Department of Economics, University of Warwick

Monash Business School, Monash University

as part of

Monash Warwick Alliance

Government Expenditures in a Small Open Economy Model: The Role of Credit Constraint

Zhe Wu

Warwick-Monash Economics Student Papers

September 2022 **No: 2022-42**

ISSN 2754-3129 (Online)

The Warwick Monash Economics Student Papers (WM-ESP) gather the best Undergraduate and Masters dissertations by Economics students from the University of Warwick and Monash University. This bi-annual paper series showcases research undertaken by our students on a varied range of topics. Papers range in length from 5,000 to 8,000 words depending on whether the student is an undergraduate or postgraduate, and the university they attend. The papers included in the series are carefully selected based on their quality and originality. WM-ESP aims to disseminate research in Economics as well as acknowledge the students for their exemplary work, contributing to the research environment in both departments.

"*We are very happy to introduce the Warwick Monash Economics Student Papers (WM-ESP). The Department of Economics of the University of Warwick and the Economics Department at Monash University are very proud of their long history of collaboration with international partner universities, and the Monash Warwick Alliance reflects the belief in both Universities that the future will rely on strong links between peer Universities, reflected in faculty, student, and research linkages. This paper series reflects the first step in allowing our Undergraduate, Honours, and Masters students to learn from and interact with peers within the Alliance.*"

Ben Lockwood (Head of the Department of Economics, University of Warwick) and Michael Ward (Head of the Department of Economics, Monash University)

Recommended citation: Wu, Z. (2022). Government Expenditures in a Small Open Economy Model: The Role of Credit Constraint. *Warwick Monash Economics Student Papers* 2022/42.

[1] Warwick Economics would like to thank Lory Barile, Gianna Boero, and Caroline Elliott for their contributions towards the selection process.

Government Expenditures in a Small Open Economy Model: The Role of Credit Constraint

Zhe Wu*

Abstract

We investigate the role of international credit market constraint in a dynamic stochastic general equilibrium model in determining the effect of government spending policies on macroeconomic variables such as consumption and the real exchange rate in a small open economy. The numerical results show that increasing government expenditure under certain economic shocks can increase the value of the real exchange rate and reduce the chance of the small open economy reaching the borrowing limit. Hence, the dynamics of consumption and the real exchange rate can be significantly affected by government spending policies under international credit market constraints.

JEL classifications: F41

Keywords: Credit Constraint, Real Exchange Rate, Government Spending

* Contact information: wzinfinity001@gmail.com

1. Introduction

Ever since the 2008 global financial crisis (GFC), there have been extensive debates about how countries could resolve the problem of overborrowing. Does government policy play any role to restrict or ease the international borrowing situation of an open economy? We in this paper aim at filling the theoretical void in the literature by investigating the role of government spending in determining the borrowing situation of a small open economy.

Government spending is an important policy tool that can be used to influence the macroeconomy. For example, since COVID-19, we see a large increase in Australian government spending which started from $679 billion in 2018-19 to $792 billion in 2019-20 (as shown in Figure 1 and Table 1). How does the policy change affect the Australian economy? To provide some policy guidance, we built up a dynamic stochastic general equilibrium model (DSGE) to analyze the effect of various government spending policies in this paper. Specifically, we focus on the transitions after economic shocks by varying the share of government spending (in total GDP). In other words, we are mostly interested in the impulse responses of macroeconomic variables to shocks under different government policies.

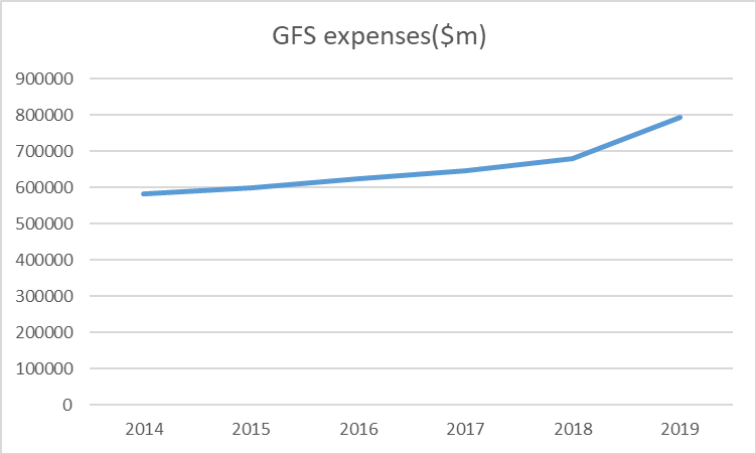


Figure 1 - Australian Government Expenditure

	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
	$m	$m	$m	$m	$m	$m
Operating results						
GFS revenue	556 090	577 704	609 625	657 219	696 299	685 187
GFS expenses	583 401	600 206	623 176	647 054	679 669	792 174
GFS net operating balance	- 27 311	- 22 502	- 13 551	10 165	16 630	- 106 987
Net acquisitions of non-financial assets	20 094	21 462	24 784	33 763	40 721	43 560
GFS net lending(+)/borrowing(-)	- 47 405	- 43 965	- 38 335	- 23 598	- 24 090	- 150 547
Cash flow results						
GFS cash surplus(+)/deficit(-)	- 34 465	- 37 316	- 32 643	- 17 543	- 10 868	- 135 024
Balance sheet results						
Total assets	1 948 730	2 066 069	2 199 427	2 320 982	2 415 429	2 583 776
Total liabilities	1 121 933	1 301 804	1 315 105	1 399 268	1 615 112	1 897 502
GFS Net worth	826 797	764 266	884 322	921 715	800 316	686 274

Table 1 - Australian Government Expenditure. Source: ABS, 2021

The standard business cycle literature usually adopts the (log) linear approximation methodology to show the impulse responses of macro variables. In a such linear system, the government spending policy (say we adjust the share of government spending in total output) usually generates symmetric responses of macro variables to positive and negative shocks. However, this might not reflect what has happened in the real world. For instance, Schmitt-Grohé & Uribe (2017) find that the GFC caused a very slow recovery in European economies – it takes quite a long time period for the employment rate to get back to the normal level. The slow recovery process described in their work does not seem to hold symmetrically when an economy is hit by a positive shock. Motivated by this pattern, we examine possible reasons that an economy may behave asymmetrically after positive and negative shocks.

We show that international credit constraint is one key determinant that can generate the asymmetric responses of macro variables to economic shocks. The logic is quite intuitive. If there is a good shock that increases the total output of a small open economy, the economy may be associated with a net capital outflow which in turn implies that the borrowing constraint is not binding. The model in this scenario is quite

similar to standard business cycle models. However, if the economy is hit by the opposite shock that the country may borrow from the rest of the world, there is a chance the small open economy may reach the borrowing limit. Once the borrowing constraint is binding, the whole dynamics of the system will change and differ from the results in standard business cycle models.

