199	Beta	0.01
$\boldsymbol{\rho_H}$	price stickiness coefficient of healthcare	0.81	0.8095	0.793	0.8266	Beta	0.01
$\boldsymbol{\tau_R}$	Indexation Parameter of non-healthcare Sector	0.5	0.5016	0.4845	0.5171	Beta	0.01

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τ_H	Indexation Parameter of healthcare Sector	0.65	0.6527	0.6364	0.6696	Beta	0.01
α_o	Share of capital in oil production	0.007	0.007	0.0068	0.0072	Beta	0.0001
ρ_M	Autoregressive coeificient of money	0.75	0.7287	0.7121	0.7454	Beta	0.01
ρ_C^d	Autoregressive coefficient of government non-healthcare expenditures	0.75	0.75	0.7331	0.7663	Beta	0.01
ρ_H^d	Autoregressive coefficient of government healthcare expenditures	0.75	0.7492	0.7321	0.766	Beta	0.01
ρ_R^s	Autoregressive coefficient of non-healthcare technology	0.75	0.7542	0.7379	0.7712	Beta	0.01
ρ_H^s	Autoregressive coefficient of healthcare technology	0.75	0.7546	0.7481	0.7792	Beta	0.01
ρ_o	Autoregressive coefficient of oil technology	0.21	0.2085	0.1917	0.2248	Beta	0.01
ρ_{po}	Autoregressive coefficient of oil price	0.15	0.1501	0.1329	0.1648	Beta	0.01
ϵ_X	Autoregressive coefficient of health statuse shock	0.01	6.1878	4.6204	7.8428	Inv.Gamma	Inf
ϵ_M	The Standard deviation of monetary policy shock	0.01	14.4937	10.7359	18.9327	Inv.Gamma	Inf
ϵ_{G_C}	The Standard deviation of government non-healthcare shock	0.01	11.7726	8.6034	15.0561	Inv.Gamma	Inf
ϵ_{G_H}	The Standard deviation of government healthcare shock	0.01	0.0084	0.0024	0.0151	Inv.Gamma	Inf

ϵ_{sR}	The Standard deviation of non-healthecare production technology shock	0.01	9.8589	6.9524	12.6499	Inv.Gamma	Inf
ϵ_{sH}	The Standard deviation of healthecare production technology shock	0.01	201.3773	137.4733	261.5488	Inv.Gamma	Inf
ϵ_{o}	The Standard deviation of oil price shock	0.01	10.3541	7.3603	13.4476	Inv.Gamma	Inf
ϵ_{markR}	The Standard deviation of markup non-healthcare price shock	0.01	0.0076	0.0026	0.0141	Inv.Gamma	Inf
ϵ_{markH}	The Standard deviation of markup healthcare price shock	0.01	18.7194	12.9993	24.6277	Inv.Gamma	Inf

Source: Research Findings.

According to the Geweke(1992) test results reported in Appendix 2, all parameters, except for the standard deviation of government non-healthcare shock, the price stickiness coefficient of healthcare, and the autoregressive coefficient of oil technology, are statistically significant at a 5% significance level. Therefore, the parameter estimates are reliable and can be considered credible for economic analysis.

4 Results

In order to analyze the results of the model, impulse response functions for variables are provided. Figure 1 depicts the impulse response functions for a positive monetary shock.

The monetary shock leads to an increase in inflation of health and non-health goods, as well as general inflation. As can be observed, the impact on the inflation of non-health goods is greater due to its higher share in the basket of goods. It means that monetary shock has negative impact on the relative prices of health sector.

Also, as a result of a monetary shock, the production of health and non-health goods increase, however the impact of the shock on the production of non-health goods is greater because of the relative prices change. Moreover, the monetary shock, by increasing the production and consumption of health and non-health goods leads to an improvement in the health status in the short run.

