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THE SHOCK REACTION IN A SIMPLE SMALL OPEN ECONOMY

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ABSTRACT. This work presents an analysis of a simple small open economy model which incorporates the public goods into the household consumption bundle to investigate the effect of various shocks on the domestic economy. The model is constructed based on the small open economy DSGE framework and estimated by using the Bayesian technique with the quarterly detrended data of Thailand, 2001:Q1-2019:Q2. Most of the results obtained from the analysis are consistence with previous studies. Especially, it found that the government spending on public goods can crowd out private investment as explained in economic theory.

1. INTRODUCTION

Dynamic stochastic general equilibrium (DSGE) model is a useful tool for economists to learn the business cycles, carry out hypothetical policy experiments in Lucas critique-proof frameworks, and use in macroeconomic forecasting. Also, it can help to identify the sources of fluctuations and link between structural features of the economy and reduced-form parameters that were not always possible with large-scale macroeconomic models [1].

Before this work, we constructed a simple close economy to study the effect of some shocks. In that model, we put the public good which supported by government expenditure into the household consumption bundle. In this manner,

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we can learn the impacts of public good on our economy. In this work, we follow our first move by extending the model to tackle some features of the foreign environment which basically embedded in a well-known small open economy model, SOE model. This SOE model allows us to explore the transmission of external shock to a small scale economy, e.g, oil-price shock, exchange rate shock, and credit crisis [2]. Nevertheless, the basic application of the SOE model is to analyze the effects of monetary and fiscal policy on the domestic economy while simultaneously considering the impacts of foreign countries. Regarding to monetary policy, there are many works conducted to investigate its the effect on various macroeconomic variables. Some of them showed that there occur the negative reaction of macroeconomics variables, e.g., price, working hour, and output, investment, consumption, to the positive shock in monetary policy. In case of fiscal policy, the previous works shows that, for some variables, there is both positive and negative reaction to fiscal policy shock. For instance, when there occurs a positive shock in government spending, private consumption may either increase [**?**] or decrease [4]. However, the reaction direction of some variables is likely conclusive, e.g., the negative reaction of private investment to the positive shock in government spending, namely the crowding-out effect of government spending.

Besides the effect of monetary and fiscal policy shock, the effect of other shocks that have been prevalently analyzed within SOE model includes the shock in consumption preference, technology, exchange rate, foreign price, and foreign income. The effect of these shocks on the domestic economy is as follow. For the consumption preference shock, when this shock occurs, it can push up household consumption while making a drop in the investment. However, the reaction to this shock is very sensitive to the elasticity of substitution between domestic and foreign goods. especially, when price and wage stickiness are not assumed, this shock has a large effect on the inflation. For the technology shock, it can raise the level of employment and output while reducing the level of the price and interest rate. In the case of the exchange rate shock, it can make a decrease in price, output, and interest rate. For a world prices shock, it primarily causes an increase in household consumption. For the shock of world income, it can lead to the growth of foreign demand for domestic goods and investment demand for production to satisfy an increase in the country's exports [5].

Motivated by the reaction of macroeconomic variables to the shocks discussed above, this work is thus designed to analyze the effects of shocks on the economy by constructing a simple SOE model which is extended from our previous work of the close economy. The remaining of this work is organized as follows. In section 2, the model formulation will be discussed. The data and estimation will be highlighted in Section 3. Finally, Section 4 will provide a brief discussion of the results.

2. Monetary and Fiscal Policy in Open Economies

An open economy is linked to the rest of the world through international transaction activities. These activities have occurred in three main international markets of goods, production factors, and financial assets. As these market link the domestic to international market, they can produce a potential effect on the effectiveness of the domestic macroeconomic policies. Hence, in the following we will discuss the effect of these three linkages on the domestic economy.

