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Financial friction in an emerging economy☆

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A B S T R A C T

The objective of this study is to evaluate the role of the frictional domestic credit market in an emerging country by using a small-open-economy DSGE model with a banking sector. The calibration results show that the financial friction does not significantly influence the macroeconomic effects of the shocks to the domestic productivity, foreign interest rate and export demand. We also evaluate whether and how the trade and financial openness can influence the effects of the domestic financial shocks that in turn affect the supply of loans in the credit market. We show that greater trade and financial openness can reduce the macroeconomic impacts of the domestic financial distress. Under a more open international capital market, the capital outflow caused by the domestic financial shock does not lead to drastic exchange rate variation. This helps dampen the adverse effects of the financial distress on the economy.

1. Introduction

The financial crises in emerging economies in the 1990s have led to a considerable number of studies, most of which emphasize the credit-constrained international borrowing of developing countries. Few of the studies have, however, addressed the domestic credit market friction, even though frictional bank lending has also played a key role in the financial crises. The recent subprime crisis, in particular, has led to increased interest in the domestic credit market friction. However, since

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the crisis has mostly pervaded advanced nations, studies on credit market friction in emerging economies, which normally perform less well than advanced economies and are potential problems, have still been largely neglected in literature. Therefore, by using a small-open dynamic stochastic general equilibrium (DSGE) model that is embedded in a frictional banking sector, the objective of this study is to investigate the role of financial friction in an emerging economy. We also examine a long-lasting issue in the literature: whether and how trade openness and capital mobility can influence the impact of financial shock to a developing country's domestic credit market.

The financial crises, most of which have occurred in developing countries in the last century, have given rise to many studies. However, while most of these studies emphasize the financial friction in international capital markets and the currency crises that may occur because of them,[1] the failure of domestic banks, in addition to the international capital markets, has proved to be one of the key factors accounting for the financial crises in emerging economies. Kaminsky and Reinhart (1999) show that a banking crisis can precede a currency crisis by examining 26 banking crises and 76 currency crises from the 1970s to the 1990s. The recent subprime crisis has further highlighted the critical role of the domestic credit market and shows that domestic financial distress itself can be devastating. While the crisis has given rise to many discussions on the failure of domestic banks, most recent studies are based on a closed economy,[2] or a two-country framework with an emphasis on international financial contagion.[3] Studies on banking crises in an emerging economy that have been triggered by domestic financial distress have still been lacking.[4] Goldstein and Turner (1996) point out, however, that banking crises occurred more frequently in developing countries than in developed countries in the 1980s and 1990s. Therefore, investigating financial crises in an emerging economy, where the banking sector appears weaker, can be particularly important.

In this study, we attempt to reevaluate the financial friction in an emerging economy and examine the shocks that occur in the domestic banking sector. By using the collateralized loan production function that Goodfriend and McCallum (2007) introduce,[5] we characterize the financial distress as the shocks to the effectiveness of collateral and monitoring efforts in the loan-making process. The financial shocks to the loan production function can resemble the weakness underlying the credit market where the loans can be made without a careful credit check or with inferior collateral.[6]

Our study centers on whether and how economic openness may influence the impact of financial shocks. While this is a question that frequently arises in the study of financial crises in emerging economies and has been extensively examined in the literature,[7] past research has also been restricted to financial crises that feature the impact of credit-constrained international borrowing. Due to the

[1] For instance, Devereux et al. (2006) examine the welfare implications of monetary policies for an emerging economy with credit-constrained international borrowing. They find that the binding credit constraint on international borrowing can amplify the foreign interest rate and terms of trade shocks. Other studies include Bacchetta and Banerjee (2001) and Gertler et al. (2007).

[2] For example, Gertler and Karadi (2010) and Dib (2010) use a closed-economy DSGE model with the banking sector to evaluate the effects of the credit policy for the crisis.

[3] For example, Kollmann et al. (2011) establish a two-country framework with a global bank to show how the shocks from a country can spill over to another country via the financial integration by the global bank.

[4] The banking friction in a small open economy has been examined previously. Edwards and Végh (1997) address this issue and use a dynamic general equilibrium model with a banking sector, whose services are subject to the operating costs, under a fixed exchange rate. Lim and McNelis (2008) have also examined the frictional domestic credit market in a small open economy. However, their studies emphasize how and whether the credit-constrained bank lending can amplify the real or nominal shocks by reducing the loans available to firms, but neither of them examine how the financial shocks that originate from the domestic credit market in a developing country may impact the economy.

[5] Hwang and Yang (2010) use the similar framework by examining the implications of trade openness for the financial crisis of the US.

[6] Many studies have shown that real estate price declines can account for the crises in the developing countries. Kaminsky and Reinhart (1999) show that the collapses in real estate prices, which serve as the collateral for mortgages, can lead to a deterioration in the banks' assets and result in a banking crisis. The financial shocks to the collateral values in our study can resemble the symptoms.

[7] There are two contrasting views in the literature. One is that the economic openness can help insulate the economy from the crisis, and the other is that the economic openness can make the economy more vulnerable to the crisis. Related studies include Martin and Rey (2006), Cavallo and Frankel (2008) and Aizenman (2004, 2008).

intertwined relationship between the domestic and international financial markets, we would like to evaluate whether more open international goods and capital markets help to either reduce or further exacerbate the adverse impacts of domestic financial distress at the macroeconomic level in a small open economy.

To examine financial distress in a developing country, we take Korea as an example because it has experienced the East Asian financial crisis of 1997 and the fundamental weakness in their banking system was one of the factors that exacerbated the impact of the crisis. Thus, we calibrate the model with the data of Korea ranging from the first quarter of 1998 through to the fourth quarter of 2006, thereby covering the period just after the East Asian financial crisis of 1997 until right before the outbreak of the subprime crisis of 2007, to characterize fundamental financial frictions.[8]

Our calibration results show that domestic financial friction may not significantly alter the macroeconomic responses to the productivity, foreign interest rate and export demand shocks. However, a financial shock that affects the loan-making process may lead to a credit contraction which results in a recession, or a rise in the EFP that leads to a capital outflow. We show that both financial and trade openness can help dampen the impact of financial shocks on the output, but the effect is small.

