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The Fiscal Multiplier in Small Open Economy:
The Role of Liquidity Frictions

by Jasmin Sin

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I N T E R N A T I O N A L M O N E T A R Y F U N D

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Fiscal Affairs Department

The Fiscal Multiplier in a Small Open Economy: The Role of Liquidity Frictions

Prepared by Jasmin Sin*

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Abstract

This paper studies the fiscal multiplier using a small-open-economy DSGE model enriched with financial frictions. It shows that the multiplier is large when frictions are present in domestic and international financial markets. The reason is that in the model government bonds are more liquid than private financial assets and that entrepreneurs face liquidity constraints. A bond-financed fiscal expansion eases these constraints and stimulates investment and hence growth. This mechanism, however, breaks down under the assumption of perfect international capital mobility, suggesting that conventional models which ignore the presence of frictions in international capital markets tend to underestimate the fiscal multiplier.

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I. Introduction

Conventional economic theory tends to suggest that fiscal policy is ineffective in stimulating output in an open economy. The traditional Mundell-Fleming model, for example, predicts the government spending multiplier to be zero in a small open economy. In the simplest Mundell-Fleming model, nominal prices are fixed, exchange rates are flexible and capital is perfectly mobile. As fiscal expansion creates upward pressures on inflation and interest rates, the interest rate parity implies that the currency would appreciate, causing a fall in net exports. Under perfect international capital mobility, the crowding-out of net exports would be large enough to completely offset the effects of a fiscal stimulus, hence giving a zero multiplier. In a standard open-economy New Keynesian dynamic stochastic general equilibrium (DSGE) model, fiscal expansion in a small open economy similarly leads to a real appreciation of the exchange rate and a deterioration of the trade balance. The fiscal multiplier implied by such models is bigger than zero but still much smaller than unity.¹

The aim of this paper is to divert from conventional theory and study the effects of fiscal policy in an environment where financial frictions are present both within country and across borders. The model that I employ is based on the one proposed by Del Negro, Eggertsson, Ferrero and Kiyotaki (2011) (henceforth “DEFK”). The DEFK model incorporates the financial frictions described in Kiyotaki and Moore (2008) into an otherwise standard New Keynesian DSGE model similar to the ones in Christiano, Eichenbaum and Evans (2005) and Smets and Wouters (2007). In the DEFK model, there are two different types of financial assets: government bonds and private equity. Government bonds are liquid, while private equity is only partially liquid due to a resaleability constraint that limits the amount that holders can sell in each period.² The representative household consists of entrepreneurs and workers: entrepreneurs invest in physical capital which generates rental income, whereas workers work in the production sector to earn labour income. Investment opportunities are scarce and particularly attractive. Entrepreneurs may borrow to invest by issuing equity but there is a limit on the amount that they can issue in each period.

¹See Monacelli and Perotti (2006) for a detailed analysis of the effects of fiscal policy in a standard open-economy DSGE model with complete financial markets.

²Private equity in this model has a broad definition. It can be interpreted as privately issued paper such as commercial paper, bank loans, mortgages, and so on.

Entrepreneurs' ability to invest is thus bound by two forms of liquidity constraints: the borrowing constraint and the resaleability constraint on their equity holdings.

I introduce a role for government spending in the DEFK model to study the fiscal multiplier in an economy where liquidity is scarce. Del Negro et al. (2011) develop the DEFK model to study the macroeconomic effects of unconventional monetary policy carried out by the Federal Reserve at the onset of the financial crisis in 2009. Government spending is absent in their model.

In addition, I extend the DEFK model into a small-open-economy framework using the features adopted in Leeper, Traum and Walker (2011). In the resulting small-open-economy model (henceforth the "SOE-DEFK model"), the home country trades with the rest of the world but there is home bias in consumer preferences. Savers at home have access to foreign government bonds which are denominated in foreign currency. International asset markets are incomplete; trading of foreign bonds incurs a debt-elastic risk premium whose size is dependent on the home country's degree of access to foreign capital markets.

I use a relatively high elasticity of the risk premium to represent the case of low international capital mobility and study how this may affect the size of the fiscal multiplier in a small open economy. Under the assumption of a debt-elastic risk premium, if a country is a net debtor, the premium that it needs to pay to borrow money from abroad increases with its foreign debt position; on the other hand, if a country is a net creditor, the real return that it receives from lending abroad decreases with its net foreign asset position. This assumption has been widely adopted in the open-economy literature in models with incomplete financial markets. Benigno and Thoenissen (2008), for example, include a debt-elastic risk premium in their model which successfully addresses the consumption-real exchange rate anomaly observed in empirical data.³ Their findings suggest that international asset markets are less complete than previously assumed. De Paoli (2009) studies optimal monetary policy under incomplete asset markets using a small-open-economy model featuring this kind of premium. In a recent paper, Kuralbayeva (2013) applies a similar interest rate premium to model developing countries' lack of access to international capital

³If the assumption of complete financial markets holds, one should observe a strong correlation between the real exchange rate and relative consumption across countries. However, Chari, Kehoe and McGrattan (2002) find no such correlation in empirical data, casting doubt on this assumption.

markets. The empirical relevance of the debt-elastic risk premium is shown by Lane and Milesi-Ferretti (2002) and Selaive and Tuesta (2003), who separately find evidence which suggests that the net foreign asset position plays a role in explaining the interest rate differentials observed across countries.

The main finding of this paper is that in the SOE-DEFK model, the long-term fiscal multiplier in the small open economy is as large as 1.6 if international capital mobility is imperfect (where the debt-elastic risk premium is high). However, if capital can flow freely across borders, the fiscal multiplier is smaller than unity. In a standard open-economy DSGE model without liquidity frictions, on the contrary, the fiscal multiplier is small regardless of the degree of capital mobility in international markets. These results imply that fiscal policy is most effective in affecting output if the home country is liquidity constrained *and* has only imperfect access to international capital markets. I carry out a sensitivity analysis of the results to different open-economy features. My results are robust to changes in (i) the degree of trade openness in the goods market, (ii) the trade elasticity of substitution and (iii) the pricing assumption for exporting firms.

The main reason for the large fiscal multiplier in the SOE-DEFK model is that government bonds are more liquid than private equity. When the government increases its consumption, it has to be at least in part financed by issuing government bonds since tax adjustments are slow. The increase in public debt results in more liquidity in the private-sector wealth, allowing entrepreneurs to increase their investment in physical capital. In the case of a closed economy, private investment and private consumption are crowded in by the fiscal expansion, giving a large fiscal multiplier.

This result changes if the home country is a small open economy with perfect access to international capital markets. Since higher government consumption creates inflationary pressure, the domestic real interest rate goes up following the fiscal expansion. The higher rate interest rate at home prompts savers to borrow money from abroad to buy domestic government bonds, hence creating large buildup of foreign debts in the private-sector wealth. This reduces the amount of liquidity available for entrepreneurs when an attractive investment opportunity arrives. Investment is thus crowded in by less than in the case of a closed economy, causing consumption also to crowd-in by less and hence a small fiscal multiplier. In the case where international

capital mobility is imperfect, the small open economy faces higher costs to access foreign capital markets. The private sector would accumulate fewer foreign debts after a fiscal expansion, leaving households with more liquidity to spend and invest over the long term. As a consequence, the fiscal multiplier in this case is similar to the one in the case of a closed economy.

Another important finding of this paper is that, in the SOE-DEFK model, consumption increases while the real exchange rate depreciates over the long run in response to a fiscal expansion. Such responses, contrary to the predictions by conventional theory, are more in line with the empirical evidence based on structural vector autoregression analysis (see Monacelli and Perotti (2006) and Ravn, Schmitt-Grohe and Uribe (2012)). Several papers have introduced unconventional features to a standard open-economy model in an attempt to replicate the responses of consumption and the real exchange rate to a government spending shock observed in the empirical data. Ravn, Schmitt-Grohe and Uribe (2012) assume that consumers form deep habits over individual varieties of goods, whereas Corsetti, Meier and Muller (2012) propose the anticipation of future public spending reversals by the private sector. The simulation results that I obtain with the SOE-DEFK model suggest that the presence of financial frictions at both country and international levels may help explain the increase in private consumption and the real depreciation noted in a fiscal expansion.