What are the consequences if the economy reaches the borrowing limit, that is, the borrowing constraint is binding? The standard macroeconomic theory implies that the consumption will not be smoothed in this case (the consumption is determined by the borrowing constraint rather than the standard optimal intertemporal condition), which potentially may yield welfare loss to all households in the economy. Then for policymakers, one goal is to design proper policies that can help the households jump out of the credit constraint. In this paper, we investigate whether changing government spending can achieve such a goal or not. If adjusting the share of government expenditure in total output may help reduce the chance of being credit constrained, what are other consequences of the policy change? Our numerical results show that, when a small open economy tries to increase international borrowing after certain shocks, increasing government expenditure can help the households stay away from the borrowing constraint. Here is the logic. In general, the international borrowing constraint implies that the maximum amount of borrowing by a country depends on the value of the country's collateral in the credit market. The value of a country's collateral is strongly affected by the real exchange rate. The stronger the currency, the more the country is able to borrow. As suggested by the standard open economy literature, increase in government spending (mainly on the demand for the non-tradable good) tends to appreciate the real exchange rate of a country (Froot and Rogoff, 1991). This

then builds a positive connection between government spending and the borrowing ability of the households in a small open economy.

The methodology we adopt in the analysis is to solve a DSGE model with occasionally binding constraints (OBC henceforth). We consider a two-sector model: with one tradable good sector and one non-tradable good sector. We consider the tradable good as the numeraire in the model. For simplicity, we do not assume productions in this model and outputs in the two sectors follow some exogenous stochastic processes. Households face borrowing constraints (in the international credit market). Specifically, households cannot borrow more than a fraction of total output. The model is solved numerically by using the toolbox DynareOBC, which is designed to deal with the credit constraint in DSGE models. Considering relatively large economic shocks (to mimic the crisis period in the world), we show that a negative endowment shock in the tradable good sector may lead the households to reach the borrowing limit. In this scenario, an increase in the share of government spending in total output may help the households stay away from the credit constraint, that is, the borrowing constraint is less likely to bind. When there is a positive endowment shock in the tradable good sector, the small open economy is associated with a net capital outflow and hence, credit constraint will not be binding and the results are consistent with what the standard literature suggests. For shocks in the non-tradable good sector, we show that when there is a positive endowment shock, the borrowing constraint is likely to bind and in this case, increasing government spending leads to lower chance of a binding borrowing constraint.

The contributions of this paper are mainly focused on following two parts. First, we add to the standard business cycle literature that asymmetric impulse responses to economic shocks can be generated by credit market frictions. This enhances our

understanding of what the real world is about and provide useful theoretical guidance to policy makers. Second, we show that policies such as government spending changes may affect the chance of a binding borrowing constraint. The effects of government expenditure changes on the real exchange rate and other macro variables are significant which may guide policy makers re-visiting the optimal design of macroeconomic policies.

The rest of paper is organized as follows. In Section 2, we conduct a literature review and introduce the background of international borrowing and government policies in a small open economy analysis. In Section 3, we build a theoretical model and solve the equilibrium conditions. In Section 4, we conduct a numerical analysis and examine the impulse responses of macro variables to economic shocks and interpret the mechanisms. In Section 5, we conclude and discuss potential extensions of the current study.

2. Literature Review

After 2008 global financial crisis, the debates on regulating international borrowings increase dramatically. Literature suggests that overborrowing in international assets leads negative externality on consumptions via affecting the real exchange rate movement. Bianchi (2011) analyses how overborrowing may lead welfare loss in a dynamic stochastic general equilibrium (DSGE) model. In his model, there exists an occasionally binding credit constraint which ties the international borrowing to the value of the collateral (which depends on the country's real exchange rate). With such credit constraint, when the economy is in booming periods, the real exchange rate appreciates and hence the value of the collateral in this economy rises,

which in turn leads to overborrowing. One negative effect from the overborrowing is that as negative shocks hit the economy, the real exchange rate falls and the credit constraint then becomes much tighter. In other words, the borrowing ability of households dramatically falls during the crisis period. As a result, consumption falls significantly which yields very high welfare loss.

The mechanism in Bianchi (2011) is quite similar to Mendoza (2005) in which declines in personal consumption, the price of the non-tradable good and access to international financing mutually reinforce each other to trap the economy in a deflation spiral. In order to mitigate the negative effect of overborrowing, Bianchi (2011) considers various policy measures to restrict the borrowing of individuals such as imposing taxes on debt, tightening margins and requiring more capital and liquidity in financing.

Based on the analysis in Bianchi (2011), we consider the role an alternative fiscal policy tool, namely, government spending policy. The logic of thinking of government spending is as follows. The open economy literature suggests that government expenditure is closely associated with the real exchange rate movement. Froot and Rogoff (1991) document evidence that increasing government expenditure will tend to appreciate the real exchange rate. This is mainly because the government expenditure is mainly on the demand for the non-tradable good in a country. The exchange rate literature usually implies that the price of the non-tradable good can be considered as one measure of the real exchange rate. Hence, a rise in government spending usually is associated with an appreciation in the real exchange rate. Note that the real exchange rate movement is the key driving force to affect the borrowing constraint as in Bianchi (2011). We then will consider how government spending will affect the borrowing ability via the exchange rate channel in this paper.

There is a fast-growing macroeconomic literature that studies the optimal policy during economic crisis. Most of them, however, focus on a closed economy. One related paper to our discussion which studies the effect of government expenditure during normal periods and crisis periods is Benigno et al. (2009). They consider a model which allows for the role of subsidy on the non-tradable good and use a ex-post purchase to stabilize the change in the price of the non-tradable good. Again, we differ from their work by investigating the role of government spending instead of taxes.

Our paper is also related to the literature that studies fiscal policy in developing countries, given the fact that most developing countries are facing strong credit constraint in the international credit market. Alesina and Tabellini (2005) show that government spending in developing countries is procyclical, which is different from the theoretical literature that the spending should optimally be countercyclical. We do not aim at examining the fact of whether optimal fiscal policy should be pro- or counter-cyclical in our framework, however, we do consider different cyclical government spending policies and explore the impulse responses of macroeconomic variables in our model.

3. Model

In this section, we will first introduce a simple small open economy model with government spending and credit constraint. Consider an economy with two sectors: the tradable good sector and the non-tradable good sector. Only the tradable good can be traded in the international market, the non-tradable good can only be purchased and consumed in the domestic market such as hair-cut service.

3.1 Households

We assume that each household lives for infinite periods in this economy with the life-time utility given by:

(1) $$E_0\{\sum_{t=0}^{\infty}\beta^t u(c_t)\}$$

where c represents the household consumption and β is the subjective discount factor. More specifically, we assume a CRRA utility function which takes the form

$$u(c_t) = \frac{c_t^{1-\theta} - 1}{1-\theta}$$

In our model, the final good consumption consists of two parts: a tradable good consumption (c_t^T) and a non-tradable good consumption (c_t^N). As in the standard literature, the final consumption good is aggregated as follows

$$c_t = [\omega(c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta}]^{-\frac{1}{\eta}}, \eta > -1, \omega \in (0,1)$$

where η is a parameter which governs the elasticity of substitution between the tradable good and the non-tradable good. ω captures the importance of the tradable good consumption in the consumption basket.