The key mechanism of the shock transmission under domestic financial distress in a developing economy is that the capital outflow in the international capital markets caused by financial shock will drive exchange rate movements which will in turn be passed on to the domestic real and nominal sectors. With more open capital markets, the capital will flow out of the domestic economy without being subject to large exchange rate variations and thus can help stabilize the economy. This mechanism differs from that under credit-constrained international borrowing, although it may lead to qualitatively similar macroeconomic impacts from adverse shocks. On the other hand, relying more heavily on trades can help reduce the direct impact of financial friction on domestic consumption and domestic production.

The remainder of this paper is structured as follows. In Section 2, we present the model. The results of the steady state are listed in Section 3. In Section 4, we conduct the dynamic analyses to examine whether financial friction may influence the impact of domestic productivity, foreign interest rates and export demand shocks. In Section 5, we investigate the effects of economic openness on domestic credit market distress characterized by shock to the collateral value. Section 6 summarises and provides a final recap on our findings.

2. The model

2.1. The goods market

In a small open economy, all goods are traded across countries by using capital and labor as inputs that are immobile across countries. Under monopolistically competitive markets, the consumption bundle of each country consists of domestic goods and imports. The consumption bundle of the home country is composed in the fashion of CES:

$$c_t^i = \left[\int_0^1 c_t^i(j)^{\frac{\mu-1}{\mu}} ds\right]^{\frac{\mu}{\mu-1}},\ i = h,f, \quad c_t = \left[\left(\alpha^h\right)^{1-v}\left(c_t^h\right)^{\frac{(v-1)}{v}} + \left(\alpha^f\right)^{1-v}\left(c_t^f\right)^{\frac{(v-1)}{v}}\right]^{\frac{v}{(v-1)}}.$$

The goods of type h and f represent domestically produced goods and imported goods, respectively, where α^h (α^f) is the percentage of the domestic (imported) goods in c_t, and therefore the sum should be equal to one. μ and v are the price elasticities of each individual goods and each type of goods in the aggregate consumption. With the consumption bundle, the associated price index of the composite goods can be expressed as follows:

[8] The calibrations based on the data of Philippines and Thailand generate results qualitatively similar to those of Korea, thus we simply use Korea as a representative case.

$$P_t^i = \left[\int_0^1 P_t^i(j)^{1-\mu}dj\right]^{\frac{1}{1-\mu}},\ i = h,f, \quad P_t = \left[\alpha^h\left(P_t^h\right)^{1-\nu}+\alpha^f\left(P_t^f\right)^{1-\nu}\right]^{\frac{1}{1-\nu}},$$

where $P_t^f = e_t P_t^m$, and P_t^i is the price of goods associated with the firms of the country. Therefore, we can obtain the demand function for each type of goods as shown below:

$$c_t^i(j) = \left(P_t^i(s)/P_t^i\right)^{-\mu}c_t^i,\ c_t^i = \alpha^i\left(P_t^i/P_t\right)^{-\nu}c_t, \quad i = h,f. \tag{1}$$

The consumption demand and the price index in the rest of the world would follow in similar fashion:

$$c_t^x = \left[\int_0^1 c_t^x(j)^{(\theta-1)/\theta}dj\right]^{\theta/(\theta-1)} \quad and\ P_t^x = \left[\int_0^1 P_t^x(j)^{1-\theta}dj\right]^{1/(1-\theta)}, \tag{2}$$
$$c_t^x(j) = \left(P_t^x(j)/P_t^x\right)^{-\theta}c_t^*, \quad with\ c_t^* = X_t\left(P_t^x/P_t^*\right)^{-\eta}.$$

Here, P_t^x is the foreign-currency price of the home exports and P_t^* is the aggregate price index in the foreign currency for the rest of the world. X_t is the scale factor for the exports and can be subject to an exogenous shock. We assume that the law of one price holds for tradable goods and thus $P_t^h = e_t P_t^x$ and $P_t^f = e_t P_t^m$. Here, e_t is the nominal exchange rate, which is stated as the home-currency price of the foreign currency, and P_t^m is the foreign-currency price of foreign goods.

2.2. Firm

The domestic goods market is monopolistically competitive. Output of the firm j is determined by the demand which consists of the demand from the domestic market and exports:

$$K_t^{j\alpha}\left(A_t^P l_t^j\right)^{1-\alpha} - \alpha^h\left(\frac{P_t^h(j)}{P_t^h}\right)^{-\mu}\left(\frac{P_t^h}{P_t}\right)^{-\nu}c_t^A - X_t\left(\frac{P_t^x(j)}{P_t^x}\right)^{-\theta}\left(\frac{P_t^x}{P_t^*}\right)^{-\eta} = 0. \tag{3}$$

Here, $c_t^A = c_t + q_t(K_{t+1} - (1-\delta)K_t) + g_t$ where g_t stands for the government expenditure. A_t^P is the productivity of production which is subject to the technology shock.

We assume that firms adopt the Calvo (1983) staggered pricing strategy. In each period, the probability of firms changing the price is $1-\varsigma_d$. Therefore, the mean interval of the price change is $1/(1-\varsigma_d)$. In period t, the profit maximization problem of a typical firm s that can change its price is to choose $P_t^h(s)$ to maximize the profit within the period t and $t+z$ when the price remains valid. The optimal price that a typical firm sets is:

$$P_{t,t}^{h,flex} = \frac{\mu}{\mu-1}\frac{\left\{\sum_{z=0}^{\infty}(\varsigma_d)^z E_t \Omega_{t,t+z}^h mc_{t+z}\right\}}{\left\{\sum_{z=0}^{\infty}(\varsigma_d)^z E_t \Omega_{t,t+z}^h\right\}}, \tag{4}$$

where $\Omega_{t,t+z}^h = (\beta^z C_t/C_{t+z})(P_t/P_{t+z})(c_t^h + c_t^x)(P_{t+z}^h)^{\nu}$ and mc_t is the marginal production cost which can be stated as $w_t(1-\alpha)A_t^{1-\alpha}(K_t/n_t)^{\alpha}$.