In the latter part of this paper, I also study the fiscal multiplier in a crisis environment where the liquidity constraints facing households tighten. The results show that in a liquidity crisis, the nominal interest rate is bound at zero for longer if the small open economy has imperfect access to foreign capital markets. Since fiscal policy is more effective at the zero lower bound (see, e.g., Christiano, Eichenbaum and Rebelo (2011)), the fiscal multiplier is even larger in crisis times than in normal times. This finding strengthens the main conclusion drawn from the normal-times episodes: fiscal policy is more effective if financial frictions are present at both country and international levels.

Although there is a rich literature on the study of the fiscal multiplier, little research focuses on the role that financial frictions play in determining the size of the multiplier in an open economy. The study carried out in this paper is closely related

to the work by Castro, Felix, Julio and Maria (2013) and Erceg and Linde (2011). These papers employ an open-economy DSGE model embedded with the form of financial frictions proposed by Bernanke, Gertler and Gilchrist (1999) to study the fiscal multiplier in a small open economy that belongs to a currency union, both in normal times and in crisis times. My research differs from previous studies in that I examine the effects of fiscal policy in a small-open-economy model where international capital market frictions are present in addition to domestic financial frictions. I show that both kinds of frictions need to be present in order to produce a large fiscal multiplier.

The rest of the paper is structured in the following way: Section II gives an overview of the SOE-DEFK model. Section III studies the fiscal multiplier in the SOE-DEFK model in normal times and in times of crisis. A sensitivity analysis is also included in this section. Section IV summarises the findings of my study.

II. A Small-Open-Economy Model with Liquidity Constraints

A. Overview of the Model

The model that I use in this paper is a small-open-economy version of the liquidity constrained model proposed by DEFK. In the DEFK model, government bonds are liquid while private equity is illiquid. In each period, a random portion of household members receives a profitable investment opportunity and becomes entrepreneurs. Nevertheless, their ability to invest is limited by a borrowing constraint and a resaleability constraint on their equity holdings. When the resaleability constraint on private equity tightens, it causes the nominal interest rate to fall to its zero lower bound, simulating a liquidity crisis.

I modify the DEFK model by introducing exogenous government spending and open-economy features similar to those in Leeper, Traum and Walker (2011). As Leeper, Traum and Walker (2011) assume two large countries in their model, I modify their equations using the small-open-economy assumptions proposed by Galí and Monacelli (2005). In the resulting model (the “SOE-DEFK model”), the home economy trades differentiated intermediate goods with the rest of the world but there is home bias in consumer preferences. Final-goods firms bundle home-produced and imported

intermediate goods into final goods for consumption and investment. I assume that the government consumes only domestically produced goods. As standard in the New Keynesian literature, nominal rigidities arise from staggered price- and wage-setting by intermediate-goods firms and labour unions, respectively. Exporting firms adopt local currency pricing, i.e. they set prices in the currency of buyers. Fiscal and monetary policies are standard in this model: government spending is exogenous and follows an AR(1) process, while the nominal interest rate is set according to the Taylor (1993) rule. The home economy is small relative to the world economy in the sense that it has no influence on foreign variables. The rest of the world is modelled as one large economy. The details of the SOE-DEFK model and the equilibrium equations are presented in the Online Appendix.

In the SOE-DEFK model, households' options for saving are the same as those in the closed-economy DEFK model except that, in addition to domestic government bonds and private equity, they have access to an international government bond which gives rise to uncovered interest parity. International asset markets are incomplete. Trading of foreign government bonds incurs a debt-elastic risk premium, $\eta \widehat{F}_t$, where η is the risk premium parameter and \widehat{F}_t is the home country's net foreign asset position. If the home country is a net creditor (i.e. $\widehat{F}_t > 0$), households receive a rate of return lower than the international risk-free rate on their foreign asset holdings. On the other hand, if the home economy is a net debtor (i.e. $\widehat{F}_t < 0$), households need to pay a premium on the international risk-free interest rate to borrow money from abroad. The parameter $\eta > 0$ measures the elasticity of the risk premium to changes in the net foreign asset position. Given a certain level of \widehat{F}_t , a higher value of η means that households incur a higher premium to trade foreign assets. A large η can therefore be regarded as a measure of lack of access to foreign capital markets by the small open economy.⁴

In my model, both domestic and foreign government bonds are assumed default risk-free. The risk premium is introduced to reflect the frictions present in international capital markets. It compensates for the intermediary costs and taxes associated with

⁴In a standard open-economy DSGE model, introducing the risk premium is a way to ensure stationarity in the model. (See Schmitt-Grohe and Uribe (2003) for a detailed discussion.) However, in the SOE-DEFK model, stationarity can be achieved even without the risk premium since the steady-state net foreign asset position of the home economy is pinned down by the aggregate investment function (A.3). It is not for technical reasons that I introduce this risk premium in my model.

the trading of foreign bonds, rather than any risk of default.⁵ By changing the size of the risk-premium parameter, η , I demonstrate in the following sections how the degree of frictions in international capital mobility may affect the effectiveness of fiscal policy in a liquidity constrained small open economy.

B. Simulation of Shocks

I study the government spending multiplier in normal times and in times of crisis. A government spending shock is measured as a percentage of GDP and follows an AR(1) process:

$$\widehat{G}_t = \rho_G \widehat{G}_{t-1} + e_t^G, \quad (1)$$

where $\widehat{G}_t \equiv \ln\left(\frac{G_t}{G}\right)$ and ρ_G is the persistence parameter. Normal times are defined as the times when fiscal policy shocks are the only source of disturbance to the system. Liquidity frictions are present in the SOE-DEFK model even in normal times due to the borrowing and the resaleability constraints facing households. Crisis times are the times when the economy is also struck by a negative liquidity shock, which is modelled as a large drop in the value of the equity resaleability parameter, ϕ_t . Evolution of ϕ_t follows:

$$\widehat{\phi}_t = e_t^\phi < 0 \quad (2)$$

where $\widehat{\phi}_t \equiv \ln\left(\frac{\phi_t}{\phi}\right)$. Unlike DEFK, who assume that $\widehat{\phi}_t$ follows a two-state Markov process, I assume that $\widehat{\phi}_t$ stays constant and below the steady state in a liquidity crisis for a deterministic number of periods. Under this assumption, agents have perfect foresight on the paths of shocks and they expect with certainty that no subsequent shock will follow in the future. The findings by Carlstrom, Fuerst and Pautian (2014) suggest that the fiscal multiplier can be unboundedly large in a liquidity-trap crisis with a stochastic exit. They show that with the exit date of the liquidity trap being uncertain, the value of the multiplier can be inflated by the low-probability event of the zero-bound interest rate lasting for a very long time. Although in reality it is hard to assess people's expectations about the probability distributions of shocks, my deterministic-exit assumption can nevertheless provide a lower-bound estimate of the fiscal multiplier for a certain expected duration of the liquidity crisis.

⁵As noted by Coeurdacier and Rey (2013), the home bias in investors' portfolio observed worldwide is partly attributed to the presence of asset trade costs in international financial markets.

III. The Fiscal Multiplier in a Small Open Economy

A. The Multiplier in Normal Times

I calibrate the SOE-DEFK model to the UK economy as described in the Online Appendix and use it to study the fiscal multiplier in a liquidity constrained environment. I focus on the cumulative multiplier, defined as the expected cumulative change in output given a one-dollar cumulative change in government spending, or

$\frac{E_t \sum_{t=0}^{\infty} dY_t}{E_t \sum_{t=0}^{\infty} dG_t}$. This is used instead of the impact multiplier, $\frac{dY_t}{dG_t}$, because in the SOE-

DEFK model, the effects of a government spending shock on output are much more persistent than the shock itself. As noted by Woodford (2011), the impact multiplier is meaningful only if the output rise follows the same shape of time path as that of the government spending rise.