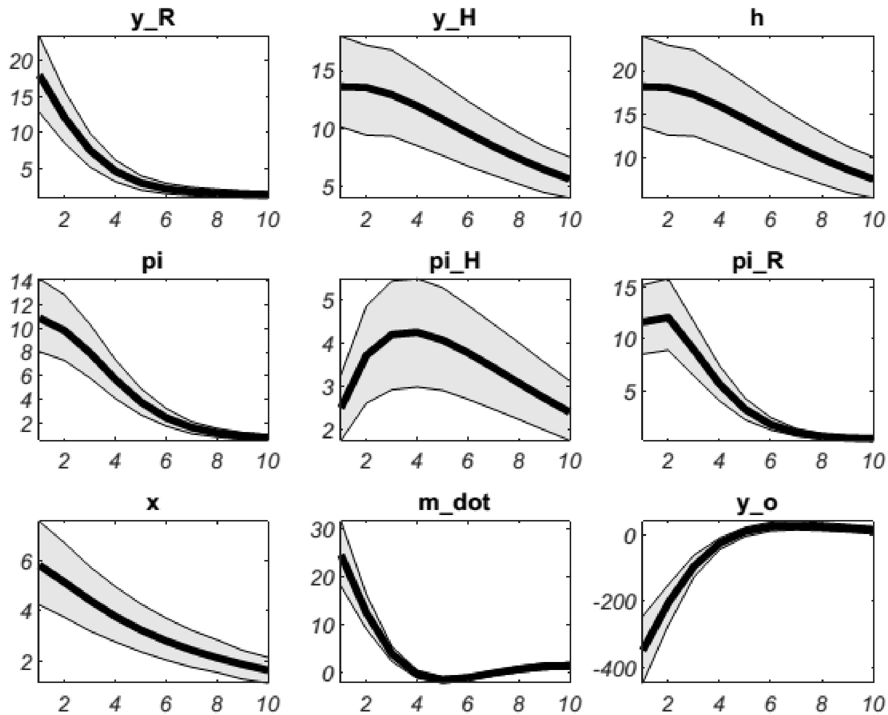

Figure 1. Effects of a Monetary Policy Shock
Source: Research Findings.

Figure 2 illustrates the impact of a positive shock in oil price shock. As can be observed from the impulse response functions, an increase in oil revenues leads to greater imports, resulting in reduced production of non-health goods. In the initial phase of the shock, it has no impact on production of health goods, but it ultimately results in a decrease in production within this sector. This situation can be seen as evidence of a Dutch disease scenario occurring in Iran's economy.

Furthermore, with the increase in oil revenues and foreign exchange earnings, the central bank's monetary base expands. As a result, liquidity increases, leading to inflation in health and non-health goods, as well as

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general inflation. Given the rising inflation and the lack of a positive impact on production, this leads to a deterioration in the health status of the society.

