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Research Article

Impacts of Government Spending Shock on Vietnamese Macroeconomic Aggregate Variables: DSGE and SVAR Models

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Abstract. Our research studies the impacts of government expenditure on the economical aggregate variables of Vietnam's economy such as GDP, household consumption, government revenue, etc., with the presence of Non-Ricardian consumers. Our paper argues that aggregate household consumption and output will rise in response to an increase in government expenditure. Firstly, we use a structural vector auto-regression (SVAR) model to estimate the effects of government spending shock and find that it generates a strong increase in output, but it generates a weak increase in consumption. Then, we develop an open economy Dynamic Stochastic General Equilibrium (DSGE) model with the presence of Non-Ricardian households and find that the results of DSGE model are a little better than those of SVAR model. In particular, the response of aggregate household consumption is relatively strong after government spending shock due to the consumer behavior of Non-Ricardian households. The assumption about the presence of Non-Ricardian households in DSGE model makes it differ from the Real Business Cycle (RBC) model. In DSGE model, an increase in government expenditure will induce to an increase in household consumption. In contrast with RBC model, an increase in government expenditure will induce to decrease in household consumption.

Keywords. RBC; DSGE; SVAR; IS-LM; Fiscal policy; Ricardian households; Non-Ricardian households

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1. Introduction

This paper is a contribution to the discussion about the fiscal policy in Vietnam's economy in order to analyze the impact of Government expenditures on economical aggregate variables such as GDP, household consumption, Government revenue, etc. In the literature, most macroeconomic models state that a rise in Government expenditure will have an expansionary effect on output: IS-LM [16] model, Standard Real business Cycle (RBC) [17] model provide. In those models, the household consumption plays an important role on the effect of fiscal policy, but its effect is quite different for each model. RBC model suggests that an increase in government expenditure induces to a decrease in household consumption. The reason is that the RBC model considers an infinite lived Ricardian households, whose consumption decisions at any moment are based on an inter-temporal budget constraint. As explained by Baxter and King (1993) [19], an increase in government expenditure creates a negative wealth effect by lowering the households' permanent income which is called the "*crowding out effect*"[1]. To prevent a large drop in consumption, households increase their labor supply, but this substitution effect is typically not strong enough to offset the wealth effect. As a result, consumption decreases in equilibrium. By way of contrast, in the IS-LM model, all consumers behave in a non-Ricardian fashion. Their consumption is a function of their current disposable income and not of their lifetime resources. Accordingly, the increase in government expenditure increases the current disposable (after-tax) income. The increase in income induces successive rounds of increased consumption.

The assumption that consumers are homogeneous (all are Ricardian, or all are non-Ricardian) are some how too strict. This motivate us to study a modification of New Keynesian model called Dynamic Stochastic General Equilibrium (DSGE), where the economy is populated by a mixture Ricardian and non-Ricardian households. Ricardian households smooth their consumption function and maximizes an expected utility function, i.e. an lifetime utility function, which concerns to the investment. On the other hand, non-Ricardian (or rule-of-thumb) households solve an optimization problem under constraint that they consume their whole current income. The origin of this constraint is that non-Ricardian households are restricted to access capital markets or they are unwilling to save or borrow funds. This kind of model is studied in Galí at et. (2007) [15], for the US economy. Here we make several modifications of this model to adapt, and estimate it for the Vietnam economy.

In order to clearly explain the effects of the impact of Government expenditure on economical aggregate variables, we will use Structural Vector Auto-regression (SVAR) model to perform the analysis. SVAR models is considered as a standard tool for empirical analysis by macroeconomists. They often used the restrictions imposed by economic theory to identify the system, i.e. from a reduced form of shocks to obtain an economic interpretative function of the impulse response. Literally, the model was successfully applied by many authors: Giuseppe De Arcangelis

[1]"*crowding out effect*": The crowding out effect is an economic theory stipulating that rises in public sector spending drive down or even eliminate private sector spending.

and Serena Lamartina (2003) [13], Lozano and Rodriquez (2008) for Colombia [18], de Plesis, Smith and Struzenegger (2007) for South Africa [10]. In all these papers, SVAR models were used for simulating fiscal shocks, but they partially differed in the selected model variables. Here, we use the approach by Blanchard and Perotti (2002) [24]. The author described the dynamic effects of shocks in government spending and taxes on economic activity in the United States in the post-war period. In the model, authors took only three variables: government spending, net taxes and real GDP. As mentioned above, it was not sufficient due to the numerous household consumption effects on the economic activity. Therefore, we follow the paper of Vasicek and Mushi [23] which makes an extension by the adding the fourth variable as household consumption or government debt. The results of our model will be compared with the results of DSGE model.

2. Literature Overview

There were lots of papers studied on the predictions of fiscal policy effects. Fiscal policy was changes in the taxing and spending of the government for purposes of expanding or contracting the level of aggregate demand. Most of the authors agreed that government expenditure had a positive effect on output and household consumption such as Cohen, Isabelle, Freiling, Thomas, Robinson, Eric (January 2012) [7], Ashni Parekh (2008) [1], Galí at el. (2007) [15].