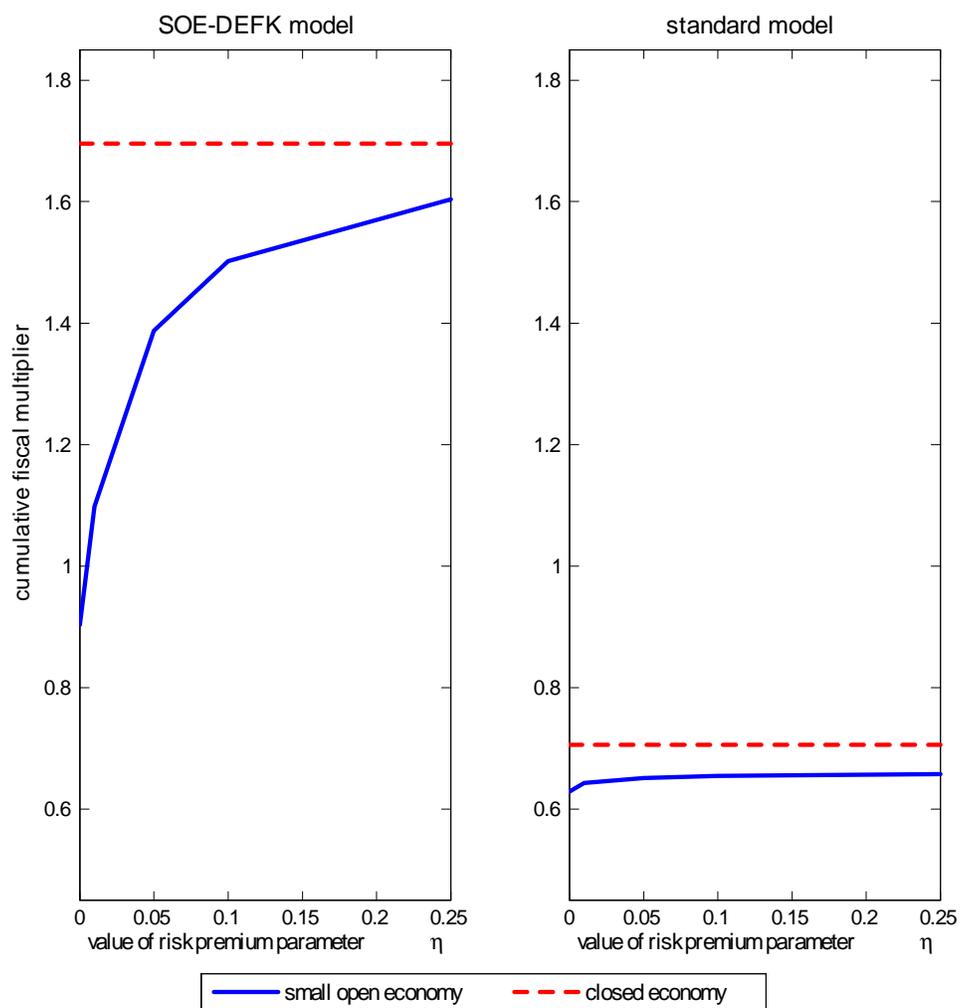
I obtain the cumulative fiscal multiplier in normal times by introducing a government spending shock of 1% of GDP to the system at steady state.⁶ I carry out my study using two different models: the SOE-DEFK model and a standard small-open-economy DSGE model without liquidity-constraint features (henceforth the “standard model”).⁷ The results are presented in Figure 1. The left-hand panel shows the value of the cumulative fiscal multiplier obtained with the SOE-DEFK model, while the right-hand panel shows the one obtained with the standard model. A comparison of the two shows the impact of introducing liquidity frictions within the home country on the size of the fiscal multiplier.

In each model, I also study how the size of the multiplier may change with the degree of frictions in international capital markets by changing the risk premium parameter, η . As discussed in the previous section, a higher value of η implies less access by the small open economy to international capital markets. When $\eta = 0$, the

⁶In a linearised model, the value of the multiplier is independent of the size of the government spending shock as long as the nominal interest rate is not zero-bound. Here, the size of the shock is chosen to follow that in the first section of Cogan, Cwik, Taylor and Wieland (2010).

⁷In the standard model, investment opportunities are not scarce. Investing in capital provides the same return as saving in government bonds. The investment function (A.3) hence reverts to a standard Euler equation. I use the calibration as shown in Table 2 where applicable with the exception of β , which is adjusted slightly upward to 0.9915 to keep steady-state interest rates in line with those in the SOE-DEFK model.

Figure 1. Government spending multiplier in normal times under different values of the risk premium parameter: SOE-DEFK model vs. the standard model



small open economy can lend and borrow freely at the international risk-free rate, representing the case of perfect international capital mobility.⁸ The opposite extreme case of a closed economy is also considered. In a closed economy, the home country does not trade with the rest of the world and has no access to international capital markets. The SOE-DEFK model in this case reduces to the one used in Kara and Sin (2016).

Consistent with empirical evidence (see, e.g., Ilzetzki, Mendoza and Vegh (2013)), the results in both panels of Figure 1 suggest that, *ceteris paribus*, the fiscal multiplier is smaller in an open economy than in a closed one. With the standard model (right-hand panel), in the case of a closed economy where the parameter η is not relevant, the fiscal multiplier is 0.7. In the case of a small open economy, the multiplier is smaller at around 0.6 and does not change much with the value of η . Therefore, applying a standard New Keynesian model without liquidity frictions, one may conclude that fiscal policy is ineffective regardless of a country's trade openness and its degree of access to foreign capital markets.

The multipliers obtained with the SOE-DEFK model are much bigger by comparison (left-hand panel). If the home country is a closed economy, the multiplier predicted by the SOE-DEFK model is as large as 1.7. If it is a small open economy, unlike the case in the standard model, the size of the multiplier depends very much on the risk-premium parameter, η . Under perfect international capital mobility ($\eta = 0$), the value of the multiplier is only 0.9. The size of the multiplier increases quickly as η becomes larger, implying that fiscal policy is more effective in boosting output when access to international capital markets is limited. When $\eta = 0.25$, the value of the multiplier increases to 1.6, which is very close to that in the case of a closed economy.

To the best of my knowledge, there is no published estimate for the value of η in the UK. Using Euro area data for the period 1970 - 2002, Adolfson, Laseen, Linde and Villani (2007) find by Bayesian estimation that the value of η lies in the range between 0.131 and 0.145. In a separate study, Forster, Vasardani and Ca'Zorzi (2011)

⁸When there is no risk premium ($\eta = 0$), the standard model is non-stationary as the equilibrium level of net foreign assets displays a unit root (see Schmitt-Grohe and Uribe (2003) for a discussion). As a result, the second moments in this case are not well defined. However, one can still obtain the impulse response functions and calculate the fiscal multiplier with the model.

show that international financial integration, as measured by the sum of cross-border assets and liabilities, was much higher in the UK than in the Euro area even before the financial crisis. If I assume that the risk premium parameter in the UK falls at the lower end of Adolfson et al. (2007)'s estimate, the UK's government spending multiplier predicted by the SOE-DEFK model is still as large as 1.5.

Based on these results, a standard DSGE model predicts fiscal stimulus to be ineffective in a small open economy regardless of its degree of access to foreign capital markets. However, such a conclusion changes when liquidity constraints are introduced. Incorporating liquidity frictions, the SOE-DEFK model suggests that the fiscal multiplier in a small open economy would be much bigger under imperfect international capital mobility, implying that the liquidity created through fiscal expansion is much more effective in stimulating output if capital flows across countries are costly.

To understand the underlying mechanism behind these results, I plot the impulse-response functions (IRFs) of the key macroeconomic variables to a government spending shock under three scenarios: (i) a small open economy under perfect international capital mobility, i.e. $\eta = 0$; (ii) a small open economy with imperfect access to international capital markets where $\eta = 0.1$; and (iii) a closed economy. Figures 2 and 3 show the IRFs obtained with the SOE-DEFK model, whereas Figures 4 and 5 show those obtained with the standard model.

A rise in government spending tends to increase output and inflation, causing the real interest rate to rise. In the standard model, as seen from Figures 4 and 5, both private consumption and investment are crowded out by the higher real interest rate, resulting in a small government spending multiplier. In the case of an open economy, consistent with the traditional Mundell-Fleming model, the standard model predicts that the higher domestic interest rate will lead to a real exchange rate appreciation (a drop in s_t). Net exports therefore decrease, giving an even smaller fiscal multiplier than the one in a closed economy. It is important to point out that, in the standard model, the degree of access to international capital markets does not affect the IRFs to a government spending shock by much, suggesting that in a model without liquidity frictions, the ease or difficulty to obtain funds from abroad is not of significance.