For simplicity, as in Bianchi (2011), we do not assume productions in this model. Instead, we simply assume that households are endowed with the tradable good y_t^T and the non-tradable good y_t^N. Without loss of generality, we normalize price of the tradable good to 1 and denote the price of the non-tradable good by p_t^N.

The budget constraint facing the representative household is given by

(2) $$b_{t+1} + c_t^T + p_t^N c_t^N = b_t(1+r) + y_t^T + p_t^N y_t^N - p_t^N g_t^N - \frac{1}{2}\gamma b_{t+1}^2$$

where b_{t+1} is international bond holdings that the household choose at time t. Following the standard literature, we assume that the interest rate r on the international bond is fixed as a constant. To make sure the system is stationary, we assume a

quadratic bond holding cost $\frac{1}{2}\gamma b_{t+1}^2$ as in Schmitt-Grohe and Uribe (2003). We will let the cost very small such that it will not have a quantitatively large effect on the dynamics.

We plan to examine the role of international credit constraint in determining the dynamics of all equilibrium variables in our model. Specifically, we assume a similar borrowing constraint as in Bianchi (2011) that

$$b_{t+1} \geq -(\kappa^N p_t^N y_t^N + \kappa^T y_t^T) \tag{3}$$

where the small open economy cannot borrow over a certain ratio of the GDP. The higher the κ is, the less credit constraint is facing the representative household. In the benchmark model, we simply assume that $\kappa^T = \kappa^N = \kappa = 0.1$.

3.2 Government Expenditure:

$$p_t^N g_t^N = \sigma(y_t^T + p_t^N y_t^N) \tag{4}$$

where σ is the proportion of government expenditure on total output. We assume that government adjusts σ in business cycles. Specifically, we assume that the adjustment in σ takes the following form

$$\log(\sigma / \ \sigma\_ss) = \ \varepsilon * \log(\text{GDP/GDP\_ss}) \tag{5}$$

where ε is the elasticity used to determine the percentage change in sigma in relation to the percentage change in GDP. Elasticities take values of 1, -1 and 0. When elasticity is equal to 1, this means that when there is a negative shock on GDP, the sigma would decrease as well, which leads to a reduction in government expenditure. When elasticity is equal to -1, negative shock on GDP would cause an increase in government spending. And when elasticity is equal to 0, the expenditure police does not respond to

GDP changes. As in Froot and Rogoff (1991), we assume that government expenditure is in terms of only the non-tradable good.

3.3 Optimal Conditions

To solve the model, we adopt a Lagrangian approach. Assume λ_t and μ_t are the multipliers to constraints (2) and (3), respectively.

We have

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t + \lambda_t(b_t(1+r) + y_t^T + p_t^N y_t^N - p_t^N g_t^N - b_{t+1} - c_t^T - p_t^N c_t^N) + \mu_t(b_{t+1} + \kappa(p_t^N y_t^N + y_t^T))]$$

The first order conditions are

(6) $$\lambda_t = c_t^{-\theta-\frac{1}{\eta}-1} \omega (c_t^T)^{-\eta-1}$$

(7) $$\lambda_t = c_t^{-\theta-\frac{1}{\eta}-1} (1-\omega)(c_t^N)^{-\eta-1}$$

(8) $$\lambda_t(1 + \gamma b_{t+1}) = \beta(1+r)\lambda_{t+1} + \mu_t$$

(9) $$b_{t+1} + c_t^T + p_t^N c_t^N = b_t(1+r) + y_t^T + p_t^N y_t^N - p_t^N g_t^N - \frac{1}{2}\gamma b_{t+1}^2$$

In equilibrium, we have the market clearing condition for the non-tradable good.

(10) $$c_t^N + g_t^N = y_t^N$$

We assume that endowments are subject to shocks in each period. Specifically, the shock processes are AR(1) processes as follows.

(11) $$\log(y_t^T) = \rho_1 * \log(y_{t-1}^T) + e_t$$

(12) $$\log(y_t^N) = \rho_2 * \log(y_{t-1}^N) + u_t$$

e_t and u_t are exogenous shocks on output, in this model I assume there is no correlation between these two shocks, they independently enter and affect the economy.

4. Numerical Analysis

4.1 Methodology

In this section, we numerically solve the model. We proceed the numerical analysis via two steps. First, we consider a simple model without credit constraint. With derived first order conditions, we code all equations in Dynare which is a useful toolbox in Matlab to conduct dynamic analysis in DSGE models. The experiment helps us understand the effect of government spending on macroeconomic variables such as consumption and the real exchange rate as in the standard literature.

Second, we will re-compute the equilibrium by adding the credit constraint. Note that Dynare usually deals with systems without inequality constraint, we switch the toolbox to DynareOBC in order to conduct the equilibrium analysis when the credit constraint occasionally binds. Comparing the results obtained in this analysis to the previous one will provide information on how the limited borrowing situation may affect the role of government spending policies under various economic shocks.

4.2 Calibration

The values assigned to all model's parameters are listed in Table 2. A period in the model stands for one year. The baseline calibration uses similar values which are taken from Bianchi (2011).

The interest rate is set at 2 percent, and we set the value of β to 1/(1+r). The intratemporal elasticity of substitution 1/(1+ η) is of key importance since it affects the magnitudes of the price adjustment. For example, when there is negative shock in the tradable good sector, a higher intratemporal elasticity of substitution would cause a smaller change in the price of the non-tradable good (real exchange rate). 0.83 is a conservative choice that was used in Bianchi (2011), since we wish to separate the effect of shocks in two-good sectors, it aligns with our targets on analyzing the impulse responses of different shocks respectively.

Table 2 – Calibration

	Value
Interest rate	r = 0.02
Discount factor	β=0.98
Elasticity of substitution	1/(1+ η) = 0.83
Credit coefficients	$\kappa^T = \kappa^N = \kappa = 0.1$
Weight on the tradable good	$\omega = 0.32$
Autoregressive coefficients	$\rho_1 = \rho_2 = 0.9$
Steady state value of sigma	$\sigma_{ss} = 0.25$

The parameter ω governs the share of the tradable good in the CES aggregator and is set to match 32 percent share of tradable production. The credit coefficients κ implies maximum value of borrowing related to total output. Here we set $\kappa = 0.1$, which means that total personal borrowing cannot exceed ten percent of total output. 0.1 is just a

reasonable value, in future studies, we would vary this value according to different environment settings.

4.3 Simulation Results

4.3.1 Shocks in the tradable good sector (without credit constraint)

In this section, we are aiming to understand how government expenditure policies may affect the dynamics of macroeconomic variables when there exists no international borrowing constraint. Specifically, we vary the value of the elasticity in the government spending policy when the tradable and the non-tradable good sector are hit by various endowment shocks and examine how different government policies would affect the real exchange rate, the asset to GDP ratio and social welfare. Note that the elasticity in the government spending policy is the key policy variable in our model, when it takes value one, the government spending will go the same direction as the GDP. When the elasticity takes value -1, it implies that the government countercyclically choose the expenditure policy. If the elasticity takes value zero, the expenditure police does not respond to GDP changes.

We consider 10 percent decrease (or increase) to the tradable good sector endowment as the shock. This is a transitory shock which happens only in period 0. We will use real exchange rate and price of the non-tradable good interchangeably.

