The Role of Foreign Debt and Financial Friction in a Small Open Economy DSGE Model *

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Abstract

We examine the role of foreign debt and financial friction in the Korean business cycle using a small open economy DSGE (dynamic stochastic general equilibrium) model where domestic banks borrow funds from foreign investors for a risk premium and make loans to domestic producers. We find that the Korean economy is financially

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vulnerable’, which means that the risk premium increases when the domestic currency depreciates. Through a historical decomposition, we also find that the risk premium shock played a critical role both just before a financial crisis and during the crisis. A simulation shows that the Korean business cycle would suffer less volatility with lower steady-state level of foreign debt.

**Keywords:** Small Open Economy DSGE model, Foreign Debt, Risk Premium, Korean Economy

**JEL Classification Codes:** E32, E44, F34, F41

1 Introduction

In a standard open economy model without foreign debt nor financial friction, a currency’s depreciation leads to an increase in export and output. But in case of emerging economies, a sharp depreciation, which might be caused by an abrupt foreign capital outflow, sometimes causes a recession. The reason is that emerging economies usually have foreign debt denominated in foreign currencies, for example in dollars,\(^1\) and the domestic currency value of the debt rises with a depreciation of the currency. With financial imperfection, the deterioration of the borrowers’ balance sheet increases the cost of credit, or the risk premium, and decreases aggregate demand and output.

\(^1\)Eichengreen and Hausmann (1999) refer to the inability to borrow abroad in terms of domestic currency as ‘Original Sin’.
The Korean economy has experienced two financial or currency crises in the last two decades as shown in Figure 1. The won/dollar exchange rate soared in 1997-98 Asian currency crisis and in 2008-09 global credit crisis. Note that foreign debt grew fast just before each crisis. Figure 2 shows that most of the foreign debt was held by the banking sector. When the local currency depreciated due to the ‘flight to quality’, the balance sheets of the Korean banks deteriorated. The banks, who had difficulty to borrow abroad, had no choice but decrease the supply of credit, which made the recessions severer.
Recent empirical literature on emerging economies confirms the role of foreign debt and financial imperfection in emerging economies. Berganza, Chang and Herrero (2004) show that the balance sheet effect significantly increases the risk premium using a panel data of 27 emerging economies. Neumeyer and Perri (2005) set up a small open economy where the real interest rate consists of an international rate and a country risk premium and argue that the risk premium plays an important role to explain Argentine business cycle. Uribe and Yue (2006) show that the foreign shocks affect domestic variables through their effects on the risk premium and the re-
responses of the risk premium exacerbate the volatility of the business cycles of several emerging economies using VAR and a small open economy model. Garcia-Cicco, Pancrazi and Uribe (forthcoming) set up small-open-economy real-business-cycle model and find that shocks to the country risk premium and financial frictions account of Argentine and Mexican business cycle better than nonstationary productivity shocks. Chang and Fernandez (2010) show that the substantial amount of economic fluctuations of Mexico is accounted for by foreign interest rate shocks coupled with financial frictions rather than productivity trend shocks using Bayesian methods.

The aim of this paper is similar to that of the above studies. However, the main feature of our model is that we specify explicitly the role of net worth of banks on the risk premium which they pay for foreign debt. Most previous studies simply assume ad-hoc dynamics of the risk premium and does not consider the role of net worth of borrowers.

Another feature of this paper is that we deal with the role of banking sector in emerging economies. Since the global credit crisis occurred in 2008, the role of banks, or financial institutions, has started to be considered in macro models. Papers, including Gertler and Karadi (2009), Curdia and Woodford (2010), and Gerali, Neri, Sessa, and Signoretti (2010), incorporate banking sector in their DSGE (dynamic stochastic general equilibrium) models and analyze the role of banking sector in the business cycle and the effect of unconventional monetary policy. However, their models are adequate just for advanced economies. Notably, Choi and Cook (2004) consider a banking sector in an emerging economy and show that a fixed exchange rate rule
induces smaller volatility than an interest rate rule that targets inflation. Their setting for banking sector is very similar to ours but they just derive theoretic implications and don’t explore any empirical analysis.

Our model is an extended version of that by Cespedes, Chang and Velasco (2004). Using their theoretic model, they specify two kinds of economy, which are ‘financially stable’ and ‘financially vulnerable’ economy. In a financially stable economy, the risk premium that domestic borrowers pay for foreign debt decreases when the domestic currency depreciates. The opposite occurs in a financially vulnerable economy. They argue that the property depends on the parameters and, especially, the steady state value of foreign debt/capital ratio. We extend their model in order to be suitable for empirical study by including banking sector, Calvo-type price stickiness, incomplete exchange rate pass-through, a Taylor-type monetary policy rule, and several domestic and foreign shocks.

