# Financial Integration and Capital Account Re-regulation: An Emerging Market Perspective

**Byoung-Ki Kim, Insu Kim, Sung Ju Song and Myung-Soo Yie***

May 2011

*Preliminary and Incomplete. Please Do Not Quote*

**Abstract**

This paper presents a small open economy dynamic stochastic general equilibrium model incorporating an imperfect market structure in the cross-currency swap market. The presence of foreign banks' market power provides a new mechanism that substitutes for the traditional UIP condition with a country risk premium. With this model, we analyze the effects of financial integration and capital account re-regulation. Progress in financial integration naturally means, under our framework, the gradual disappearance of foreign banks' market power. Capital account re-regulation is meanwhile similar to imposing restrictions in an imperfect market. This paper shows that progress in financial integration might increase macroeconomic volatility under certain conditions, and that capital account re-regulation in the form of taxation could be helpful in this regard.

**JEL Classification:** F36, F41, G15

**Key Words:** Financial Integration, Capital Account Re-regulation, Interest Rate Parity, Market Power

*Economic Research Institute, Bank of Korea. Emails: bkkim@bok.or.kr, ikim005@bok.or.kr, ssong@bok.or.kr and yie@bok.or.kr, respectively. The authors thank Young Seung Jung, Geun-Young Kim, Wooheon Rhee, and seminar participants at the Bank of Korea for their helpful comments and suggestions. The authors are solely responsible for any remaining errors. The views herein are those of the authors and do not necessarily reflect the official views of the Bank.

# 1 Introduction

Financial integration has deepened substantially in recent decades. Although financial integration initially started with the growth in capital flows among developed countries, reflecting the removal of capital controls, financial innovation and technological progress, it has since then spread to developing countries.[1] According to the BIS (2010), global foreign exchange market turnover was 2.6 times higher in 2010 than in 2001, bringing the average daily turnover from 1.5 trillion USD to 4.0 trillion USD. Global cross-border lending by international banks also rose 2.5 times during the same period, from 8.9 trillion to 22.4 trillion USD.[2]

It is widely acknowledged that financial integration brings not only benefits but also costs.[3] It can contribute to higher growth and less volatility of consumption, through better global capital allocation and improved pooling of risk across countries. There are also indirect or collateral benefits, which can include improvements in the governance structures of financial institutions, the acceleration of financial market development, and better macroeconomic policies.[4] On the other hand, it is also true that many emerging countries that have increased their levels of financial integration have experienced large volumes of capital inflows and subsequent financial crises. Experience tells us that financial integration does not stabilize capital flows. Rather, quite the opposite has been observed. Capital flows move not countercyclically but procyclically. That is, capital flows into a country when the economy is strong and flows out when the economy is weak.[5] Given the procyclicality of capital flows, consumption smoothing is hard to achieve.[6]

A more subtle side of financial integration is the seeming failure of the interest parity condition, especially in developing countries. Interest rate parity, in either the uncovered or the covered form, plays an important role in international and macroeconomic models.[7] It imposes a no-arbitrage condition, so that the domestic and foreign interest

[1]See Andersen and Moreno (2005).

[2]Numbers indicate amounts outstanding. See BIS (2011) Table 7A: External loans and deposits of reporting banks vis-a-vis all sectors.

[3]See Prasad and Rajan (2008) for issues related to capital account liberalization.

[4]See Kose et al. (2006).

[5]The East Asian currency crisis of 1997 is a good example.

[6]See Stiglitz (2004). He also argues that capital account liberalization does not lead to faster growth. Recently, even the IMF (2011) acknowledges that capital inflow surges can carry macroeconomic and financial stability risks, and suggests a policy framework for managing capital flows.

[7]In essence, the uncovered interest rate parity condition combines the covered interest rate parity condition with the existence of risk neutral arbitragers who fill the gap between the forward rate and

rate differential and spot and forward (or expected future) exchange rates should fulfill a certain relationship.[8] In reality, however, the no-arbitrage condition occasionally does not hold, even after counterparty risks are taken into account.[9] Empirical tests on the validity of the interest parity condition are at best controversial.[10] Some literature emphasizes the differences between advanced and emerging economies in their tests. Skinner (2008) finds that the covered interest parity (CIP) condition holds for advanced economies, but not for longer maturities for emerging economies, including Brazil, Chile and Korea. In contrast, Flood and Rose (2002), and Frankel and Poonawala (2006) report that deviation from the uncovered interest parity (UIP) condition is less severe in emerging markets. Other literature takes periods of market turbulence into account in the tests. Recently, Baba and Packer (2008) reported observance of persistent deviations from CIP even between US dollar and the euro. Taylor (1989) also concluded that profitable arbitrage opportunities existed during periods of turbulence, after studying the movements of Eurosterling and Eurodollar deposit rates, and the US dollar/UK pound spot and forward rates of various maturities.

In this regard, Isard (2006) points out that imposing the interest parity condition into macroeconomic models by itself provides a very inaccurate framework, and that it has proven difficult to mimic the observed behaviors of key macroeconomic variables with the parity condition-imposed models. Stiglitz (2004) also warns against the limitations of the results derived from the neoclassical model based on perfect information, perfect capital markets and perfect competition. Furthermore, in analyzing the effects of financial integration and/or capital account re-regulation, imposing the interest rate parity condition causes an inconsistency problem. This is because the interest rate parity condition holds only in an ideal world, in which markets are characterized by perfect competition. Therefore, at the moment the interest rate parity condition is imposed, full financial integration is also assumed. The interest rate parity condition is not consistent with capital account re-regulation, either, since the former requires the absence of the

the expected future spot rate. See Isard (2006).

[8]The no-arbitrage condition states that, after steps have been taken to avoid foreign exchange risk, the rates of return on investment, and the costs of borrowing, will be equal irrespective of the currency denomination of the investment or the currency borrowed. See Levi (2005) p. 159.

[9]Thornton (1989) has pointed out that covered interest rate parity is, in a sense, axiomatic and can never be tested seriously. Departure from it is always attributable to some ignored relevant costs: transaction costs, political or credit risks, taxes, etc. Uncovered interest rate parity has also been criticized, by Alvarez et. al (2008) among others, on the grounds that it is not consistent with the fact that nominal exchange rates between major currencies are well approximated by random walks.

[10]Alper, et al. (2007) provides a survey on the tests for UIP conditions in emerging markets.

latter.

In this paper, instead of imposing the interest parity condition, we present a small open economy dynamic stochastic general equilibrium (DSGE) model that incorporates an imperfect market structure in the cross-currency swap market. In particular, foreign banks have market power in the determination of cross-currency swap rates.[11] With this model, we analyze the effects of financial integration and capital account re-regulation. Progress in financial integration naturally means, under our framework, the gradual disappearance of foreign banks' market power in providing foreign currency in the cross-currency swap market. Capital account re-regulation is meanwhile similar to imposing restrictions in an imperfect market. This paper shows that progress in financial integration might increase macroeconomic volatility and reduce welfare, while capital account re-regulation in the form of taxation could be helpful in this regard.

Our results are consistent with Chen and Wang (2009). They, after investigating 35 industrial and developing countries over the period 1970 - 2003, find that capital inflows increase fluctuations in consumption and output growth, especially in developing countries. Recently, Cakici (2009) and Jeanne and Korinek (2010) show similar results using different models. The former carries out a study on the impact of financial integration on macroeconomic volatility with a small open economy DSGE model under a fixed exchange rate regime in which the degree of financial integration is measured by the ratio of foreign deposits to total deposits. His findings indicate that financial integration amplifies the effect of a monetary shock on macroeconomic variables, leading to an increase in volatility of key variables. The latter find that imposing restrictions on capital inflows to emerging markets during booms decreases the potential outflows during busts, prudential policy thus helps to reduce macroeconomic volatility and improve consumer welfare. The findings of this paper are also in line with these. Our approach differs from those of the abovementioned papers, however, in that we adopt a small open economy DSGE model featuring an imperfect cross-currency swap market under a flexible exchange rate regime. In our framework, both arbitrage opportunities and financial integration play crucial roles in determining the amount of capital inflow that may affect the exchange rate volatility and therefore key macroeconomic variables.

Note, however, that our model abstracts from important beneficial roles that capital inflows could play — e.g. international risk sharing and capital formation — to focus on

[11]The strategic interactions of foreign banks are assumed to follow Cournot competition. That is, foreign banks simultaneously choose their quantities, instead of prices. Note that Kreps and Scheinkman (1983) show that capacity-constrained price games yield Cournot outcomes under some circumstances.

the workings of the imperfect cross-currency swap market. Therefore, our results should be interpreted with some cautions. Having said that, we think that this paper provides a new insight that market structure is important in analyzing the effects of financial integration and capital account re-regulation for an emerging economy.

This paper is composed as follows. Section 2 illustrates the observed deviations from covered interest parity in Korea. Section 3 describes the model including the market structure in the foreign exchange swap market. Section 4 reports the impulse response analysis of various shocks including monetary policy, technology and foreign interest rate shocks, after calibrating the structure parameters in the model. Section 5 presents a measure of welfare in the form of second order approximation of households' lifetime utility, and shows that welfare decreases as the swap market grows more competitive. The effect of imposing taxation on capital inflows as a way of capital account re-regulation is also analyzed. Section 6 concludes.

## 2 Recent Trend of Interest Parity Condition in Korea

By way of background, we briefly describe the recent trend of the covered interest rate differential (CID) in Korea, after first describing the Korean foreign exchange market structure.

After the Asian currency crisis of 1997, Korea pursued capital account liberalization aggressively.[12] Reflecting the progress of capital liberalization and macroeconomic performance, the volume of foreign exchange turnover in Korea has increased markedly as illustrated in Table 1. The foreign exchange market structure, however, is far from one of perfect competition. The Korean foreign exchange market seems to be composed of a small number of dominating banks and a large number of competitive fringe.

From the oligopolistic structure of the foreign exchange market, it is conceivable that the covered interest parity condition fails to hold in Korea. Figure 1 shows CID data collected for three months, one year, three years and five years. The three-month and one-year CIDs are calculated by the generic Korean Treasury bond rate – LIBOR – the swap rates[13] for the two maturities. The three- and five-year CIDs are calculated by the

[12]Kim et al. (2009) discussed Korea's recent experiences in opening up to capital flows.

[13]The three-month swap rate is derived by (NDF forward exchange rate (3M) - spot exchange rate) / spot exchange rate $\times$ 400, where NDF means off-shore non-deliverable forwards. The one-year swap

Table 1: Foreign Exchange Market Turnover by Instrument

(Daily average, $ 100 mil., %.)

| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Spot Market | 96.8 | 127.5 | 185.2 | 196.9 | 139.1 | 165.8 |
| | (47.8) | (48.2) | (47.0) | (41.9) | (36.7) | (39.8) |
| Forward Market | 36.1 | 50.8 | 71.6 | 95.1 | 56.8 | 65.2 |
| | (17.8) | (19.2) | (18.2) | (20.2) | (15.0) | (15.7) |
| Swap Market (Q) | 69.6 | 86.2 | 137.4 | 178.2 | 182.8 | 185.5 |
| | (34.4) | (32.6) | (34.9) | (37.9) | (48.3) | (44.5) |
| Q/GDP (%) | 0.82 | 0.91 | 1.31 | 1.91 | 2.19 | 1.83 |
| Market Participants (n) | 149 | 141 | 157 | 228 | 333 | 539 |
| $CR_{10}$ | 53.8 | 63.5 | 65.2 | 56.2 | 55.0 | 54.0 |

Note: Numbers in ( ) are the weights in total currency trade (%). $CR_{10}$ indicates the market share of the largest ten foreign banks (%).
Source : Bank of Korea.