The SOE-DEFK model, on the other hand, generates very different impulse-responses depending on the home economy's trade openness and its degree of access to foreign

Figure 2. IRFs to a government spending shock in normal times: SOE-DEFK model

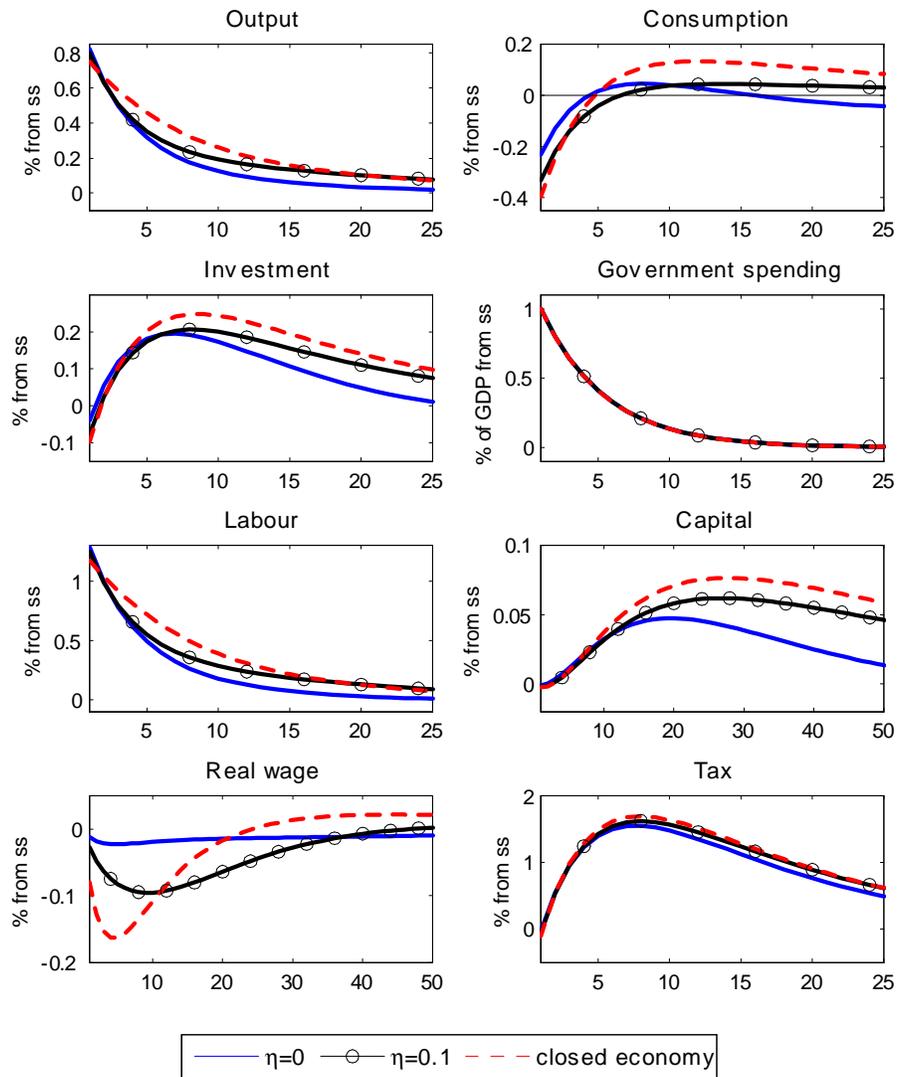


Figure 3. IRFs to a government spending shock in normal times: SOE-DEFK model

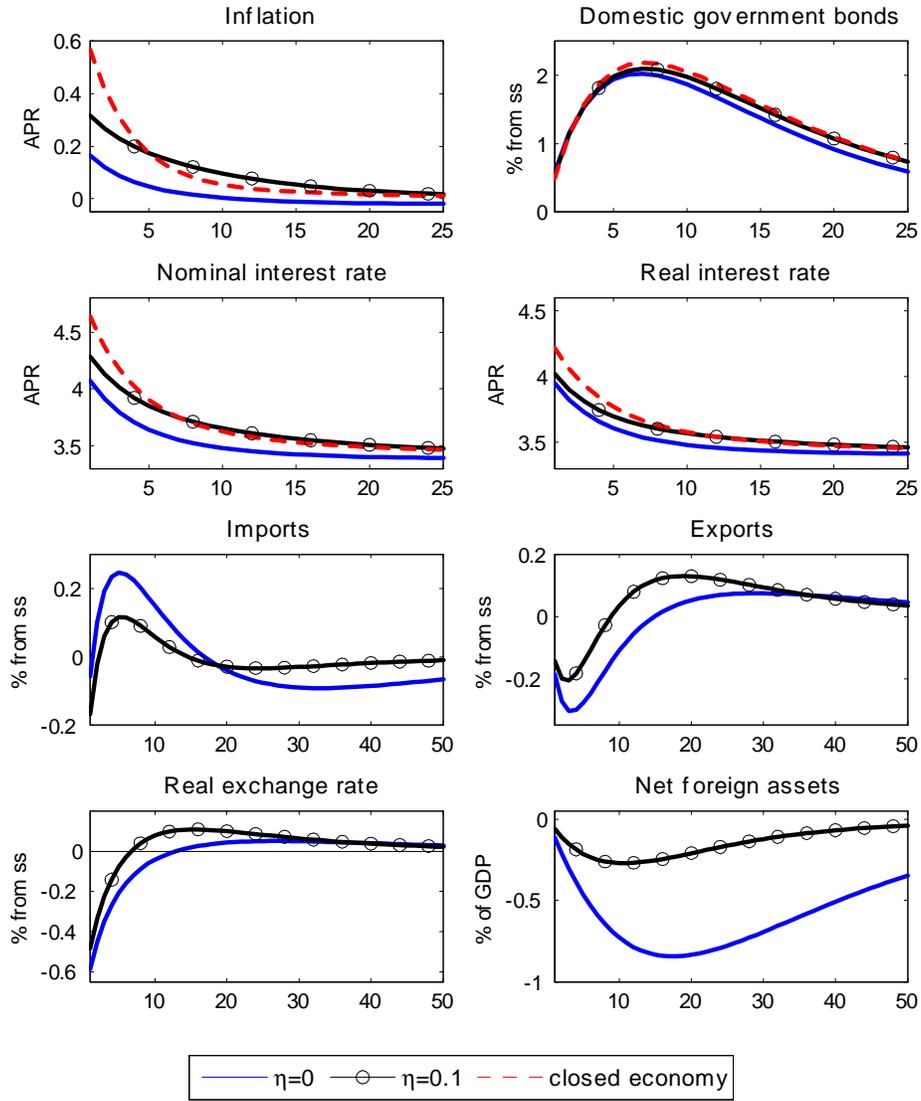


Figure 4. IRFs to a government spending shock in normal times: standard model

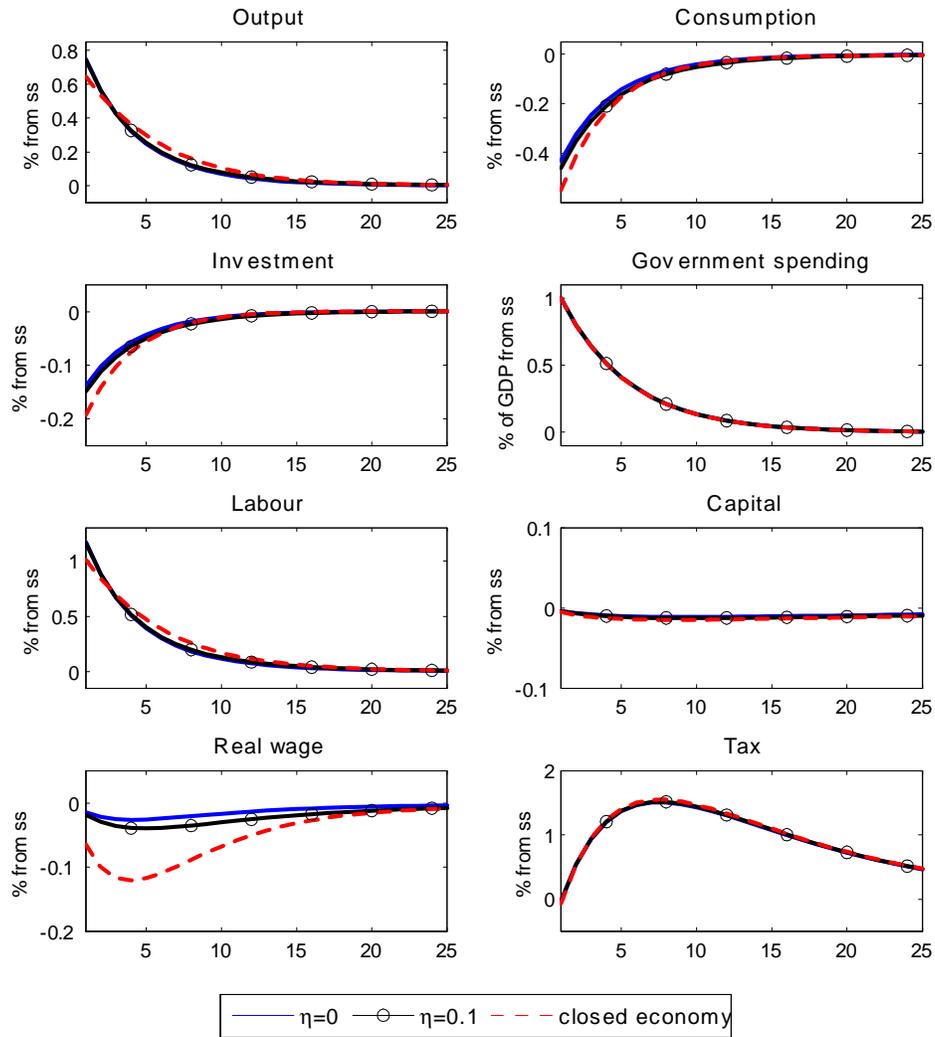
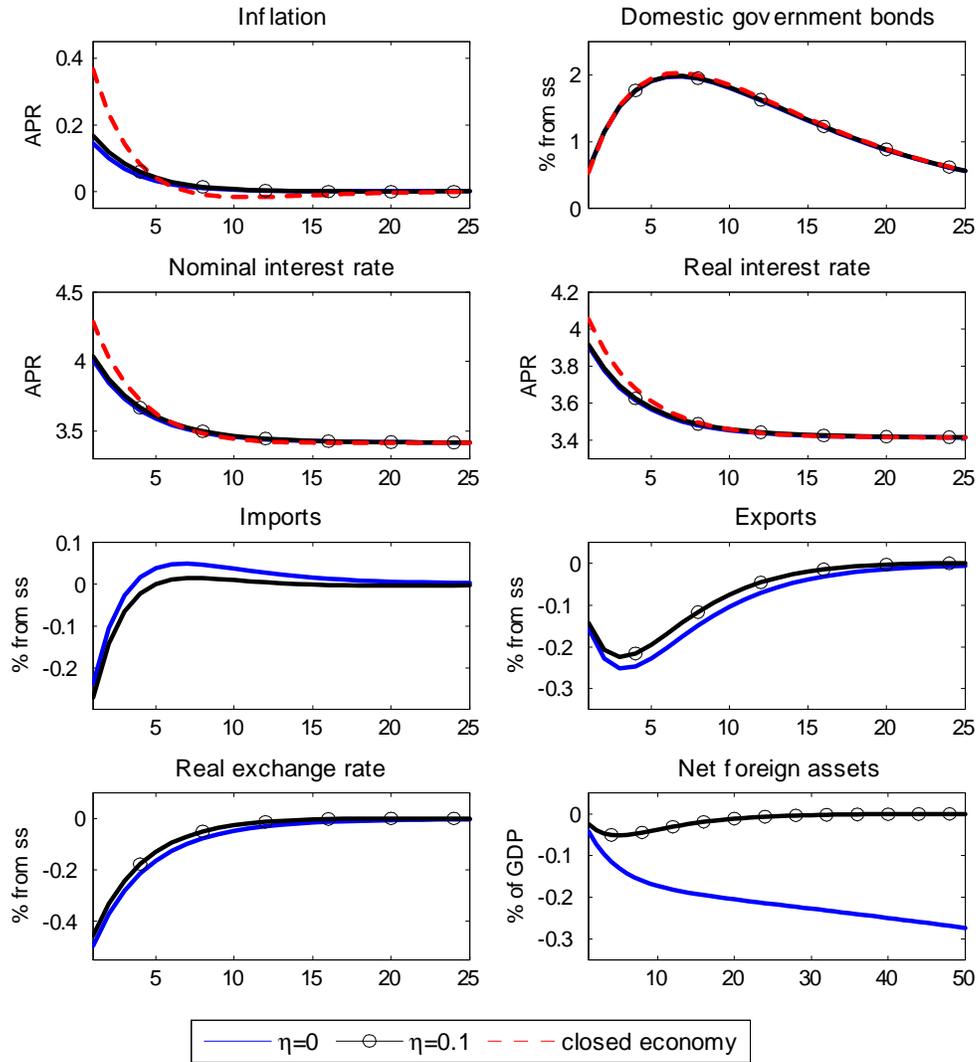


Figure 5. IRFs to a government spending shock in normal times: standard model



capital markets as indicated in Figures 2 and 3. In the case of a closed economy, the large multiplier at 1.7 in the DEFK model is due to the crowding-in effects on both investment and private consumption over the long run. In the model, a government spending expansion is financed mainly by public debt since tax adjustments are slow. As the government increases spending, higher interest rates and future tax burdens cause households to delay consumption and increase their government bond holdings. Households' liquidity improves as a result since government bonds are more liquid than private equity. When an attractive investment opportunity arrives, rational entrepreneurs sell all their liquid assets to obtain funds to invest in new capital. Investment thus increases in a hump-shaped and persistent manner as shown in Figure 2. The increase in investment has a knock-on effect on private consumption, which increases a few quarters after the investment rise. Overall, the increase in output is larger and much more persistent compared to that in the standard model. (For a detailed discussion of the mechanism driving a large fiscal multiplier in the closed-economy DEFK model and its empirical relevance, see Kara and Sin (2016))

In the case of a small open economy with perfect international capital mobility ($\eta = 0$), however, the SOE-DEFK model predicts the government spending multiplier to be a lot smaller at 0.9. The intuition, suggested by the IRFs, is as follows. As in the closed-economy case, a bond-financed government spending expansion causes an increase in households' domestic government bond holdings. In a closed economy, households need to cut spending to obtain funds to buy bonds. Consumption thus falls by 0.4% upon impact. In an open economy with perfect international capital mobility, by contrast, households can lend and borrow at the international risk-free