In this paper, we examine the role of foreign debt and financial friction in the Korean business cycle using a small open economy DSGE model where domestic banks borrow funds from foreign investors for a risk premium and make loans to domestic producers. We find that the Korean economy is financially vulnerable, which means that the risk premium rises when the domestic currency depreciates. Through a historical decomposition, we also find that the risk premium shock played a critical role both just before a financial crisis and during the crisis. A simulation shows that the Korean business cycle would suffer less volatility with lower steady-state level of foreign debt.
This paper is organized as follows. Section 2 sets up a small open economy DSGE model with foreign debt and financial friction. In Section 3, we present the estimation results and implications. Section 4 concludes this paper.

2 A Small Open Economy Model with Foreign Debt and Financial Friction

In this section, we set up a small open DSGE model with financial frictions where domestic banks have foreign debt and the cost of credit depends on the balance sheet of them. Hereafter, foreign variables are denoted by a superscript asterisk (*).

2.1 Households

Households choose consumption, \( c_t \), labor supply, \( l_t \), and domestic one-period risk-free nominal bonds,\(^2 \) \( B_t \), to maximize the following objective function:

\[
E_0 \sum_{t=0}^{\infty} \beta^t a_t u(c_t, l_t)
\]

with the budget constraint

\[
P_t c_t + \frac{B_t}{R_t} \leq W_t l_t + B_{t-1} + D_t
\]

for all \( t = 0, 1, 2, \ldots \), where \( \beta \) is the discount factor, \( a_t \) the preference shock, \( u(\cdot) \) the utility function, \( P_t \) the price index, \( R_t \) the (gross) nominal interest rate, \( B_t \) the nominal foreign debt, and \( D_t \) the foreign discount.

\(^2\)The asset market is assumed to be incomplete in this paper. And households don’t hold any foreign asset or debt.
rate, \( W_t \) nominal wage, \( D_t \) nominal dividend which is paid by domestic firms. The utility function is assumed to be

\[
    u(c_t, l_t) = \frac{1}{1 - \sigma} c_t^{1-\sigma} - \frac{\chi}{1 + \tau} l_t^{1+\tau}
\]

The consumption, \( c_t \), is the composite consumption index of domestic goods, \( c_{H,t} \), and foreign goods, \( c_{F,t} \), defined by

\[
    c_t = \left( \theta \frac{1}{\psi} c_{H,t}^{\psi-1} + (1 - \theta) \frac{1}{\psi} c_{F,t}^{\psi-1} \right)^{\frac{1}{1-\psi}} \tag{1}
\]

where \( \theta \) is the share of domestic goods in the domestic consumption bundle and \( \psi \) is the elasticity of substitution between domestic and foreign goods. A cost minimization problem yields the price index, \( P_t \), given by

\[
    P_t = \left( \theta P_{H,t}^{1-\psi} + (1 - \theta) P_{F,t}^{1-\psi} \right)^{\frac{1}{1-\psi}} \tag{2}
\]

where \( P_{H,t} \) is the price of domestic goods and \( P_{F,t} \) the price of foreign goods. In addition, we have the following equation:

\[
    \frac{c_{H,t}}{c_{F,t}} = \frac{\theta}{1 - \theta} \left( \frac{P_{H,t}}{P_{F,t}} \right)^{-\psi} = \frac{\theta}{1 - \theta} \xi_t^\psi. \tag{3}
\]

where \( \xi_t \) is the terms of trade.

The first order conditions of household’s utility maximization can be arranged into

\[
    u_c(t) = \beta R_t E_t u_c(t + 1) \frac{1}{\pi_{t+1}} a_{t+1} \tag{4}
\]

\[
    - \frac{u_l(t)}{u_c(t)} = \frac{W_t}{P_t} = w_t \frac{P_{H,t}}{P_t} = w_t \left( \theta + (1 - \theta) \xi_t^{1-\psi} \right)^{\frac{1}{1-\psi}} \tag{5}
\]

where \( \pi_t = \frac{P_t}{P_{t-1}} \) and \( w_t = \frac{W_t}{P_{H,t}} \).
The preference shock, $a_t$, is assumed to follow the following stochastic process:

$$\ln(a_t) = \rho a \ln(a_{t-1}) + \epsilon_{a,t}$$

where $\epsilon_{a,t}$ is an i.i.d innovation which is normally distributed with the standard deviation $\sigma_a$.

### 2.2 Bankers

The banking sector plays a central role in this model since only banks can hold foreign asset or debt. Bankers use their net worth, $n_t$, and foreign debt, $B^*_t$, to make loans to domestic producers. The balance sheet of a banker is

$$P_{H,t} n_t + S_t B^*_t = Q_t k_{t+1}$$

where $S_t$ is the exchange rate measured as the home currency price of the foreign currency, $Q_t$ the nominal price of capital, and $k_{t+1}$ capital stock, which will be used at $t+1$ to produce goods. In real terms, the above equation can be expressed as:

$$n_t + b_t = q_t k_{t+1}$$

where $b_t = S_t B^*_t / P_{H,t}$ is the real domestic currency value of foreign debt and $q_t = Q_t / P_{H,t}$ the real price of capital.