The theory of fiscal policy was numerous mentioned in the Keynesian theory and was studied for output stabilization in the 1960s. However, after the criticism of the Phillips curve approach by Phelps and Friedman in the 1970s, the traditional Keynesian theory was abandoned. Despite of the wide popularity of the Real Business Cycle (RBC) model, the effects of fiscal policy in these models were not studied in a deeper detail until the paper by Baxter and King (1993) [2] was published. The authors provided an analysis of the fiscal policy effects in an RBC model, which was modified in a new way. First, an instantaneous utility function was extended so that it included utility from government purchases and capital. Second, the Cobb-Douglas production function included a public capital and finally the resource constraint was adjusted by the inclusion of public spending. However, the model was still some drawbacks about the assumption of household's behavior was insufficient. This assumption states that the whole consumers in the economy was only Ricardian households. In order to improve the drawback, the simplest way to model this feature was to assume that a proportion of the population spends its current income, i.e. to assume the existence of Non-Ricardian households. Mankiw (2000) [20] summarized the evidence of Non-Ricardian's behavior, which characterized low income households with their net wealth approaching zero.

Some papers on fiscal policy effects had incorporated Non-Ricardian households into their analyses. Galí et al. (2007) [15] extended their model in (Galí et al., 2004) [14] by an introduction of simple fiscal policy rules (the former model focused on implications of the presence of Non-Ricardian households on the monetary policy). Lump sum taxes were included both types of consumers: the Non-Ricardian households consumed their after-tax income, while Ricardian households smoothed their consumption in the way predicted by other macroeconomic models. The deviation of the level of taxes from its steady state responded to the deviation of debt and government expenditures from their steady state levels. Our model will be described more detail in the following chapter but its calibration to the Vietnamese data imply that not only output, but also consumption rises as a response to positive government spending shock. It is because the presence of Non-Ricardian households mean a higher sensitivity to current income, which offsets negative wealth effect and the shrinkage of consumption of Ricardian households after a government spending shock. Furthermore, a similar approach to model the effects of fiscal policies was taken by Coenen and Straub (2004) [8]. They extended the DSGE model by Smets and Wouters (2002) [26], which provided plausible results except for the decline in consumption following a government spending shock, which is not observed in reality. The authors incorporated three features into the model: fiscal policy rule of the government, lump sum taxes and Non-Ricardian households. Parameters of the model are estimated using Bayesian inference and the results were not as positive as the results in the model by Galí et al. (2007) [15]. In the following chapters, we will show whether the presence of Non-Ricardian households is sufficient to explain the impact of fiscal policy on the aggregate variables of the Vietnamese economy.

3. Structural Vector Auto-Regression model (SVAR)

3.1 Methodology

SVAR models is a standard tool for empirical analysis by macro-economists. They often use the restrictions imposed by economic theory to identify the system, i.e. from a reduced form of shocks to obtain an economic interpretative function of the impulse response. Literally, the model was successfully applied by many authors: Giuseppe De Arcangelis and Serena Lamartina (2003) [13], Lozano and Rodriquez (2008) for Colombia [18], de Plesis, Smith and Struzenegger (2007) for South Africa [10]. In all these papers, SVAR models were used for simulating fiscal shocks, but they partially differed in the selected model variables. Here, we use the approach by Blanchard and Perotti (2002) [24] which described the dynamic effects of shocks in government spending and taxes on economic activity in the United States in the post-war period. In the model, authors took only three variables: government spending, net taxes and real GDP. As mentioned above, it was not sufficient due to the numerous household consumption effects on the economic activity. Therefore, we follow the paper of Vasicek and Mushi [23] which made an extension by the adding the fourth variable as household consumption or government debt.

First of all, let us consider the structural vector auto-regression (SVAR) model as follows:

$$AX_t = A_1^* X_{t-1} + A_2^* X_{t-2} + \ldots + A_p^* X_{t-p} + B\varepsilon_t. \tag{3.1}$$

The SVAR model can be written in reduced form as follows,

$$X_t = A^{-1}A_1^* X_{t-1} + A^{-1}A_2^* X_{t-2} + \ldots + A^{-1}A_p^* X_{t-p} + A^{-1}B\varepsilon_t \tag{3.2}$$

or

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + \ldots + A_p X_{t-p} + u_t, \tag{3.3}$$

where the structural shocks, ε_t, are white noise. $u_t = A^{-1}B\varepsilon_t$ is a vector of reduced form residuals. $X_t = [G_t, Y_t, RE_t, C_t]'$. SVAR model use the restrictions imposed by economy theory on two matrices A and B such that $Au_t = B\varepsilon_t$:

$$\begin{pmatrix} 1 & -a_1 & 0 & 0 \\ -b_1 & 1 & -b_2 & 0 \\ -c_1 & 0 & 1 & -c_2 \\ -d_1 & -d_2 & -d_3 & 1 \end{pmatrix} \begin{pmatrix} g_t \\ y_t \\ re_t \\ c_t \end{pmatrix} = \begin{pmatrix} 1 & 0 & a_2 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} e_t^g \\ e_t^y \\ e_t^{re} \\ e_t^c \end{pmatrix},$$

where $u_t = [g_t, y_t, re_t, c_t]'$, $\varepsilon_t = [e_t^g, e_t^y, e_t^{re}, e_t^c]'$.

3.2 Data

The data used in this model is quarterly data from 1990Q1 to 2013Q4. All variables come from the World Bank, except the quarterly average of three-month nominal Treasury bill rates which comes from the International Monetary Fund. Due to the government expenditure (or spending) is unavailable on the website, we define the government expenditure as sum the government investment plus government consumption. The government revenue (or net taxes) variable was computed as a difference between all tax receipts (which include social and health security contributions) and transfers.