First three graphs and fifth graph (government expenditure) depicts percentage change from its steady state. For example, -0.04 in the tradable good consumption means that the tradable good's consumption at period 0 decrease by 4 percent from its steady state. The last graph is about welfare of individuals, we only look at the starting point since it is calculated as life-time utility and we discount all future utility back to current period.

Figure 2A Negative shock in the tradable good sector (without credit constraint)

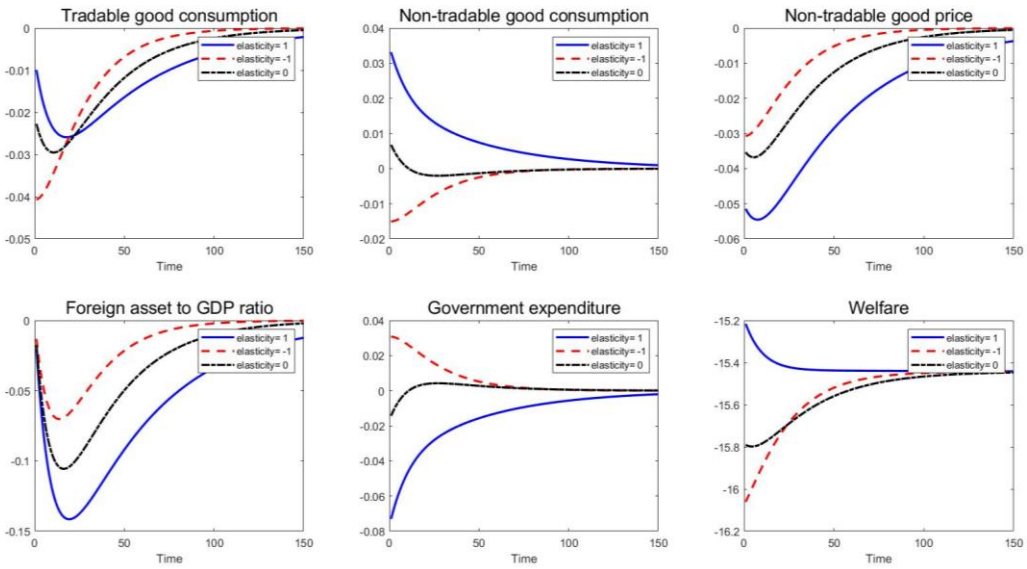
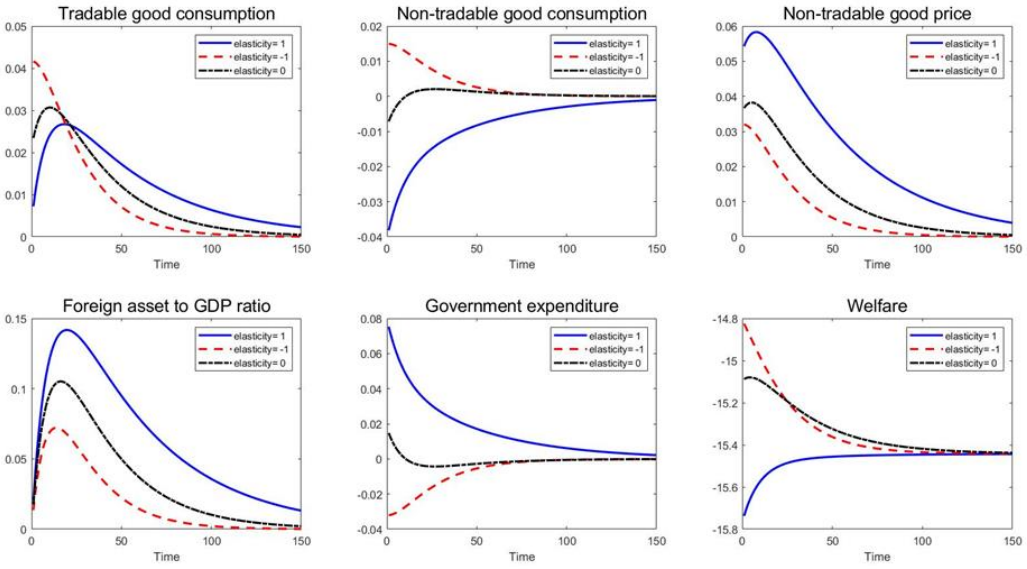


Figure 2B Positive shock in the tradable good sector (without credit constraint)



Figures 2A and 2B present the impulse responses macroeconomic variables such as consumption, the real exchange rate and the debt-to-GDP ratio to negative and positive endowment shock in the tradable good sector, respectively. Take the negative endowment shock as an example. In Figure 2A, we can see that the tradable good consumption will fall after the shock while the consumption of the non-tradable good

will increase. This is mainly due to the resource re-allocation effect that relatively more supply of the non-tradable good reduces its price and hence, households will increase the consumption of the non-tradable good. In this case, we observe a real exchange rate depreciation (decline in p_t^N). Interestingly, even the government expenditure increases when elasticity is equal to one (as shown by the red line), the price of the non-tradable good still goes down. This shows that government expenditure crowds out household consumption by a large amount. This is in line with our observations in graph 1 and 2 (tradable good consumption and non-tradable good consumption) where consumption of household with elasticity equal to -1 deviates from its steady state by the largest proportion. The negative endowment shock also leads to borrowing of the small open economy from the rest of the world, that is, the holding of the foreign bond declines. When varying the elasticity of government expenditures, we can see that decrease in government expenditure (showed by the blue line when elasticity is equal to one) yields highest welfare in this experiment. That is, the government may optimally choose to decrease government spending when a negative shock to the tradable good output occurs.

When the shock is positive, we find symmetric pattern in Figure 2B and all variables take the opposite signs but similar percentage deviations as in Figure 2A. Due to the positive shock in the tradable good sector, we can see that the tradable good consumption increases after the shock while the consumption of the non-tradable good decreases. Resource reallocation now shifts the non-tradable good consumption to the tradable good consumption. People now save more money and invest them on foreign bonds. Government expenditure do support the price of the non-tradable good as shown by blue line in graph 3 (price of the non-tradable good) of Figure 2B, which aligns with our initial conjecture about the effect of government spending on real exchange rate.

When there is a positive shock in the tradable good sector without credit constraint, it is better for government to reduce its expenditure to achieve highest social welfare.

4.3.2 Shocks in the non-tradable good sector (without credit constraint)

Figures 3A and 3B present the impulse responses of macroeconomic variables to negative and positive endowment shock in the non-tradable good sector.