Commodity market linkages: The explanation of the influence of this linkage on macroeconomic policy in open economies is based on the concept of purchasing power parity (PPP) which states that the price of a particular goods sells in international markets should be set equally after conversed by the exchange rate. This PPP implies that it is difficult for a country, especially a small country, to design its long-run inflation and exchange rate by using its monetary policy. Also, the domestic price is induced by foreign prices. Therefore, either monetary policy or fiscal policy cannot effectively produce any change in the long-run equilibrium of macroeconomic variables.

Capital Market Linkages: International capital mobility links interest rates on financial assets through the principle of interest parity which requires that interests differ between securities denominated in different currencies are equalled to the forward discount or premium on foreign exchange. This international capital mobility provides an important channel for the international transmission of macroeconomic disturbances and imposes a constraint on the use of monetary and fiscal policy within the domestic economy. However the effect of this linkage on the effectiveness of monetary policy is varied with the assumption applied to the exchange rate system, i.e.,a fixed exchange rate or a flexible exchange rate system. Regarding fiscal policy in the perfect asset substitutability, the fiscal expansion that raises long-run aggregate demand can cause the

crowding out effect which work through the depreciation of the exchange rate and the current account deteriorates.

Money market linkages: The concept of monetary equilibrium implies that any change in the supply of money or any exogenous disturbance to money demand must lead to changes in the market equilibrium. In the demand side, it is largely beyond the control of the central bank, while controlling the money supply is more practical, i.e., when the central bank desire to encourage the output, it can simply expand the money supply. As in open economy, this action will cause the foreign exchange depreciation and hence the deficits in the current and capital accounts of the balance of payments. Hence the foreign exchange reserve will decline until the money supply is reduced to the long-run equilibrium.

At this point, we have some ideas about the connection between domestic and international markets. This connection implies that when the international market environment change, they can produce some disturbances on the domestic economy which can affect the ability of both monetary and fiscal policy in controlling the domestic economy. For the original detail related to this discussion please study in [6, 7].

3. The Model

In the following, the hypothesized model based on a small open economy framework will be discussed.

3.1. **Households.** The representative household in this economy seeks to maximize its lifetime utility which is increased by consumption but decreased by the working hour. The utility function utilized in this work was adapted from the usual utility function by augmenting the public goods and import goods in the household consumption bundle. Therefore the household utility can be written as follow

$$E_t \sum_{t=0}^{\infty} \beta^t \left(A_{C,t} \frac{\left(\begin{array}{l} \omega_1 (C_{H,t})^{\eta} + \omega_2 (C_{G,t})^{\eta} \\ + (1-\omega_1-\omega_2)\,(C_{M,t})^{\eta} \end{array} \right)^{\frac{1}{\eta}}\Bigg)^{1-\sigma}}{1-\sigma} - \frac{{L_t}^{1+\varphi}}{1+\varphi} \right), \tag{3.1}$$

where the constants β, ω_1, ω_2, η, σ, and φ represent the intertemporal discount factor, proportion of private good in consumption bundle, proportion of public good in consumption bundle, elasticity of substitute between private, public, and import good, the inverse elasticity of consumption, and the inverse elasticity of labour supply. $C_{H,t}$, $C_{G,t}$, $C_{M,t}$, and L_t are private good, public good, import good, and household working hour, respectively. $A_{C,t}$ denote consumption evolution that accounts for anomaly changes in consumption that not explained in the model. This shock follows a first-order autoregressive process expressed by $\ln(A_{C,t}) = (1-\rho_{AC})\ln(A_{Css}) + \rho_{AC}\ln(A_{C,t-1}) + \varepsilon_{AC,t}$, where $|\rho_{AC}| < 1,\ \varepsilon_{AC,t} \sim N(0, Q_{AC})$.