The observations in the model are on a the quarterly basis, such as GDP, CPI, private investment,etc. So, there are the existence of the seasonal factor and trend factor of time series. A trend exists when there is a long-term increase or decrease in the data. The shape of data is not linear. A seasonal pattern exits when a series is influenced by seasonal factor such as the quarter of year, the month, the day of week. For example, the private consumption and retail sales quickly increases during the month of December due to the purchase for the New Year. As a result, the fourth quarterly GDP also quickly increases. In order to get better the result of analysis, we remove the seasonal factor and trend factor of time series in data.

4. Impulse Response Function

All variables in SVAR model were seasonally adjusted and detrended. According to Augmented Dickey-Fuller (ADF) test, the variables are stationary processes. An important preliminary step in model building and impulse response analysis is the selection of the SVAR lag order. In this paper, We use some commonly used lag-order selection criteria to choose the lag order, such as AIC, HQ, SC and FPE. We use "*VARselect*" function in R to get the results in Table 1.

Based on the AIC, HQ and SC criteria, the lags of each endogenous variables are chosen three. Other criteria suggest to include more lags but because the time series is relatively short, a lot of degrees of freedom would be lost due to the inclusion of more lags, so only three lags were chosen. The impulse response function of four endogenous variables to structural shock are illustrated in Figure 1.

Table 1. The result of the criteria with largest lag equal 5

	1	2	3	4	5
AIC (n)	–2.177065e+01	–2.981839e+01	–3.065727e+01	–3.102825e+01	–3.103266e+01
HQ (n)	–2.149673e+01	–2.936187e+01	–3.001813e+01	–3.020650e+01	–3.002830e+01
SC (n)	–2.109039e+01	–2.868464e+01	–2.907002e+01	–2.898750e+01	–2.853841e+01
FPE (n)	3.511639e-10	1.126702e-13	4.904786e-14	3.428713e-14	3.484710e-14

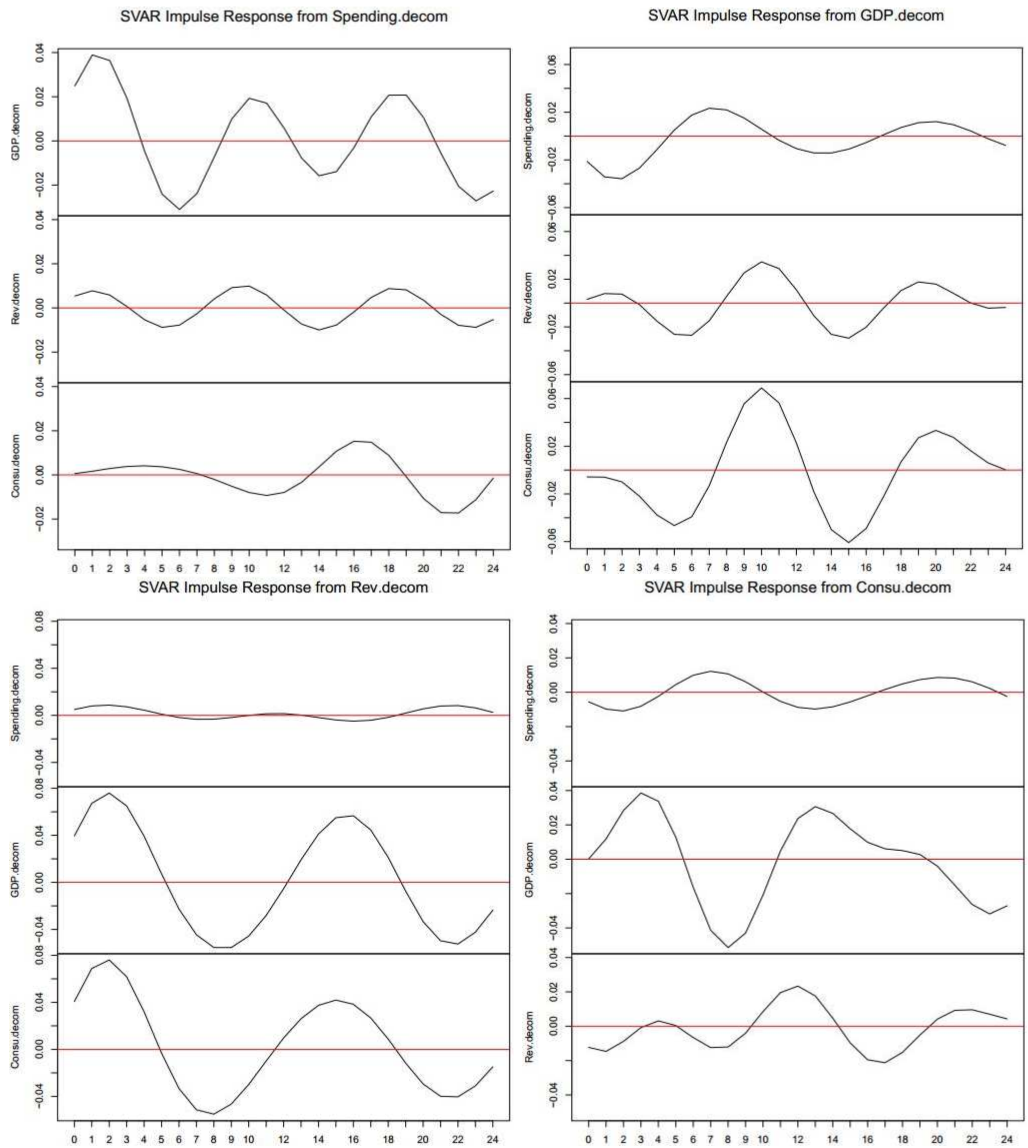

Figure 1. Impulse response function (IRF)