Here, we assume that there is asymmetric information between domestic bankers and foreign investors. That is, domestic bankers have to pay the risk premium when they borrow money denominated in foreign currencies from
foreigners. The demand of foreign debt is determined to equate the return on investment to the cost of foreign borrowing, as follows:

$$\frac{E_t R_t Q_t k_{t+1}/S_{t+1}}{Q_t k_{t+1}/S_t} = R_t^* \Phi_{t+1}$$

(8)

where $R_t^*$ is the (gross) nominal interest rate of the foreign country and $\Phi_{t+1}$ is the risk premium. The above equation is a modification of the uncovered interest parity condition. Following Bernanke, Gertler, and Gilchrist (1999), the risk premium is assume to be a function of the leverage ratio of banks, $q_{kt+1}/n_t$, that is

$$\Phi_{t+1} = \left(\frac{q_{kt+1}}{n_t}\right)^{\phi} v_t$$

(9)

where $\phi > 0$ and $v_t$ is the risk premium shock, which has the following dynamics:

$$\ln(v_t) = \rho_v \ln(v_{t-1}) + \epsilon_{v,t}$$

(10)

where $\epsilon_{v,t}$ is an i.i.d innovation which is normally distributed with the standard deviation $\sigma_v$. A positive risk premium shock is a financial market-related shock which raises the risk premium and depreciates the domestic currency. An abrupt outflow of foreign capital due to ‘flight to quality’ can be interpreted as a positive risk premium shock.

Finally, the dynamics of the net worth is as follows:

$$P_{H,t}n_t = \nu(R_{t-1}Q_{t-1}k_t - R_{t-1}^* \Phi_{t-1} S_t B_{t-1}^*) + (1 - \nu)P_{H,t}g_t$$

where $\nu$ is the probability that a banker survives and $g_t$ is the transfer that a new banker receives from a failed banker.\(^3\) In real terms, the above equation

\(^3\)We treat it as constant. Refer to Bernanke, Gertler, and Gilchrist (1999) for details.
is equivalent to

\[ n_t = \frac{\nu}{\pi_{H,t}}(R_{t-1}q_{t-1}k_t - R^*_t \phi_{t-1} \frac{S_t}{S_{t-1}}) + (1 - \nu)g_t \quad (11) \]

2.3 Domestic Producers

Domestic producers consist of three sectors: entrepreneurs, capital producers, and retailers.\(^4\) Entrepreneurs borrow money from domestic banks and buy capital from capital producers with the funds. Using the capital and labor, entrepreneurs produce consumption goods. Retailers buy the consumption goods from the entrepreneurs, set prices of them and sell them to households.

2.3.1 Entrepreneurs

Entrepreneurs borrow \(Q_{t-1}k_t\) from bankers, buy capital from capital producers and hire labor from households. After they produce consumption goods, \(y_t\), they sell the depreciated capital to capital producers. Therefore, they minimize

\[ R_{t-1}Q_{t-1}k_t - Q_t(1 - \delta)k_t + W_t l_t \]

subject to

\[ y_t = z_t f(k_t, l_t) = z_t k_t^{\alpha} l_t^{1-\alpha} \quad (12) \]

where \(\delta\) is the depreciation rate and \(z_t\) is the productivity shock, which has the following dynamics:

\[ \ln(z_t) = \rho_z \ln(z_{t-1}) + \epsilon_{z,t} \quad (13) \]

\(^4\)This section is largely based on Christensen and Dib (2008).
where $\epsilon_{zt}$ is an i.i.d innovation which is normally distributed with the standard deviation $\sigma_z$.

The first order conditions are

$$W_t = z_t f_l(t) MC_{H,t}$$

$$R_{t-1} Q_{t-1} - (1 - \delta) Q_t = z_t f_k(t) MC_{H,t}$$

where $MC_{H,t}$ is the nominal marginal cost of entrepreneurs.

### 2.3.2 Capital Producers

Capital producers buy a fraction of final goods from domestic goods market to produce investment goods, $i_t$, using a linear technology. Combining the existing capital stock and the new investment goods, they sell new capital goods, $k_{t+1}$ to the entrepreneurs. Under quadratic capital adjustment cost, they choose $i_t$ to maximize

$$q_t i_t - i_t - \kappa \left( \frac{i_t}{k_t} - \delta \right)^2 k_t$$

subject to

$$k_{t+1} = i_t + (1 - \delta) k_t$$

where $\kappa > 0$ is the degree of capital adjustment cost. Then, the first order condition is

$$q_t = 1 + \kappa \left( \frac{i_t}{k_t} - \delta \right),$$

which is the standard Tobin’s Q equation. In the steady state where $i_t/k_t = \delta$, the real price of capital is 1.
2.3.3 Retailers