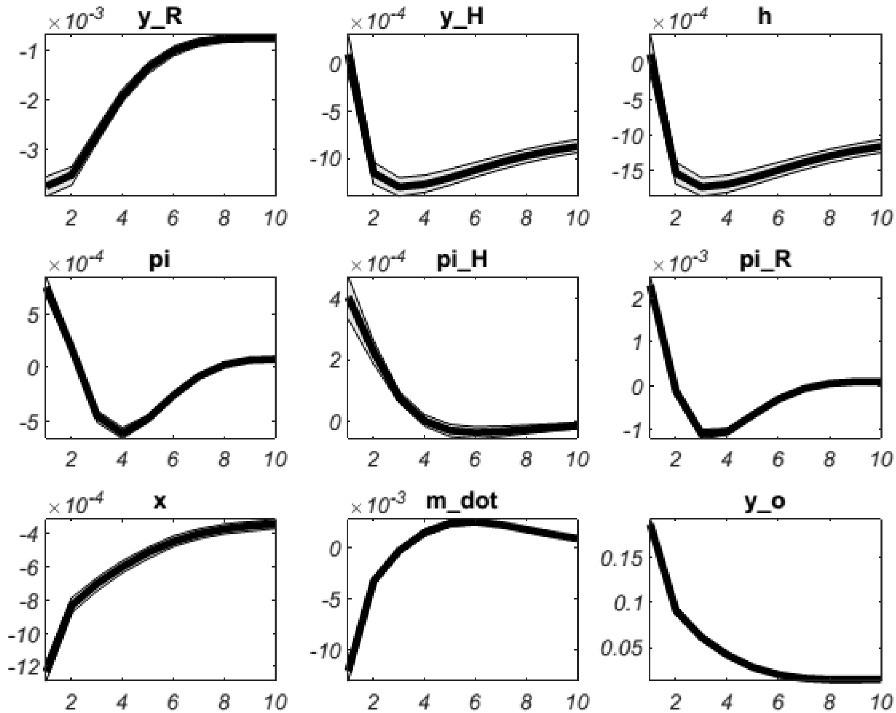

Figure 2. Effects of a Oil Pprice Shock
Source: Research Findings.

In Figure3, the impact of a shock in government healthcare expenditures is examined. An increase in government healthcare expenditures, acting as a fiscal shock, leads to a reduction in the production of goods and services within the healthcare sector and a decline in sector-specific inflation. This demonstrates that instead of increased government healthcare expenditures being allocated to the production of healthcare goods and services, it primarily results in reduced out-of-pocket expenses for the public, increased insurance coverage, and other related areas. This, in turn, leads to a decrease in inflation in the healthcare sector, increased consumption of healthcare goods, and ultimately an improvement in the health status.

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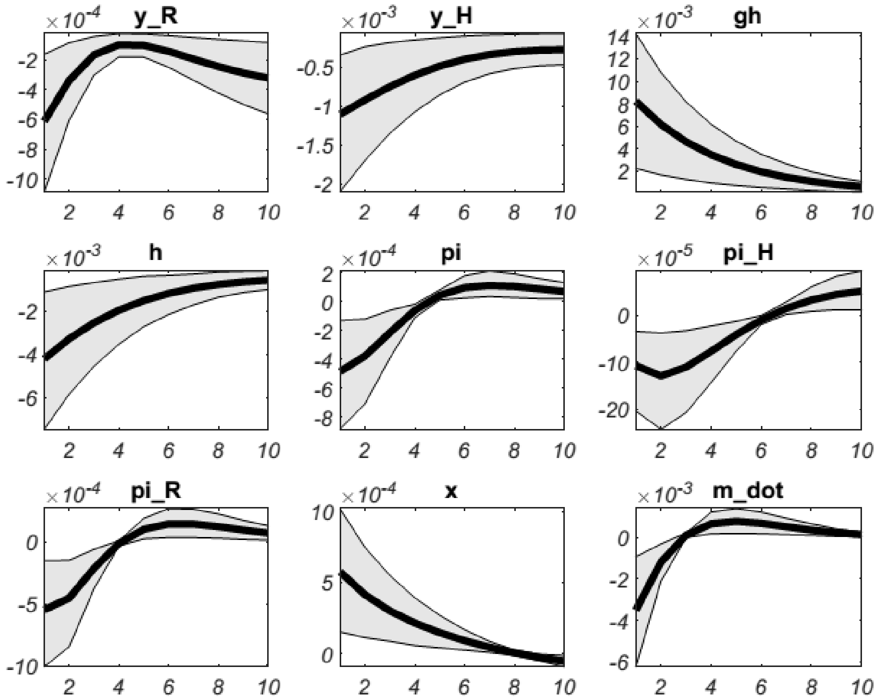

Figure 3. Effects of a Government Healthcare Expenditures Shock
Source: Research Findings.

In Figure4, the result of a positive technology shock in the healthcare goods production is examined. This shock leads to an increase in the productivity and efficiency of factors of production in the healthcare sector. As a result, production increases, and due to the increased productivity, the unit cost of production decreases, leading to a reduction in inflation in this sector.

Furthermore, as a result of this increase in productivity, investment in the healthcare sector also increases, leading to the accumulation of physical capital. Households, benefiting from increased income from wages and capital returns, consume more healthcare goods. This, in turn, results in an improvement in the health status of the community.