interest rate without incurring any premium. Instead of simply cutting consumption spending, households also borrow from abroad to acquire domestic government bonds (as indicated by a negative net foreign asset position, \widehat{F}_t , in Figure 3). The post-shock consumption fall is therefore smaller (0.2%) compared to the closed-economy case. The borrowing creates a large amount of foreign debts in households' portfolios and hence reduces the liquidity available for investment in the future. As the liquidity constraints facing entrepreneurs tighten, the rise in investment is smaller and less persistent, thus reducing the crowding-in effect on consumption. The cumulative government spending multiplier is small as a result. In a nutshell, because of the ease to borrow from abroad, households in the small open economy save less in response

to a fiscal expansion, limiting the amount of funds available for investment.⁹

How would the impulse-responses differ when frictions in international capital markets are introduced in the SOE-DEFK model? When there is a risk premium for trading foreign financial assets ($\eta = 0.1$), households cannot borrow from abroad as cheaply as in the case with free access to international capital markets. Figure 2 shows that in this case, households need to reduce their consumption spending by more (0.33%) following the government spending shock in order to spare funds to buy domestic government bonds. Moreover, since the risk premium creates a wedge between the domestic and international real interest rates, the real exchange rate appreciates by less upon impact as shown in Figure 3. Imports therefore increase by less than in the case of perfect international capital mobility. As a result, households accumulate fewer foreign debts, reflected by a less negative net foreign asset position, leaving entrepreneurs with more liquidity to invest when an investment opportunity arrives. The crowding-in effect on investment is much more persistent than that without the risk premium. Investment is above the steady-state level even after 25 periods from the shock, giving rise to a spillover effect on private consumption, which increases gradually after the initial fall. This explains why the cumulative government spending multiplier is that much larger relative to the one under frictionless international capital markets (1.5 vs. 0.9). An important implication from this result is that fiscal policy is more powerful in promoting output growth in an economy with difficulty to borrow from abroad.