We introduce retailers just to incorporate nominal price rigidity into the model. Retailers purchase the wholesale goods, \( y_t \), from entrepreneurs at a price equal to the entrepreneurs nominal marginal cost, and differentiate them according to

\[
y_t = \left( \int_0^1 y_t(i) \frac{\epsilon - 1}{\epsilon} \, di \right)^\frac{\epsilon}{\epsilon - 1}
\]

where \( \epsilon > 0 \) is the intermediate-goods elasticity of substitution. Finally, they sell the retail goods in a monopolistically competitive market. Following Calvo (1983), let’s assume that a fraction \( \omega_H \) of retailers cannot adjust their prices optimally in any period \( t \). Then a retail \( i \) chooses \( P_{H,t}(i) \) to maximize

\[
E_t \sum_{k=0}^{\infty} \omega_H^k \beta^k u_c(t+k) \frac{D_{H,t+k}(i)}{P_{H,t+k}}
\]

where

\[
D_{H,t+k}(i) = \frac{P_{H,t}(i)}{P_{H,t+k}} y_{t+k}(i) - \frac{MC_{H,t+k}}{P_{H,t+k}} y_{t+k}(i)
\]

and

\[
m_{C_{H,t}} \equiv \frac{MC_{H,t}}{P_{H,t}}.
\]

The first order condition under a symmetric equilibrium is

\[
E_t \sum_{k=0}^{\infty} \omega_H^k \beta^k \frac{u_c(t+k)}{u_c(t)} \left( P_{H,t}^{new} + \frac{\epsilon}{1-\epsilon} MC_{H,t+k} \right) P_{H,t+k}^{\epsilon-1} y_{t+k} = 0
\]

where \( P_{H,t}^{new} \) is the newly-set equilibrium price. The domestic aggregate price index evolves according to

\[
P_{H,t}^{1-\epsilon} = (1 - \omega_H) P_{H,t}^{new1-\epsilon} + \omega_H P_{H,t-1}^{1-\epsilon}.
\]
2.4 Domestic Importers

In this section, we incorporate the incomplete exchange rate pass-through following Monacelli (2005). Domestic importers also face a Calvo-style price-setting problem as domestic retailers do in the previous section except that the nominal marginal cost is now $S_t P_{F,t}^*$. Since a fraction $\omega_F$ of firms cannot adjust their prices optimally in any period $t$, a retail firm $i$ chooses $P_{F,t}(i)$ to maximize

$$E_t \sum_{k=0}^{\infty} \omega_F^k \beta^k u_c(t + k) \frac{D_{F,t+k}(i)}{P_{F,t+k}}$$

where

$$\frac{D_{F,t+k}(i)}{P_{F,t+k}} = \frac{P_{F,t}(i)}{P_{F,t+k}} c_{F,t+k}(i) - \frac{MC_{F,t+k}}{P_{F,t+k}} c_{F,t+k}(i).$$

and

$$mc_{F,t} \equiv \frac{MC_{F,t}}{P_{F,t}} = \frac{S_t P_{F,t}^*}{P_{F,t}}.$$ 

which is called the law-of-one-price gap. Under the complete pass-through, the gap is 1, which is $S_t P_{F,t}^* = P_{F,t}$.

The first order condition under a symmetric equilibrium is

$$E_t \sum_{k=0}^{\infty} \omega_F^k \beta^k u_c(t + k) \left( P_{F,t}^{new} + \frac{\epsilon}{1 - \epsilon} MC_{F,t+k} \right) P_{F,t+k}^{\epsilon-1} c_{F,t+k} = 0$$

where $P_{F,t}^{new}$ is the newly-set equilibrium price. The import price index evolves according to

$$P_{F,t}^{1-\epsilon} = (1 - \omega_F) P_{F,t}^{new 1-\epsilon} + \omega_F P_{F,t-1}^{1-\epsilon}.$$
2.5 Monetary Policy

The central bank is assumed to adjust the short-term interest rate, $R_t$, following a Taylor-type rule:

$$ R_t = R_{t-1}^{\alpha_r} p_t^{(1-\alpha_r) \alpha_p} y_t^{(1-\alpha_r) \alpha_y} s_t^{(1-\alpha_r) \alpha_s} \epsilon_{r,t} $$

(29)

where $s_t = S_t P_t^*/P_t$ is the real exchange rate and $\epsilon_{r,t}$ is an i.i.d innovation which is normally distributed with the standard deviation $\sigma_r$. It is controversial whether a monetary authority respond the exchange rate directly. Lubik and Schorfheide (2007) find empirical evidence that the Bank of Canada and the Bank of England include the exchange rate in their policy rule. Here, we leave open the possibility that the Bank of Korea react the exchange rate.