Figure 3A Negative shock in the non-tradable good sector (without credit constraint)

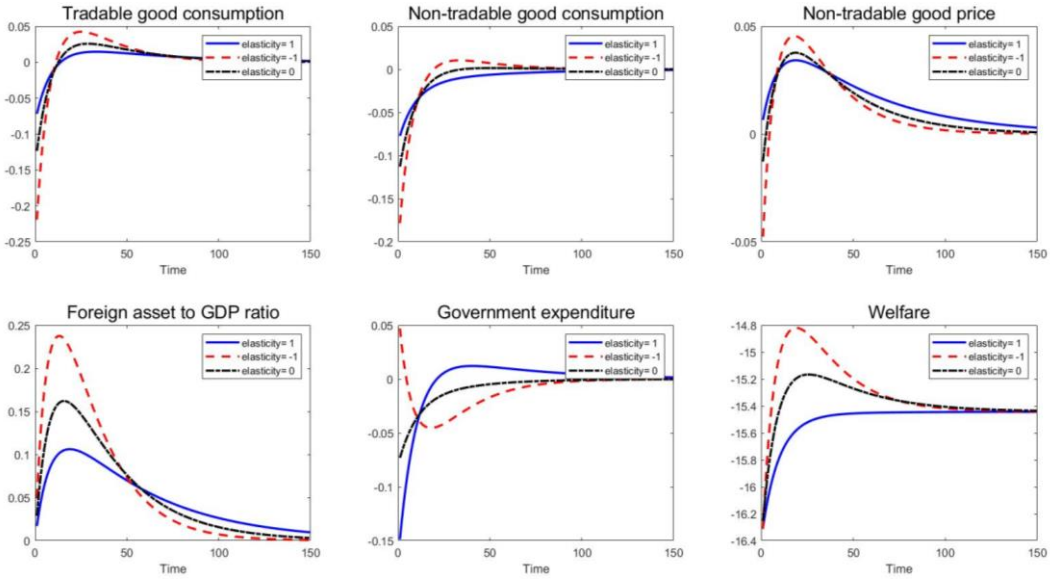
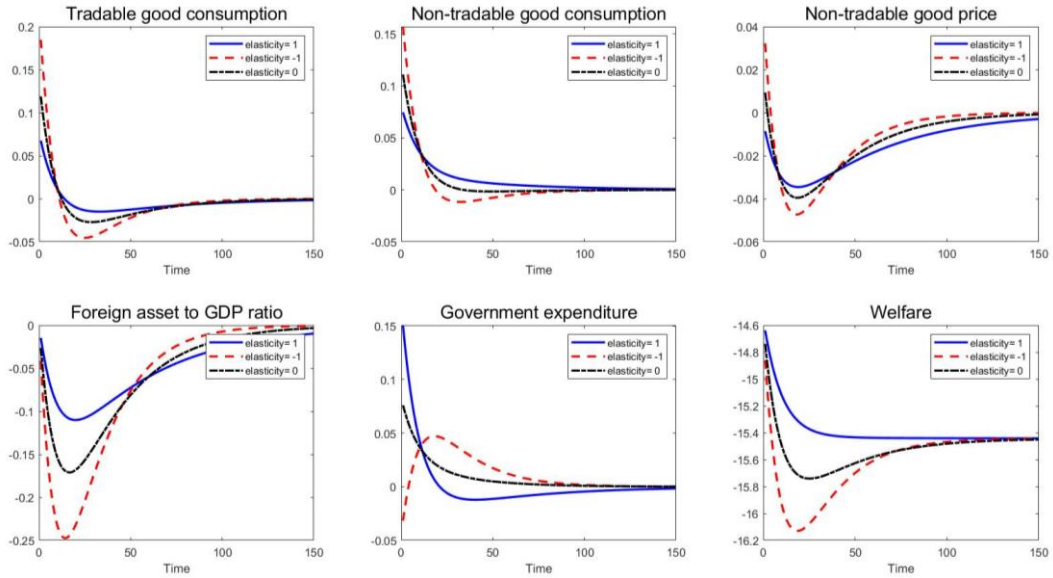


Figure 3B Positive shock in the non-tradable good sector (without credit constraint)



As shown in Figure 3A, when there is a negative shock in the non-tradable good's endowment, the situation is quite different from that of negative shock in the tradable good sector.

Firstly, both the tradable good's consumption and the non-tradable good's consumption decrease. However when there is a negative shock in the tradable sector, only the tradable good's consumption decreases, the non-tradable good's consumption increases in case that elasticity of government expenditure is equal to 0 or 1. Meanwhile, instead of borrowing more money to smooth consumption, people actually save money during the crisis when negative shock in the non-tradable good sector hits the economy as we see in fourth graph (Foreign asset to GDP ratio). Therefore, though government increases its spending on the non-tradable good, price of the non-tradable good still decreases as indicated by red line in third graph. Since people are more vulnerable to shock in non-tradable good sector, the increase in government expenditure would lead to crowd-out effect of personal consumption. When crowd-out effect dominates, the real exchange rate still decreases even though government spends more money on purchasing domestic good and try to stabilize the price. The welfare of individuals is lowest when government levies more tax on individuals (red line is lower than blue line in graph 6 at the starting point). Hence, when negative shock impacts the non-tradable good sector, it would be better for government to reduce its expenditure.

When the shock is positive, we find symmetric pattern in Figure 3B and all variables take the opposite signs but similar percentage deviations as in Figure 3A. So situation in Figure 3B is just a reverse or counterfactual event of Figure 3A, the interpretation is very similar but the conclusion is different. In Figure 3B, both tradable and non-tradable good consumption increase by a large amount, especially when government chooses to countercyclically decrease its expenditure (as shown by red

line). But due to large increase in consumption, the real exchange rate still appreciates. If we compare the simulation indicated by red line with that by blue line, though total consumption with elasticity equal to -1 (red line) is higher than that with elasticity equal to 1 (blue line) at the beginning, there is a huge drop in red line afterwards. And blue line is above the red line in a relatively longer periods in graph 1 and 2, which indicates a more stable and higher consumption of individuals when elasticity is equal to 1. Therefore, under the positive shock in the non-tradable good sector, government is supposed to increase its expenditure to smooth the change in real exchange rate and help individuals achieve a high welfare.

Figure 3B actually describes a very interesting economical story. When there is an unexpected increase in endowment of the non-tradable good, people become over-optimistic and increase their consumption by a large amount. In initial period, they even borrow from outside to consume as shown in graph 4. Meanwhile, due to reduction in taxation, people are overconfident about the future, which also increases the demand and pushes the price of the non-tradable good. However, this is only a transitory shock rather than a long-term permanent technological growth in production, the initial overconsumption drops sharply and leads to very long-time relatively low consumption in following periods. When we refer to reality, this happens frequently. Economy is boosting due to some transient positive shock, government reduces tax to encourage people to consume more. The debt is accumulated and prices keep going up until the bubble finally burst. This model warns us that when economy grows, government should distinguish whether the growth is just a transient shock or a potential long-term technological change. If it is a long-term change, then reducing tax might be a good choice though we do not include this kind of evaluation in this model, which could be an extension on future work. On the contrary, if the growth of production is just a

transient positive shock, it would be better for government to impose more tax and prepare to stabilize the price in advance.

4.3.3 Shocks in the tradable good sector (with credit constraint)

In this section, we introduce the occasionally binding constraint into the model and investigate the impact of borrowing constraint on the dynamics of macroeconomic variables. We restrict the borrowing ability of a representative household in the way that total borrowing cannot exceed 10% of total output in any period. Since the value of total output is related to the real exchange rate, the government expenditure policies may affect the borrowing situation via influencing the real exchange rate.