Interestingly, the responses of the real exchange rate generated by the SOE-DEFK model are different from those in the standard model. Upon impact of a positive government spending shock, due to the real interest rate rise, the real exchange rate appreciates (i.e. s_t falls), causing imports to rise and exports to fall. The rise in imports helps explain the smaller initial fall in consumption when the economy is open. In the standard model, the real exchange rate returns to steady state after the initial appreciation. In the SOE-DEFK model, on the contrary, the real exchange rate

⁹The SOE-DEFK model can also be applied to study the effects of a fiscal consolidation by assuming a negative government spending shock. If the government cuts its spending, the falls in domestic interest rates prompt households to increase their consumption spending. In a small open economy where access to international capital markets is free, households would choose to invest in an international bond and receive the foreign interest rate instead of spending. The resulting increase in household savings leaves entrepreneurs with more liquidity to invest, hence alleviates the adverse effects of a fiscal consolidation.

depreciates over the long run as government spending and interest rates return to steady state (see Figure 3). The magnitude of the depreciation depends on the degree of international capital mobility. The real exchange rate depreciates more in the presence of frictions in international capital markets.¹⁰ Even in the case with perfect international capital mobility ($\eta = 0$), the real exchange rate still depreciates in the long run due to the presence of financial frictions within the home economy in the SOE-DEFK model. Although the depreciation is milder in this case, it is very persistent.

The real depreciation predicted by the SOE-DEFK model is more consistent with empirical evidence obtained by Monacelli and Perotti (2006) and Ravn, Schmitt-Grohe and Uribe (2012). Applying structural vector autoregression (SVAR), these authors find that the real exchange rate depreciates in response to a government spending rise in a panel of countries. The simulation results obtained with the SOE-DEFK model suggest that by introducing financial frictions at both country and international levels, a DSGE model would be able to replicate the empirical observations that the real exchange rate depreciates in a fiscal expansion.

On a side note, as the real exchange rate depreciates over the long run in the SOE-DEFK model, it reduces the relative wealth of the small open economy. The crowding-in effects on private consumption and investment are thus smaller compared to the closed-economy case. Nonetheless, at $\eta = 0.1$, the cumulative fiscal multiplier on private consumption in the SOE-DEFK model is still positive, and the multiplier on overall output is still almost as large as that in the closed-economy case.

B. Sensitivity Analysis of Open-Economy Parameters

In this section, I study the sensitivity of the government spending multiplier in the SOE-DEFK model to the parameters related to open-economy features. First, I look at the degree of trade openness, α . A larger α implies a lower degree of home bias in consumer preferences, and hence larger amounts of imports and exports at steady state. In the baseline case, α is calibrated to 0.34. In this exercise, I change α to 0.2

¹⁰The reason is that, when $\eta > 0$, the real exchange rate s_t is negatively correlated with the home country's net foreign asset position under the interest rate parity. A negative net foreign asset position after fiscal expansion thus causes s_t to rise (depreciate) more when $\eta > 0$.

Table 1. Government spending multiplier in the SOE-DEFK model in normal times: sensitivity analysis

	Government spending multiplier	
	$\eta = 0$	$\eta = 0.1$
$\alpha = 0.2$	1.04	1.53
$\alpha = 0.34$ (baseline)	0.90	1.50
$\alpha = 0.5$	0.79	1.48
$\mu = 0.7$	0.99	1.52
$\mu = 1$ (baseline)	0.90	1.50
$\mu = 2$	0.74	1.48
Law of one price	0.78	1.42

and 0.5, separately, and study its effect on the government spending multiplier. Table 1 reports the multiplier obtained with the SOE-DEFK model under two different cases: (i) a SOE with perfect access to international capital markets ($\eta = 0$); and (ii) a SOE with imperfect access to international capital markets where the risk premium parameter, η , equals to 0.1. In both cases, as α increases, the value of the multiplier decreases slightly. The IRFs generated under different values of α (not shown) suggest the following reason for the decrease: after a government spending rise, the initial real exchange rate appreciation deteriorates the trade balance, worsening the net foreign asset position of the small open economy. A higher degree of trade openness results in a more negative net foreign asset position after the shock as suggested by equation (A.39), causing a reduction in the amount of liquidity held by households in the home country. Consumption and investment are crowded-in by less as a result. The impact of a change in α on the value of the multiplier is smaller when $\eta = 0.1$ since it is more expensive to change the net foreign asset position in that case.

Next, I study the sensitivity of the multiplier to changes in the elasticity of substitution between home-produced and foreign goods, μ . As noted by Corsetti, Dedola and Leduc (2010), if the product of μ and the relative risk aversion parameter in the utility function, σ , is greater than 1 (i.e. $\sigma\mu > 1$), the marginal utility of consuming home-produced goods decreases with the consumption of foreign goods, i.e. the two goods are substitutes in utility. On the contrary, if $\sigma\mu < 1$, the two goods are complements in utility. In the baseline model, σ and μ are set to 1.15 and 1, respectively, so that home-produced goods and foreign goods are substitutes. In this experiment, I change μ to 0.7 and 2, in turn, and obtain the government spending multiplier (Ta-

ble 1). The results show that the value of the multiplier increases slightly if the trade elasticity μ is low. The reason is straightforward in the case where access to international capital markets is perfect ($\eta = 0$): as the real exchange rate appreciates upon impact, the drop in net exports is less severe when foreign goods and home-produced goods are complements ($\mu = 0.7$) than when they are substitutes, resulting in a larger fiscal multiplier. However, if access to international capital markets is imperfect ($\eta = 0.1$), the mechanism at work is different. As shown by the model's IRFs in Figure 3, the depreciation of the real exchange rate over the long run is much bigger when $\eta > 0$. In this case, if the trade elasticity is low ($\mu = 0.7$), the real depreciation would be even larger and much more persistent, causing net exports to increase over the long run. However, the large real depreciation also reduces the relative wealth of the small open economy, weakening the crowding-in of private consumption. As the two effects offset each other, the fiscal multiplier on overall output stays fairly constant as μ varies in the case where $\eta = 0.1$.

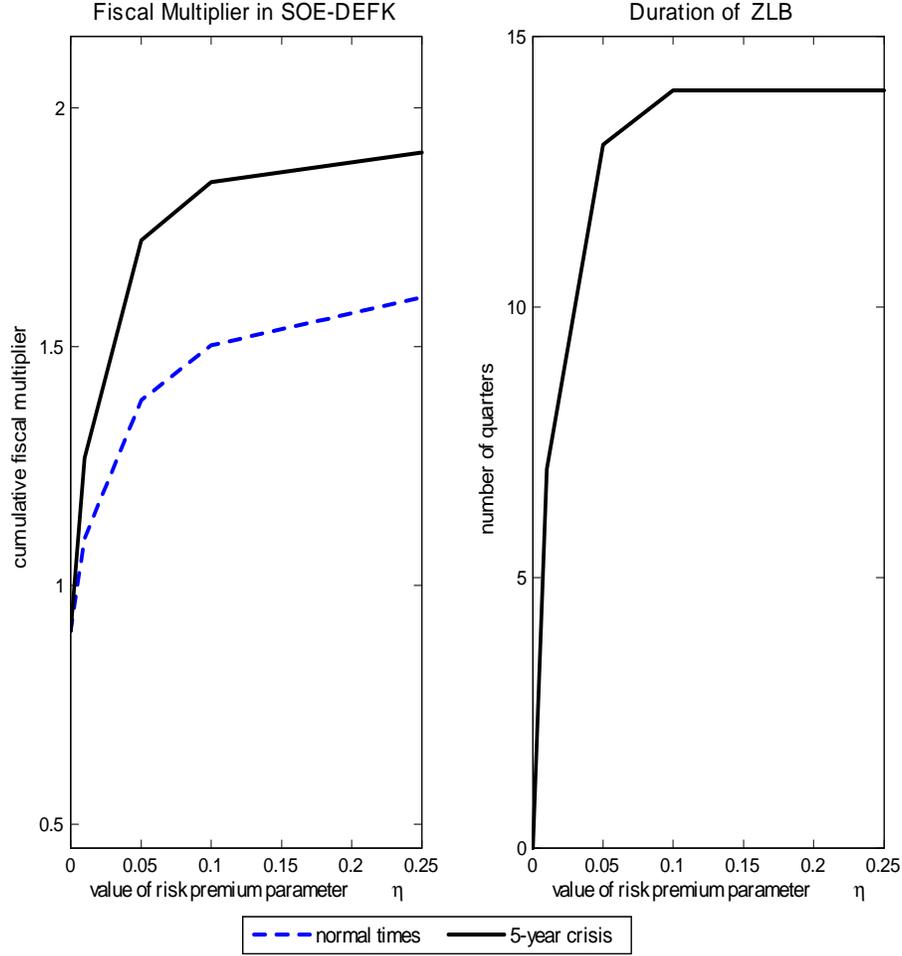
Finally, I study the robustness of the results to different price-setting assumptions for exporting firms. In the baseline case, I assume that exporting firms set different prices at home and abroad. An alternative way to model firms' price-setting behaviour is to assume that the law of one price holds as in Galí and Monacelli (2005). As shown in Table 1, the value of the government spending multiplier decreases somewhat under the law of one price, both where $\eta = 0$ and $\eta = 0.1$. The reason for the decrease is that the prices of domestic firms' exports, which are denominated in foreign currency, are more flexible relative to steady state under the law of one price. The aggregate price index of exports thus increases more quickly following a fiscal expansion at home, depressing the demand for exports from abroad.