The price index for the domestic price will evolve as follows:

$$\left(P_t^h\right)^{1-\mu} = \varsigma_d\left(P_{t-1}^h\right)^{1-\mu} + (1-\varsigma_d)\left(P_{t,t}^{h,flex}\right)^{1-\mu}. \tag{5}$$

2.3. The representative household

The typical household's preference is described by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\psi c_t^{1-\rho} \Big/ (1-\rho) + (1-\psi) \log\left(1 - l_t^s - m_t^s\right) \right], \tag{6}$$

where ρ is the CRRA coefficient and $\beta \in (0,1)$ stands for the subjective discount rate. The time that the typical household owns is normalized to one, and l_t^s and m_t^s are the labor supplied in the goods production and banking sector. ψ captures the importance of the utility from consumption.

The typical household supplies labor in both the production and banking sectors, l_t and m_t, respectively, at the wage rate w_t and accumulates productive capital for production K_{t+1}. The household's consumption spending is financed by holding the deposit D_t, thus facing a deposit-in-advance constraint as described below. The household also borrows from the domestically operating bank L_t, the home government bonds B_t, as well as the internationally traded bonds from the international asset market B_t^*, which is denominated in the foreign currency. Therefore, the budget constraint can be written as:

$$\begin{aligned} & w_t\left(l_t^s + m_t^s\right) + \frac{\left(1+R_t^D\right)D_t^i}{P_t} - \frac{\left(1+R_t^L\right)L_t^i}{P_t} + \frac{B_t}{P_t} + \frac{e_t B_t^*}{P_t} + \alpha^h \left(\frac{P_t^h(j)}{P_t^h}\right)^{1-\mu} \left(\frac{P_t^h}{P_t}\right)^{1-\nu} c_t^A \\ & + \left(\frac{e_t P_t^x(j)}{P_t}\right) \left(\frac{e_t P_t^x(j)}{P_t^x}\right)^{-\theta} \left(\frac{P_t^x}{P_t^*}\right)^{-\eta} X_t - w_t(l_t + m_t) \\ & = c_t + q_t K_{t+1} - q_t(1-\delta)K_t + \frac{D_{t+1}^i - L_{t+1}^i}{P_t} + \frac{B_{t+1}}{P_t\left(1+R_t^B\right)} + \frac{e_t B_{t+1}^*}{P_t\left(1+R_t^{B^*}\right)} + T_t. \end{aligned} \tag{7}$$

Here, q_t denotes the capital price in terms of consumption goods and δ is the depreciation rate of capital. T_t is the real lump-sum tax levied in each period.

2.4. Banks

The banking sector, as the financial intermediary, operates to supply financial services to households, including demand deposits, D_t, and loans, L_t. Hence the balance sheet of the bank can be written as:

$$M_t + L_t = D_t, \tag{8}$$

where M_t stands for the reserve (which is equal to the high-powered money because currency is absent from the economy).

Consumption demand is subject to the credit-in-advance constraint as specified below:

$$c_t = \frac{VD_t}{P_t}, \tag{9}$$

where D_t represents the nominal deposits, and V stands for the velocity of deposits. To facilitate the derivation of interest rates, following Goodfriend and McCallum (2007), we assume the reserve is a fixed fraction γ of the total deposit. Thus, $M_t = \gamma D_t$.[9]

The loan production process requires labor for the loan monitoring as well as collateral which consists of home bonds and capital. The loan production function is assumed to follow the Cobb–Douglas form:

[9] That is to say, γ is the ratio of the required and excess reserves to the overall deposits. This assumption implies that $L_t/P_t = (1-\gamma)D_t/P_t = (1-\gamma)D_t/P_t = (1-\gamma)c_t/V$ such that the amount of loans outstanding moves closely with the consumption. However, we should note that this does not imply that the loans are made to finance the consumption, but simply that the level of the real loans is a constant share of the consumption. This assumption is made purely for analytical simplification.

$$\frac{L_t}{P_t} = Z\left(b_{t+1} + A_t^k \varphi q_t K_{t+1}\right)^{\phi} \left(A_t^m m_t\right)^{1-\phi}, \quad 0 < \phi < 1, \tag{10}$$

where Z is the measure of the loan production efficiency and $b_{t+1} = B_{t+1}/(P_t(1+R_t^B))$. The first set of parentheses in the loan production function represents the collateral and the latter denotes the monitoring effort. φ is a constant, representing the inferiority of capital for collateral uses, and ϕ denotes the relative share of the collateral that the loan production process requires.

The collateral requirement for the loan making is consistent with the collateral constraint for borrowing from the financial intermediary that recent studies specify, and implies that the collateral constraint for loans binds. The inclusion of the monitoring workers is in order to characterize the inefficiency of bank's loan making. The negative shocks to A_t^k and A_t^m can be considered to be financial shocks to the supply of loans in the credit market. A_t^k is the shock to the efficiency of capital as the collateral, and A_t^m is the shock to the effectiveness of monitoring, both of which can lead to a credit contraction.

2.5. Government and monetary policy

The budget constraint of the government can be written as:

$$g_t - T_t = \frac{M_t}{P_t} - \frac{M_{t-1}}{P_t} + \frac{B_{t+1}}{P_t\left(1+R_t^B\right)} - \frac{B_t}{P_t}. \tag{11}$$

The government does not hold any international tradable bonds, but finances its expenditures by levying tax, issuing high-powered money and bonds.

Since some Asian countries including Korea, Philippine, Thailand and Indonesia have started to use the inflation targeting rule after the East Asian financial crisis, we assume that the monetary policy follows the inflation targeting rule such that:

$$\Delta p_t = 0, \tag{12}$$

where $\Delta p_t = \log P_t - \log P_{t-1}$.[10]

2.6. Optimization

The household chooses 7 variables $\{m_t^s, m_t, l_t^s, l_t, K_{t+1}, B_{t+1}, B_{t+1}^*\}$ to maximize Eq. (6), subject to the budget constraint Eq. (7) with the substitution of the balance sheet of the bank and using the zero-profit condition of the competitive bank, and the market clearing condition Eq. (3), with ζ_t and λ_t as the Lagrangian multipliers associated with Eqs. (3) and (7) respectively. In addition, we define

$$\Lambda_t = \frac{\phi c_t}{b_{t+1} + A_t^k \varphi q_t K_{t+1}}, \tag{13}$$

which represents the marginal liquidity yield of the two types of collateral b_{t+1} and K_{t+1}. The first-order conditions are listed in Appendix 1. Most of the first-order conditions are same as those in Goodfriend and McCallum (2007) except the condition with respect to the foreign bonds. The combination of the first-order conditions associated with the home and foreign bonds yields the uncovered interest parity condition in this model:

$$\left(\frac{\psi c_t^{-\rho}}{\lambda_t} - 1\right)\Lambda_t + \beta E_t\left(\frac{\lambda_{t+1}P_t}{\lambda_t P_{t+1}}\left(\left(1+R_t^B\right) - \frac{e_{t+1}}{e_t}\left(1+R_t^{B^*}\right)\right)\right) = 0. \tag{14}$$

In addition to the conventional uncovered interest parity condition shown by the second parenthesis in Eq. (14), the first term comes from the liquidity premium that the home bond, as the collateral,

[10] The monetary policy rule can be stated as a general Taylor rule under which the interest rate can respond to the output gap and inflation gap where the inflation targeting rule is consistent with the policy parameters that are specified as $\alpha_p^R = \infty$, while the others are set to 0.

generates. This equation shows that the home and foreign interest rate differential will result in the exchange rate movement.