Korean Treasury bond rate - CRS rate[14] for the relevant maturities. As clearly seen in Figure 1, persistent deviation from the covered interest rate parity condition has been observed at all maturities.[15]

Taking counter-party default risk into account does not change the observation. Figure 2 depicts the five-year CID with credit risk taken into account.[16] Due to the temporary hike of CDS rate after the bankruptcy of Lehman Brothers, the CID values swung to negative territory during 2008 and 2009. It is obvious, however, that there have been persistent deviations from the CIP condition. Foreign capital flows, which show a close relationship with the CID, exhibit a high level of volatility. During the fourth quarter of 2008 alone, after the fall of Lehman Brothers, 60 billion USD of foreign capital flew out of Korea.

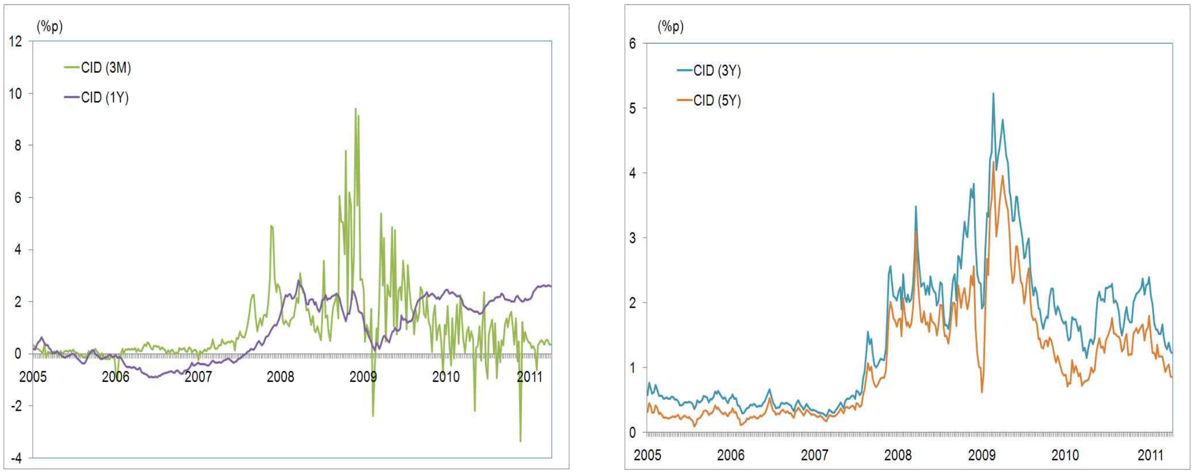
rate is derived by (NDF forward exchange rate (1Y) - spot exchange rate) / spot exchange rate × 100.

[14] The CRS rate stands for the cross-currency swap rate.

[15] The Bank of Korea (2007) attributes the deviation from the CIP condition to the imbalance between demand for and supply of foreign currency arising from massive selling of forward exchange contracts by exporters including shipbuilders and heavy industrial companies, amid bullish sentiment about the Korean won against the US dollar.

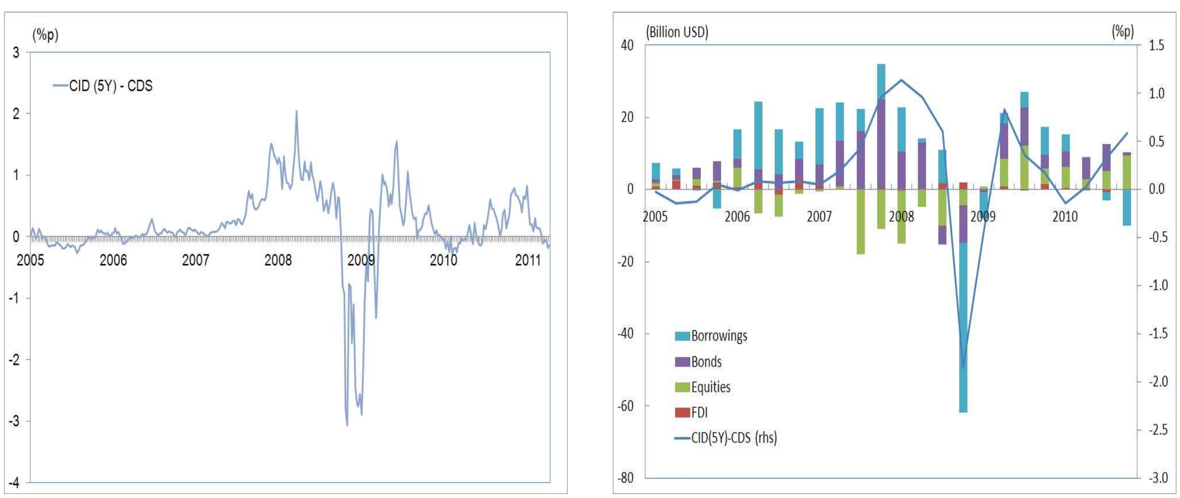
[16] Since the CDS rate is quoted in USD, the data is calculated by CID (5Y) - CDS (5Y) × NDF forward exchange rate (5Y) / spot exchange rate.

Figure 1: Recent Trend of Covered Interest Rate Differential




Source : Bloomberg.

Figure 2: Covered Interest Differentials and Foreign Capital Inflows




Sources : Bloomberg and Bank of Korea.

# 3 Model

The model economy consists of households, a representative domestic final good producer, domestic intermediate good producers, importers, domestic banks, foreign banks, a foreign country, and the central bank. Infinitely lived households consume aggregates of domestic and imported goods. The final good producer sells its output to households and the foreign country. A continuum of domestic firms, that are price setters, produce differentiated goods. Importers who supply imported goods to the households are also price setters, which implies the existence of the law-of-one price gap as in Monacelli (2003). Foreign banks invest in domestic government bonds using cross-currency swap contracts with domestic banks.

## 3.1 Households

Households consume a CES composite of domestic and imported goods. The aggregate consumption good $C_t$ is defined as

$$C_t = \left( \theta_H^{\frac{1}{\psi}} C_{H,t}^{\frac{\psi-1}{\psi}} + (1-\theta_H)^{\frac{1}{\psi}} C_{F,t}^{\frac{\psi-1}{\psi}} \right)^{\frac{\psi}{\psi-1}},$$

where $C_{H,t}$ and $C_{F,t}$ denote consumption of the home- and foreign country-produced final goods, respectively. $\theta_H$ is the share of the domestic good in a CES composite consumption, and $\psi$ is the elasticity of substitution between domestic and foreign goods. We assume that all goods are traded. Let $P_t$, $P_{H,t}$, and $P_{F,t}$ be the prices of $C_t$, $C_{H,t}$, and $C_{F,t}$, respectively. Households first minimize $P_{H,t}C_{H,t} + P_{F.t}C_{F,t}$, the cost of purchasing domestic and foreign goods, to obtain a given level of $C_t$. This yields the following first order conditions:

$$C_{H,t} = \theta_H \left( \frac{P_{H,t}}{P_t} \right)^{-\psi} C_t \tag{1}$$

$$C_{F,t} = (1-\theta_H) \left( \frac{P_{F,t}}{P_t} \right)^{-\psi} C_t \tag{2}$$

$$P_t = \left( \theta_H P_{H,t}^{1-\psi} + (1-\theta_H) P_{F,t}^{1-\psi} \right)^{\frac{1}{1-\psi}} \tag{3}$$

Next, subject to the budget constraint, households maximize their lifetime utility which is given by

$$\max_{C,l,B} \sum_{j=0}^{\infty} \beta^j u(C_{t+j}, l_{t+j}).$$

The period household utility depends on the aggregate consumption and labor supply $l_t$, which is assumed to be

$$u(C_t, l_t) = a_t \left( \frac{C_t^{1-\sigma}}{1-\sigma} - \phi \frac{l_t^{1+\alpha}}{1+\alpha} \right),$$

where $\sigma$ is a risk aversion parameter, $\alpha$ is the inverse of the elasticity of labor, and $a_t$ is a preference shock, which follows a log AR(1) process. Households purchase the composite consumption good, and nominal one-period bonds ($B_t$) whose gross interest rate is $R_t$. The income of households comes from supplying labor ($l_t$), holding domestic bonds, and profit dividends from the domestic good producing firms, importers and domestic banks. Hence, the budget constraint can be written as

$$B_t + P_t C_t = W_t l_t + R_{t-1} B_{t-1} + \bar{\Pi}_t^F + \bar{\Pi}_t^I + \bar{\Pi}_t^{DB} + T_t, \tag{4}$$

where $W_t$ denotes the household's nominal wage, $T_t$ is a tax or money transfer from the government, and $\bar{\Pi}_t^F$, $\bar{\Pi}_t^I$, and $\bar{\Pi}_t^{DB}$ are the profits of domestic good producers, importers, and domestic banks, respectively.

From the first order conditions, we have the following Euler equations:

$$a_t C_t^{-\sigma} = \beta R_t E_t a_{t+1} \tfrac{C_{t+1}^{-\sigma}}{\pi_{t+1}} \tag{5}$$

$$\phi \tfrac{l_t^{\alpha}}{C_t^{-\sigma}} = \tfrac{W_t}{P_t} \tag{6}$$

## 3.2 Domestic Good Producers

### 3.2.1 Final Good Producer

The representative final domestic good producer operates under perfect competition. The production of the final domestic good, $y_t$, is a composite of a continuum of differentiated intermediate goods, each supplied by a different firm. The technology to produce the final good is given by the constant elasticity of substitution (CES) function:

$$y_t = \left( \int_0^1 y_{i,t}^{\frac{\varepsilon_H - 1}{\varepsilon_H}} di \right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}}, \tag{7}$$

where $y_{i,t}$ is an intermediate good produced by firm $i \in (0,1)$, and $\varepsilon_H > 1$ is the elasticity of substitution between different types of goods. Profit maximization by the final good producers leads to the following demand equation for each intermediate good:

$$y_{i,t} = \left( \frac{P_{H,t}^i}{P_{H,t}} \right)^{-\varepsilon_H} y_t, \tag{8}$$

where $P_{H,t}^i$ is the price of the domestic intermediate good, $y_{i,t}$, and $P_{H,t}$ is the Dixit-Stigliz price index

$$P_{H,t} = \left( \int_0^1 (P_{H,t}^i)^{1-\varepsilon_H} di \right)^{\frac{1}{1-\varepsilon_H}}. \tag{9}$$

### 3.2.2 Intermediate Goods Producers

In the domestic intermediate goods market, there are a continuum of monopolistic competitive firms indexed by $i \in (0,1)$, and each firm $i$ produces differentiated good $y_{i,t}$ and faces a downward sloping demand for that good. Firm $i$ produces $y_{i,t}$ using the following technology

$$y_{i,t} = z_t l_{i,t}, \tag{10}$$

where $l_{i,t}$ is labor input and $z_t$ is a technology shock which follows a log AR(1) process. Cost minimization results in the following first order condition for the choice of $l_{i,t}$

$$w_t p_{h,t} = mc_{H,t} z_t, \tag{11}$$

where $w_t = \frac{W_t}{P_t}$, and $p_{h,t} = \frac{P_t}{P_{H,t}}$. $mc_{H,t} = \frac{MC_{H,t}}{P_{H,t}}$ is the real marginal cost.