The left on top is the impulse response of government spending to GDP, government revenue and household consumption. The horizontal axis is time and the vertical axis is the percent change of the response variables. The figure shows a positive response of GDP and government revenue to a positive government spending shock. The response of GDP is obviously fluctuation, the value fluctuate around the line zero. It is highest positive effect for on the second period, lowest negative effect on the sixth period. The response of government revenue is weaker than the response of GDP. Almost half response of government revenue is positive, the value fluctuate around the line zero. The response of household consumption is relatively weak, which rise slightly after a government spending shock for four periods. From the fourth period, the response is obviously meaningful to the shock government spending. The right on top is the impulse response of GDP to other variables. These responses are obviously fluctuation around zero line. At the initial time, a shock GDP has a large negative effect on government expenditures. However, it has weakly effect on both government revenue and household consumption. From the second periods onward, the response of private consumption is stronger than the other variables. The bottom left describes the response of government spending, GDP and household consumption to a government revenue shock. When the impulse is government revenue, the response of the GDP and household consumption are almost strong at the first time, there is highest positive effect on the second period. However, the response of the government expenditure has a smooth fluctuation. The bottom right is the impulse response of household consumption to government spending, GDP and government revenue. From the first period, the response of government revenue with respect to a household consumption shock is strong sensitivity. The responses of the other variables is a negative response for four periods.

5. DSGE Model

In this section, we will present a Dynamic Stochastic General Equilibrium model (DSGE) in order to study the impacts of government expenditure on economical variables. The model will follow closely the model Galí et al. (2007) [15], which shows the impacts of government spending shock in the presence of non-Ricandian households. The economic assumption is included by the main six blocks which is illustrated in the graphic as follows:

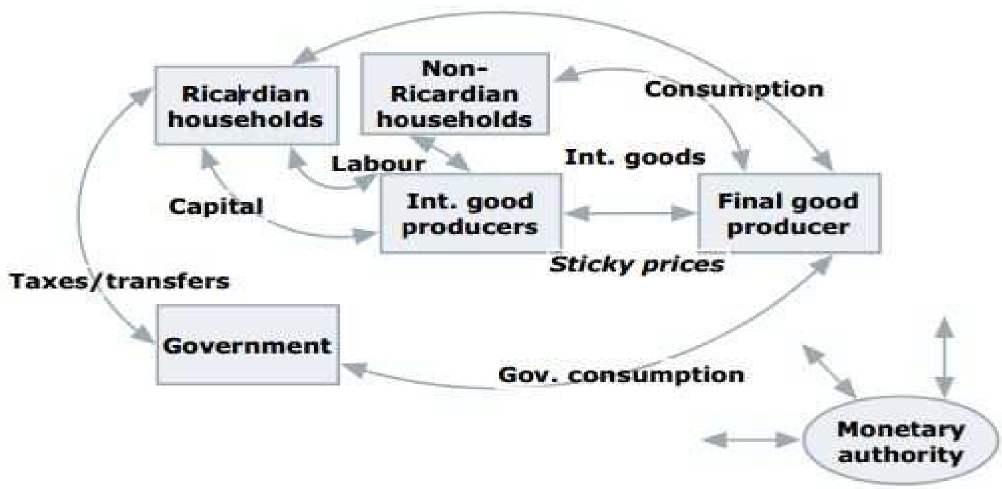

Figure 2. A flow diagram of the model

First, Ricardian households (optimizing households) are households who will be forward looking and maximize their utility function subject to an inter- temporal government's budget constraint when making their consumption decisions. Second, non-Ricardian households (rule-of-thumb households) are households who does not own any assets nor have any liabilities and just consume their current income. Generally, both of type households will supply labor and capital to the continuum of intermediate goods sector. They will also consume the most final goods of the economy. Third, the intermediate goods sector is characterized by staggered price setting and monopolistic competition. So, each firm maximizes its expected profit subject to the demand by the final goods sector. The frequency of price setting is modeled using the approach by Calvo (1983) [4]. Fourth, the final goods sector, unlike the the intermediate goods sector, the final goods sector is characterized by perfect competition and flexible price setting, so it can be modeled using one representative firm. The product of the final goods firm is equal to the gross domestic product, which can be decomposed into the household and the government consumption and investments. Next, the government will determine the fiscal policy rule through the taxes policy which is determined by lump-sum taxes imposed on households and governmental bonds. Finally, the central bank sets the nominal interest rate in order to achieve price stability.