2.7. Interest rates

Due to domestic financial friction, the domestic interest rates can vary and are listed in Table 1. Here we use the conventional interest rate, obtained from the standard Euler equation, as the benchmark rate:

$$1 + R_t^T = E_t \frac{\lambda_t P_{t+1}}{\beta \lambda_{t+1} P_t}, \tag{15}$$

where λ_t is the Lagrange multiplier associated with the budget constraint. Other interest rates, including the bond rate, loan rate, deposit rate and interbank rate, can be determined accordingly.

The four subsequent interest rates describe the relationship between other interest rates. Eq. (16) in Table 1 denotes the liquidity premium of the bond over the rate associated with the fictitious security, R_t^T.[11] Eqs. (17) and (18) determine the premium of the collateralized and uncollateralized rates over the interbank rate at which the bank retrieves the reserve to cover the marginal cost that the loan-making process incurs. With the collateral, the marginal cost of the collateralized loan is lowered by $(1-\phi)$. Finally, since the bank holds the fraction γ of deposits as the reserve, it is natural for R_t^{IB} and R_t^D to differ in terms of the reserve ratio for a perfectly competitive bank. The EFP can be obtained by taking the difference between R_t^L and R_t^{IB}.

As a small open economy, the interest rate for the tradable bond $R_t^{B^*}$ is restricted by the international rate R_t^*. Thus, in contrast to the closed-economy setting in Goodfriend and McCallum (2007), the equilibrium in a small open economy is closely related to the rest of the world. Following Kollmann (2002), the international bond rate $R_t^{B^*}$ is subject to the financial friction in the international asset market:

$$\left(1 + R_t^{B^*}\right) = (1 + R_t^*) - \omega\left(B_{t+1}^*/P_t^*\right)/\chi, \tag{21}$$

where a higher ω characterizes lower capital mobility and χ represents the steady-state exports.

Table 1
Interest rates.

$$1 + R_t^B = \left(1 - \left(\frac{\psi}{C_t \lambda_t} - 1\right) \Lambda_t\right)\left(1 + R_t^T\right) \tag{16}$$

$$\left(1 + R_t^{IB}\right) = \left[1 + \frac{V w_t m_t}{(1-\phi)(1-\gamma) C_t}\right]^{-1}\left(1 + R_t^T\right) \tag{17}$$

$$\left(1 + R_t^L\right) = \left[1 + \frac{V w_t m_t}{(1-\gamma) C_t}\right]\left(1 + R_t^{IB}\right) \tag{18}$$

$$R_t^D = R_t^{IB}(1-\gamma) \tag{19}$$

$$EFP_t = R_t^L - R_t^{IB} \tag{20}$$

[11] As shown in the first-order condition in the Appendix, there is the spread between the Euler equation associated with the home bond and that associated with the foreign bond. Due to the liquidity services whereby the home bond can serve as the collateral for loans, the spread exists due to the liquidity yield of the home bond.

2.8. Exogenous variables

We now turn to discuss the impact of productivity and financial shocks on the economy. The numerical examination of the dynamic analyses focuses on two parts. First, we evaluate whether financial friction in an emerging economy can amplify or dampen the impacts of domestic and foreign shocks. These shocks include those to domestic productivity, foreign interest rates and the demand for exports. All of them are assumed to obey the following AR(1) process:

$$\ln\left(A_t^P\right) = \left(1-\rho^P\right)a^P + \rho^P \ln\left(A_{t-1}^P\right) + \varepsilon_t^P, \quad 0 \le \rho^P < 1, \tag{22}$$

$$\ln(X_t) = (1-\rho^x)X + \rho^x \ln(X_{t-1}) + \varepsilon_t^x, \quad 0 \le \rho^x < 1, \tag{23}$$

$$R_t^* = \left(1-\rho^R\right)R^* + \rho^R R_{t-1}^* + \varepsilon_t^R, \quad 0 \le \rho^R < 1, \tag{24}$$

where a^P, X, R^* are the steady-state levels. ρ^P, ρ^x, ρ^R are the AR(1) coefficients of these variables, and ε_t^P, ε^x, ε^R are *i.i.d.* distributed disturbances.

Second, we assess the effects of domestic financial shocks on the economy, and further evaluate whether trade and financial openness can help to reduce the impacts of financial shocks. Domestic financial shocks are also assumed to follow the AR(1) process:

$$\ln\left(A_t^k\right) = \left(1-\rho^k\right)a^k + \rho^k \ln\left(A_{t-1}^k\right) + \varepsilon_t^k, \quad 0 \le \rho^k < 1, \tag{25}$$

$$\ln\left(A_t^m\right) = (1-\rho^m)a^m + \rho^m \ln\left(A_{t-1}^m\right) + \varepsilon_t^m, \quad 0 \le \rho^m < 1, \tag{26}$$

where ρ^k, ρ^m are the AR(1) persistence of these variables and ε_t^k, ε_t^m are *i.i.d.* distributed.

3. The steady state

3.1. Parameterization

To characterize the responses of an emerging economy under the frictional financial market, we first calibrate the steady state by using the data for Korea from 1998Q1 to 2006Q4. The steady state is assumed to be deterministic and non-inflationary. Due to the friction in the international asset market, the current account in the steady state can be zero. Following Goodfriend and McCallum (2007), gb which characterizes the ratio of government bonds to consumption is assumed to be a constant in the long run and ρ is assumed to be 1 for logarithmic utility. For simplification, we also assume the elasticity of substitution of home and foreign demands are identical, thus $\theta = \mu$. The equations characterizing the steady state are listed in Appendix 2.