Following a standard Calvo-Yun pricing rule, a fraction $1 - \omega_H$ of all firms change their prices every period, while the remaining $\omega_H$ fraction do not change. Firm $i$'s pricing decision problem then involves choosing $P_{H,t}^i$ to maximize the expected lifetime profit stream

$$E_t \sum_{k=0}^{\infty} \omega_H^k \Lambda_{t+k} \left( \frac{P_{H,t}^i}{P_{H,t+k}} - mc_{H,t+k} \right) y_{i,t+k}$$

$$s.t.\ \ y_{i,t} = \left(\frac{P^i_{H,t}}{P_{H,t}}\right)^{-\varepsilon_H} y_t,$$

where $\Lambda_{t+k} = \beta^k \left(\frac{C_{t+k}}{C_t}\right)^{-\sigma} a_{t+k}$ is a stochastic discount factor and $\omega^k_H$ can be defined as the probability that the price set at time $t$ will still hold at time $t+k$.

The first order condition of the optimal choice of $P^*_{H,t}$ yields

$$\begin{aligned}
\frac{P^*_{H,t}}{P_{H,t}} &= \frac{\varepsilon_H}{\varepsilon_H - 1} \frac{E_t \sum^{\infty}_{t+k} \omega^k_H \Lambda_{t+k} mc_{H,t+k} \left(\frac{P_{H,t+k}}{P_{H,t}}\right)^{\varepsilon_H} y_{t+k}}{E_t \sum^{\infty}_{t+k} \omega^k_H \Lambda_{t+k} \left(\frac{P_{H,t+k}}{P_{H,t}}\right)^{\varepsilon_H - 1} y_{t+k}} \\
&= \frac{\varepsilon_H}{\varepsilon_H - 1} \frac{K_{H,t}}{F_{H,t}}, \qquad (12)
\end{aligned}$$

where $K_{H,t}$ and $F_{H,t}$ can be written in recursive forms as

$$K_{H,t} = a_t C_t^{-\sigma} y_t mc_{H,t} + \omega_H \beta E_t K_{H,t+1} \pi^{\varepsilon_H}_{H,t+1} \qquad (13)$$

$$F_{H,t} = a_t C_t^{-\sigma} y_t + \omega_H \beta E_t F_{H,t+1} \pi^{\varepsilon_H - 1}_{H,t+1}. \qquad (14)$$

From (9), the domestic aggregate price index evolves according to

$$P_{H,t} = \left((1-\omega_H)(P^*_{H,t})^{1-\varepsilon_H} + \omega_H P^{1-\varepsilon_H}_{H,t-1}\right)^{\frac{1}{1-\varepsilon_H}}. \qquad (15)$$

Substitution of (12) into (15) implies that equilibrium inflation in any period is given by

$$\frac{1-\omega_H \pi_t^{\varepsilon_H - 1}}{1-\omega_H} = \left(\frac{\varepsilon_H}{\varepsilon_H - 1} \frac{K_{H,t}}{F_{H,t}}\right)^{1-\varepsilon_H}. \qquad (16)$$

We define $\Delta_{H,t} = \int_0^1 \left(\frac{P^i_{H,t}}{P_{H,t}}\right)^{-\varepsilon_H} di$ as a measure of price dispersion at time $t$. Using (15), then the law of motion for the price dispersion is derived as

$$\Delta_{H,t} = \omega_H \Delta_{H,t-1} \pi^{\varepsilon_H}_{H,t} + (1-\omega_H)\left(\frac{1-\omega_H \pi^{\varepsilon_H - 1}_{H,t}}{1-\omega_H}\right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}}. \qquad (17)$$

## 3.3 Domestic Importers

We incorporate the incomplete exchange rate pass-through as in Monacelli (2003). Importer $j$ imports a differentiated good $C^j_{F,t}$ whose price is $P^j_{F,t}$. Domestic importers face a Calvo-Yun type price-setting problem. The nominal marginal cost of the domestic importers is $S_t P^f_{F,t}$. A fraction $\omega_F$ of all importers do not change their prices in period $t$, and importer $j$ chooses $P^j_{F,t}$ to maximize its expected lifetime profit stream :

$$E_t \sum_{k=0}^{\infty} \omega_F^k \Lambda_{t+k} \left( \frac{P^j_{F,t}}{P_{F,t+k}} - mc_{F,t+k} \right) C^j_{F,t+k}$$

$$s.t.\ \ C^j_{F,t} = \left( \frac{P^j_{F,t}}{P_{F,t}} \right)^{-\varepsilon_F} C_{F,t},$$

where $mc_{F,t} = \frac{MC_{F,t}}{P_{F,t}} = \frac{S_t P^f_{F,t}}{P_{F,t}}$, $\varepsilon_F > 1$ is the substitution elasticity between differentiated goods, and $\omega_F^k$ can be defined as the probability that the price set at time $t$ will still hold at time $t + k$.

The first order condition of the optimal choice of $P^*_{F,t}$ yields

$$\begin{aligned} \frac{P^*_{F,t}}{P_{F,t}} &= \frac{\varepsilon_F}{\varepsilon_F - 1} \frac{E_t \sum_{t+k}^{\infty} \omega_F^k \Lambda_{t+k} mc_{F,t+k} \left( \frac{P_{F,t+k}}{P_{F,t}} \right)^{\varepsilon_F} C_{F,t+k}}{E_t \sum_{t+k}^{\infty} \omega_F^k \Lambda_{t+k} \left( \frac{P_{F,t+k}}{P_{F,t}} \right)^{\varepsilon_F - 1} C_{F,t+k}} \\ &= \frac{\varepsilon_F}{\varepsilon_F - 1} \frac{K_{F,t}}{F_{F,t}}, \end{aligned} \tag{18}$$

where $K_{F,t}$ and $F_{F,t}$ can be written in recursive forms as

$$K_{F,t} = a_t C_t^{-\sigma} C_{F,t} mc_{F,t} + \omega_H \beta E_t K_{F,t+1} \pi^{\varepsilon_F}_{F,t+1} \tag{19}$$

$$F_{F,t} = a_t C_t^{-\sigma} C_{F,t} + \omega_F \beta E_t F_{F,t+1} \pi^{\varepsilon_F - 1}_{F,t+1}. \tag{20}$$

The aggregate import price index evolves according to

$$P_{F,t} = \left( (1 - \omega_F)(P^*_{F,t})^{1-\varepsilon_F} + \omega_F P^{1-\varepsilon_F}_{F,t-1} \right)^{\frac{1}{1-\varepsilon_F}}. \tag{21}$$

Similar to the case with the domestic intermediate good price inflation, the equilibrium import good price inflation is given by

$$\frac{1 - \omega_F \pi^{\varepsilon_F - 1}_{F,t}}{1 - \omega_F} = \left( \frac{\varepsilon_F}{\varepsilon_F - 1} \frac{K_{F,t}}{F_{F,t}} \right)^{1-\varepsilon_F}. \tag{22}$$

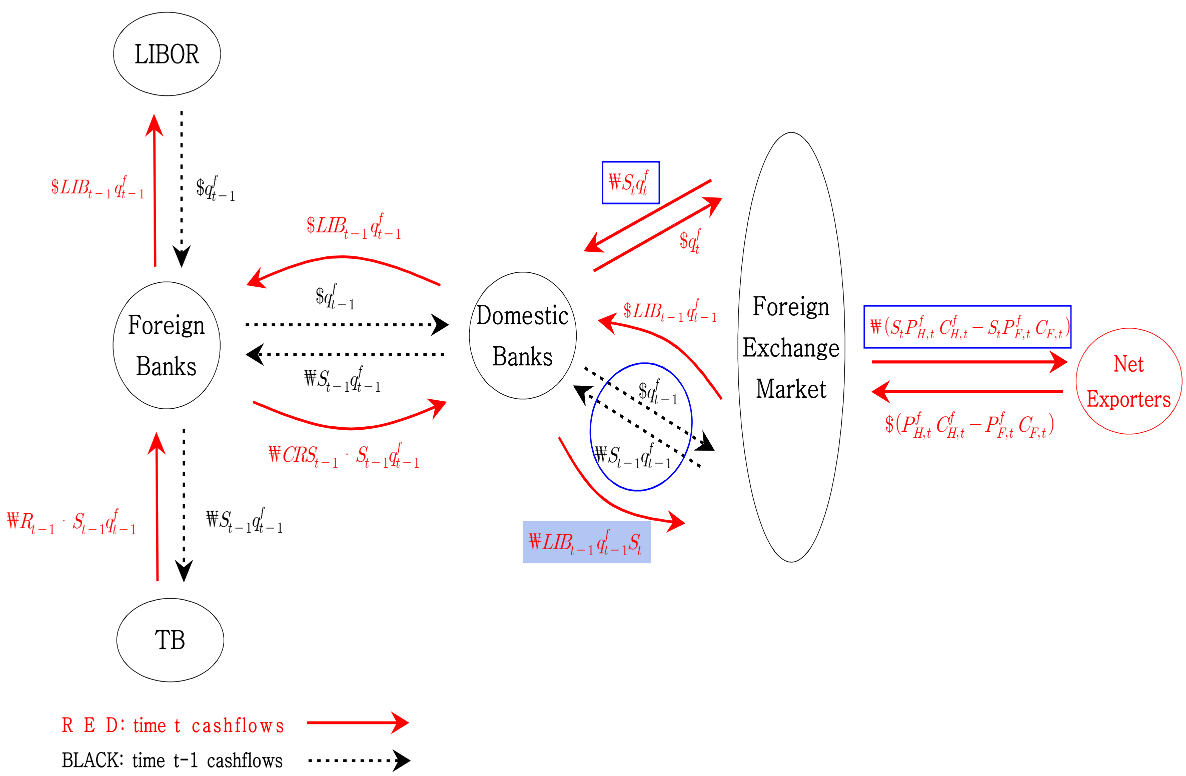
We define $\Delta_{F,t} = \int_0^1 \left( \frac{P^j_{F,t}}{P_{F,t}} \right)^{-\varepsilon_F} dj$ as a measure of imported good price dispersion, then the law of motion for the import good price dispersion is derived as

$$\Delta_{F,t} = \omega_F \Delta_{F,t-1} \pi_{F,t}^{\varepsilon_F} + (1-\omega_F) \left( \frac{1-\omega_F \pi_{F,t}^{\varepsilon_F - 1}}{1-\omega_F} \right)^{\frac{\varepsilon_F}{\varepsilon_F - 1}} . \tag{23}$$

## 3.4 Swap Market

In this section, we modify the model presented by Kim (2009) showing that the covered interest parity condition does not hold in an oligopolistic environment when foreign banks exercise market power in the swap market. Figure 3 depicts a cross-currency swap contract: the dashed lines represent the cash flow in period $t-1$, mainly the flow of principal, while the solid lines represent the cash flow in period $t$, mainly the return of principal and interest. Firstly, we assume that the domestic banks are homogeneous

Figure 3: Cross-Currency Swap Market Structure




and that there are a finite number of foreign banks which are interested in the designated cross-currency swap market. The domestic and the foreign banks have relative advantages in raising domestic currency- and foreign currency(USD)-denominated debt, respectively. The Domestic banks cannot borrow from the international financial market. A foreign bank $k \in \{1, 2, ...n\}$ borrows $q_{k,t}^f$ dollars in the international financial market at the gross interest rate cost of $R_t^f$, and invests in domestic government bonds after financing domestic currency through cross-currency swap contracts with domestic banks. In the next period, the domestic government bonds mature and the foreign bank repays its international financial market borrowings with interest.[17]

We define $q_t^f = \sum_{k=1}^n q_{k,t}^f$ as the total amount of foreign inflows. We then consider the surpluses of the domestic banks and the foreign bank $k$ from the currency swap contracts, expressed in domestic currency :

$$CRS_t S_t q_t^f - R_t^f E_t S_{t+1} q_t^f \geq 0 \tag{24}$$

$$R_t S_t q_{k,t}^f - CRS_t S_t q_{k,t}^f \geq 0, \tag{25}$$

where $R_t$ is the gross interest rate of government bonds, $CRS_t$ the swap rate, and $S_t$ the nominal exchange rate. Equation (24) represents the surplus of domestic banks in terms of the domestic currency, while equation (25) is the surplus of foreign bank $k$ expressed in the domestic currency.