2.6 Foreign Country

The foreign country is large relative to the home country, which means that

$$ c_{H,t}^* = \frac{\theta}{1-\theta} \left( \frac{P_{H,t}^*}{P_{F,t}^*} \right)^{-\psi} c_{F,t}^* $$

(30)

$$ c_{F,t}^* = c_t^* = y_t^* $$

(31)

$$ P_{F,t}^* = P_t^* $$

(32)

We also assume that the export price of the domestic goods is determined by

$$ P_{H,t}^* = \frac{P_{H,t}}{S_t}. $$

(33)
2.7 Market Clearing

Finally, we have the following conditions for market clearing:

\[ y_t = c_{H,t} + c_{H,t}^* + i_t \]  \hspace{1cm} (34)
\[ B_t = 0 \]  \hspace{1cm} (35)

for all \( t = 0, 1, 2, \ldots \).^5

3 Empirical Analysis

3.1 Data and Estimation Method

For the domestic data, we use Korea’s real GDP, the CPI, the 91-day CD rate, and the won/dollar exchange rate, which are seasonally adjusted and detrended by the HP filter. For the foreign variables, US real GDP, the CPI, and 3-month TB rate are used. The sample runs from 1991:Q1 to 2010:Q2.

We fix some parameters before estimation following the previous literature as Table 1. Bayesian MCMC algorithms are used for estimation.\(^6\)

3.2 Estimation Results

Table 2 and Table 3 show the prior and posterior distributions of each parameter. All the estimates are statistically significant and look reasonable. Especially, \( \phi \) is significantly positive, which means that the financial friction,

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5 The steady state and the linearized model are presented in Appendix.

6 We use a Dynare program for estimation, which is available upon request.
Table 1: Parameter Calibration

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Definition</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>discount factor</td>
<td>$1.05^{-1/4} = 0.988$</td>
</tr>
<tr>
<td>$\theta$</td>
<td>share of domestic goods in consumption</td>
<td>0.7</td>
</tr>
<tr>
<td>$\nu$</td>
<td>survival rate of bankers</td>
<td>0.98</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>share of capital income</td>
<td>0.3</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>intermediate-goods elasticity of substitution</td>
<td>6</td>
</tr>
<tr>
<td>$\delta$</td>
<td>depreciation rate</td>
<td>0.025</td>
</tr>
<tr>
<td>$R^*$</td>
<td>steady state of foreign interest rate</td>
<td>$1.02^{1/4} = 1.005$</td>
</tr>
<tr>
<td>$c_H^*/y$</td>
<td>steady state ratio of export and output</td>
<td>0.3</td>
</tr>
</tbody>
</table>

expressed in Equation (9), works. $\alpha_s$ is also estimated as significantly positive even though the prior distribution is quite flat and have high probability of being negative. This implies that the Bank of Korea includes the exchange rate in its policy rule.

Impulse Responses of major variables to each shock are shown as solid lines in Figure 3 to 9. The responses to three domestic shocks, which are $\epsilon_{a,t}$, $\epsilon_{z,t}$, and $\epsilon_{r,t}$, are generally consistent to past literature. Cespedes, Chang and Velasco (2004) define a financially stable economy as an economy where the risk premium and the exchange rate move in the opposite direction responding to a foreign shock. On the other hand, the risk premium and the exchange rate move in the same direction in a financially vulnerable econ-
Table 2: Prior and Posterior Distributions I

<table>
<thead>
<tr>
<th>Distr</th>
<th>mean</th>
<th>s.d.</th>
<th>mean</th>
<th>95% HPDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>σ</td>
<td>Gamma</td>
<td>1.5</td>
<td>0.2</td>
<td>1.4906 [1.2808, 1.7239]</td>
</tr>
<tr>
<td>τ</td>
<td>Gamma</td>
<td>3</td>
<td>0.5</td>
<td>3.3109 [2.3162, 4.2706]</td>
</tr>
<tr>
<td>φ</td>
<td>Gamma</td>
<td>1</td>
<td>0.5</td>
<td>0.0038 [0.0033, 0.0043]</td>
</tr>
<tr>
<td>ψ</td>
<td>Normal</td>
<td>1.5</td>
<td>0.2</td>
<td>1.3957 [1.1383, 1.6980]</td>
</tr>
<tr>
<td>κ</td>
<td>Gamma</td>
<td>1</td>
<td>1</td>
<td>0.9714 [0.4452, 1.6158]</td>
</tr>
<tr>
<td>ω_H</td>
<td>Beta</td>
<td>0.7</td>
<td>0.1</td>
<td>0.5246 [0.4136, 0.6057]</td>
</tr>
<tr>
<td>ω_F</td>
<td>Beta</td>
<td>0.7</td>
<td>0.1</td>
<td>0.8980 [0.8256, 0.9490]</td>
</tr>
<tr>
<td>α_r</td>
<td>Beta</td>
<td>0.7</td>
<td>0.1</td>
<td>0.8058 [0.7585, 0.8561]</td>
</tr>
<tr>
<td>α_π</td>
<td>Gamma</td>
<td>1.5</td>
<td>0.2</td>
<td>1.3633 [1.1550, 1.6204]</td>
</tr>
<tr>
<td>α_y</td>
<td>Gamma</td>
<td>0.4</td>
<td>0.2</td>
<td>0.6612 [0.4302, 0.8458]</td>
</tr>
<tr>
<td>α_s</td>
<td>Normal</td>
<td>0.05</td>
<td>1</td>
<td>0.1475 [0.0916, 0.2009]</td>
</tr>
</tbody>
</table>

omy. We find that the risk premium and the exchange rate move in the same direction to all the shocks which means that the Korean economy is a financially vulnerable economy.