Following the conventional settings, we set the quarterly discount factor β as 0.99, and $\delta = 0.025$ for the quarterly depreciation rate. The price levels are assumed to be one, such that $P = P^h = P^m = 1$ and $e = 1$. We assume that the world interest rates $R^{B^*} = R^*$ which are specified to be $1/\beta - 1$, following Kollmann (2002), which is also equal to the level of the domestic uncollateralized interest rate R^T.

ψ is assumed to be 0.4 to generate the labor input in the production sector, and 1/3 of the total time endowment, which is consistent with the empirical findings. Following Kollmann (2002), the steady-state price-marginal cost markup factor for goods produced by domestic firms is set at $\nu/(\nu-1) = 1.2$, and both the price elasticity for all goods in the country, θ, and the rest of the world, μ, are specified as 1.1. The relative share of capital in the goods production α is chosen to be 0.36.

The economic openness is characterized by $\alpha^f = 0.35$ in the benchmark calibration, so that the steady-state import/GDP ratio is 35%, which is consistent with the average import share for Korea

between 1998Q1 and 2006Q4. There are two parameters associated with the financial (monetary) sector. The velocity of the money turnover rate is specified as $V = 0.2$, being measured by the average ratio of Korea's nominal GDP to M2 and the bank reserve ratio γ is specified to be 0.04, which is the average ratio of Korea's total reserve to M2 during the sample period.

The parameters for the loan production φ, Z, α, are calibrated for three facts as mentioned in Goodfriend and McCallum (2007): firstly, the 1% riskless rate; secondly, a 3.6% p.a. average EFP (the loan-discount rate spread) for Korea from 2003 to 2008; and, thirdly, the share of the banking employment in the total labor force is assumed to be 1.6%, as reported by Goodfriend and McCallum (2007) for the US.[12] These three parameters are calibrated as $\varphi = 0.4$, $Z = 8$, $\phi = 0.65$. gb is assumed to be 0.52, the average value of Korea's debt to output ratio during the same sample period. g_t is left out of the calibrations below and is thus specified as zero. Lane and Milesi-Ferretti (2001) obtain the estimate of the capital mobility for the OECD countries to be 0.0019. We assume the Korean economy to be less open than those countries and, thus, ω is chosen as 0.019. The parameter values are listed in Table 2.

3.2. The results

The steady-state results of the baseline model are illustrated in Table 3. In the absence of inflation, all the interest rates are in "real" terms.

As reported, the total labor employment is 0.30 of the total time endowed, which is consistent with the findings in the business cycle literature. The calibrated short-term bond rate R^B is 0.6% p.a., which is also consistent with the short-term real riskless rate of 1.0% p.a., the widely accepted level in finance literature. The employment in the banking sector is approximately 2% of the total employment, close to the 1.6% reported by Goodfriend and McCallum (2007). The spread between the home bond rate and foreign bond rate ($R^{B^*} = R^T$) denotes the liquidity premium of the home bond and serves as the collateral for loans, in contrast to the foreign bonds. The EFP is 1.2% p.a., which is lower than the average EFP of 3.6% p.a.

To demonstrate the long-term effects of the frictional banking sector, we also calibrate the steady state for higher banking productivity where $Z = 80$. Under the more efficient banking sector, there are no interest rate differentials as in the conventional model without the frictional credit market. Thus, the value of the EFP is at a level close to zero, in contrast to the significant level under the less efficient financial intermediary. A comparison between the inefficient and efficient banking sectors, where $Z = 8$ and $Z = 80$, can reveal the effects of the frictional financial intermediary on the economy, as shown in the dynamic analyses.

4. Financial friction in an emerging economy

In this section, we examine the role of a frictional financial market in an emerging economy. We calibrate the model by a 1% shock to home productivity, foreign interest rates and the export demand under different degrees of loan making efficiency, and see whether banking friction can amplify the impacts of these shocks. For analytical simplification, we assume that the capital is equal to the steady-state level, following Goodfriend and McCallum (2007). We also assume that the foreign currency-denominated import and international prices, P_t^f and P_t^*, are constant at their steady-state level.

The calibration results are shown in Fig. 1. The solid lines in Fig. 1 represent the responses of macroeconomic variables to a 1% shock under the inefficient banking sector where $Z = 8$. The dashed lines characterize the macroeconomic responses to the same shock under the efficient banking sector where $Z = 80$. The AR(1) persistence of these shocks is assumed to be 0.9.

The results in Fig. 1 are consistent with the business cycle facts.[13] They show that the aggregate output, the consumption as well as the loans rise in response to the positive productivity shock. The

[12] Goodfriend and McCallum (2007) reported that US banking employment accounted for 1.6% of total employment as of August 2005.

[13] In the following analyses, the home bond and foreign bond are measured by $B_t/(P_t(1+R_B))$ and $B_t^* e_t/(P_t(1+R_B^*))$ respectively.

Table 2
Parameter values for the baseline model.

Parameter	Description	Value
ψ	The importance of consumption in the utility function	0.4
α	Capital share in goods production	0.36
β	Discount rate	0.99
δ	Depreciation rate of capital	0.025
gb	Real government bonds/consumption bundle	0.52
V	Velocity of aggregate bank deposits	0.20
γ	Reserve rate	0.04
φ	Collateral share in loan production	0.65
Z	Efficiency parameter of banking sector	8
φ	Inferiority of capital to bonds for collateral purposes	0.4
α^{f}	Ratio of imported goods to aggregate consumption in the steady state	0.35
α^{h}	Ratio of domestic goods to aggregate consumption in the steady state	0.65
ν, η	Elasticity of substitution among different varieties of goods	6
θ	Elasticity of substitution between domestic goods and imported goods	1.1
μ	Price elasticity of demand for exports	1.1
ω	The degree of capital mobility	0.019

technological improvement causes a rise in the capital value due to the higher marginal product of capital.[14] To facilitate increased spending, the loans expand. The interest rates are also lowered. However, the decrease in the employment in the goods production reflects an increase in the banking employment which results in higher banking costs and thus causes the EFP to rise. The positive shock to the export demand can act as a positive shock to income and thus generates similar dynamics to that under the positive productivity shock. When the foreign interest rate rises, higher interest rates may impose a negative effect on the borrowing by raising the borrowing cost. The output, employment in the production of goods, and consumption are reduced. Fewer loans mean that less employment is required in banking, which in turn may result in lower operating costs and thus the EFP will be lowered.