Figures 4A and 4B present the results when there are endowment shocks to the tradable good sector. Under a negative endowment shock, the qualitative patterns of all variables are different to our previous analysis when there exists no international borrowing constraint.

Figure 4A Negative shock in the tradable good sector (<u>with</u> credit constraint)

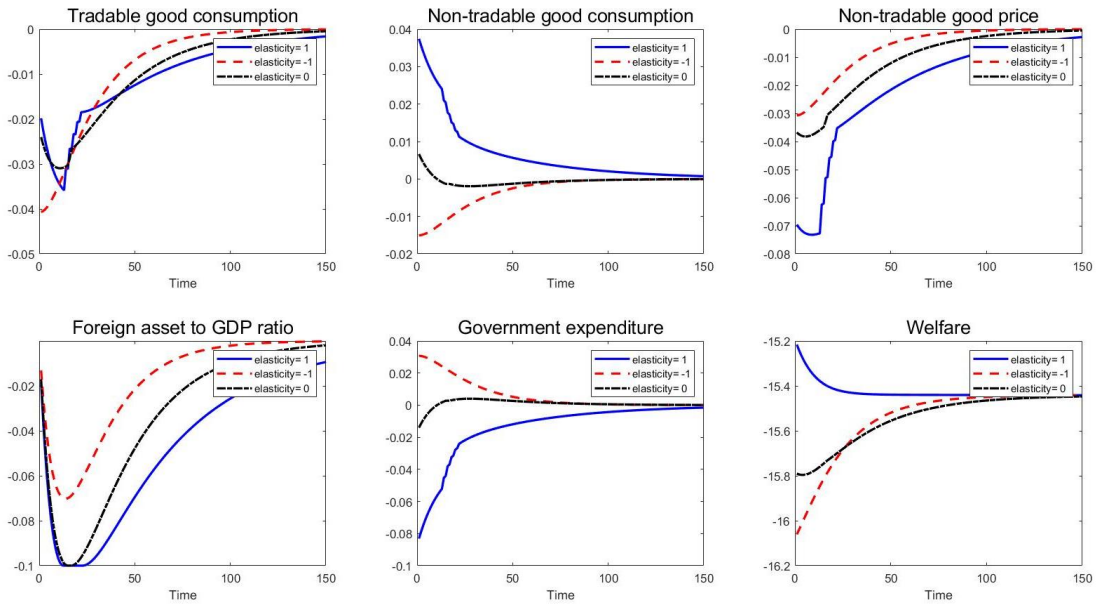
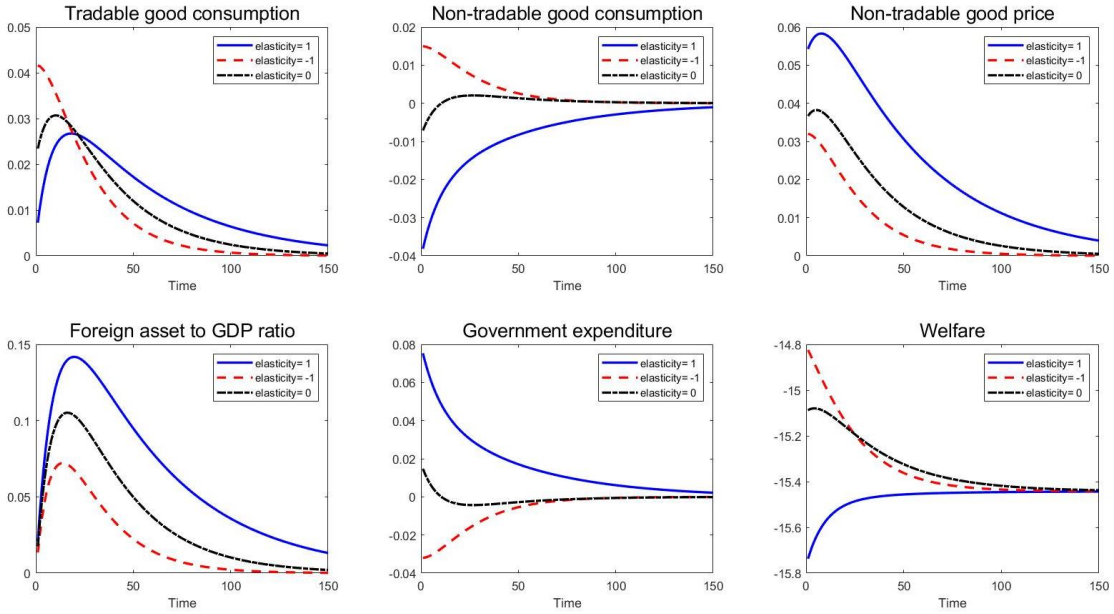


Figure 4B Positive shock in the tradable good sector (<u>with</u> credit constraint)



As in Figure 4A when there is a negative endowment shock in the tradable good sector, however, we now see the debt-to-GDP ratio may reach the boundary, that is, the credit constraint is binding. As we can see in our experiment, increasing the government expenditure (the red curve when the elasticity takes value -1) yield less real exchange rate depreciation such that the small open economy does not reach the borrowing limit. This is consistent with our conjecture on how government spending policy may affect the likelihood of a binding borrowing constraint via the effect on the real exchange rate. Interestingly, though the economy does not reach the borrowing limit, the social welfare in this case is the lowest. The main reason behind such result is that the increase in government expenditure significantly crowds out the consumption (especially the consumption on the non-tradable good), which in turn leads to low social welfare. The numerical result in this experiment seems to suggest that, as long as the foreign debt is not extremely high (say 10% of GDP as in our model), the optimal government expenditure may let the borrowing constraint bind to reduce the crowd-effect (caused by government expenditure) on consumptions.

Now we compare the response function of variables with and without credit constraint under the same negative shock in the tradable good sector. If we compare the same graphs in Figure 2A and 4A, we can see some similarity between these two models. Taking graph 2 for example (Non-tradable good consumption), the changing mode for non-tradable good consumption with elasticity equal to -1 and 0 (red and black line) are actually the same in two models, except that there is a jagged move of blue line in Figure 4A compared to the smooth one in Figure 2A due to occasionally binding constraint. This is true for other three variables such as price of non-tradable good, government expenditure and welfare. These two models have same welfare ranking but different changing mode in tradable good's consumption. As shown by graph 1 in Figure 4A, the economy facing with borrowing limit would experience a volatile change in the tradable good consumption especially when government choose not to increase its expenditure to support the real exchange rate (as indicated by blue line). Since real exchange rate depreciates significantly, the value of collateral (total output) decreases, which limits people's ability to borrow from foreign investors. This is again in line with our conjecture on how government spending policy may affect the borrowing situation via the effect on the real exchange rate. Consumers would experience a rather painful adjustment of tradable good consumption, which implies a huge drop in initial periods following by a dramatical surge after a certain periods. Although the conclusion remains the same, this is mainly because of the setting of government spending in our model. Here, we only assume that government spending is just a segmentation of total output, so crowd-out effect always dominate in the welfare analysis. With assuming positive effect from government spending (productive government spending such as infrastructure investment) in the future study, the role of government expenditure could be more versatile. The conclusion regarding optimal

government policy may also change. Instead of reducing the government expenditure whether there is a positive or negative shock in the tradable good sector, government may increase its spending due to improvement of the productivities of firms by investment in infrastructure.