Especially, the responses of output to the foreign interest rate shock and to the risk premium shock are notable. In a standard model without any financial friction, an increase in the foreign interest rate depreciates the domestic currency, which boosts export and output. However, in our model with foreign debt and financial imperfection, the rise in the exchange rate
decreases net worth of banks, \( n_t \), and increases the domestic currency value of foreign debt, \( b_t \), and the risk premium, \( \Phi_t \). As a result, investment and output go down as shown in Figure 8.

A similar phenomenon happens in Figure 9. A positive risk premium shock would raise the exchange rate, which leads to increase in export and output without any financial friction. However, the actual output decreases when there is a positive risk premium shock since a depreciation lowers the net worth of banks and, as a result, decreases investment and output.

Figure 10 shows the historical decomposition of output gap. We find a common feature between the Asian currency crisis in 1997-98 and the global credit crisis in 2008-09. Just before each crisis occurred, negative risk premium shocks played a substantial role in economic expansion. Note that a negative risk premium shock raises output according to the impulse responses in Figure 9. During each crisis, on the other hand, positive risk premium shocks led the economy into a deep recession.

We find some differences between the two crises, of course. The negative productivity shocks played an important role during the currency crisis while they didn’t during the recent crisis. This reflects the fact that many big companies failed during the 1997-98 crisis and not during the 2008-09 crisis. Instead, the negative foreign output shocks affected the Korean economy during the recent global credit crisis. These findings confirm the observation that the currency crisis in 1997-98 stemmed from inside while the credit crisis in 2008-09 did from outside. During the recent crisis, central banks in advanced economies lowered the policy rates to boost their domestic output. In
a standard open economy model, such policy appreciates emerging economies’
currencies and decreases export and output of the emerging economies. As
Figure 10 shows, however, the negative foreign interest rate shocks actually
had a positive effect on the Korean economy because the appreciation of the
won lowered the risk premium and boosted domestic investment and output.
This mechanism is also shown by the impulse responses in Figure 8.

### 3.3 Simulation

To see the role of foreign debt in the Korean economy, we do a simulation
where the foreign debt to capital ratio is less than that of the estimation
result, which means that the net worth to capital ratios is set to be higher
than that of the previous section.\(^7\) Table 4 shows the setting for the simula-
tion and compares it with that of the estimation. Note that, under the lower
foreign debt, the variations in the net worth decrease a lot.

The dotted lines in Figure 3 to 9 are the impulse responses under the
simulation. A first observation is that the variations of variables are less
in the case of low debt to capital ratio than those in the case of high ratio.
Especially, the net worth varies very little under the simulation. We, however,
find that the Korean economy would still be financially vulnerable under the
lower level of foreign debt to capital ratio.

The most notable feature is the responses of output to the foreign interest
rate shock and the risk premium shock. Under the simulation, where the

\[^7\text{In the steady state, } \frac{\alpha}{\kappa} + \frac{\beta}{\kappa} = 1.\]
foreign debt to capital ratio is low, output increases to a positive foreign interest rate shock and risk premium shock since they depreciate the domestic currency and the depreciation boosts export and output as shown in Figure 8 and 9. However, the actual responses of output are the opposite under the case of a substantial amount of foreign debt like our estimation result, as we mentioned earlier. One interesting finding is that the magnitude of the response of the risk premium to a risk premium shock are similar in both estimation and simulation. In this case, investment decreases by a large amount, which causes output to go down.

The thin line in Figure 11 represents the simulated output gap under the lower foreign debt to capital ratio. We find that the variations in output would be much smaller especially just before the crises and during the crises if the Korean economy had lower foreign debt. The dotted line indicates another simulated output gap when we assume there has been no risk premium shock, $v_t$. Notably, the two simulated output gap are very close. All this means that the Korean economy would achieve stable business cycles either by lowering the foreign debt to capital ratio or by preventing the risk premium shock from occurring.

4 Conclusion

Emerging economies usually have a substantial amount of foreign debt and pay risk premia for that. And the risk premium rises when foreign investors lose confidence in the emerging economies. That is why the depreciation of
emerging economies’ currencies causes recession rather expansion. However, the standard open macro models cannot explain this phenomenon since they don’t deal with foreign debt and financial friction.

In this paper, we examine the role of foreign debt and financial friction in the Korean business cycle using a small open economy DSGE model where domestic banks borrow funds from foreign investors for a risk premium and make loans to domestic producers. We find that the Korean economy is financially vulnerable, which means that the risk premium increases when the domestic currency depreciates. Through a historical decomposition, we also find that the risk premium shock played a critical role both just before a financial crisis and during the crisis. A simulation shows that the Korean business cycle would suffer less volatility with lower steady-state level of foreign debt.