The dashed lines, however, demonstrate that the bank efficiency does not significantly lead to different macroeconomic responses to shocks, except for the movement in EFP. The EFP is lowered under efficient banking. Efficient banking can raise the loans slightly to support greater spending. However, this effect is infinitesimal. That the credit market frictions do not amplify the shocks is consistent with the results in Claus (2007). In the two-country model with a global bank, Kollmann et al. (2011) also find that a frictional global credit market does not aggravate the impact of financial shocks, except in the case of large shocks. In this model, however, the effects of bank efficiency under greater shocks do not make significant differences.

5. Economic openness and financial distress

In this section, we turn our attention to the question of whether openness in the goods and assets markets of a small open economy helps dampen the shock to the domestic frictional credit market. To approach this question, we calibrate the dynamics according to the decline in the collateral value, A_t^k, which resembles the decline in the housing prices, one of the triggers to the recent subprime crisis.[15]

In the following analysis, we experiment in the more open goods market where $\alpha^f = 0.6$ and the more open international asset market where $\sigma = 0.0019$, which is 10 times smaller than the benchmark model where $\alpha^f = 0.35$ and $\sigma = 0.019$.[16]

[14] This causes the home currency to depreciate and, in turn, results in a deterioration in the terms of trade, which are defined as the ratio of the domestic price to the import price.

[15] The dynamics under the shock to the banking productivity is similar to the shock to the collateral value. Thus, we restrict our attention to the crisis that is caused by the decline in the value of the collateral.

[16] In the past decade, following the East Asian crisis, the Korean economy has continued to open up its market. The import ratio has risen to a level close to 0.5 in 2008. Thus, we may investigate how the greater openness may enhance or dampen the macroeconomic impacts of the financial shocks.

Table 3
Steady state results.

	c	Y	l	m	K	R^{IB}	R^{B}	R^{L}	EFP
$Z=8$	0.8168	1.0616	0.3042	0.0062	9.7921	0.0002	0.0015	0.0032	0.0029
$Z=80$	0.8185	1.0409	0.3114	0.0000	8.8971	0.0101	0.0101	0.0101	0.0000

5.1. Trade openness

We introduce a 1% negative shock to the value of the collateral with the AR(1) coefficient being 0.95.[17] The results are listed in Fig. 2. As demonstrated by the solid lines for the baseline economy, the negative financial shock leads to a decline in outstanding loans. This, in turn, results in decreases in consumption, output, employment and trade. The EFP surges due to the rising demand for banking employment for loan making. The rise in the EFP can amplify the direct adverse impacts of the credit contraction caused by the financial distress.

To lessen the adverse effects on the economy, it is necessary to lower the interbank rate. The interbank rate decline is followed by other interest rates in the market and, thus, the home bond rate is also lowered. This makes the households reduce their holdings of home bonds, while increasing their foreign bond holdings. The increase in the holdings of foreign bonds is consistent with the capital outflow which normally occurs during the financial crisis. However, while the home bond rate falls more than the foreign bond rate, an expected appreciation of the home currency is required to offset the home and foreign bond rate spread for the interest rate parity to hold.

The dashed lines show the results under a more open economy where $\alpha^f = 0.6$. It is clearly shown that the higher trade openness helps dampen the responses of the macroeconomy to financial shocks. Because the consumption can rely more heavily on imports than on domestic production, the decline in consumption due to adverse financial shock can be reduced by greater openness to import. The smaller decrease in consumption helps reduce the initial declines in output and employment.

To support greater future consumption and imports, households need to save more by raising their holdings of home and foreign bonds. The magnitude of home currency appreciation should be smaller for the foreign bonds to be more profitable. Furthermore, higher trade openness can have certain implications for the credit market. The higher consumption, relative to the previous case, helps raise the loan demand and thus eases the decline in loans. This, however, does not lead to a significant difference in the EFP movement.

5.2. Degree of capital mobility

Greater capital mobility may result in different dynamic responses of the economy to financial shock. As shown by the dashed lines in Fig. 3, under a more open international capital market, consumption declines more significantly at the beginning, but the initial declines in output and employment are smaller. Thus, the variation in consumption is slightly larger, but the variations in output and employment can be reduced. The greater initial decline in consumption comes from the greater saving by cutting the consumption. While the capital flows can be freer in the international capital market, the saving falls more heavily in relation to foreign bonds.[18] When the domestic financial crisis occurs, households reduce their deposits in the bank which leads to lower consumption at the beginning, and they hold more of foreign bonds instead. Therefore, the capital outflow can be more

[17] Goodfriend and McCallum (2007) assume that the persistence of the shock to A_t^k is 0.9 to capture the modestly persistent financial distress. Here we assume that the AR coefficient is 0.95 while the current crisis seems to be persistent.

[18] Bandiera et al. (2000) examine the effects of financial liberalization on savings and globalization of the capital market is one of the stages of the process of financial liberalization. They address that one of the benefits of greater openness on the international capital markets is the greater availability of credit, and the removal of the barrier to capital outflow may also lead to the rise in the rate of return which have both positive and negative effects on savings. However, their empirical studies show that financial liberalization does not have clear effects on savings.