When there is a positive endowment shock as in Figure 4B, we obtain the same result as in Figure 2B since the borrowing constraint is not binding in this case. Therefore the conclusion is very similar, which suggests that government is supposed to reduce the expenditure when positive shocks in the tradable good sector hit the economy. But with credit constraint, positive and negative shocks in the tradable good generate asymmetric response while the standard RBC model without credit constraint presents a symmetric response of those variables.

4.3.4 Shocks in the non-tradable good sector (with credit constraint)

Figures 5A and 5B exhibit the results when there are endowment shocks in the non-tradable good sector.

Figure 5A Negative shock in the non-tradable sector (<u>with</u> credit constraint)

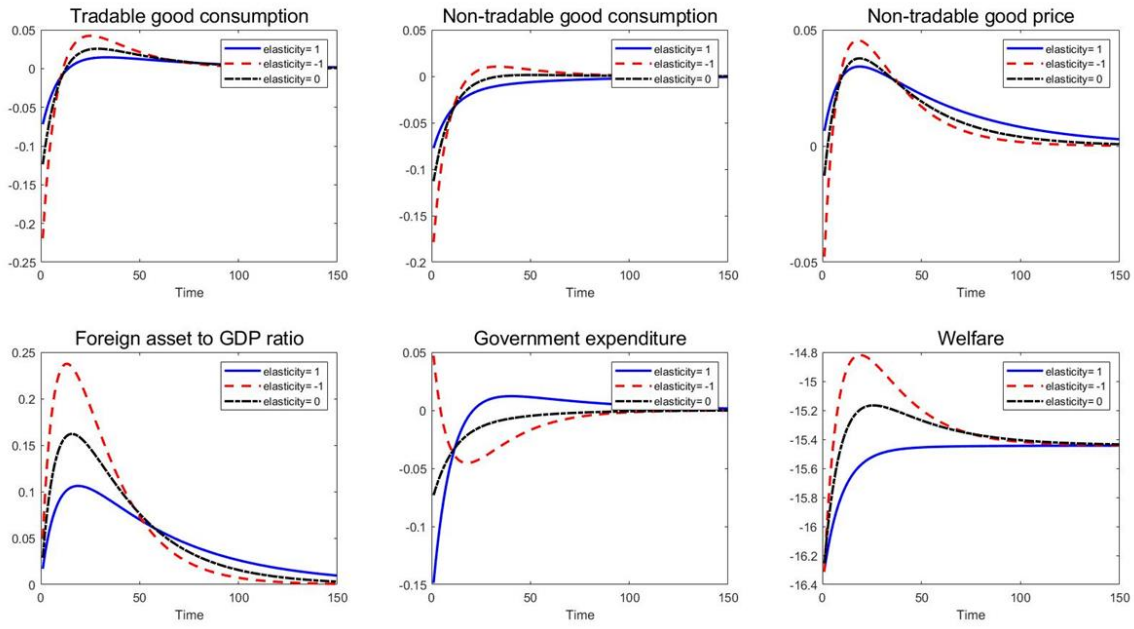
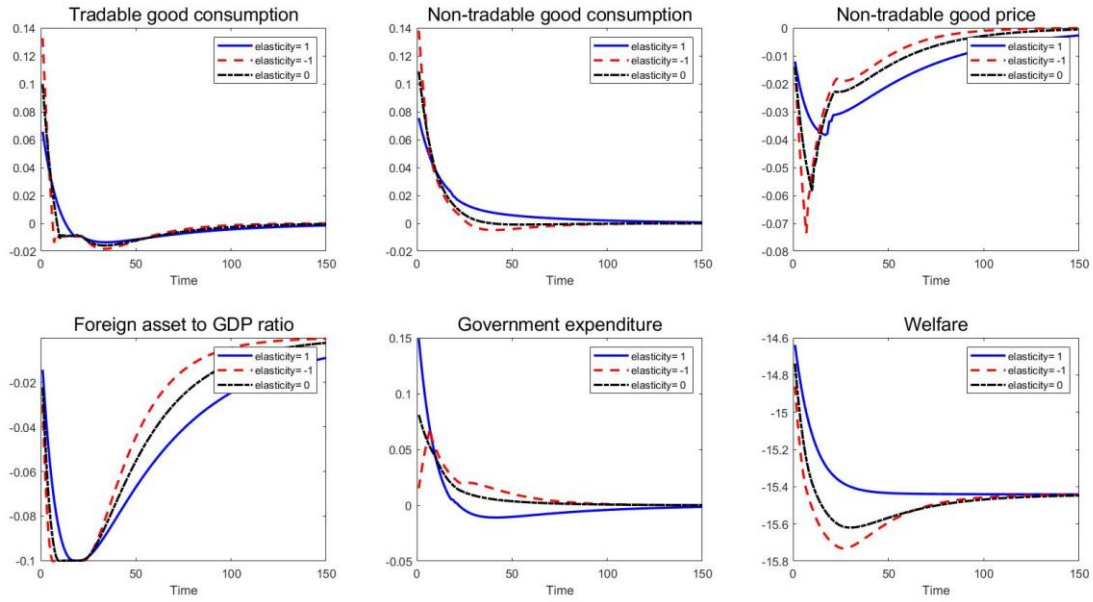


Figure 5B Positive shock in the non-tradable sector (<u>with</u> credit constraint)



Under a negative endowment shock, the qualitative patterns of all variables are similar to our previous analysis when there exists no international borrowing constraint.

To be specific, the situation in Figure 5A is same with the situation in Figure 3A since both of them have a positive asset to GDP ratio which indicates that there is an increase in personal saving when international borrowing constraint does not bind here.

In Figure 5B, as we can see from fourth graph (Foreign asset to GDP ratio), all of the lines touch the restriction which indicates that debt-to-GDP ratio reach the boundary, that is, the credit constraint is binding. Even though consumption of the non-tradable good by individuals and government increases, price of the non-tradable good still falls. The reason is that with borrowing constraints, the increase in demand cannot further be sustained, the actual demand is below the potential demand, therefore, endowment (supply) of the non-tradable good exceeds the demand and hence leading to the depreciation in real exchange rate (price of the non-tradable good). This could be more obvious when we compare the same shock with and without occasionally binding constraint. As shown in sixth graph (Welfare), government is supposed to increase the

government expenditure to help the economy stabilize the real exchange rate when borrowing constraint is binding. This fiscal policy can shorten the time period during which people suffers from borrowing constraint and help people get higher welfare.

Now we compare the response function of variables with and without credit constraint under the same positive shock in the non-tradable good sector (Figure 3B and Figure 5B).