5.1 Household

As mentioned above, the model assume that households in the economy have two different types: Ricardian and non-Ricardian households

- **Ricardian households** (optimizing households) have access to financial markets, where they buy and sell government bonds, and accumulate physical capital. we assume that a fraction $(1-\lambda)\in[0,1]$ of total households belong to this group.
- **Non-Ricardian households** (rule-of-thumb households) are households who does not own any assets nor have any liabilities and do not access to financial markets. Simply, they just consume their current income. The remaining fraction λ of total households belong to this group

5.1.1 Ricardian household

Each Ricardian household i receives positive utility from a consumption, C_t^0, and negative utility from labor, L_t^0 denotes total hours worked (labor hours). It seeks to maximize the present discounted value of lifetime utility in the following Galí et al. (2007):

$$\max_{C_t^0,L_t^0} E_t\sum_{t=0}^{\infty}\beta^t\left[\log\left(C_t^0\right)-\frac{\left(L_t^0\right)^{1+\varphi}}{1+\varphi}\right], \tag{5.1}$$

subject to the following budget constraints,

$$P_t\left(C_t^0+I_t^0\right)+R_t^{-1}B_{t+1}^0=W_tP_tL_t^0+R_t^kP_tK_t^0+B_t^0+D_t^0-P_tT_t^0, \tag{5.2}$$

and the capital accumulation equation,

$$K_{t+1}^0=(1-\delta)K_t^0+\phi\left(\frac{I_t^0}{K_t^0}\right)K_t^0, \tag{5.3}$$

5.1.2 Non-Ricardian Household

Non-Ricardian households' utility function is given by

$$U\left(C_t^r, L_t^r\right) = \left(\log\left(C_t^r\right) - \frac{\left(L_t^r\right)^{1+\varphi}}{1+\varphi}\right) \tag{5.4}$$

subject to the budget constraints,

$$P_t C_t^r = W_t P_t L_t^r - P_t T_t^r. \tag{5.5}$$

Due to the household do not optimize inter-temporally, they consume their whole income, i.e. the level of consumption will equate labor income net of taxes:

$$C_t^r = W_t L_t^r - T_t^r. \tag{5.6}$$

5.2 Firms

There are two types of firms operating in the economy: Final goods sector and intermediate goods sector.

5.2.1 Final Goods Sector

Consumption goods are produced in the final goods sector which is characterized by perfect competition and constant returns to scale. Due to these characteristics, we can assume that there is one single representative firm selling its output at a price equal to the marginal cost. They will seek to maximize their profit problem in the following way:

$$L = \max_{Y_t(i)} \left(P_t Y_t - \int_0^1 P_t(i) Y_t(i) di\right), \tag{5.7}$$

where $Y_t = \left(\int_0^1 Y_t(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$ is a final good, $Y_t(i)$ is the amount of the i-th intermediate good used as an input, $\varepsilon > 1$ is the elasticity of substitution parameter, $P_t(i)$ is the price of the i-th intermediate good and P_t is the final goods price, all $i \in [0,1]$. The results of final good price as follows,

$$P_t = \left(\int_0^1 P_t(i)^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}}. \tag{5.8}$$

5.2.2 Intermediate goods sector

They will seek to minimize their cost problem as below,

$$\min_{K_t(i), L_t(i)} \left(W_t L_t(i) + R_t^k K_t(i)\right), \tag{5.9}$$

subject to

$$K_t(i)^{\alpha} L_t(i)^{1-\alpha} \geq Y_t(i), \tag{5.10}$$

with using a Cobb-Douglass production technology:

$$Y_t(i) = K_t(i)^{\alpha} L_t(i)^{1-\alpha}, \tag{5.11}$$

where $K_t(i)$ and $L_t(i)$ represent the capital and labor hired by firm i.

Optimal Price Setting in Calvo (1983) model

Following the Calvo (1983) firms can not change their price optimally in every period. Instead, it is assume that only fraction of the firms reset their prices with probability $(1-\theta)$ each period, while a fraction θ keeps their prices unchanged, where $\theta \in (0,1)$. The price level in period t is given by:

$$P_t = \left[\theta P_{t-1}^{1-\varepsilon} + (1-\theta)\left(P_t^*\right)^{1-\varepsilon}\right]^{\frac{1}{1-\varepsilon}}. \tag{5.12}$$

A firm resetting its price in period t will seek to solve:

$$\max_{P_t^*} E_t \sum_{k=0}^{\infty} \theta^k E_t \left\{\Lambda_{t,t+k} Y_{t+k}(i)\left(\frac{P_t^*}{P_{t+k}} - MC_{t+k}\right)\right\}, \tag{5.13}$$

subject to the sequence of demand constraints:

$$Y_{t+k}(i) = \left(\frac{P_t^*}{P_{t+k}}\right)^{-\varepsilon} Y_{t+k}, \tag{5.14}$$

where P_t^* represents the price chosen by firms resetting prices at time t.

5.3 Government

We choose a simple log-linear fiscal policy rule as in Galí et al. (2007):

$$t_t = \phi_b b_t + \phi_{\tilde{g}} \tilde{g}_t, \tag{5.15}$$

where ϕ_b and ϕ_g are the elasticities of the lump-sum taxes with respect to government debt and government spending, respectively. Notice that $t_t = \frac{(T_t - T)}{Y}$, $b_t = \frac{\left(\frac{B_t}{P_{t-1}} - \frac{B}{P}\right)}{Y}$ and $\tilde{g}_t = \frac{(G_t - G)}{Y}$ are deviation of government expenditures, taxes and real bond holdings from their steady state values normalized by steady state income.

And subject to the government budget constraint as below:

$$P_t T_t + \frac{B_{t+1}}{R_t} = B_t + P_t G_t, \tag{5.16}$$

Finally, government spending is assumed to evolve according to an AR (1) process,

$$\tilde{g}_t = \rho_{\tilde{g}} \tilde{g}_{t-1} + \varepsilon_t, \tag{5.17}$$

where $0 < \rho_{\tilde{g}} < 1$ and ϵ_t is a white noise process with constant variance σ_t^2 which represents a shock to the government expenditure.