We assume that the foreign bank has market power over the domestic banks in the swap contracts. The swap rate is assumed to be determined as a function of $q_t^f$ :

$$CRS_t = R_t^f \frac{E_t S_{t+1}}{S_t} + \chi \frac{S_t}{P_t} q_t^f \tag{26}$$

One way to derive this equation is to assume that the domestic banks must pay additional costs in the currency swap contracts. Hence, the surplus of the domestic banks in terms of consumption units can be replaced by

$$\Pi_t^{DB} = CRS_t \frac{S_t}{P_t} q_t^f - R_t^f \frac{E_t S_{t+1}}{P_t} q_t^f - \frac{\chi}{2} \left( \frac{S_t}{P_t} q_t^f \right)^2 . \tag{27}$$

Here, we assume that there is a quadratic cost in increasing foreign capital inflows. We can think of this cost as a managerial cost. When the domestic banks are involved in bigger sizes of currency swap contracts, this requires more paper work or labor. The choice of the domestic banks' $q_t^f$ to maximize their surplus results in the first order condition (26).

Observing domestic banks' actions, the foreign bank maximizes its profit with respect

[17] We assume that there are no capital gains.

to $q_{k,t}^f$ as follows :

$$\begin{aligned}\Pi_{k,t}^{FB} &= R_t \frac{S_t}{P_t} q_{k,t}^f - CRS\left(q_t^f\right) \frac{S_t}{P_t} q_{k,t}^f \\ &= R_t \frac{S_t}{P_t} q_{k,t}^f - R_t^f \frac{E_t S_{t+1}}{P_t} q_{k,t}^f - \chi \sum_{h=1}^{n} q_{h,t}^f \frac{S_t}{P_t} \frac{S_t}{P_t} q_{k,t}^f \end{aligned} \quad (28)$$

The second line of (28) comes from the fact that the domestic banks' optimal choice of $q_t^f$ results in $CRS_t = R_t^f \frac{E_t S_{t+1}}{S_t} + \chi \sum_{h=1}^n q_{h,t}^f \frac{S_t}{P_t}$. The first order condition of foreign bank $k$'s choice of $q_{k,t}^f$ is

$$R_t = R_t^f \frac{E_t S_{t+1}}{S_t} + \chi Q_t + \chi \frac{S_t}{P_t} q_{k,t}^f. \quad (29)$$

Taking summation from $k = 1$ to $n$ on both sides of (29), we obtain the aggregate condition as follows :

$$R_t = R_t^f \frac{E_t S_{t+1}}{S_t} + \chi \left(1 + \frac{1}{n}\right) Q_t, \quad (30)$$

where $Q_t = \frac{S_t}{P_t} q_t^f$ and $q_t^f = \sum_{h=1}^n q_{h,t}^f = n q_{h,t}^f$ for all $k \neq h$ under the symmetric equilibrium assumption. As we can see from equation (30), in equilibrium there exists a positive gap between the domestic bond rate and the world interest rate adjusted by the expected change in the exchange rate. The relationship between domestic and foreign interest rates in (30) is not different from the UIP condition derived in the standard small open economy DSGE literature, in which an extra term is added from outside the model exogenously.[18] But in our model the source of the deviations from the UIP condition is endogenously imposed. Specifically, there are two sources of the gap between domestic and foreign interest rates. One source of this gap is related to the swap market structure. The individual foreign bank has market power over the domestic banks in the swap contracts. But as the number of foreign banks increases ($n \to \infty$), the gap from the swap market structure disappears. The other source of the gap relates to the domestic financial market's inefficiency. Since domestic banks pay additional costs in the currency swap contracts, the swap rate is higher than the world interest rate as long as foreign capital inflow, $q_t^f$, is positive.

From (30), the equilibrium swap rate is determined in-between the domestic bond

[18] Begnigno (2009) adds additional costs of holding foreign assets. Choi and Cook (2004) and Yie and Yoo (2011) introduce an asymmetric information friction as a source of risk premium.

rate and the world interest rate adjusted by the expected change in the exchange rate as follows :

$$CRS_t = \frac{n}{n+1}R_t + \frac{1}{n+1}R_t^f \frac{E_t S_{t+1}}{S_t} \tag{31}$$

When the swap market becomes more competitive, i.e. the number of foreign banks $n$ in the swap market increases, the swap rate approaches the domestic bond rate and moves away from the world interest rate.

## 3.5 Monetary Policy

The central bank's budget constraint is given by

$$B_t^s = B_{t-1}^s R_{t-1} + T_t \tag{32}$$

The central bank is assumed to adjust the short term interest rate, $R_t$, following the rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_r} \left(\left(\frac{y_t}{y_{t-1}}\right)^{\alpha_y} \pi_t^{\alpha_\pi}\right)^{1-\rho_r} e^{e_{r,t}}, \tag{33}$$

where $R$ is the steady state interest rate, and $e_{r,t}$ is an i.i.d. shock.

## 3.6 Foreign Country

The demand for domestic goods by the foreign country is given by

$$C_{H,t}^f = \left(\frac{P_{H,t}^f}{P_t^f}\right)^{-\psi} C_t^f, \tag{34}$$

where the superscript $f$ represents the foreign country. Hence, $C_{H,t}^f$ and $C_t^f$ denote consumption goods produced in the home country and consumed in the foreign country, and aggregate consumption goods consumed in the foreign country, respectively, and $P_{H,t}^f$ and $P_t^f$ are the prices of $C_{H,t}^f$ and $C_t^f$ in the foreign country, respectively. We assume that the law of one price holds for export goods, i.e., $S_t P_{H,t}^f = P_{H,t}$. We also assume that $C_t^f = y_t^f$ and $P_{F,t}^f = P_t^f$. Let's define $q_t = \frac{S_t P_t^f}{P_t}$ as the real exchange rate.

By using the law-of-one price condition, we can rewrite equation (34) as

$$C^f_{H,t} = \left(\frac{P_{H,t}}{q_t P_t}\right)^{-\psi} y^f_t. \tag{35}$$

Since we consider a small open economy, the behavior of domestic agents does not alter foreign country variables such as foreign price ($P^f_t$), foreign output ($y^f_t$), and the foreign interest rate ($R^f_t$). We assume that the foreign country variables follow the log AR(1) processes as below

$$\log y^f_t = (1-\rho^f_y)\log y^f + \log y^f_{t-1} + e_{y^f,t} \tag{36}$$

$$\log P^f_t = (1-\rho^f_y)\log P^f + \log P^f_{t-1} + e_{P^f,t} \tag{37}$$

$$\log R^f_t = (1-\rho^f_y)\log R^f + \log R^f_{t-1} + e_{R^f,t}, \tag{38}$$

where $e_{y^f,t}$, $e_{P^f,t}$, and $e_{R^f,t}$ are i.i.d. shocks.

## 3.7 Equilibrium

The equilibrium in the domestic goods market and the bond market require that

$$y_t = C_{H,t} + C^f_{H,t}, \tag{39}$$

$$B^s_t = B_t + S_t q^f_t. \tag{40}$$

From the household budget constraint, we have the following balance of payments equation

$$\begin{aligned} R^f_{t-1}S_t q^f_{t-1} - S_t q^f_t &+ (R_{t-1} - CRS_{t-1})S_{t-1}q^f_{t-1} + \frac{\chi}{2}\left(\frac{S_{t-1}}{P_{t-1}}q^f_{t-1}\right)^2 P_{t-1} \\ &= S_t P^f_{H,t} C^f_{H,t} - S_t P^f_{F,t}\Delta_{F,t} C_{F,t}, \end{aligned} \tag{41}$$

where the last two terms of the left hand side represent the profit of the foreign banks and the extra cost of the domestic banks, respectively.

# 4 Calibration and Model Dynamics

## 4.1 Calibration

The calibration of structure parameters is done as follows. For domestic price stickiness, we follow the standard new Keynesian small open economy DSGE model papers. The discount factor, $\beta$, is set to 0.99, implying that the annual real interest rate is 4%, and the steady state annual foreign interest rate is set at 2.5%. The substitution elasticities between domestic intermediate goods and between import goods are set at 6, which implies that the steady state markup is 1.2. The Calvo parameters for domestic goods and for import goods are set to 0.75 and 0.5, respectively, implying that importers change their import good prices more frequently than domestic intermediate good producers do. The substitution elasticity between home and foreign goods is set to 1.5 as in Monacelli (2003), and the fraction of domestic consumption is set at 0.66, which corresponds roughly to one minus the import-to-GDP ratio in Korea during 2000 and 2010. The measure of additional costs for domestic banks, $\chi$, is set to be 0.15, implying that the steady state value of $\frac{Q_t}{y_t} = 0.012$, which is close to the average of the liability inflows to GDP ratio. For the monetary policy rule, the interest rate smoothing parameter is set at 0.7, and the coefficients of inflation and output growth are set at 1.5 and 0.5, respectively.

The AR(1) coefficients of the exogenous shocks are set to 0.6. In order to see the responses of the economy to the exogenous shocks, we assume that the standard deviations of the shocks are 0.01.

## 4.2 Model Dynamics

In this subsection, we are interested in whether the model is able to generate the stylized facts. For this purpose, we examine the effects of various shocks on key macroeconomic variables. We consider six shocks: three of which are domestic and three external. The domestic shocks include a preference shock, a technology shock, and a monetary policy shock. The external shocks considered are a foreign interest rate shock, a foreign output shock, and a foreign price shock.

Figure 4 shows the impulse responses to a monetary policy shock. When the domestic interest rate rises, both inflation and output fall. Because of the relatively lower borrowing costs in the world market to the returns from holding domestic bonds, for-

Table 2: Calibration of Parameters

| Parameters | Values | Definition |
|---|---|---|
| $\beta$ | $1.04^{-1/4}$ | Preference coefficient |
| $\theta_H$ | 0.66 | Fraction of domestic consumption |
| $\psi$ | 1.5 | Substitution elasticity between home and foreign goods |
| $\sigma$ | 2 | Inverse of risk aversion |
| $\alpha$ | 3 | Inverse of labor elasticity |
| $\phi$ | 0.5 | Weight of labor in the utility |
| $\varepsilon_H$ | 6 | Substitution elasticity between intermediate goods |
| $\varepsilon_F$ | 6 | Substitution elasticity between import goods |
| $\omega_H$ | 0.75 | Calvo parameter for domestic goods |
| $\omega_F$ | 0.5 | Calvo parameter for import goods |
| $\chi$ | 0.15 | Measure of domestic banks' additional cost |
| $R^f$ | $1.025^{1/4}$ | Foreign interest rate in steady state |
| $\rho_R$ | 0.7 | Interest rate smoothing parameter in policy rule |
| $a_\pi$ | 1.5 | Inflation coefficient in policy rule |
| $a_y$ | 0.5 | Output growth coefficient in policy rule |
| $\rho' s$ | 0.6 | AR(1) coefficient of shocks |

eign banks increase the amount of their dollar borrowings in the international financial market and purchase domestic government bonds through cross-currency swap contracts with domestic banks. This, in turn, increases capital inflows, $Q_t$, and the real exchange rate falls, which further reduces net exports and output.