In each period, the household derives income from working, renting out capital, retaining the profit from investment in the domestic firm, and holding bonds. While spending his/her income for consumption, investment, and tax. Therefore, the budget constraint of the household can be represented by

$$P_t(C_{H,t} + I_t) + E_t P_{F,t} C_{M,t} + \frac{B_{t+1}}{R_t} + T_t = W_t L_t + R_{K,t} K_t + B_t + \Pi_t, \tag{3.2}$$

where K_t, B_t, $\prod_t$, I_t, and T_t are capital, riskless one-period bonds, profit, investment, and lump-sum tax, respectively. W_t , $R_{K,t}$, R_t, $P_{F,t}$, and E_t denote, respectively, the wage, capital rental rate, policy rate, foreign price, and exchange rate in domestic currency. The law of motion of capital is given by $K_{t+1} = (1-\zeta)K_t + I_t$, where ζ is the capital depreciation rate.

3.2. **Firms.** Firms use capital and labour to produces outputs which are sell in a competitive market. Their production function is characterized by the following Cobb-Douglas technology. $Y_t = A_{T,t} {K_t}^{\alpha} {L_t}^{1-\alpha}$, where α is shares of capital in the production and $A_{T,t}$ is a technology evolution which follows a first-order autoregressive process.

Because a portion of goods produced within the domestic economy is consumed by foreign countries, thus we define the demand for the domestic produced goods as follow

$$C_{X,t} = \left((1-\omega_1^* - \omega_2^*) \frac{\omega_1^* P_{X,t}}{P_t} {Y_t^*}^{1-\eta^*} \right)^{\frac{1}{1-\eta^*}}, \tag{3.3}$$

where $P_{X,t} = E_t P_t^*$ is the export price in the domestic currency.

3.3. **Government authority.** The fiscal authority used the balanced budget policy and decide on spending for producing the public good, $C_{G,t}$ by taking into account the previous level of national income [8] and inflation. Therefore the spending rule can be written in the following form

$$\frac{C_{G,t}}{C_{Gss}} = \left(\frac{C_{G,t-1}}{C_{Gss}}\right)^{\zeta_G} \left(\frac{Y_{ss}}{Y_{t-1}} \frac{\pi_{ss}}{\pi_{t-1}}\right)^{(1-\zeta_G)\kappa_G} A_{G,t}. \tag{3.4}$$

For monetary authority, it was assumed to sets a short-term nominal interest rate, according to a simple Taylor type rule [9] as follows

$$\frac{R_t}{R_{ss}} = \left(\frac{R_{t-1}}{R_{ss}}\right)^{\zeta_M} \left(\left(\frac{Y_t}{Y_{ss}}\right)^{\kappa_Y} \left(\frac{\pi_t}{\pi_{ss}}\right)^{\kappa_\pi}\right)^{(1-\zeta_M)} A_{M,t}, \tag{3.5}$$

where $A_{G,t}$ and $A_{M,t}$ are government spending and monetary evolution which also follow a first-order autoregressive process.

3.4. **Market clearing condition.** As the outputs are domestically consumed and used for investment, while the rest is exported. Therefore, the market-clearing condition can be written by $Y_t = C_{H,t} + C_{G,t} + I_t + C_{X,t}$.

Lastly, the exchange rate, foreign price, and foreign output are assumed to evolve endogenously.

3.5. **Log-linear model.** The main log-linear equations are as follow

$$(1 - \eta)\, C_{M,t} + P_{F,t} + E_t = (1 - \eta)\, C_{H,t} + P_t, \tag{3.6}$$

$$\begin{aligned} &\tilde{W}_t - \varphi \tilde{L}_t - (1-\eta)\, \tilde{C}_{H,t} - \tilde{P}_t \\ &\quad = \left(\frac{\eta \left(\omega_1 C_{Hss}^{\eta} \tilde{C}_{H,t} + \omega_2 C_{Gss}^{\eta} \tilde{C}_{G,t} + (1 - \omega_1 - \omega_2)\, C_{Mss}^{\eta} \tilde{C}_{M,t} \right)}{\omega_1 C_{Hss}^{\eta} + \omega_2 C_{Gss}^{\eta} + (1 - \omega_1 - \omega_2)\, C_{Mss}^{\eta}} \right) \\ &\quad \cdot \left(1 + \frac{\sigma}{\eta} - \frac{1}{\eta}\right) - \tilde{A}_{C,t}, \end{aligned} \tag{3.7}$$