5.4 Central Bank

The central bank in this model determines the nominal interest rate by following a simple version of the Taylor rule (1993):

$$r_t = r + \phi_\pi \pi_t, \tag{5.18}$$

where $\phi_\pi \geq 0$ is the parameter of the response of interest rate to inflation, r is the steady state interest rate which determined as $r = \beta^{-1} - 1$ and $\pi_t = \log\left(\frac{P_t}{P_{t-1}}\right)$ is inflation at time t.

5.5 Log-linearized Equilibrium Condition

DSGE model is a system of complex linear or non-linear equations, which can not be solved analytically, i.e. we cannot find a closed form solution of policy function of households and firms.

Instead, several numerical models are used to such type of complex macroeconomic models. Though this model has several drawbacks: it is slow and suffers from the curse of dimensionality. Its disadvantages have led to the development of new solution procedure, which is quite safe and reliable and has good convergence properties. In this section, we will present the log-linear approximation of the equilibrium conditions around their steady state values and market-clearing conditions that will be used in our analysis of the model's equilibrium dynamics. The following notational convention will be used. Lower-case letters will denote log-deviations with respect to the corresponding steady state values. For example: $x_t = \log\left(\frac{X_t}{X}\right) = \log(X_t) - \log(X)$, where x_t is the log-linearzed around steady state of X_t variable, X_t is the initial value of variable and X is the steady state value of X_t variable.

In order to conveniently calculate of log-linear approximation around steady state, We use some of rules following:

- **Rule 1:** $x_t = \log\left(\frac{X_t}{X}\right) = \log\left(\frac{X_t - X}{X} + 1\right) \approx \frac{X_t - X}{X}$, where the approximation $\log(1+a) \approx a$ can be used for small value of a.
- **Rule 2:** For small value of x_t, We use approximation $e^{x_t} \approx 1 + x_t$. This is implied that,
$$X_t = Xe^{x_t} \approx X(1 + x_t). \tag{5.19}$$
- **Rule 3:** We assume that variables characterizing the economy are very close to their steady state values. So, We can approximate products of their log-linear deviation from the steady state values as zero. This rule is written as follows:
$$x_t y_t \approx 0. \tag{5.20}$$
Moreover, this assumption implied that if a variable X_t equals a variable Y_t at time t, their steady state will be the same:
$$X_t = Y_t \Rightarrow X = Y. \tag{5.21}$$
- **Rule 4:** This rule is used to approximate a function of a variable using its steady state value and log linear deviation from its steady state by applying the first order Taylor expansion,
$$\begin{aligned} f(X_t) &= f(X) + f'(X)(X_t - X), \\ &= f(X) + f'(X)(X(1 + x_t) - X), \\ &= f(X) + f'(X)\frac{X}{f(X)} f(X)x_t, \\ &= f(X)(1 + \varepsilon x_t), \end{aligned} \tag{5.22}$$

where $\varepsilon = f'(X)\frac{X}{f(X)}$.

After solving these constraints and utility function of sectors, we get results as follows:

$$\mathbf{A}E_t(x_{t+1}) = \mathbf{B}x_t + \varepsilon_t, \tag{5.23}$$

where $x_t = [l_t, c_t, \pi_t, k_t, b_t, \tilde{g}_{t-1}, y_t, t_t, i_t, w_t]'$. The element of matrices **A** and **B** are all function of the underlying structural parameters, as show in Appendix. The results of **A** and **B** matrices can be illustrated following,

$$A = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & \frac{\delta}{1-\tilde{\gamma}_c} & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -\Theta_n & 1 & \frac{1}{\tilde{\sigma}} & 0 & \Theta_t\phi_b & \Theta_t\left(\rho_{\tilde{g}}-1\right)\phi_{\tilde{g}} & 0 & 0 & 0 & 0 \\ [\omega(1+\varphi)+\beta(1+\alpha)] & \omega-\beta\gamma_c & (1-\tilde{\gamma}_c)\eta & -[\omega+\beta(1-\tilde{\gamma}_c-\alpha)] & 0 & (1-\beta\rho_{\tilde{g}}) & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -(1+r)(1-\phi_{\tilde{g}}) & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$B = \begin{pmatrix} \frac{\delta(1-\alpha)}{1-\tilde{\gamma}_c} & -\frac{\delta\gamma_c}{1-\tilde{\gamma}_c} & 0 & \left(1-\delta+\frac{\delta\alpha}{1-\tilde{\gamma}_c}\right) & 0 & 0 & 0 & 0 & 0 & 0 \\ -(\alpha+\varphi)\lambda_p & -\lambda_p & 1 & \alpha\lambda_p & 0 & 0 & 0 & 0 & 0 & 0 \\ -\Theta_n & 1 & \frac{\phi_\pi}{\tilde{\sigma}} & 0 & \Theta_t\phi_b & 0 & 0 & 0 & 0 & 0 \\ (1-\alpha) & -\gamma_c & (1-\tilde{\gamma}_c)\eta\phi_\pi & (\tilde{\gamma}_c+\alpha-1) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & (1+r)(1-\phi_b) & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \rho_{\tilde{g}} & 0 & 0 & 0 & 0 \\ (1-\alpha) & 0 & 0 & \alpha & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \phi_b & \phi_{\tilde{g}} & 0 & -1 & 0 & 0 \\ \frac{1-\alpha}{1-\tilde{\gamma}_c} & \frac{-\gamma_c}{1-\tilde{\gamma}_c} & 0 & 1-\frac{1-\tilde{\gamma}_c-\alpha}{1-\tilde{\gamma}_c} & 0 & -\frac{1}{1-\tilde{\gamma}_c} & 0 & 0 & -1 & 0 \\ \varphi & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}$$