From a positive preference shock, as shown in Figure 5, domestic firms produce more output and inflation rises in accord with the increase of consumption demand. In turn, the domestic interest rate rises, which increases capital inflows since the purchasing of domestic bonds by foreign banks becomes more profitable.

Figure 6 depicts the impulse responses to a positive technology shock. Given a positive technology shock, domestic firms produce more output but inflation falls due to the increase in aggregate supply. Since the inflation weight on the policy rule is greater than that of output growth, the monetary authority responds by reducing interest rates. Because of the relatively lower returns on domestic bonds, foreign banks cut their investment in domestic bonds, which reduces the supply of dollars in the spot market, and the exchange rate and net exports rise.

As shown in Figure 7, when foreign interest rates rise exogenously foreign banks reduce their cross-currency swap contracts because of the higher costs of borrowing to purchase domestic government bonds. Hence, the amount of foreign inflows shrinks. The supply of dollars in the spot exchange market decreases, and the exchange rate rises (the US dollar appreciates). The depreciation of the domestic currency boosts net exports, and increases output, inflation, and hence the policy rate.

Figure 8 shows the impulse responses to a positive foreign output shock. Increased foreign demand for domestic goods boosts exports and foreign exchange rates fall, which reduces import prices. Domestic firms produce more output, while aggregate price inflation falls because the amount of downward pressure on import prices is greater than that of the upward pressure on domestic goods prices. The central bank raises the policy rate to stabilize the domestic economy. Foreign banks then withdraw their investment in domestic bonds, because the exchange rate is expected to rise in the future which raises the swap rate by more than the return on domestic bond holdings.

The impulse responses to a foreign price shock are shown in Figure 9. A positive foreign price shock increases the marginal cost of imported goods, which raises their price. The increase in foreign price raises the real exchange rate directly, which increases exports. As net exports increase, domestic output and inflation rise and the central bank responds by raising interest rates to stabilize the domestic economy. In the swap market, foreign banks reduce their investment in domestic bonds. While the increased returns on domestic bond holdings tend to encourage foreign banks to purchase more domestic bonds, the swap rate at the same time rises owing to domestic banks' expectations that the exchange rate will rise in the future. Since the upward pressure on the swap rate, which is the investment costs of foreign banks, is higher than the returns on domestic bond holdings, foreign banks cut their capital inflows.