References


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### A The Steady State

\[
\frac{1}{\beta} = \frac{R}{\pi} \tag{36}
\]
\(m_{cH} = \frac{\epsilon - 1}{\epsilon}\) \hfill (37)

\(q = 1\) \hfill (38)

\(i = \delta k\) \hfill (39)

\(\frac{k}{y} = \alpha \frac{m_{cH}}{R - (1 - \delta)}\) \hfill (40)

\[\frac{n}{k} + \frac{b}{k} = 1\] \hfill (41)

\(R = R^* \Phi\) \hfill (42)

\(\Phi = (\frac{n}{k})^{\phi}\) \hfill (43)

\(n = \frac{1 - \nu}{1 - R \nu} g\) \hfill (44)

**B  The Linearized Model**

**Households**

\(\hat{c}_t = \theta \hat{c}_{H,t} + (1 - \theta) \hat{c}_{F,t}\) \hfill (45)

\(\hat{\pi}_t = \theta \hat{\pi}_{H,t} + (1 - \theta) \hat{\pi}_{F,t}\) \hfill (46)

\(\hat{c}_{H,t} - \hat{c}_{F,t} = \psi \hat{\xi}_t\) \hfill (47)

\(\hat{\xi}_t = \hat{P}_{F,t} - \hat{P}_{H,t}\) \hfill (48)

\(\hat{c}_t = E_t \hat{c}_{t+1} - \frac{1}{\sigma}(\hat{R}_t - E_t \hat{\pi}_{t+1}) + \frac{1}{\sigma}(\hat{a}_t - E_t \hat{a}_{t+1})\) \hfill (49)

\(\hat{\pi}_t = \hat{P}_t - \hat{P}_{t-1}\) \hfill (50)

\(\tau \hat{b}_t + \sigma \hat{c}_t = \hat{w}_t - (1 - \theta) \hat{\xi}_t\) \hfill (51)

**Bankers**

\(\hat{q}_t + \hat{k}_{t+1} = \frac{n}{k} \hat{n}_t + \left(1 - \frac{n}{k}\right) \hat{b}_t\) \hfill (52)
\[ \hat{R}_t + \hat{S}_t - E_t \hat{S}_{t+1} = \hat{R}^*_t + \hat{\Phi}_{t+1} \]  
\[ \hat{\Phi}_{t+1} = \phi (\hat{q}_t + \hat{k}_{t+1} - \hat{n}_t) + \hat{v}_t \]  
\[ \hat{n}_t = \frac{R \nu}{\pi_H} \left( \frac{k}{n} (\hat{R}_{t-1} + \hat{q}_{t-1} + \hat{k}_t - \hat{\pi}_{H,t}) \right) \]  
\[ - (1 - \frac{k}{n}) (\hat{R}^*_t - \hat{\Phi}_t + \hat{\pi}_{t-1} - \hat{\pi}_{H,t}) \]  
\[ + \hat{S}_t - \hat{S}_{t-1} \]  

Domestic Producers

\[ \hat{y}_t = \hat{z}_t + \alpha \hat{k}_t + (1 - \alpha) \hat{l}_t \]  
\[ \hat{w}_t = \hat{z}_t + \alpha (\hat{k}_t - \hat{l}_t) + \hat{m}_H \hat{H}_t \]  
\[ \frac{R}{R - (1 - \delta) \pi_H} (\hat{R}_{t-1} + \hat{q}_{t-1} - \hat{\pi}_{H,t}) = \frac{(1 - \delta) \pi_H}{R - (1 - \delta) \pi_H} - \hat{q}_t \]  
\[ = \hat{m}_H \hat{H}_t + \hat{z}_t + (\alpha - 1)(\hat{k}_t - \hat{l}_t) \]  
\[ \hat{k}_{t+1} = \delta \hat{t}_t + (1 - \delta) \hat{k}_t \]  
\[ \hat{\pi}_{H,t} = \beta E_t \hat{\pi}_{H,t+1} + \kappa_H \hat{m}_H \hat{H}_t \]  
\[ \hat{\pi}_{H,t} = \hat{P}_{H,t} - \hat{P}_{H,t-1} \]  

where

\[ \kappa_H = \frac{(1 - \omega_H)(1 - \beta H)}{\omega_H} \]  

Domestic Importers

\[ \hat{\pi}_{F,t} = \beta E_t \hat{\pi}_{F,t+1} + \kappa_F \hat{m}_F \hat{H}_t \]  
\[ \hat{m}_F \hat{H}_t = \hat{S}_t + \hat{P}^*_F - \hat{P}_F \]  
\[ \hat{\pi}_{F,t} = \hat{P}_{F,t} - \hat{P}_{F,t-1} \]
where
\[ \kappa_F \equiv \frac{(1 - \omega_F)(1 - \beta \omega_F)}{\omega_F} \]