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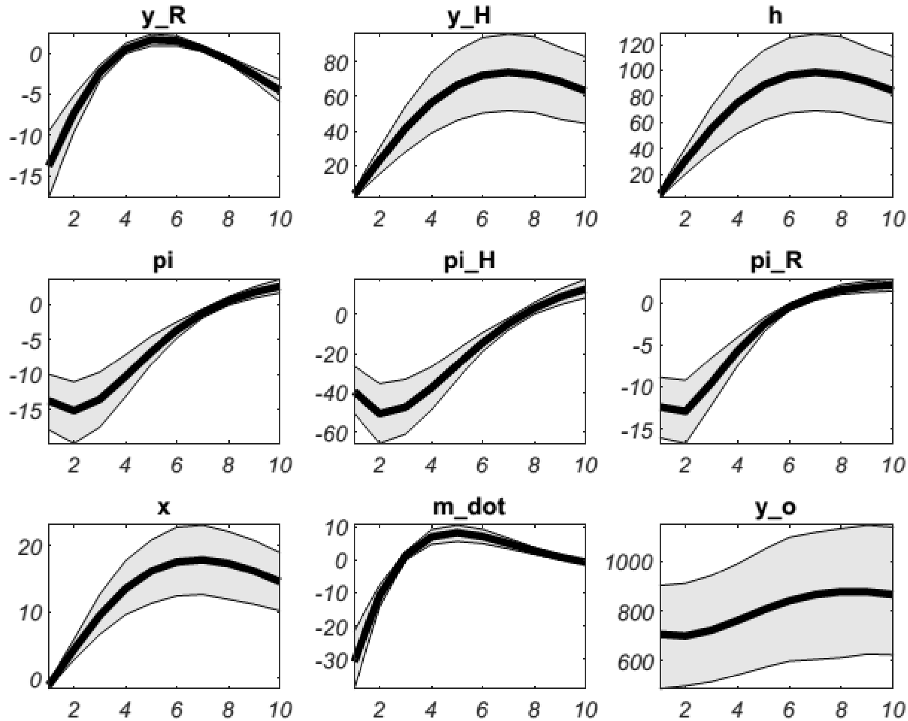

Figure 4. Effects of a Positive Healthcare Goods Production Technology Shock
Source: Research Findings.

As a result of a positive shock in the production technology of non-health goods, the efficiency of production factors increases, as can be observed from Figure5. This leads to an increase in the production of both non-health and health goods. This is because the production of health goods also benefits from the technologies used in the production of other goods. Given that the share of this technology in the production of non-health goods is higher, the production of non-health goods increases more than that of healthcare goods as a result of this shock.

With the advancement of this technology and the increase in production, along with the reduction in the total cost due to improved productivity of production factors, the prices and inflation in the non-health goods sector and general inflation decrease. In subsequent periods following this shock, inflation in the healthcare goods sector also decreases. These factors lead to

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increased consumption of both types of goods by society, resulting in an improvement in the health status of the community.