Figure 4: Impulse Responses to a Monetary Policy Shock

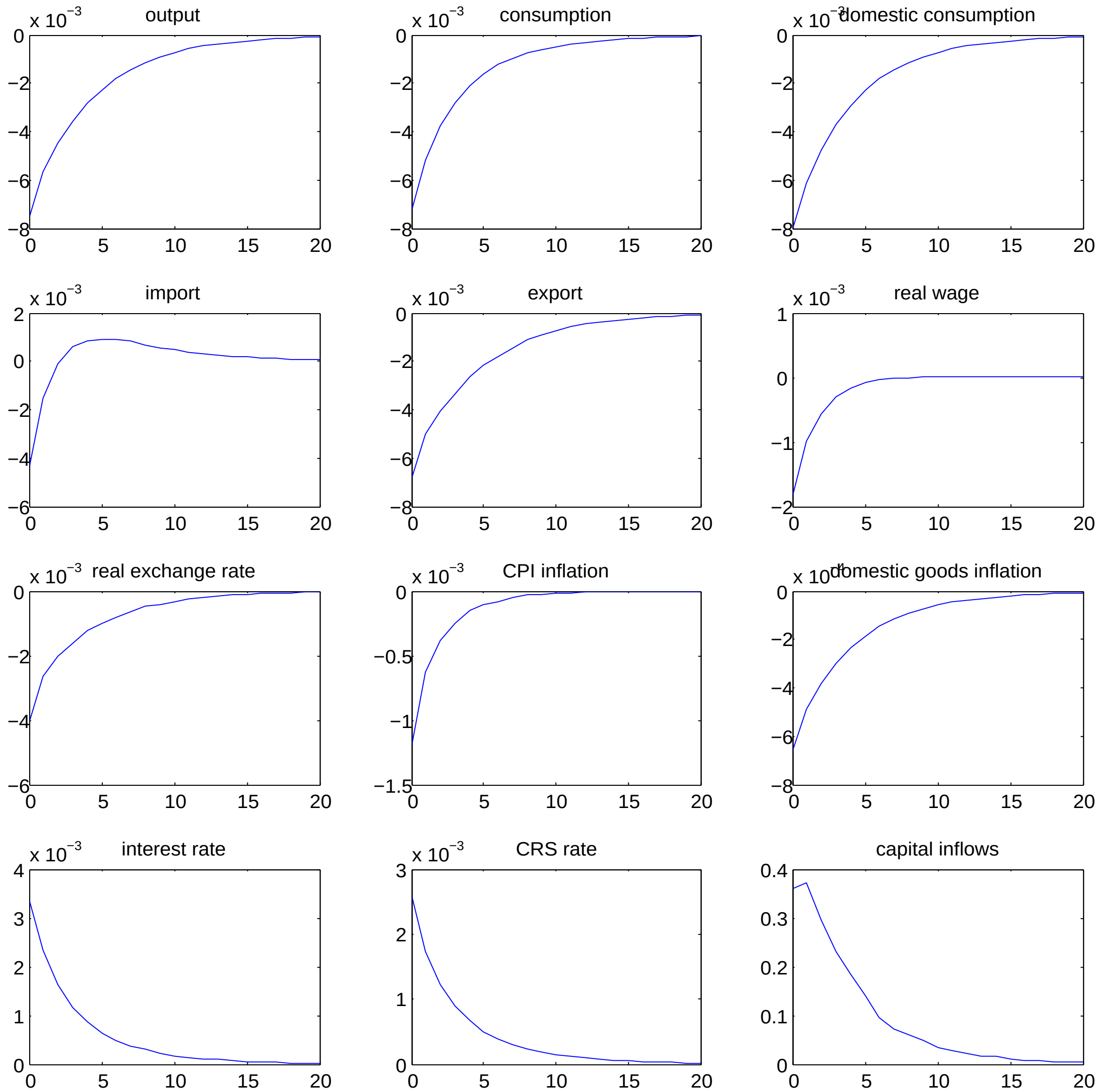


Figure 5: Impulse Responses to a Preference Shock

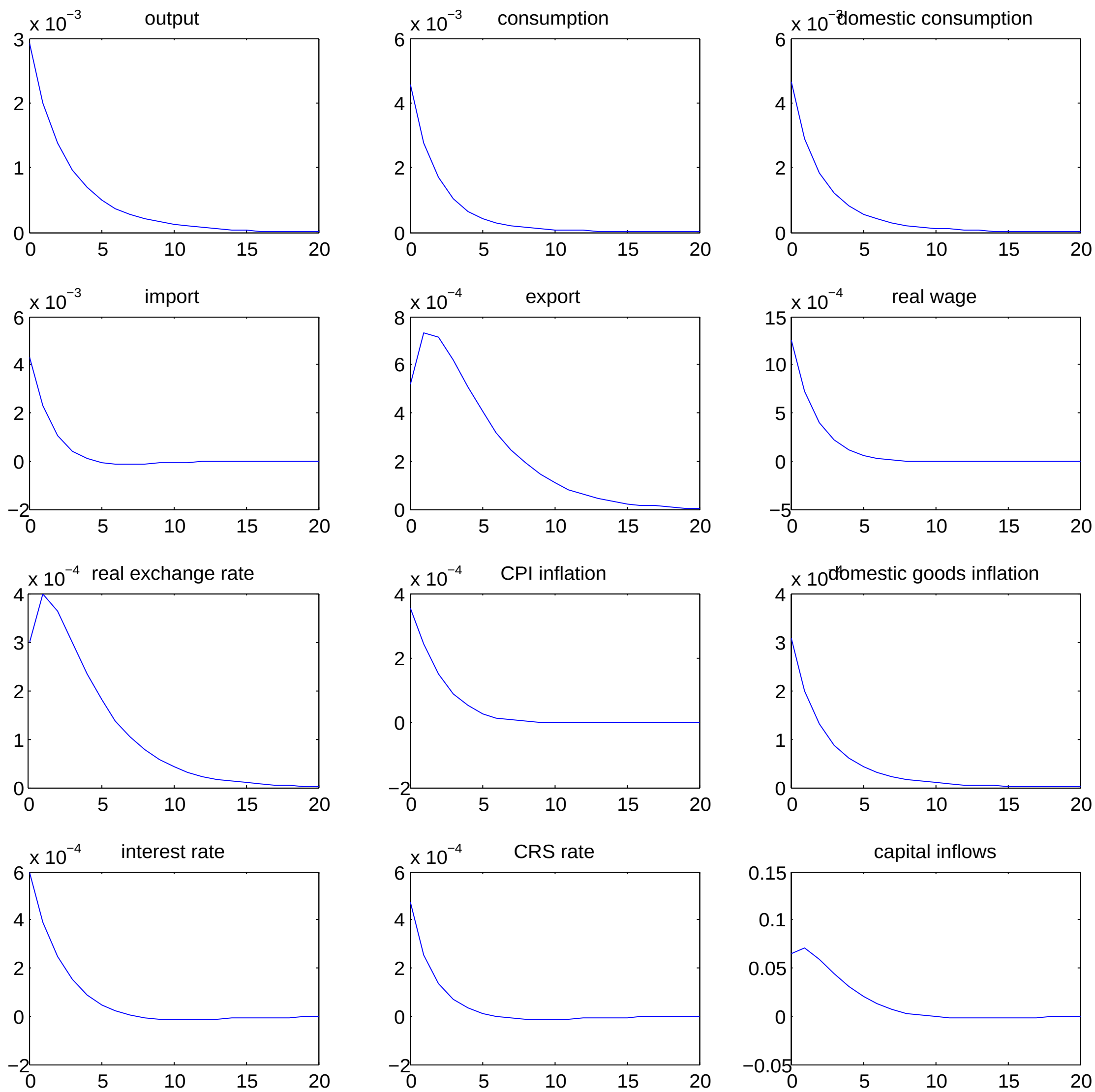


Figure 6: Impulse Responses to a Technology Shock

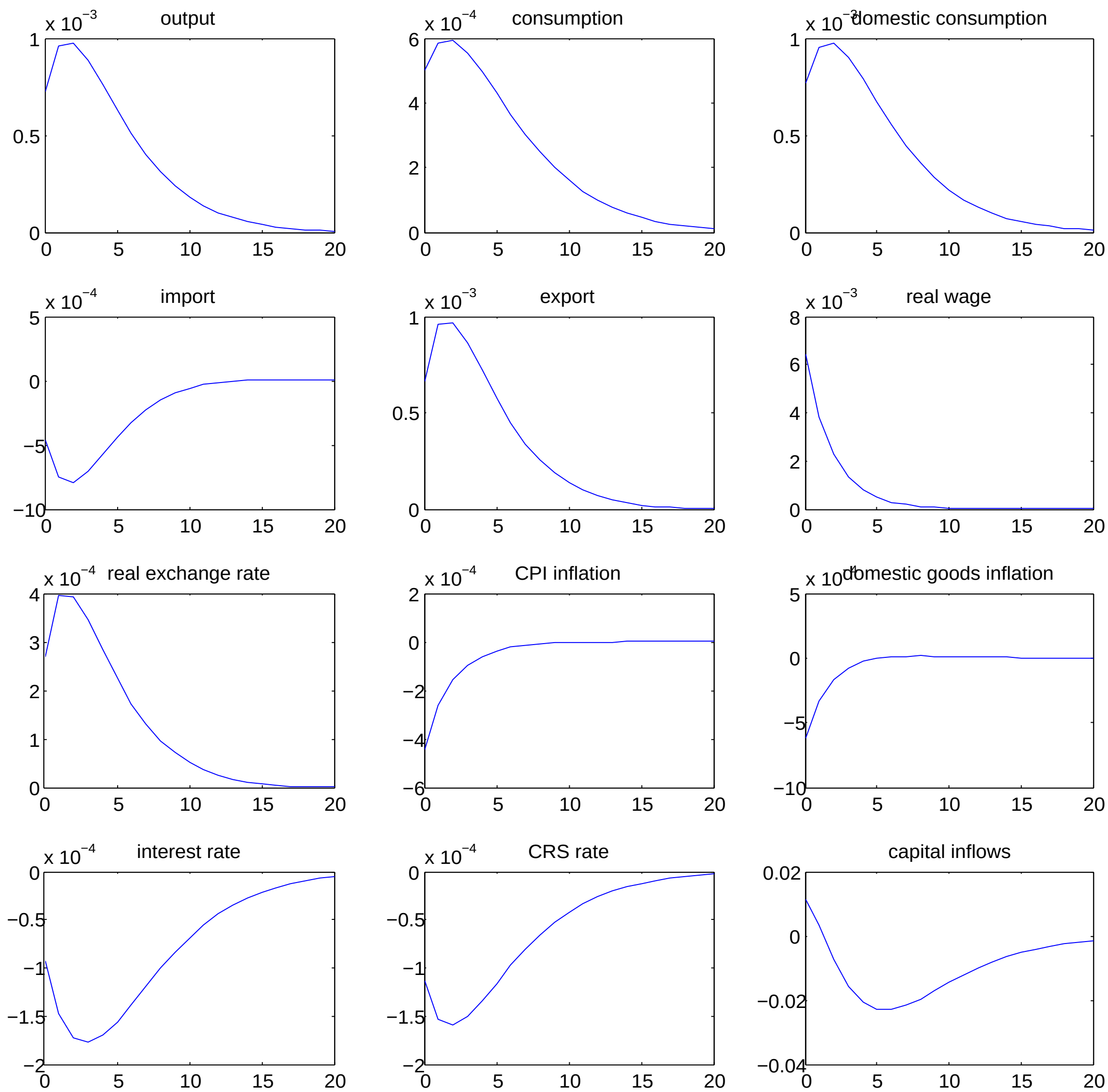


Figure 7: Impulse Responses to a Foreign Interest Rate Shock ($R_t^f$)

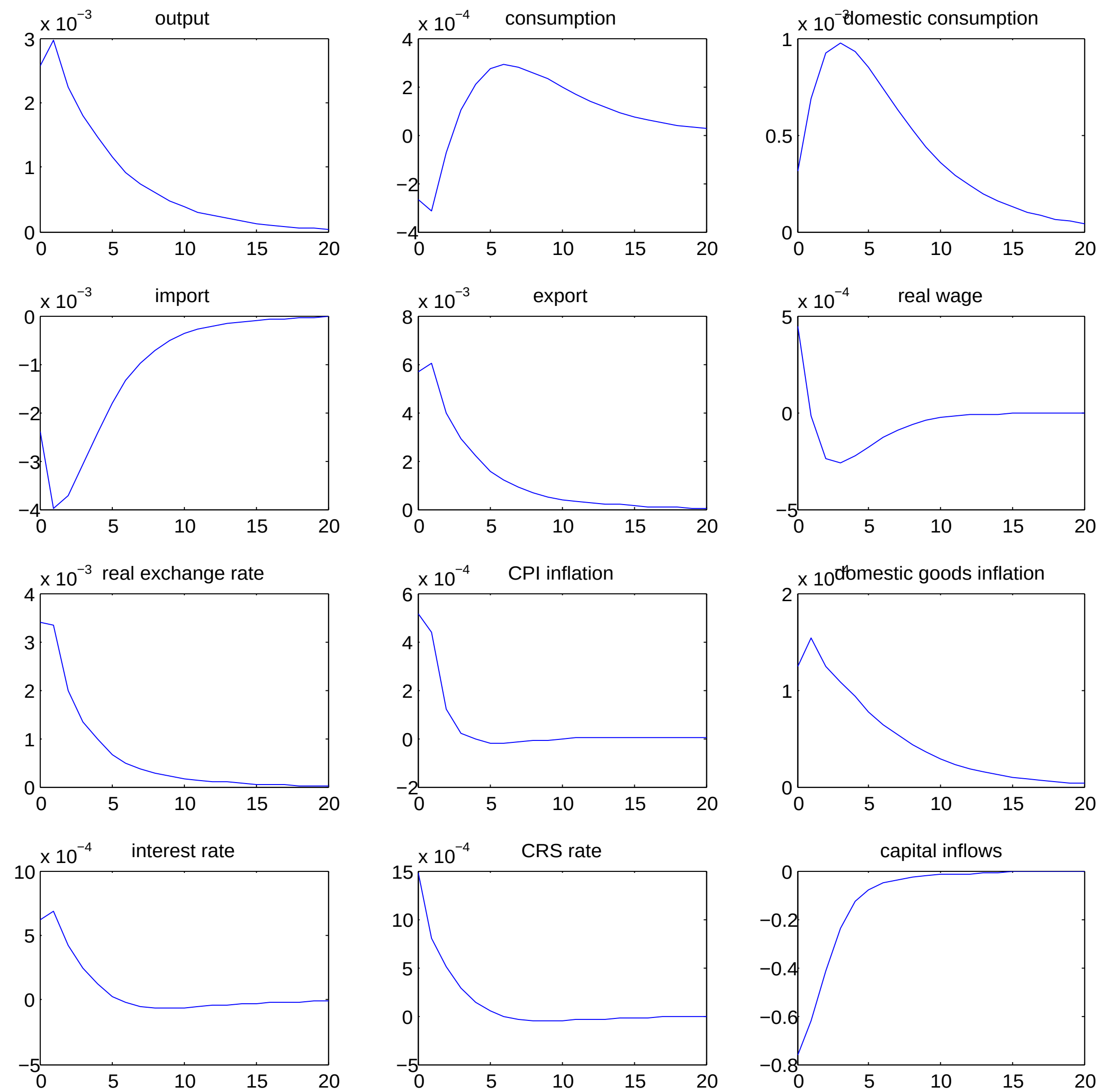


Figure 8: Impulse Responses to a Foreign Output Shock ($y_t^f$)

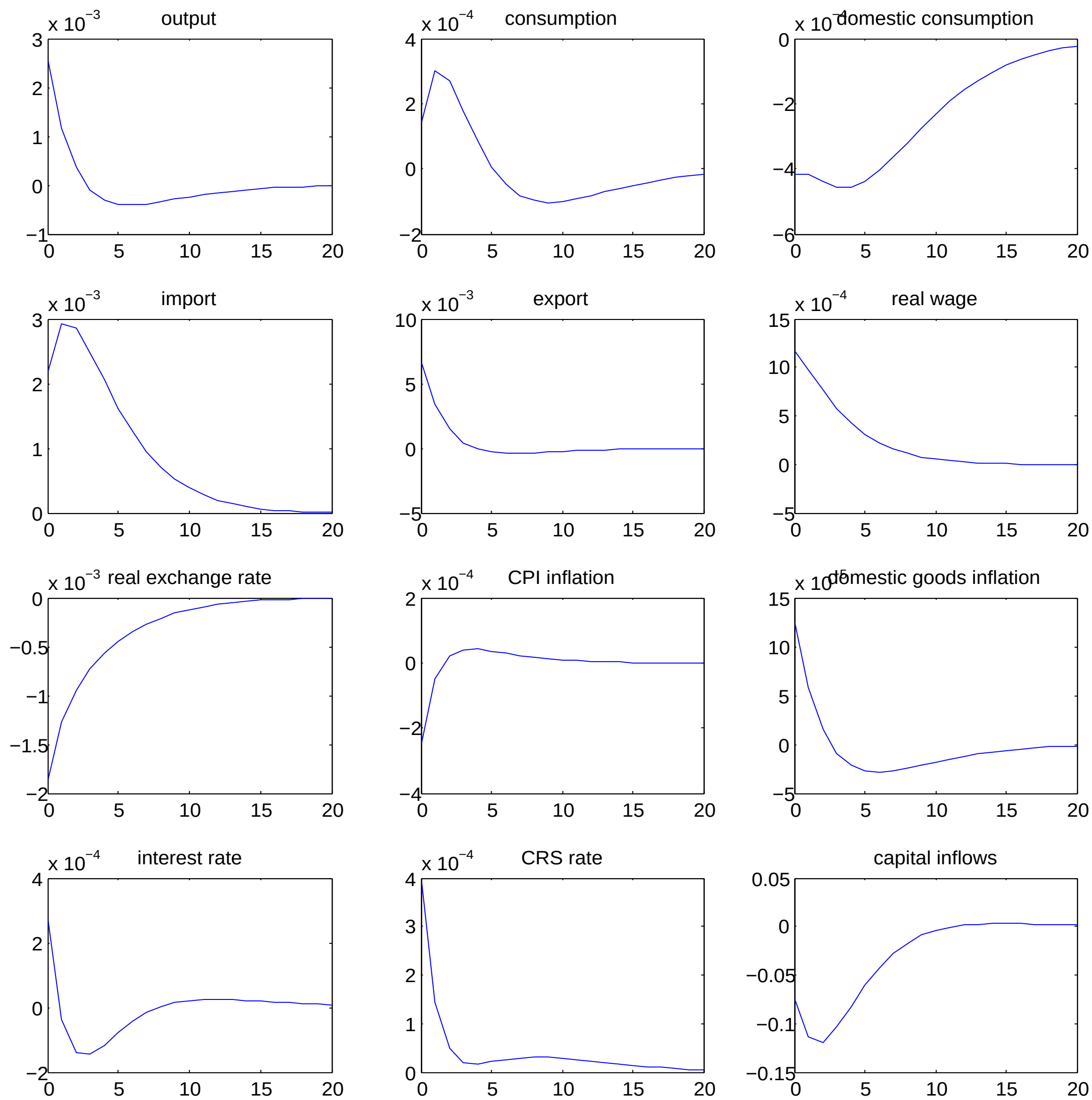
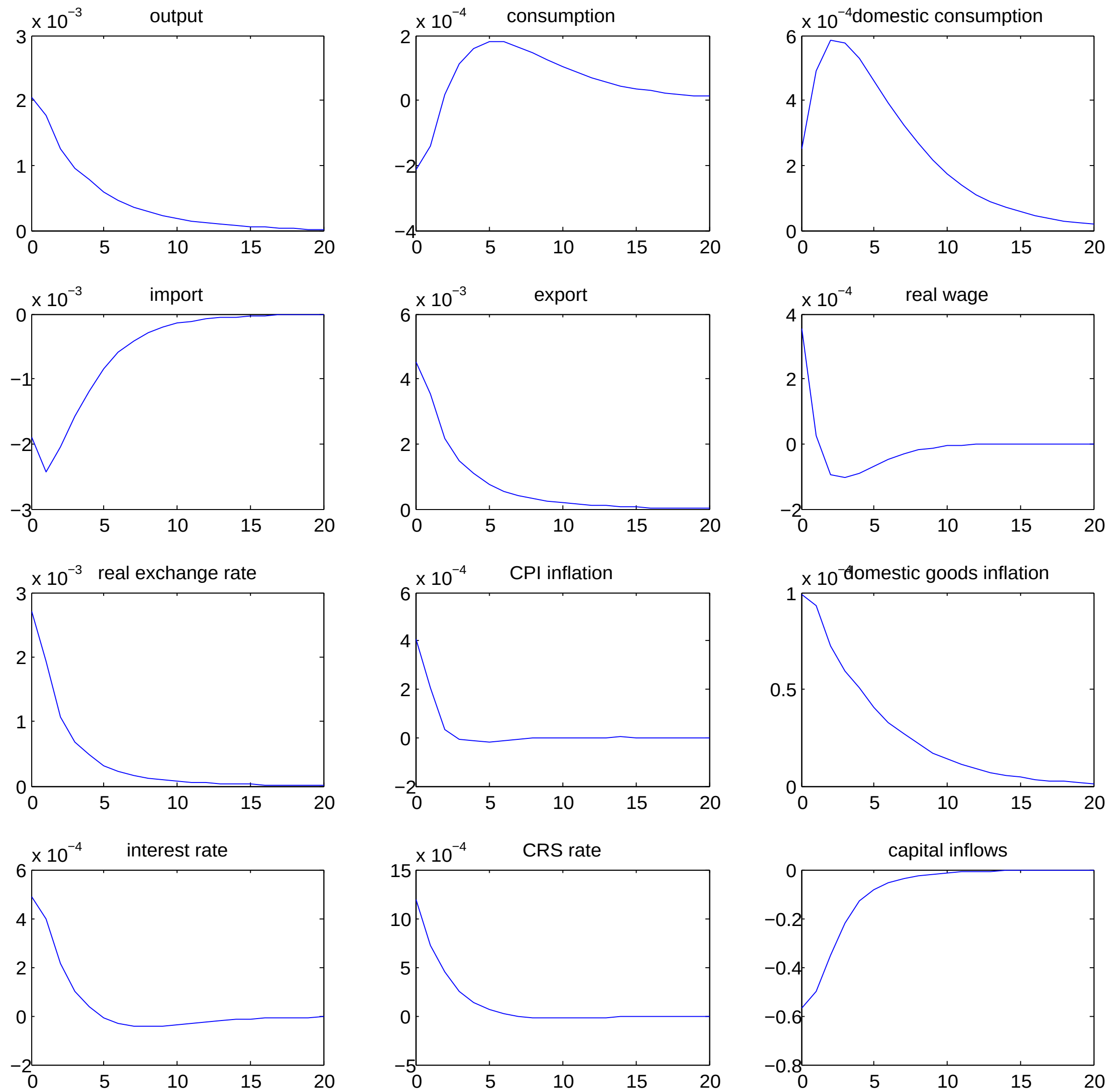