Both models have large increases in tradable good and non-tradable good consumption. And they have similar welfare ranking. But when we take a closer look, the adjustment process of these variables is quite different. In Figure 3B, when there is no borrowing constraint, tradable good consumption increases by nearly 20 percent and non-tradable good consumption increases by 15%. However, in Figure 5B, when borrowing constraint binds for all three government policies, the tradable good consumption only increases by less than 14 percent and the non-tradable good consumption increases by 14%. From the surface, the change in real exchange rate of two models should not diverge from each other by such a big amount (an increase in price of the non-tradable good in Figure 3B compared to a sharp decrease in Figure 5B) since the consumption of non-tradable good in two models increases by a relatively close magnitude (15% verses 14%) and government expenditure varies in similar pattern. Actually, the price of non-tradable good is also influenced by the consumption of tradable good. Since marginal rate of substitution of the two goods, the tradable good and the non-tradable good should be equal to their relative price and we normalize the price of the tradable to 1. Therefore we can derive equation (11) below:

$$p_t^N = \left(\frac{1-\omega}{\omega}\right)\left(\frac{c_t^T}{c_t^N}\right)^{\eta+1} \tag{11}$$

It is easy to see that a reduction in consumption of the tradable good generates a reduction in price of the non-tradable good in equilibrium, which reduces the collateral value and leads to the binding of international borrowing constraint. To conclude, due to this discrepancy in the increase of tradable and non-tradable good consumption, the economy with credit constraint encounters a depreciation in price of non-tradable good even there is a positive shock in endowment of non-tradable good, while in the economy without credit constraint, we see an appreciation in real exchange rate. Again, crowd-out effect of government expenditure dominates and reduces the price of non-tradable good as indicated by blue line in Figure 3B. In Figure 5B, increase in government expenditure plays a more important and positive role in stabilizing the whole economy, which reduces the likelihood of a binding borrowing constraint. To be specific, government spending avoids extreme volatility in price of the non-tradable good and shortens the time span of international borrowing constraint.

Although welfare ranking and government expenditure policy are same in these two models, the changing modes in the tradable and non-tradable good's consumption as well as real exchange rate are different. It is worth mentioning that this is the only case that increase in government expenditure could maximize welfare of individuals (other cases are all about decrease in government spending). The optimal government policy seems to be monotonous in our discussion. But just as we mentions above, this is just a starting point. When considering the positive effect of government expenditure, the conclusion might be different. To make the model more close to reality, we can further assume different effects of different kinds of government expenditure to discuss the role and optimal policy of government in our future study.

5. Conclusion and Future Extension

This paper investigates the effect of changing government spending in a small open economy with and without international credit constraint. The numerical results show that the existence of international credit constraint plays an important role in determining the effect of varying government expenditures in responding to economic shocks. When there is a negative shock in the tradable good sector, the debt-to-GDP ratio will reach the boundary if government does not purchase the non-tradable good. As we can see in our analysis, increasing the government expenditure yield less real exchange rate depreciation such that the small open economy does not reach the borrowing limit. It shows how government spending policy may affect the likelihood of a binding borrowing constraint via the effect on the real exchange rate. Interestingly, though the economy does not reach the borrowing limit, the social welfare in this case is the lowest. The main reason behind such result is that the increase in government expenditure significantly crowds out the consumption (especially the consumption on the non-tradable good), which in turn leads to low social welfare. We also see resource reallocation between the tradable good and the non-tradable good sector in this case. Shortage in the tradable good pushes the economy to produce and consume more the non-tradable good instead. However, when shock is in non-tradable good sector, the adjustment process becomes different. Compared to reaching the borrowing limit under the negative shock in the tradable good sector, positive shock in the non-tradable good sector becomes the preliminary conditions which may leads to the binding of borrowing limit. Under the positive shock in the non-tradable good sector, household increases consumption of the tradable and the non-tradable good but real interest rate falls since borrowing constraint restricts their purchase power to fulfill the actual demand. By increasing the government expenditure, the real exchange rate depreciates by a smaller

amount, which smooths the adjustment process of the economy. Therefore, with less volatility in consumptions, individuals achieve a higher social welfare.

The key contribution of this paper is extending the discussion related to government expenditure under a standard small open economical DSEG model and clarify the net effect of government spending which responds to the change in total output under credit constraint. We add to the standard business cycle literature that asymmetric impulse responses to economic shocks can be generated by credit market frictions. This enhances our understanding of what the real world is about and provide useful theoretical guidance to policy makers. Also, we show that policies such as government spending changes may affect the chance of a binding borrowing constraint. The effects of government expenditure changes on the real exchange rate and other macro variables are significant which may guide policy makers re-visiting the optimal design of macroeconomic policies.

On the policy side, We define elasticity to vary fiscal policies and compare their effects. Elasticity is used to determine the percentage change in the proportion of government expenditure on total output in relation to the percentage change in GDP, which allows for procyclical, countercyclical or constant strategies of government expenditure. We show that three different policies have different impacts on the economy, the optimal policy is not fixed and varies with different shocks and credit constraint.

Since we do not include production sector and only assume endowments of products, it is unclear about what will happen to the production sector when there exists occasionally binding constraint. Meanwhile, government expenditure is just a proportion of total output, therefore crowd-effect always dominates and incur

efficiency loss in economy. However when we adjust this set up of government expenditure, conclusions will be more interesting.

In the future, we can assume a production sector and a positive effect of government expenditure on production. Besides, currently we assume the interest rate is exogenous. However, in future study, we can internalize interest rate and include discussion of foreign exchange market.

References

[1] Australian Bureau of Statistics. (2022B, April 27). Table 6. General government sector, all levels of government [Graph]. Statistics about Finances of the General Government and Public Corporation Sectors for the Various Levels of Government in Australia.https://www.abs.gov.au/statistics/economy/government/government-finance-statistics-annual/2019-20#time-series-2014-15-to-2019-20

[2] Alesina, A. F., & Tabellini, G. (2005). Why is Fiscal Policy Often Procyclical? *SSRN Electronic Journal*. Published. https://doi.org/10.2139/ssrn.780225

[3] Benigno, Gianuluca, Huigang Chen, Christopher Otrok, Alessandro Rebucci, and Eric R.Young.(2009). Optimal Stabilization Policy in a Model with Endogenous Sudden Stops. Unpublished.

[4] Froot, K. A., & Rogoff, K. (1991). The EMS, the EMU, and the Transition to a Common Currency. NBER Macroeconomics Annual, 6, 269–317. https://doi.org/10.1086/654171

[5] Javier Bianchi (2011).“Overborrowing and Systemic Externalities in the Business Cycle“ American Economic Review 101:3400-3426

[6] Mendoza, Enrique G.(2005).“Real Exchange Rate Volatility and the Price of Nontradable Goods in Economies Prone to Sudden Stops.” *Economia: Journal of the Latin American and Caribbean Economic Association*, 6(1): 103-35

[7] Schmitt-Grohé, S., & Uribe, M. (2017). Liquidity Traps and Jobless Recoveries. American Economic Journal: Macroeconomics, 9(1), 165–204. https://doi.org/10.1257/mac.20150220

[8] Schmitt-Grohé, S., & Uribe, M. (2003). Closing small open economy models. Journal of International Economics, 61(1), 163–185. https://doi.org/10.1016/s0022-1996(02)00056-9