5.6 Empirical Results

Figure 3 presents the results of responses of all variables of the model with a five percentage shock to governmental expenditures normalized by the level of output, i.e. $\tilde{g}_t = \frac{G_t - G}{Y}$. The horizontal axis is time and the vertical axis is the percent change of response variables. We can observe that the response of the household consumption rapidly falls down for first five periods. In next periods, it reverts back zero line. After a shock to government expenditure, these responses of GDP, inflation and labor fall immediately after six periods due to the impact of decreasing government expenditure. The responses of government debt and government revenue are relatively strong because the value of both policy parameters are relatively higher ($\phi_b = 0.225,\ \phi_{\tilde{g}} = 0.348$) than the value of estimated parameters by Galí et al. (2007) [15] ($\phi_b = 0.06,\ \phi_{\tilde{g}} = 0.19$). These responses increase in first five periods and decreases onward periods. The aggregate consumption variable is a combination of the consumption of each type of households. The consumer behavior of Non-Ricardian has a positive correlation with the government expenditure, i.e. an increase in government expenditure induces an increase in Non-Ricardian household consumption, and vice versa. Therefore, if the proposition of Non-Ricardian household was higher, we would observe more periods where total consumption decreases or increases with respect to government expenditure after a government spending shock. In contrast with RBC model, an increase in government spending creates an increase in labor and a decrease in consumption. This can be explained in Figure 3 and Figure 4 as follow.

The proposition of Non-Ricardian in Figure 3 is 74.6% ($\lambda = 0.746$), we can realized that a decrease in government expenditure will drive down aggregate consumption. However, in Figure 4, the share of Non-Ricardian is 10% ($\lambda = 0.1$), and now, we can see that consumer behavior of household is heavily dependent on consumer behavior of Ricardian household. Therefore, it is not surprising that aggregate consumption increases the following a decrease in government expenditure.

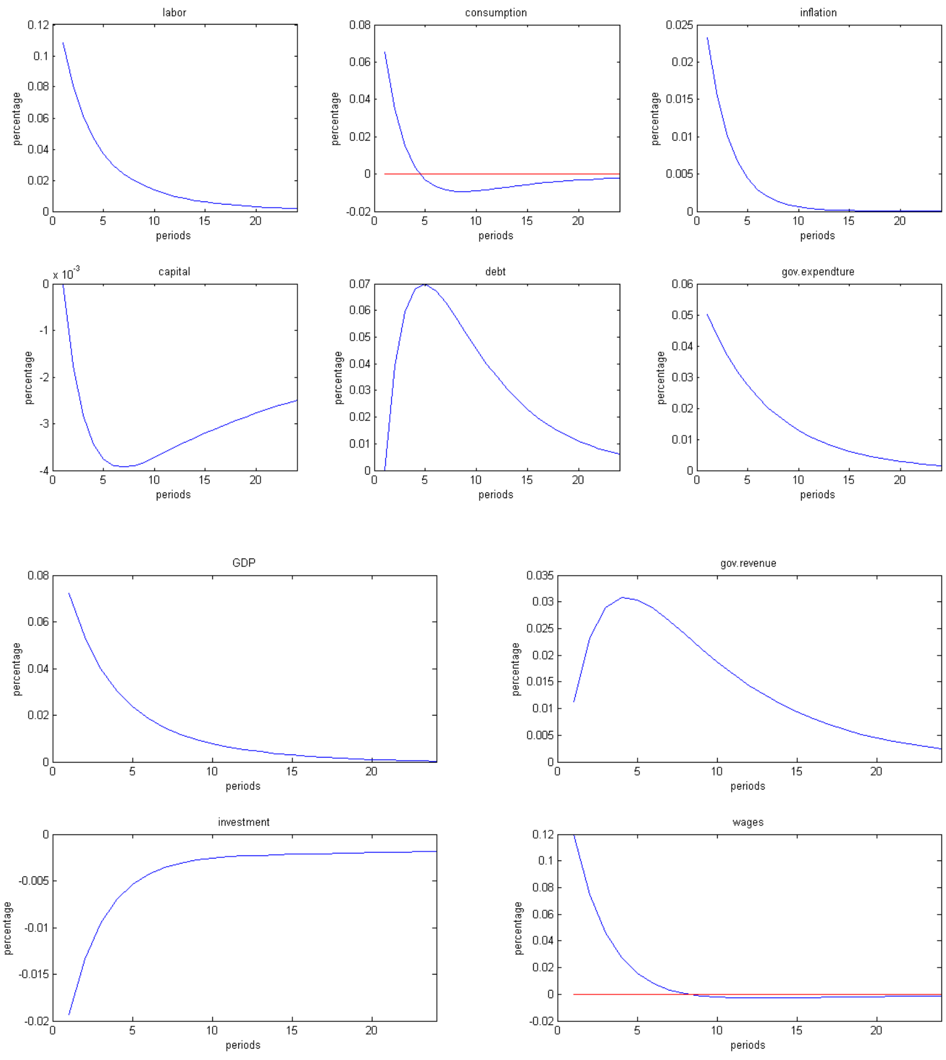

Figure 3. Impulse response function after a government expenditure shock ($\lambda = 0.746$)