$$
\begin{aligned}
&(1-\eta\ -\ \sigma\ )\left[\left(\frac{\eta\left(\begin{array}{c}\omega_1 C_{Hss}^{\eta}\tilde{C}_{H,t+1}+\omega_2 C_{Gss}^{\eta}\tilde{C}_{G,t+1}\\ +(1-\ \omega_1-\omega_2)\,C_{Mss}^{\eta}\tilde{C}_{M,t+1}\end{array}\right)}{\omega_1 C_{Hss}^{\eta}+\omega_2 C_{Gss}^{\eta}+(1-\omega_1-\omega_2)\,C_{Mss}^{\eta}}\right)\right.\\
&\qquad\left.-\left(\frac{\eta\left(\begin{array}{c}\omega_1 C_{Hss}^{\eta}\tilde{C}_{H,t}+\omega_2 C_{Gss}^{\eta}\tilde{C}_{G,t}\\ +(1-\ \omega_1-\omega_2)\,C_{Mss}^{\eta}\tilde{C}_{M,t}\end{array}\right)}{\omega_1 C_{Hss}^{\eta}+\omega_2 C_{Gss}^{\eta}+(1-\omega_1-\omega_2)\,C_{Mss}^{\eta}}\right)\right] \qquad (3.8)\\
&=\eta\,(\beta\,(\delta\ -1)+\ 1\ )\,\tilde{P}_{t+1}+\eta\,(\beta\,(1-\ \delta)-\ 1)\,\tilde{R}_{K,t+1}\\
&\quad+\eta\,(1\ -\eta\ )\left(\tilde{C}_{H,t+1}-\tilde{C}_{H,t}\right)-\eta\left(\tilde{A}_{C,t+1}-\ \tilde{A}_{C,t}\right),
\end{aligned}
$$

$$\tilde{W}_t+\tilde{L}_t=\tilde{P}_t+\tilde{Y}_t, \qquad (3.9)$$

$$\tilde{R}_{Kt}+\tilde{K}_t=\tilde{P}_t+\tilde{Y}_t, \qquad (3.10)$$

$$\tilde{P}_t=\alpha\tilde{R}_{Kt}+\tilde{W}_t\,(1-\alpha)-\tilde{A}_{T,t}, \qquad (3.11)$$

(3.12)

$$
\begin{aligned}
&(1-\eta\ -\ \sigma\ )\left[\left(\frac{\eta\left(\begin{array}{c}\omega_1 C_{Hss}^{\eta}\tilde{C}_{H,t+1}+\omega_2 C_{Gss}^{\eta}\tilde{C}_{G,t+1}\\ +(1-\ \omega_1-\omega_2)\,C_{Mss}^{\eta}\tilde{C}_{M,t+1}\end{array}\right)}{\omega_1 C_{Hss}^{\eta}+\omega_2 C_{Gss}^{\eta}+(1-\omega_1-\omega_2)\,C_{Mss}^{\eta}}\right)\right.\\
&\qquad\left.-\left(\frac{\eta\left(\begin{array}{c}\omega_1 C_{Hss}^{\eta}\tilde{C}_{H,t}+\omega_2 C_{Gss}^{\eta}\tilde{C}_{G,t}\\ +(1-\ \omega_1-\omega_2)\,C_{Mss}^{\eta}\tilde{C}_{M,t}\end{array}\right)}{\omega_1 C_{Hss}^{\eta}+\omega_2 C_{Gss}^{\eta}+(1-\omega_1-\omega_2)\,C_{Mss}^{\eta}}\right)\right] \qquad ,\\
&=\eta\left(\tilde{P}_{t+1}-\tilde{P}_t\right)+\eta\,(\,1-\eta\,)\left(\tilde{C}_{H,t+1}-\ \tilde{C}_{H,t}\right)-\eta\left(\tilde{A}_{C,t+1}-\ \tilde{A}_{C,t}+\tilde{R}_t\right)
\end{aligned}
$$