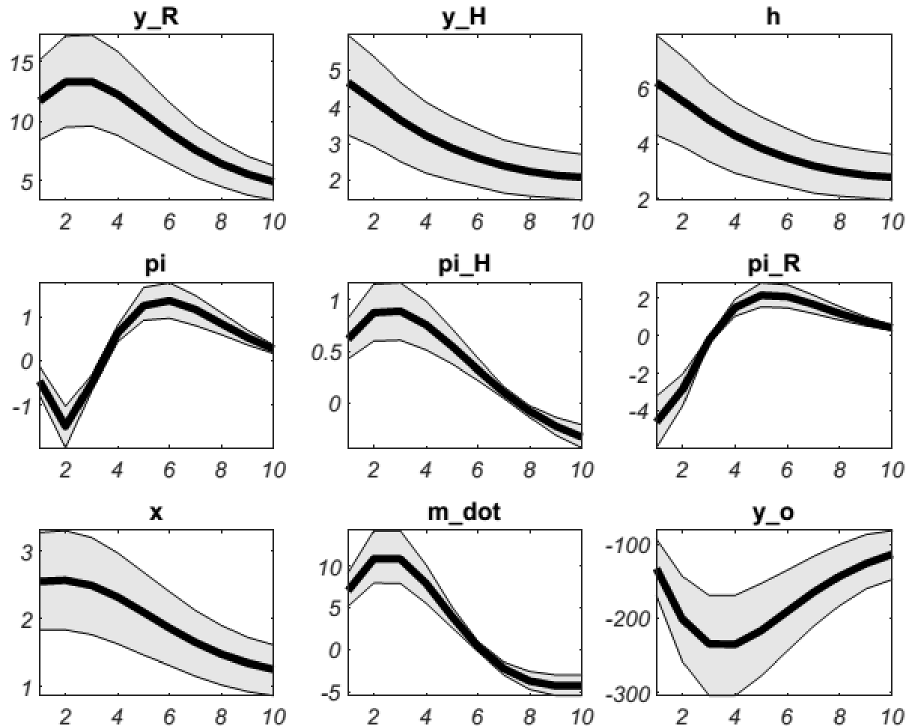

Figure 5. Effects of a Positive Non-Healthcare Goods Production Technology Shock
Source: Research Findings.

5 Conclusion

This study employs DSGE models to analyze the health sector in Iran, with a particular focus on monetary, fiscal and technology shocks. The findings reveal that positive monetary shocks have direct impact on inflation but tends to be reduced the relative prices of the health sector. Thus, the positive impact of the shock on the production of non-health goods is greater than the health sector.

Conversely, positive shocks related to oil income, government health sector expenditures, and technology increase the production of health and non-health goods and have an inverse effect on inflation in this sector.

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To manage the performance of the health sector effectively, it is recommended to prioritize optimal money supply control, allocate oil revenues and government expenditures efficiently to boost the production of health goods and services. Additionally, economic policymakers should prioritize the advancement and deployment of innovative production technologies to support the health sector, aligning with strategies employed in other sectors of the economy.

It is important to note that the unavailability of health sector data in Iran from 2019 to the present has posed a constraint on this study. Given the occurrence of the COVID-19 shock at the end of 2019 and its widespread economic impacts, the findings of this study may be subject to influence.

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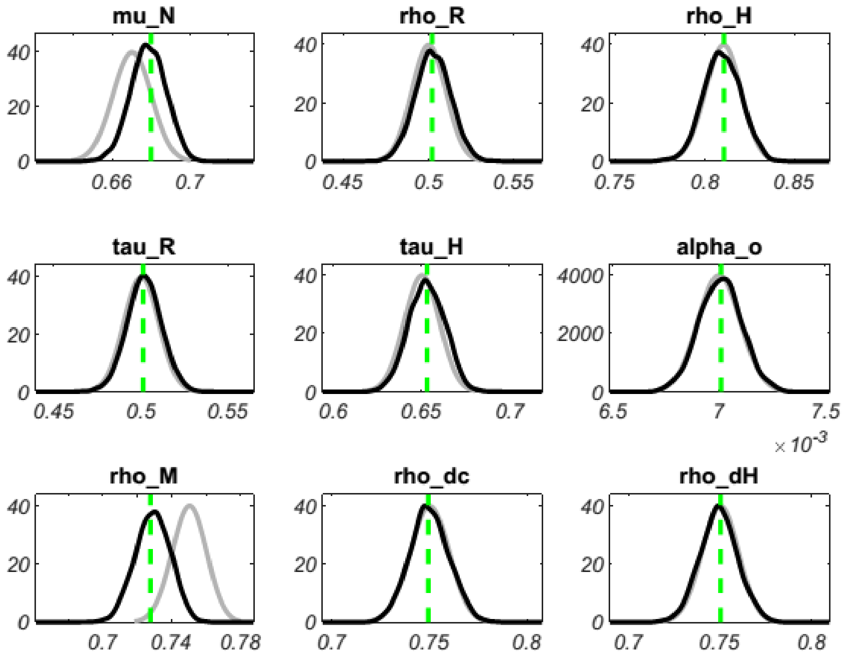
Appendix 1