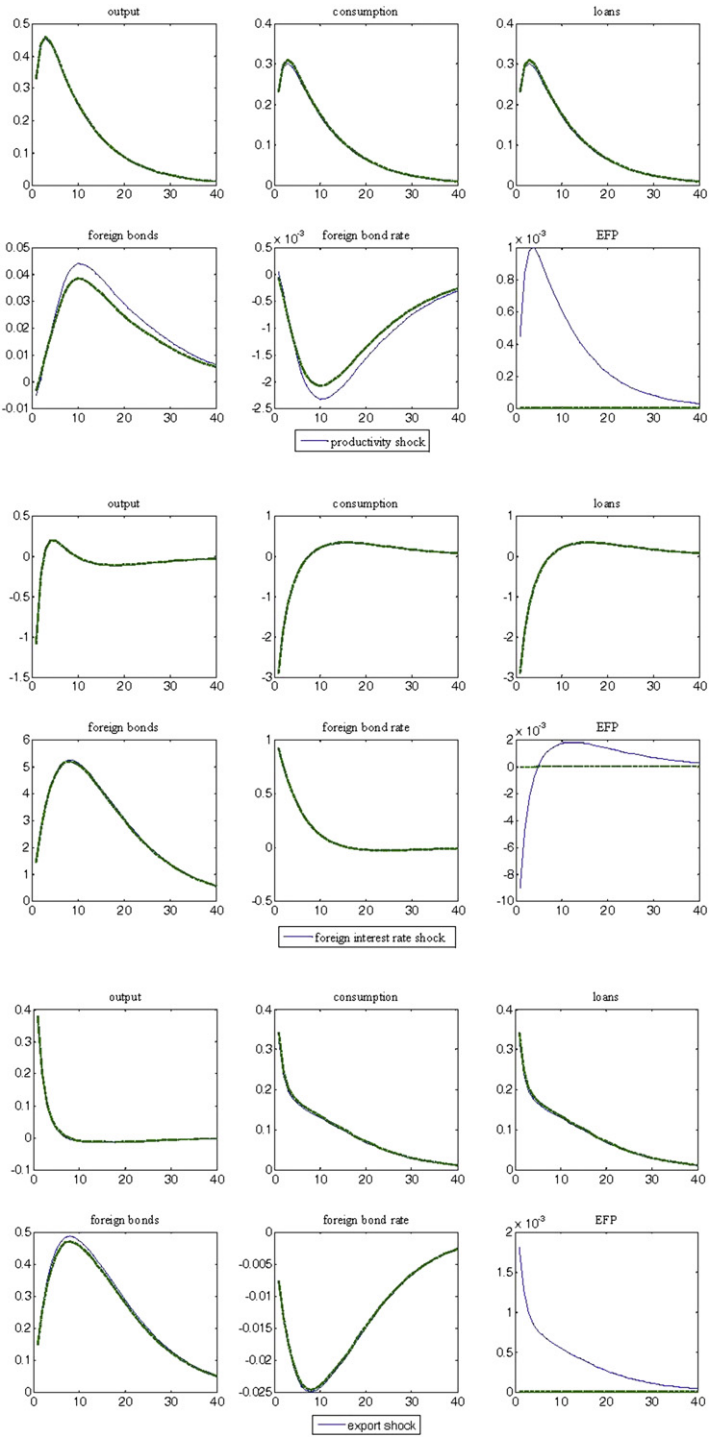

Fig. 1. 1% increase in the productivity shock. Notes: The solid lines represent the baseline economy where the financial intermediary is frictional and $F = 8$. The dashed lines represent the highly efficient banking where $F = 80$.

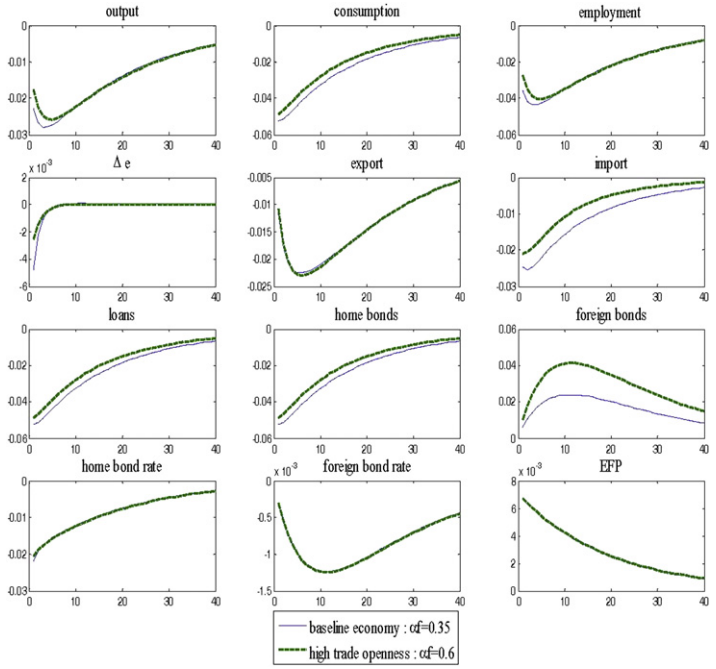

Fig. 2. 1% decrease in the shock to the value of collateral for loans under alternative degrees of trade openness.

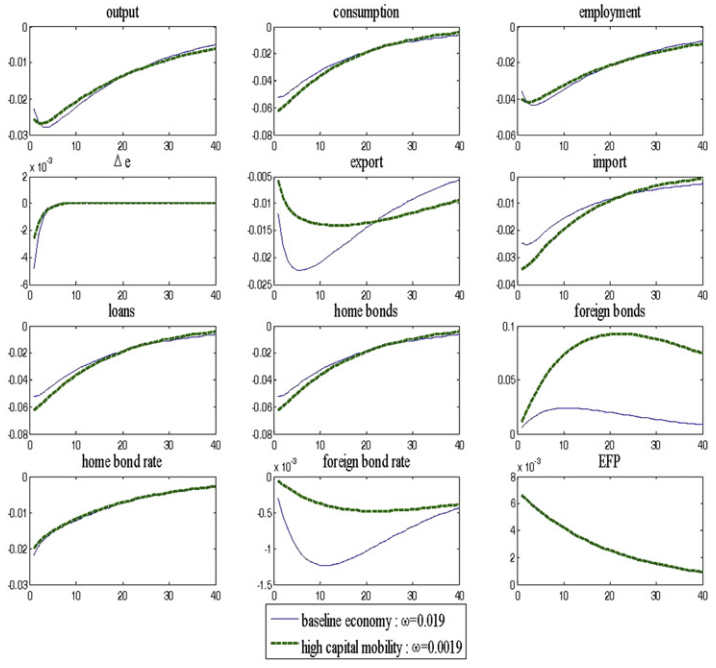

Fig. 3. 1% decrease in the shock to the value of collateral for loans under alternative degrees of capital mobility.

severe under a more open capital market. However, with the lower friction in the international capital market, the capital outflow can be subject to smaller exchange rate fluctuations which, in turn, help dampen the impact on exports and output.