$$(1-\ \eta)dC_{Xt}+dP_t=dP_{Ft}+dE_t+dY_{Ft}, \qquad (3.13)$$

$$\tilde{C}_{G,t}=\zeta_G\tilde{C}_{G,t-1}-\ (1-\ \zeta_G)\,\kappa_G\left(\tilde{\pi}_{t-1}+\tilde{Y}_{t-1}\right)+\tilde{A}_{G,t}, \qquad (3.14)$$

$$\tilde{R}_t = \zeta_M \tilde{R}_{t-1} + (1-\zeta_M)\left(\kappa_\pi \tilde{\pi}_t + \kappa_Y \tilde{Y}_t\right) + \tilde{A}_{M,t}. \tag{3.15}$$

4. Data and Bayesian Estimation

The model is estimated by using the quarterly data of Thailand which obtain from the World Bank database. The five series of the detrended data which cover the period between 2001:Q1-2019:Q2 include GDP, policy rate, employment, consumer price index (CPI), and exchange rate. To use Bayesian Estimation techniques in this work, the prior information of distribution and mean, show in Table 1 , are selected from the related literature. In addition, to facilitate the estimation we calibrate some parameters according to the following value, δ = 0.300, ζ = 0.011, ζ_G = 0.800, and ζ_M = 0.850 [10].

5. Results

In this section, the result of the analysis will be discussed. Presented by $(A)-(B)$ in Fig 1, the consumption preference shock produces the positive impact on both private and import consumption which rise the aggregate demand in the economy which in turn positively affect to the level of price and national income. Fig $(C)-(D)$ which represent the effect of technology shock shows the instantly increase in price but suddenly decrease. The wage rate, in this case, increase as technology induce production, output, and labor demand. In this case, the total consumption which is the combination of private, public, and import good does not instantly increase since it encounters with the reduction of goods that are imported. The increase of investment may be supported by the income generated from export and the initial fall of aggregate consumption in the first stage of shock. Fig $(E)-(F)$ shows the impact of government spending shock on public goods. It can be observed that the rising in public goods leads households to reduce the consumption of private goods and also crowding out private investment. The raising of output caused by government spending on public goods, however, push up the level of price, and wage which all of these, in turn, produce the negative result on the output. The result of monetary policy shock shown in Fig $(G)-(H)$ indicates the negative effect of raising the interest rate on investment and aggregate consumption. It can be observed that the reduction of output and price come along an increase in export. However,

the effect of export may not sufficient to cover the decline of consumption in the early stage of monetary policy operation. Thus the economy as a whole is shrunk before it recovers to its equilibrium. In the case of exchange rate shock, shown in Fig $(I) - (J)$, it makes a decrease in price and interest rate. In case of interest rate, when the domestic currency is depreciated it makes the actual return from investing abroad decrease and thus the domestic interest rate is adjusted to equate the return from abroad and domestic investment. Although this exchange rate shock has a positive effect on export and investment after some periods, it may unable to overcome the negative effect of this shock and thus the economy is regressed in the early period of shock. Fig $(K) - (L)$ and $(N) - (M)$ show the effect of foreign prices shock and foreign income shock, respectively. The results are likely to coincide with the previous work, i.e., when the foreign price increase the import, consumption, and national income decline and when foreign income increase export and national income increase.