To conclude, the fiscal multiplier in the SOE-DEFK model under frictional international capital markets is still much bigger than that under frictionless capital markets, strengthening the findings in the previous section.

C. The Multiplier in Times of Crisis

One of the advantages of the SOE-DEFK model is that the presence of liquidity frictions allows us to simulate a liquidity crisis. As mentioned earlier, in the SOE-DEFK model, a liquidity crisis occurs when there is a negative shock to the resaleability

Figure 6. Government spending multiplier and the duration of ZLB in a 5-year liquidity crisis in the SOE-DEFK model



constraint parameter, ϕ_t . The sudden drop in the equity resaleability worsens households' liquidity, causing large falls in investment and consumption, generating a liquidity trap endogenously.¹¹

I simulate a liquidity crisis that is expected to last for 5 years using the SOE-DEFK model. To obtain the fiscal multiplier, I assume that, in addition to the negative liq-

¹¹In DEFK (2011), the government carries out quantitative easing in a liquidity crisis to buy illiquid assets in the open market. Such a policy helps alleviate the negative effects of a liquidity shock. In this paper, my focus is on the effectiveness of fiscal policy. To simplify the number of variables, I assume that no quantitative easing is carried out in a crisis.

uidity shock, there is a government spending shock of 1% of GDP.¹² The same exercise cannot be carried out in the standard model since the standard model does not account for liquidity frictions. As in the normal-times scenario, I focus my study on the cumulative multiplier. The government spending multiplier in crisis times is de-

defined as $\frac{E_t \sum_{t=0}^{\infty} (dY_t - dY_t^*)}{E_t \sum_{t=0}^{\infty} dG_t}$, where dY_t denotes the change in output from steady state due

to the combined effects of the liquidity shock and the government spending shock, while dY_t^* denotes the same due to the liquidity shock alone. The difference between the two measures the output change that is solely due to the government spending shock. The fiscal stimulus is assumed to be carried out in the same quarter as the arrival of the liquidity shock, i.e. $t = 1$.

I examine the crisis-times multiplier in the small open economy under different degrees of international capital mobility, and present the results in the left-hand panel of Figure 6. The normal-times multiplier (extracted from Figure 1) is also included in the same panel for easy reference. The results once again suggest that the size of the fiscal multiplier depends largely on the home country's degree of access to international capital markets. When access to international capital markets is free ($\eta = 0$), the multiplier in a five-year crisis is the same as that in normal times at 0.9. However, as η increases, i.e. when there are more frictions in international capital flows, the fiscal multiplier becomes much bigger in a liquidity crisis than in normal times. When $\eta = 0.2$, for example, the value of the multiplier increases from 1.58 in normal times to 1.91 in a five-year liquidity crisis, which is very close to the crisis-times multiplier in the case of a closed economy (1.93).

The reason for the larger multiplier in a liquidity crisis is linked to the duration of the zero nominal interest rate. In the right-hand panel of Figure 6, I plot the duration when the nominal interest rate is bound at zero in a 5-year liquidity crisis against the value of η . As suggested in the figure, the liquidity shock would cause the zero lower bound (ZLB) to be binding only if η is greater than zero, i.e. when there are frictions in international capital markets. Since fiscal policy is more effective in

¹²Erceg and Linde (2014) find that in a model where the length of the liquidity trap is endogenous, the value of the fiscal multiplier is decreasing with the size of the government spending shock. This is because a larger fiscal stimulus may cause an earlier exit of the liquidity trap. I test my results by increasing the size of the government spending shock to 2% of GDP and find that its effect on the value of the fiscal multiplier is negligible.

boosting output at the ZLB (more discussion follows), the liquidity shock causes the fiscal multiplier to be larger only in the cases where $\eta > 0$. In the case where $\eta = 0$, the liquidity shock does not cause the nominal interest rate to fall to zero, the fiscal multiplier is thus the same as that in normal times.

To understand the mechanism driving these results, I obtain the IRFs to a government spending shock in a five-year liquidity crisis using the SOE-DEFK model.¹³ In Figures 7 and 8, I report the IRFs for the cases of (i) a SOE with perfect international capital market access; (ii) a SOE with the risk premium parameter η equals to 0.1; and (iii) a closed economy. A liquidity shock causes the resaleability of private equity to fall significantly, reducing entrepreneurs' liquidity for investment. The IRFs show that, in the case of a closed economy, investment falls by almost 10% upon impact. The decrease in investment leads to large falls in labour hours, output and consumption, causing severe deflation. To combat the recession, the central bank cuts the nominal interest rate to zero. At the ZLB, deflation causes a sharp rise in the real interest rate, further discouraging consumption. Under this circumstance, an increase in government spending creates inflationary pressure, which helps reduce the real interest rate since the nominal interest rate is zero-bound. A lower real interest rate promotes private consumption, the government spending multiplier is thus larger in a liquidity crisis.¹⁴

The IRF results are very different for the case of a small open economy with perfect access to international capital markets, i.e. $\eta = 0$. Upon impact, the liquidity shock causes investment to fall substantially as in the case of a closed economy. The consequent fall in output prompts the central bank to cut the nominal interest rate, reducing the return on domestic government bonds. Under frictionless international asset markets, savers quickly switch to foreign government bonds to obtain higher returns. The resulting large outflow of capital causes the real exchange rate to depreciate, as indicated by an increase in \hat{s}_t in the IRF. Real depreciation stimulates exports, which greatly alleviates the adverse effects of the liquidity shock on output and employment. The post-shock fall in output (-3%) is therefore only around one

¹³The IRFs are not smooth in crisis times since the resaleability constraint parameter, ϕ_t , is assumed to stay constant until it returns to steady state at the end of the crisis (20 quarters in this simulation). The evolution of the liquidity shock is designed in this way to make clear how variables behave in and out of a crisis.

¹⁴The mechanism for a larger government spending multiplier in the zero-bound state is discussed in detail in Kara and Sin (2016).