Prior Distribution and Estimated Posterior Distribution of the Parameters



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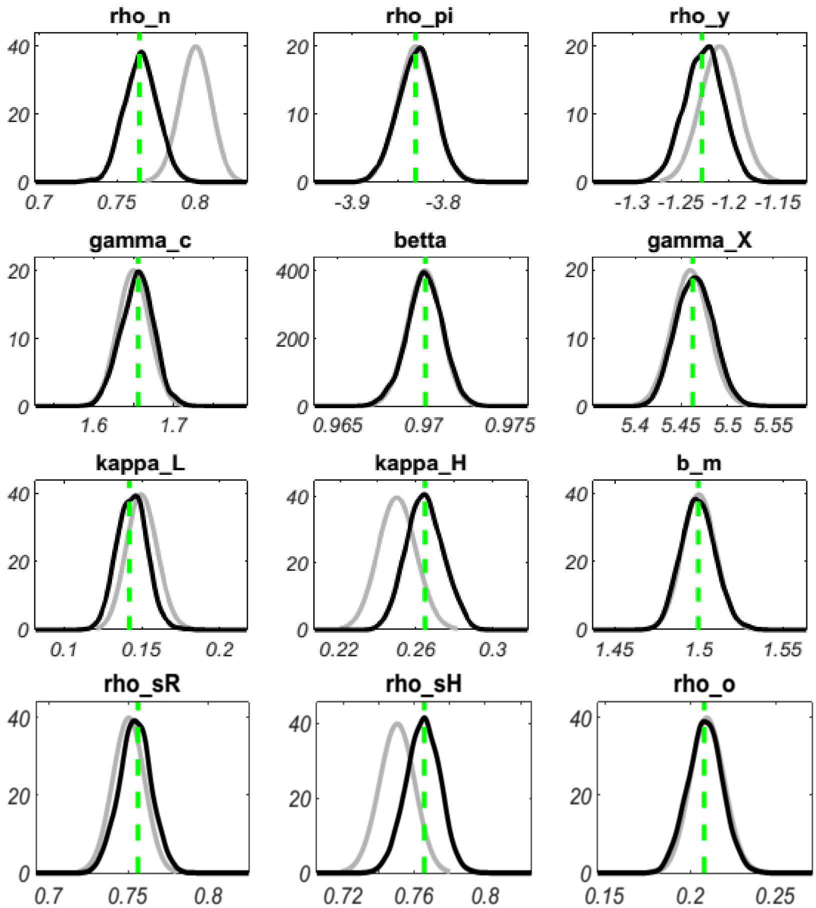