Figure 9: Impulse Responses to a Foreign Price Shock ($P_t^f$)



# 5 Policy Analysis

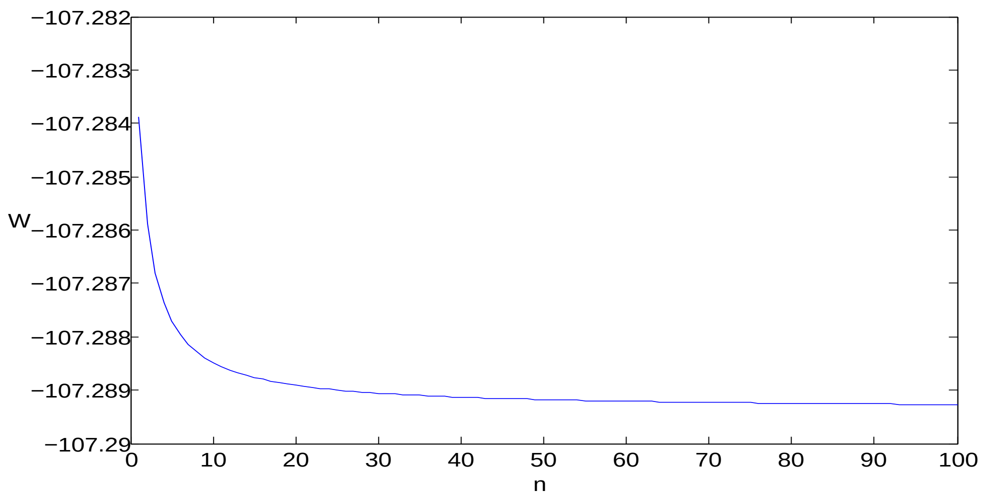
## 5.1 Welfare Comparison

We consider the following discounted sum of utilities of a representative household as a measure of welfare :

$$W = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t U(C_t, l_t) \right\}, \tag{42}$$

We do simulations based on the second order approximation of the equilibrium conditions following the suggestions by Kim and Kim (2003), in which they showed that if equilibrium relations are linearized to the first order while welfare is linearized to the second order, there may be spurious welfare effects.

Figure 10: Welfare Comparison along Number of Foreign Banks




Note : $n$ is the number of foreign banks, and $W$ denotes welfare measured by a second order approximation to a technology shock.

Figure 10 depicts welfares in accordance with numbers of foreign banks, given a technology shock. As the international capital market becomes integrated, welfare decreases. This is quite different from the view of small open economy models that argue that one can achieve welfare improvement as the degree of openness in the financial market increases, because of full risk sharing or the improvement in production efficiency. In our model, in contrast, there is no direct link of foreign capital inflows to the production process, nor to consumption smoothing. Instead, foreign capital inflows are solely determined by foreign banks. In this environment, the existence of a friction in the domestic financial market could generate the opposite welfare implications.

Table 3 compares welfares under two swap markets with different structures: one having a monopolistic foreign bank dollar supplier ($n = 1$), and the other oligopolistic foreign banks dollar suppliers ($n = 100$). We assume that the standard deviation of each shock is 0.01. As we can see, welfare decreases as the number of foreign banks increases for all shocks. The intuitive explanation of this result is as follows. As the foreign capital market becomes integrated, the dependency of the domestic economy on foreign capital inflows increases. In a small open economy, the exchange rate becomes more volatile to exogenous shocks, which makes the domestic economy more volatile. We can see this in Figure 11. The left side of Figure 11 shows that the ratio of steady state foreign capital inflows to output increases as the foreign capital market becomes more integrated. The right panel meanwhile shows a positive relationship between the ratio of the steady state foreign capital inflows to output and the variance of the real exchange rate, implying that the exchange rate becomes more volatile as foreign capital inflows grow relative to domestic output. This is consistent with Calderón and Kubota (2009), who empirically show a positive relationship between financial openness, measured by the foreign liabilities-to-GDP ratio, and real exchange rate volatility in emerging markets.

Table 3: Welfare Comparison to Different Shocks

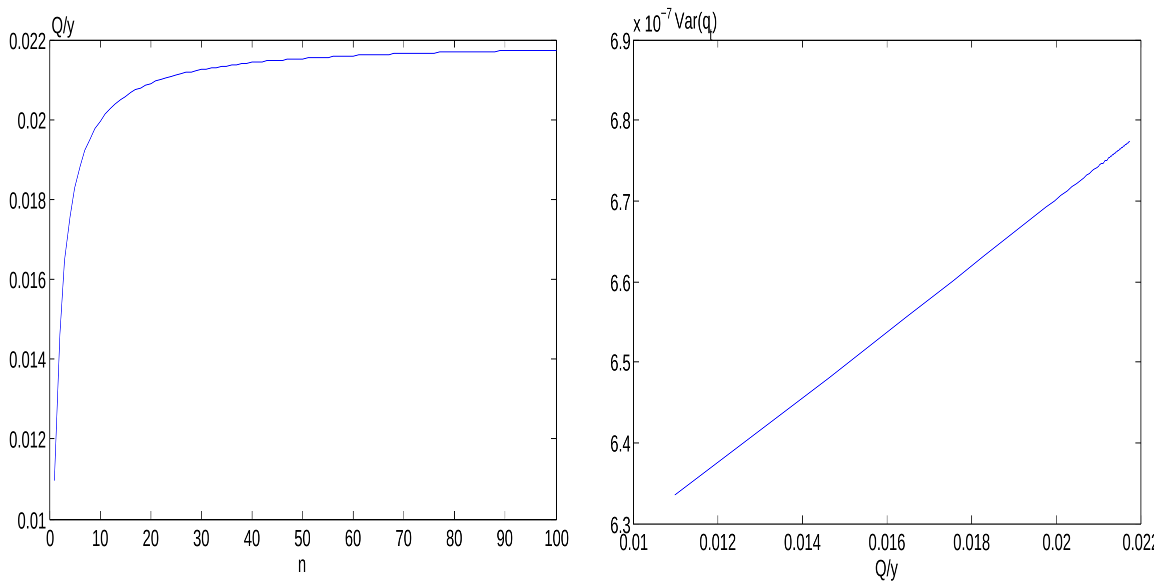
| | $e_{a,t}$ | $e_{z,t}$ | $e_{R^f,t}$ | $e_{y^f,t}$ | $e_{P^f,t}$ |
|---|---|---|---|---|---|
| $\Delta W$ | -0.00559 | -0.00538 | -0.00536 | -0.00532 | -0.00414 |

Note: $\Delta W$ denotes the change from the case of $n = 1$.

## 5.2 Effects of Prudential Policies

This subsection presents ways of improving welfare through macro-prudential policies in the form of taxes levied on foreign banks. For this purpose, we perform experiments on two types of tax simulations, and compare the welfare improvements. One simulation is of a tax on the profits of foreign banks, and the other of a progressive tax on capital inflows.

Figure 11: $\frac{Q_t}{y_t}$ Ratio and Foreign Exchange Rate Volatility




### 5.2.1 Tax on Foreign Bank Profits

First, we assume that the government levies a tax, $\tau \in [0,1]$, on the profits of foreign banks. Foreign bank $k$ maximizes the following profit function with respect to $q^f_{k,t}$ :

$$\Pi^{FB}_{k,t} = (1-\tau)\left(R_t \frac{S_t}{P_t} q^f_{k,t} - CRS(q^f_t)\frac{S_t}{P_t} q^f_{k,t}\right) \tag{43}$$

Since the tax is levied on the profits of foreign banks, the government's action does not affect the foreign bank's decision. On the other hand, the tax proceeds are transfered to households. The government's budget constraint (32) is altered as follows :

$$B^s_t = B^s_{t-1}R_{t-1} - \sum_{k=1}^{n} \tau \left(R_{t-1}S_{t-1}q^f_{k,t-1} - CRS_{t-1}S_{t-1}q^f_{k,t-1}\right) + T_t \tag{44}$$

Accordingly, the balance of payments equation (41) is modified as

$$\begin{aligned} R^f_{t-1}S_t q^f_{t-1} - S_t q^f_t &+ (1-\tau)(R_{t-1} - CRS_{t-1})S_{t-1}q^f_{t-1} + \frac{\chi}{2}\left(\frac{S_{t-1}}{P_{t-1}}q^f_{t-1}\right)^2 P_{t-1} \\ &= S_t P^f_{H,t} C^f_{H,t} - S_t P^f_{F,t}\Delta_{F,t} C_{F,t} \end{aligned} \tag{45}$$

In Table 4, we compare the welfare improvements when the tax rates are 5% and 10% on the profits of foreign banks. We assume $n = 100$. Since the profit tax does not change the foreign bank's decision, welfare improvements are very small, even though the money is transfered to households from outside the domestic economy.