Figure 7. IRFs to a government spending shock in a 5-year liquidity crisis: SOE-DEFK model

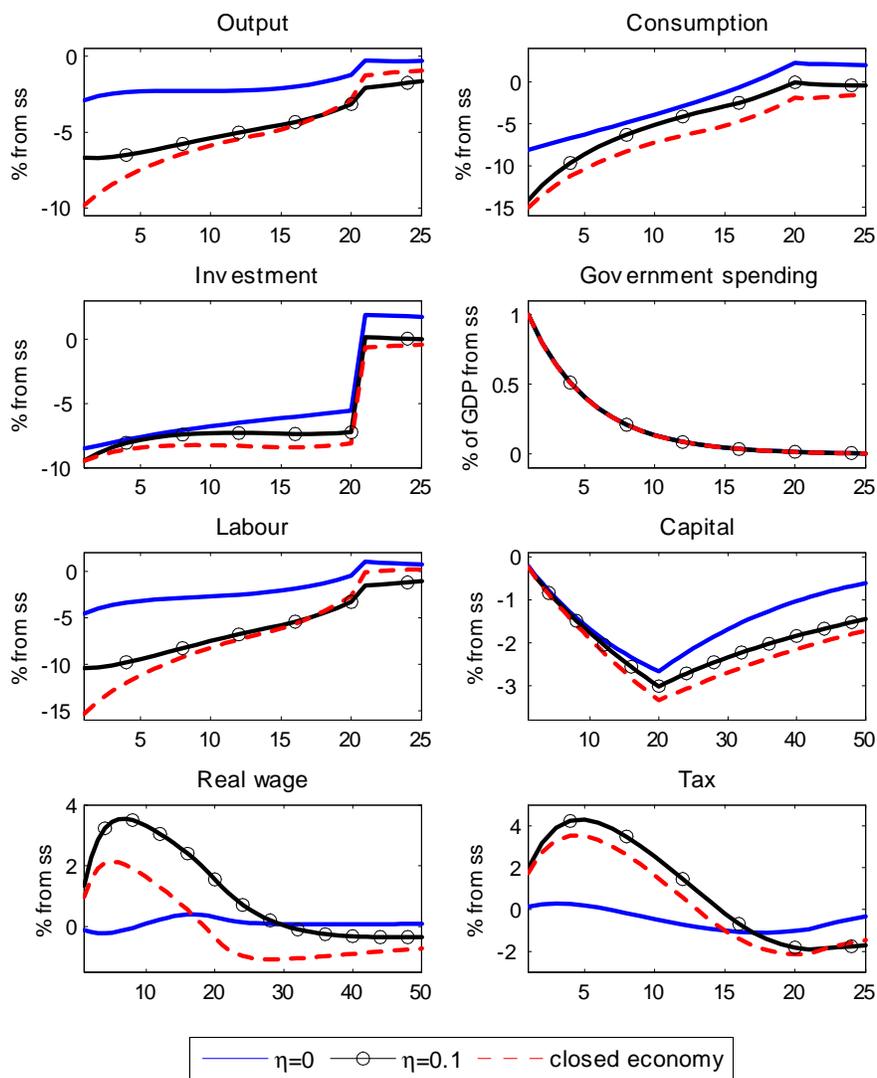
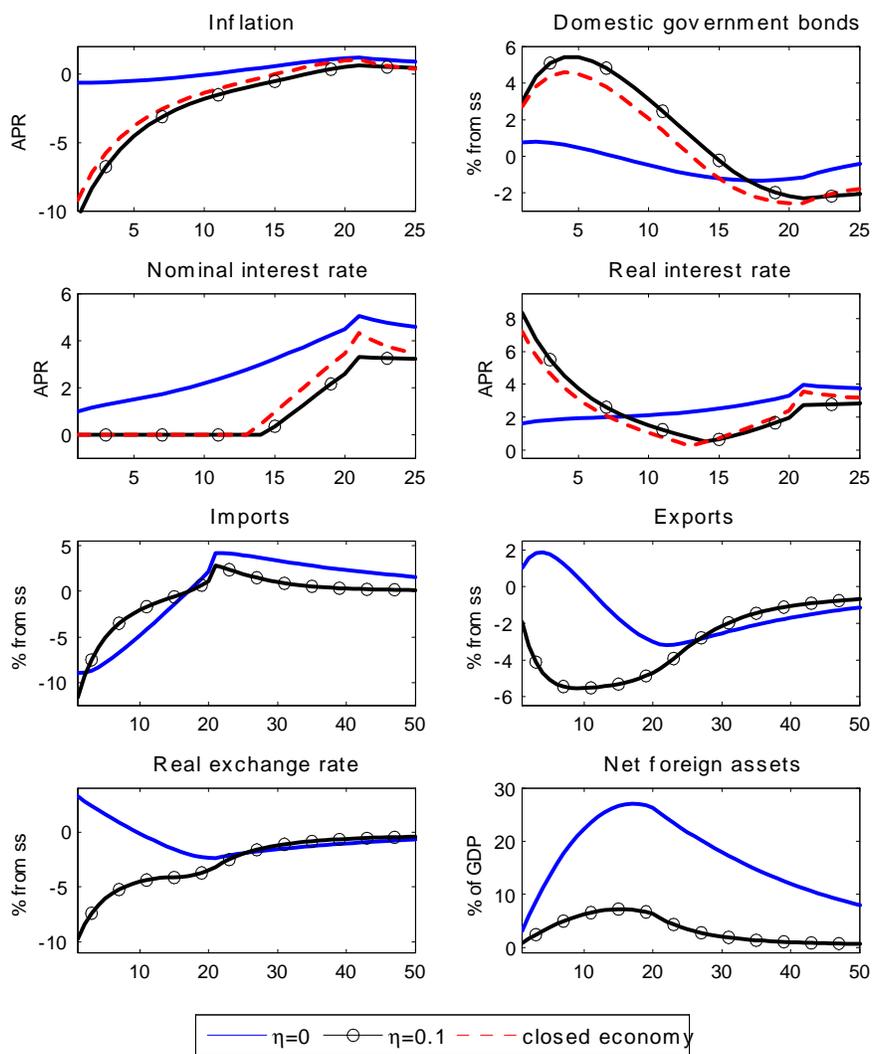


Figure 8. IRFs to a government spending shock in a 5-year liquidity crisis: SOE-DEFK model



third of that in the closed-economy case (-10%). The smaller fall in economic activity, together with the real exchange rate depreciation, prevents inflation from going too negative. Without the problem of severe deflation, the real interest rate remains below steady state throughout the crisis, so the fall in consumption is much smaller compared to that in a closed economy. The decrease in the nominal interest rate is not large enough to cause the ZLB to bind. Absent a liquidity trap, the government spending expansion works in the same way as in normal times, the fiscal multiplier in this case is thus the same as that in normal times (0.9).

In a small open economy where access to international capital markets is imperfect ($\eta = 0.1$), the impulse-response results are more similar to those in a closed economy. Because of the risk premium for trading foreign assets in this case, savers in the home country are less willing to switch to foreign bonds in a liquidity crisis despite the fall in the nominal rate of return on domestic bonds. Without a large capital outflow, unlike in the case where $\eta = 0$, the real exchange rate does not depreciate, so that the small open economy cannot stimulate output through an increase in exports. The size of the output fall is therefore comparable to that in a closed economy. As in the closed-economy case, the fall in demand causes deflation and the ZLB on the nominal interest rate to bind, leading to a surge in the real interest rate. The higher real interest rate leads to real exchange rate appreciation, which exacerbates the problem of deflation. This is why the ZLB is binding for even longer in this case than in a closed economy. As government spending is more effective in boosting output at the ZLB, the fiscal multiplier increases from 1.5 in normal times to 1.8 in crisis times in this case.

The implication of the results in this section is that fiscal policy can be highly effective in a liquidity crisis if the small open economy has only imperfect access to foreign capital markets. A global liquidity crisis can dampen capital mobility across countries. Broner, Didier, Erce and Schmukler (2013), for example, find empirical evidence that international capital flows fell sharply during the 2008 financial crisis. As foreign funds become less accessible, fiscal stimulus would be more effective than in normal times, as suggested by the SOE-DEFK model for the cases where η is high.

IV. Summary and Conclusions

In this paper, I extend the liquidity constrained model proposed by Del Negro et al. (2011) into a small-open-economy framework and apply it to study the government spending multiplier in a small open economy where financial frictions are present at both country and international levels.

In the first part of my study, I look at the multiplier in “normal” times when a government spending shock is the only source of disturbance to the economy. I find that under the assumption of perfect international capital mobility, the fiscal multiplier in the small open economy is smaller than unity even if liquidity frictions are present domestically. However, if international capital mobility is imperfect, the size of the multiplier would increase remarkably and can be almost as large as that in the closed economy (1.7). An important implication of this result is that when foreign funds are not fully accessible, the liquidity made available through fiscal expansion in the home country would be more valuable, making fiscal policy a more powerful tool in affecting output.

In the second part, I study the fiscal multiplier in a financial crisis that is caused by a negative liquidity shock. My model suggests that, compared to the case with perfect capital mobility, the nominal interest rate is bound at zero for longer if the small open economy’s access to foreign capital markets is imperfect. As fiscal policy is more effective when the nominal interest rate is zero-bound, the fiscal multiplier becomes even larger under this scenario than in normal times. The conclusion that the fiscal multiplier is larger when financial frictions are present at both country and international levels is therefore strengthened in the case of a financial crisis.

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