6. CONCLUSIONS

This work addresses the question of how an open economy reacts to changes when the public good is handled in the consumption bundle. To answer this question, we construct a model based on the simple small open economy environment. By employing some parameters from the related literature and estimation with data of Thailand, we found the results that most of them come along with the previous works. However, as the results produced from this work came from the small scale model, thus the model extension should be considered in the future works. For example, the model may be extended by discarding the assumption of endogenously evolve of the international related variables, i.e., foreign price, foreign income, and exchange rate, and assign a specific function to explain the dynamic of these variables and their effect on the domestic economy. In this manner, it should allow the future works to deal with the new perspective on the effect of shocks.

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TABLE 1. Calibrated parameters

Parameters	Prior		Posterior			Parameters	Prior		Posterior		
	Distr.	Mean	Mean	HPD inf	HPD sup	Distr.	Mean	Mean	HPD inf	HPD sup	
φ	gamma	3.000	3.0537	2.9957	3.1340	σ	gamma	0.600	0.5897	0.5731	0.6088
κ_G	gamma	0.200	0.3097	0.2297	0.4014	κ_π	gamma	0.200	0.2366	0.1685	0.3006
κ_Y	gamma	0.200	0.4911	0.4260	0.5606	ρ_{AG}	beta	0.800	0.8302	0.7849	0.8888
ρ_{AM}	beta	0.800	0.4722	0.4206	0.5220	ρ_{AT}	beta	0.800	0.4572	0.4300	0.4887
ρ_{AC}	beta	0.800	0.8716	0.8598	0.8853	ρ_{PF}	beta	0.800	0.7905	0.7102	0.8682
ρ_{YF}	beta	0.800	0.7880	0.8527	0.7058	ρ_E	beta	0.800	0.7711	0.7015	0.8237

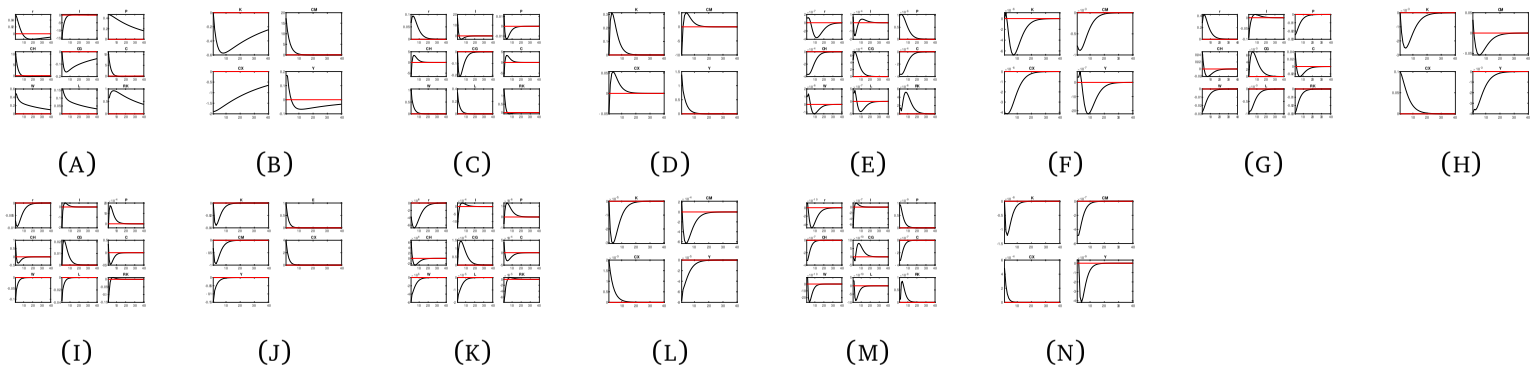

FIGURE 1. The reactions of macroeconomic variables to shocks: (A)-(B) are the reactions to consumption shock, (C)-(D) are the reactions to technology shock, (E)-(F) are the reactions to fiscal policy, (G)-(H) are the reactions to monetary policy shock, (I)-(J) are the reactions to exchange rate shock, (K)-(L) are the reactions to foreign price shock, (M)-(N) are the reactions to foreign income shock

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