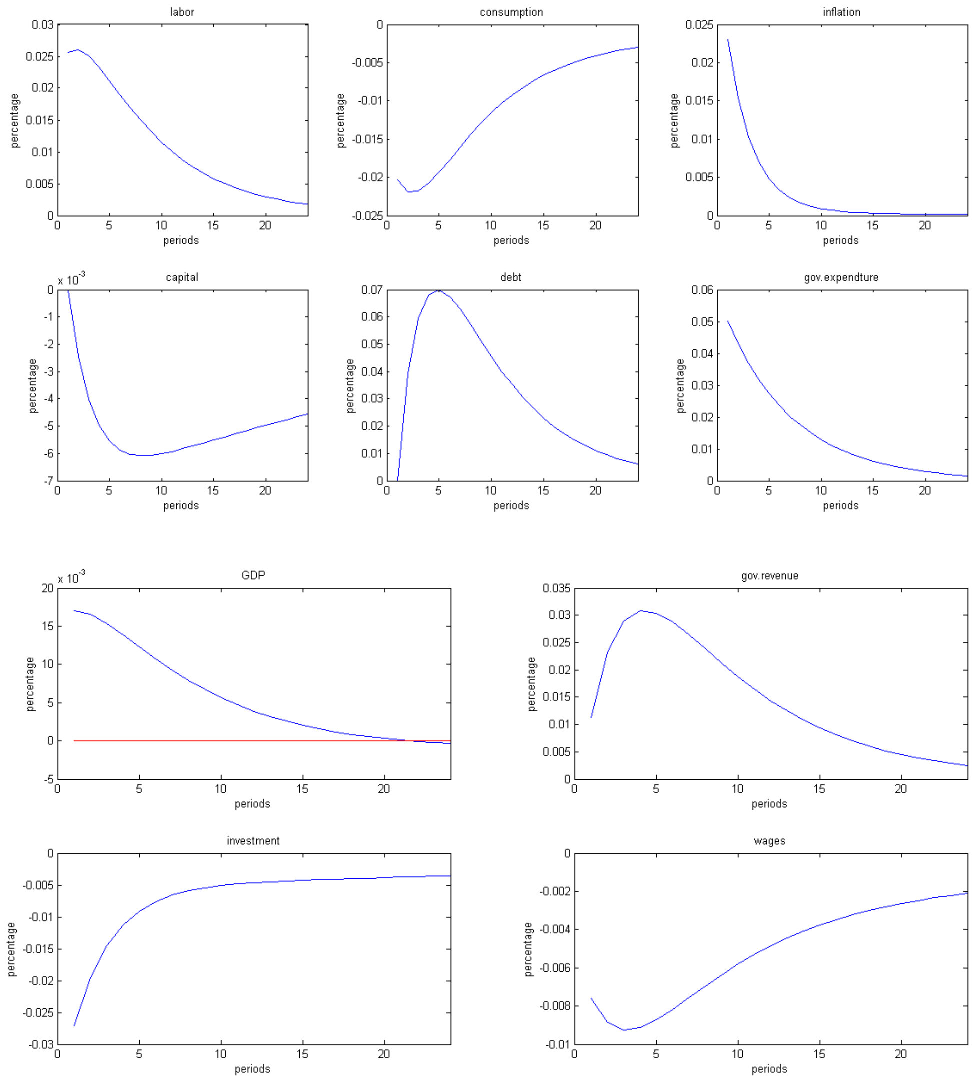

Figure 4. Impulse response function after a government expenditure shock ($\lambda = 0.1$)

Symmetrically, when an increase in government expenditure will induce an increase in GDP and household consumption. In fact, the model can be explained the Vietnam's fiscal policy in 2006-2008. In this period, Vietnam's government applied the expansionary fiscal policy by cutting tax and increasing government spending in order to achieve economic growth. According to the report of the Vietnamese Ministry of Finance in 2006-2008,

- Total government expenditure in 2006 reached about 315 thousand billions VND, up 20% on 2005. GDP reached about 1061.5 thousand billions VND, up 26.5% on 2005. Household consumption approximate $58,7$ thousand billions VND, up to 17.5% on 2005.
- In 2008, total government expenditure reached 399 thousand billions VND, up 22.3% on 2007. GDP reached about 1477 thousand billions VND, up 29% on 2007. Household consumption approximate 91.9 thousand billions VND, up to 31.3% on 2007.

6. Conclusion

- The results imply that government expenditure plays an important role in the Vietnamese economy stabilization. Especially, in deeper recession, Government should use this fiscal policy in order to stabilize output (GDP).
- Interestingly, the results of the model applied on Vietnamese economy are similar the results of the model by Galí at el. (2007) applied on US economy as below:
  - Output (GDP) and private consumption increase following a government spending shock.
  - The response of consumption depends on the proposition of Non-Ricardian households in the economy.
- The results show that the response of aggregate household consumption and GDP in SVAR model are relatively weaker than in DSGE model after receiving a positive government spending shock.

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Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

All the authors contributed significantly in writing this article. The authors read and approved the final manuscript.

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