Monetary Policy
\[ \hat{R}_t = \alpha_r \hat{R}_{t-1} + (1 - \alpha_r)\alpha_x \hat{\pi}_t + (1 - \alpha_r)\alpha_y \hat{y}_t + (1 - \alpha_r)\alpha_s \hat{s}_t + \epsilon_{r,t} \] (66)

Foreign Country
\[ \hat{c}_{H,t}^* = -\psi(\hat{P}_{H,t}^* - \hat{P}_t^*) + \hat{y}_t^* + \hat{e}_t \] (67)
\[ \hat{\pi}_{H,t}^* = \beta^* E_t \hat{\pi}_{H,t+1} + \kappa_{H}^* \hat{m}\hat{c}_{H,t}^* \] (68)
\[ \hat{m}\hat{c}_{H,t}^* = \hat{P}_{H,t} - \hat{S}_t - \hat{P}_{H,t}^* \] (69)
\[ \hat{\pi}_{H,t}^* = \hat{P}_{H,t}^* - \hat{P}_{H,t-1} \] (70)
\[ \hat{\pi}_t^* = \hat{P}_t^* - \hat{P}_{t-1}^* \] (71)

where
\[ \kappa_{H}^* \equiv \frac{(1 - \omega_{H}^*)^2 (1 - \beta^* \omega_{H}^*)}{\omega_{H}^*} \]

\[ \hat{y}_t^* = \rho_{y^*} \hat{y}_{t-1}^* + \epsilon_{y^*,t} \] (72)
\[ \hat{\pi}_t^* = \rho_{\pi^*} \hat{\pi}_{t-1}^* + \epsilon_{\pi^*,t} \] (73)
\[ \hat{R}_t^* = \rho_{r^*} \hat{R}_{t-1}^* + \epsilon_{r^*,t} \] (74)

Market Clearing
\[ \hat{y}_t = \frac{c_H}{y} \hat{c}_{H,t} + \frac{c_H^*}{y} \hat{c}_{H,t}^* + \frac{i_z}{y_t} \] (75)
Shocks

\[
\hat{a}_t = \rho_a \hat{a}_{t-1} + \epsilon_{a,t} \quad (76)
\]
\[
\hat{z}_t = \rho_z \hat{z}_{t-1} + \epsilon_{z,t} \quad (77)
\]
\[
\hat{v}_t = \rho_v \hat{v}_{t-1} + \epsilon_{v,t} \quad (78)
\]
\[
\hat{e}_t = \rho_e \hat{e}_{t-1} + \epsilon_{e,t} \quad (79)
\]
## Table 3: Prior and Posterior Distributions II

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<th>Distr</th>
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<td>Inv.Gamma</td>
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<tr>
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<td>Inv.Gamma</td>
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</tr>
<tr>
<td>( \sigma_{y^*} )</td>
<td>Inv.Gamma</td>
<td>0.01</td>
</tr>
<tr>
<td>( \sigma_{\pi^*} )</td>
<td>Inv.Gamma</td>
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<tr>
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## Table 4: Estimation vs Simulation

<table>
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<th>n/k</th>
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<th>sd((b_t))</th>
<th>sd((\Phi_t))</th>
<th>sd((y_t))</th>
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<td>0.5</td>
<td>0.5</td>
<td>0.13</td>
<td>0.12</td>
<td>0.015</td>
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</table>
Figure 3: Impulse Responses to a Positive Preference Shock, $\epsilon_{a,t}$
Figure 4: Impulse Responses to a Positive Productivity Shock, $\epsilon_{z,t}$
Figure 5: Impulse Responses to a Positive Monetary Policy Shock, $\epsilon_{r,t}$

- $y$: Output
- $c$: Consumption
- $i$: Interest Rate
- $\Delta H^*$: Change in Home Investment
- $n$: Employment
- $q$: Quantity
- $s$: Saving
- $\theta$: Tax Rate

Graphs show the response of various economic variables to a positive monetary policy shock. The graphs compare estimation (n/k=0.1) and simulation (n/k=0.5) scenarios.
Figure 6: Impulse Responses to a Positive Foreign Output Shock, $\epsilon_{y^*,t}$
Figure 7: Impulse Responses to a Positive Foreign Inflation Shock, $\epsilon_{\pi^*,t}$
Figure 8: Impulse Responses to a Positive Foreign Interest Rate Shock, $\epsilon_{r*,t}$.
Figure 9: Impulse Responses to a Positive Risk Premium Shock
Figure 10: Historical Decomposition of Output Gap
Figure 11: Simulated Output Gap

-0.10 -0.08 -0.06 -0.04 -0.02 0.00 0.02 0.04 0.06
1991Q1 1993Q1 1995Q1 1997Q1 1999Q1 2001Q1 2003Q1 2005Q1 2007Q1 2009Q1

-0.02 -0.04 -0.06 -0.08 -0.10

data "n/k=0.5" no vt