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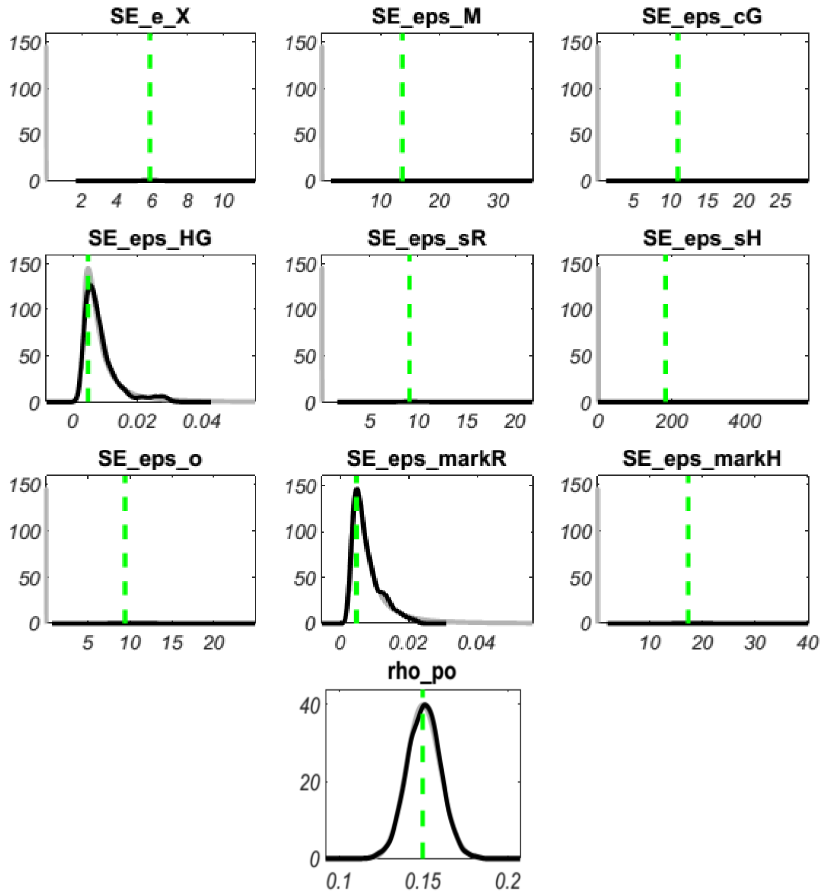

Source: Research Findings.

Appendix 2

Geweke test (1992) Estimated Parameters

Parameter	Post. Mean	Post. Std	P-val No Taper	P-val 4% Taper	P-val 8% Taper	P-val 15% Taper
σ_{ϵ_X}	6.301	1.063	0	0.144	0.127	0.1
σ_{ϵ_M}	14.934	2.643	0	0.482	0.507	0.494
$\sigma_{\epsilon_{GC}}$	11.675	1.998	0	0.56	0.59	0.612
$\sigma_{\epsilon_{GH}}$	0.009	0.007	0	0	0.002	0.002
$\sigma_{\epsilon_{sR}}$	9.727	1.764	0.001	0.74	0.733	0.732
$\sigma_{\epsilon_{sH}}$	201.012	42.027	0	0.049	0.058	0.059
σ_{ϵ_o}	10.288	1.936	0	0.337	0.322	0.293
$\sigma_{\epsilon_{mark_R}}$	0.008	0.005	0	0.482	0.561	0.586

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$\sigma_{\epsilon_{mark_H}}$	18.595	3.679	0.377	0.93	0.93	0.927
ρ_m	0.765	0.01	0.001	0.731	0.754	0.778
ρ_π	-3.83	0.02	0	0.281	0.305	0.326
ρ_Y	-1.228	0.02	0	0.232	0.252	0.225
γ_c	1.655	0.02	0.027	0.802	0.796	0.797
β	0.97	0.001	0.125	0.856	0.842	0.821
γ_X	5.464	0.02	0.003	0.755	0.762	0.756
κ_L	0.144	0.01	0	0.125	0.112	0.074
κ_H	0.265	0.01	0	0.461	0.51	0.538
b_m	1.5	0.01	0	0.467	0.461	0.433
μ_N	0.679	0.009	0.009	0.764	0.761	0.756
ρ_R	0.502	0.01	0.424	0.94	0.947	0.952
ρ_H	0.81	0.01	0	0.024	0.022	0.016
τ_R	0.501	0.01	0	0.083	0.096	0.064
τ_H	0.653	0.01	0.41	0.931	0.93	0.927
α_o	0.007	0	0	0.162	0.14	0.095
ρ_M	0.729	0.01	0.002	0.747	0.757	0.716
ρ_C^d	0.749	0.01	0	0.66	0.644	0.64
ρ_H^d	0.75	0.01	0	0.058	0.057	0.064
ρ_R^s	0.754	0.01	0	0.102	0.091	0.079
ρ_H^s	0.765	0.01	0	0.452	0.489	0.528
ρ_o	0.208	0.01	0	0.022	0.02	0.02
ρ_{p_O}	0.15	0.01	0	0.303	0.346	0.371

Source: Research Findings.

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