These experiments reveal the key mechanism under which the shocks are transmitted. The capital may flow out of the domestic economy which is adversely impacted by domestic financial distress. The capital outflow can lead to exchange rate variation which will impact exports and imports, and therefore output and consumption, through the exchange rate pass-through onto prices. Therefore, although the macroeconomic impacts of adverse real shocks are amplified by credit-constrained international borrowing, the mechanism underlying the domestic financial crises is different from that under the credit-constrained international borrowing.

6. Conclusion

The focus of this paper has been to examine the role of a domestic frictional credit market in an emerging economy by using a small-open-economy DSGE model that deals with the banking sector. We find that financial friction does not give rise to significant differences in the effects brought about by domestic productivity, foreign interest rates and export demand shocks. Under domestic financial distress, greater trade and capital openness helps reduce the adverse impacts of a financial shock on the output. The higher degree of economic openness can facilitate the capital outflow caused by the domestic financial shocks, without a large movement in the exchange rate. This helps reduce the unfavorable effect on the real economy.

Several interesting issues remain. We may modify the model by letting the bank hold the international bonds or allow defaults on bank loans, both of which may affect the balance sheet of the bank. Although this may not qualitatively alter the main results under the adverse financial shocks in this model, it may be worth evaluating the quantitative difference in the macroeconomic impacts and the balance-sheet effect of the bank on the economy.

Appendix 1. First-order conditions

Before obtaining the first-order conditions, we let

$$\Lambda_t = \phi c_t / \left(b_{t+1} + A_t^k \varphi q_t K_{t+1} \right). \tag{A.1}$$

By substituting the balance sheet and the zero profit condition of the bank into the budget constraint, and maximizing the expected utility with the budget constraint (with the multiplier λ_t) and the goods market clearing condition, Eq. (3) (with the multiplier ϑ_t), we can obtain the first-order conditions with respect to $l_t^s, l_t, m_t^s, K_{t+1}, B_{t+1}, B_{t+1}^*$ as listed below:

$$\frac{1-\psi}{1-l_t-m_t} = w_t \lambda_t, \tag{A.2}$$

$$w_t = \left(\frac{\psi c_t^{-\rho}}{\lambda_t} - 1 \right) \frac{(1-\phi) c_t}{m_t}, \tag{A.3}$$

$$w_t = \left(\frac{\vartheta_t}{\lambda_t} \right) A_t^P (1-\alpha) \left(\frac{K_t}{A_t^l l_t} \right)^{\alpha}, \tag{A.4}$$

$$\left(\frac{\psi c_t^{-\rho}}{\lambda_t} - 1 \right) A_t^k \varphi q_t \Lambda_t - q_t + \beta(1-\delta) E_t \left(\frac{\lambda_{t+1}}{\lambda_t} q_{t+1} \right) + \beta \alpha E_t \left(\frac{\vartheta_{t+1}}{\lambda_t} \left(\frac{A_{t+1}^P l_{t+1}}{K_{t+1}} \right)^{1-\alpha} \right) = 0, \tag{A.5}$$

$$\left(\frac{\psi}{c_t\lambda_t}-1\right)\Lambda_t-1+\beta E_t\left(\frac{\lambda_{t+1}P_t}{\lambda_t P_{t+1}}\left(1+R_t^B\right)\right)=0, \tag{A.6}$$

$$-1+\beta E_t\left(\frac{\lambda_{t+1}P_t e_{t+1}}{\lambda_t P_{t+1}e_t}\left(1+R_t^{B^*}\right)\right)=0. \tag{A.7}$$

The real bonds are defined as:

$$b_{t+1}=B_{t+1}/P_t\left(1+R_t^B\right), \tag{A.8}$$

$$b_{t+1}^*=e_tB_{t+1}^*/P_t\left(1+R_t^{B^*}\right), \tag{A.9}$$

and the law of one price holds for export goods:

$$P_t^x=\frac{P_t^h}{e_t}. \tag{A.10}$$

Appendix 2. The steady state

Due to the international capital market friction, the current account is zero in the steady state such that the import and the export are equal:

$$\alpha^f c^A=(P^x/P^*)^{-\eta}. \tag{A.11}$$

By assuming the elasticity of substitution of the home and foreign demands for the home goods are identical such that $\theta=\mu$, the flexible-price steady state can be stated by the following equations:

$$1=\frac{V}{1-\gamma}Z\left(gb+\frac{\varphi qK}{c}\right)^{\alpha}\left(\frac{l}{c}\right)^{1-\alpha}, \tag{A.12}$$

$$\Lambda=\frac{\phi}{gb+\frac{\varphi qK}{c}}, \tag{A.13}$$

$$\frac{1-\psi}{1-l-m}=w\lambda, \tag{A.14}$$

$$w=\left(\frac{\psi}{c\lambda}-1\right)\frac{(1-\phi)c}{m}, \tag{A.15}$$

$$w=\frac{(\mu-1)(1-\phi)}{\mu}\left(\frac{K}{l}\right)^{\alpha}, \tag{A.16}$$

$$\left(\frac{\psi}{c\lambda}-1\right)\varphi\Lambda-1+\beta\left[1-\delta+\frac{\alpha(\mu-1)}{\mu}\left(\frac{K}{l}\right)^{\alpha-1}\right]=0, \tag{A.17}$$

$$K^{\alpha}l^{1-\alpha}-\alpha^h c^A-\left(\frac{P^x}{P^*}\right)^{-\eta}=0. \tag{A.18}$$

Except Eqs. (A.11) and (A.18) which involve the international trades, the steady-state equations are identical to those in Goodfriend and McCallum (2007), which can be solved numerically with the appropriate specification of parameters. These eight equations can be solved together to obtain the eight steady state variables consisting of $c, K, l, m, w, \Lambda, \lambda, P^*$.

Different from the determination of interest rates in Goodfriend and McCallum (2007), the domestic bond rate is restricted by the international capital market. With the exogenously specified R^{B^*}, R^B can be obtained from the difference in the Euler equations associated with the home and foreign bonds to reflect the premium on the loan service that the home bond yields:

$$\left(\frac{\psi}{c\lambda} - 1\right)\Lambda - \beta\left(R^{B^*} - R^B\right) = 0. \tag{A.19}$$

Then the steady-state level of R^{lB}, R^L, R^D and the EFP can be easily solved from the interest rate conditions Eqs. (17)–(20).

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