Table 4: Welfare Improvement : Tax on Foreign Bank Profits

| | | | $e_{a,t}$ | $e_{z,t}$ | $e_{R^f,t}$ | $e_{y^f,t}$ | $e_{P^f,t}$ |
|---|---|---|---|---|---|---|---|
| $\Delta W$ | : | $\tau = 0.05$ | $3.04 \times 10^{-6}$ | $3.02 \times 10^{-6}$ | $3.01 \times 10^{-6}$ | $3.12 \times 10^{-6}$ | $4.00 \times 10^{-6}$ |
| | : | $\tau = 0.10$ | $6.09 \times 10^{-6}$ | $6.05 \times 10^{-6}$ | $6.02 \times 10^{-6}$ | $6.24 \times 10^{-6}$ | $8.01 \times 10^{-6}$ |

Note : $n$ is set to 100, and $\Delta W$ denotes the change from the case of $\tau = 0$.

#### 5.2.2 Progressive Tax on Capital Inflows

In order to investigate the effects of prudential policy on welfare, we consider, instead of a quantity restriction, a progressive tax because it is more tractable in our DSGE model. Let the government levy a progressive tax, $\tau \in [0.1]$, on foreign banks' capital inflows. Foreign bank $k$ maximizes the following profit function with respect to $q^f_{k,t}$ :

$$\begin{aligned} \Pi^{FB}_{k,t} &= R_t \frac{S_t}{P_t} q^f_{k,t} - CRS(q^f_t) \frac{S_t}{P_t} q^f_{k,t} - \tau \frac{1}{1+\eta} \left( \frac{S_t}{P_t} q^f_{k,t} \right)^{1+\eta} \\ &= R_t \frac{S_t}{P_t} q^f_{k,t} - \left( R^f_t \frac{E_t S_{t+1}}{P_t} q^f_{k,t} + \chi \sum_{h=1}^{n} q^f_{h,t} \frac{S_t}{P_t} \frac{S_t}{P_t} q^f_{k,t} \right) - \tau \frac{1}{1+\eta} \left( \frac{S_t}{P_t} q^f_{k,t} \right)^{1+\eta} \end{aligned} \tag{46}$$

The first order condition is

$$R_t = R^f_t \frac{E_t S_{t+1}}{S_t} + \chi \left( 1 + \frac{1}{n} \right) Q_t + \tau \left( \frac{1}{n} \right)^{\eta} Q^{\eta}_t. \tag{47}$$

The government's budget constraint (32) is altered as follows :

$$B^s_t = B^s_{t-1} R_{t-1} - \sum_{k=1}^{n} \tau \frac{1}{1+\eta} \left( \frac{S_{t-1}}{P_{t-1}} q^f_{k,t-1} \right)^{1+\eta} + T_t \tag{48}$$

Accordingly, the balance of payments equation (41) is modified as :

$$R^f_{t-1} S_t q^f_{t-1} \quad - \quad S_t q^f_t + (R_{t-1} - CRS_{t-1}) S_{t-1} q^f_{t-1} + \frac{\chi}{2} \left( \frac{S_{t-1}}{P_{t-1}} q^f_{t-1} \right)^2 P_{t-1}$$

$$- \sum_{k=1}^{n} \tau \frac{1}{1+\eta} \left( \frac{S_{t-1}}{P_{t-1}} q^f_{k,t-1} \right)^{1+\eta} P_{t-1} = S_t P^f_{H,t} C^f_{H,t} - S_t P^f_{F,t} \Delta_{F,t} C_{F,t} \quad (49)$$

In Table 5, we compare the welfare improvements of tax levies on capital inflows of 5% and 10%. We assume $n = 100$ and $\eta = 0.5$. Differently from the case with the profit tax, we can observe that the sizes of welfare improvements are large for all shocks. Note that the way the profit tax improves welfare is only through increasing households' budget since the optimal level of capital inflows determined by oligopolistic foreign banks does not change. The progressive tax on capital inflows, however, follows another route: it makes the optimal level of capital inflows decrease, causing capital flows and hence key macroeconomic variables to be less volatile. Since the progressive tax mitigates the bad side effects of capital inflows on the domestic economy, we observe welfare improvements for all shocks. This result is in line with Jeanne and Korinek (2010), who show that prudential controls on capital inflows to emerging markets as a form of Pigouvian taxation can improve welfare.

Table 5: Welfare Improvement : Progressive Tax on Capital Inflows

| | $e_{a,t}$ | $e_{z,t}$ | $e_{R^f,t}$ | $e_{y^f,t}$ | $e_{P^f,t}$ |
|---|---|---|---|---|---|
| $\Delta W$ : $\tau = 0.05$ | 0.0021 | 0.0009 | 0.0019 | 0.0021 | 0.0017 |
| : $\tau = 0.10$ | 0.0037 | 0.0037 | 0.0035 | 0.0036 | 0.0032 |

Note : $n = 100$, $\eta = 0.5$, and $\Delta W$ denotes the change from the case of $\tau = 0$.

# 6 Conclusion

This paper has presented a small open economy DSGE model in which foreign banks have market power over domestic banks in swap contracts. The presence of foreign banks' market power allows us to derive the relationship between domestic and foreign interest rates, and spot and future exchange rates. This new condition, substituting for the traditional UIP condition with a country risk premium, provides a mechanism through which the effects of partial and full financial integration are analyzed. In particular, this paper has shown that increased competitiveness in the swap market makes capital inflows and hence key macroeconomic variables more volatile, and that welfare measured by second order approximation of households' lifetime utility decreases as the swap market becomes more competitive and more financially integrated. Our results imply that full financial integration might not be desirable from the welfare point of view. This paper has also shown that capital account re-regulation in the form of taxation could be helpful.

Our results are consistent with the fact that official intervention in the foreign exchange market cannot succeed to the extent that the UIP condition is valid.[19] Furthermore, monetary policy effectiveness can itself be constrained if the capital account is fully liberalized. Note that the Bank of Korea frequently attributes the changes of government bond rates to the transaction behaviors of foreign bank branches and foreign investors.[20] Even US Treasury bond rates are also occasionally heavily affected by foreign investors' behavior.[21]

Note that our model does not incorporate any financial accelerators. Indeed, the role of domestic banks is limited to that of the counterparts of foreign banks in the model. There may exist a feedback mechanism, however, so that capital inflows stimulate domestic banks' lending to the ultimate borrowers. What we can say is that, if incorporated into our model, financial accelerators would further strengthen our results, because they would further increase the volatility of macroeconomic variables. In that sense, this paper demonstrates the necessity of capital account re-regulation.

Furthermore, we abstract from important beneficial roles of capital inflows to focus on the workings of the imperfect swap market. That is, we exclude some channels through which capital flows could increase social welfare — international risk sharing and capital formation, for example. Therefore, our results should be interpreted with some cautions. It might be worthwhile to extend the model by including these beneficial roles of financial integration to draw more robust results.

## REFERENCES

1. Alper, C., Oya Ardic and Salih Fendoglu, "The Economics of Uncovered Interest Parity Condition for Emerging Markets: A Survey," *MPRA Paper*, No. 4097, 2007.

[19] See Isard (2006).

[20] Please refer to Chapter 1 Section 3 of 2007 and 2008 issues of *Monetary Policy Report* published by the Bank of Korea.

[21] Read the former US Federal Reserve Chairman Greenspan's testimony before the Committee on Financial Services of US House of Representatives (2005).

2. Andersen, Palle and Ramon Moreno, "Financial Integration: Overview," in "Globalisation and Monetary Policy in Emerging Markets," *BIS Papers*, No. 23, 2005, pp. 1-8.

3. Alvarez, Fernando, Andrew Atkeson and Patrick Kehoe, "If Exchange Rates Are Random Walks, then Almost Everything We Say about Monetary Policy Is Wrong," *Federal Reserve Bank of Minneapolis Quarterly Review*, Vol. 32, No. 1, 2008, pp. 2-9.

4. Baba, Naohiko and Frank Packer, "Interpreting Deviations from Covered Interest Parity During the Financial Market Turmoil of 2007-2008," *BIS Working Paper*, No. 267, 2008.

5. Bank for International Settlements, *Triennial Central Bank Survey: Report on Global Foreign Exchange Market Activity in 2010*, 2010.

6. Bank for International Settlements, *Quarterly Review*, March 2011.

7. Bank of Korea, *Financial Stability Report*, April 2007.

8. Bank of Korea, *Monetary Policy Report*, various issues, 2007 - 2008.

9. Benigno, Pierpaolo, "Price Stability with Imperfect Financial Integration," *Journal of Money, Credit and Banking*, Vol. 41, No. 1, 2009, pp. 121-149.

10. Broner, Fernando A. and Jaume Ventura, "Rethinking the Effects of Financial Liberalization," *NBER Working Paper*, No. 16640, 2010.

11. Cakici, S. Meral, "Financial Integration in a Small Open Economy," *mimeo*, 2009.

12. Calderón, César and Megumi Kubota, "Does Higher Openness Cause More Real Exchange Rate Volatility?" *Policy Research Working Paper*, No. 4896, The World Bank, 2009.

13. Chen, Shiu-Sheng and Chien-Chian Wang, "Financial Openness and Macroeconomic Volatility: An Empirical Investigation," *mimeo*, 2009.

14. Choi, Woon Gyu and David Cook, "Liability Dollarization and the Bank Balance Sheet Channel," *Journal of International Economics*, Vol. 64, 2004, pp. 247-275.

15. Cúrdia, Vasco and Daria Finocchiaro, "An Estimated DSGE Model for Sweden with a Monetary Regime Change," *Seminar Paper*, No 740, Stockholm University, Institute for International Economic Studies, 2005.

16. Etro, Federico and Andrea Colciago, "Endogenous Market Structures and the Business Cycle," *Economic Journal*, Vol. 120, 2010, pp. 1201-1233.

17. Federal Reserve Board, *Testimony of Chairman Alan Greenspan: Federal Reserve Board's Semiannual Monetary Policy Report to the Congress*, February 2005.

18. Flood, Robert and Andrew Rose, "Uncovered Interest Parity in Crisis," *IMF Staff Papers*, Vol. 49, No. 2, 2002.

19. Frankel, Jeffrey and Jumana Poonawala, "The Forward Market in Emerging Currencies: Less Biased than in Major Currencies," *HKS Working Paper*, No. RWP09-023, 2009.

20. Gali, Jordi and Tommaso Monacelli, "Monetary Policy and Exchange Rate Volatility in a Small Open Economy," *Review of Economic Studies*, Vol. 72, 2005, pp. 707-734.

21. International Monetary Fund, *Recent Experiences in Managing Capital Inflows — Cross-cutting Themes and Possible Policy Framework*, 2011.

22. Isard, Peter, "Uncovered Interest Parity," *IMF Working Paper* WP/06/09, 2006.

23. Jeanne, Olivier and Anton Korinek, "Excessive Volatility in Capital Flows: A Pigouvian Taxation Approach," *American Economic Review: Papers & Proceedings*, Vol. 100, No. 2, 2010, pp 403-407.

24. Kim, Byoung-Ki, "Market Structure, Bargaining, and Covered Interest Rate Parity," *Institute Working Paper*, No. 365, Bank of Korea, 2009.

25. Kim, Kyungsoo, Byoung-Ki Kim and Young Kyung Suh, "Opening to Capital Flows and Implications from Korea," *Economic Papers*, Vol. 12, No. 1, July 2009, The Bank of Korea, pp. 74-112.

26. Kim, Jinill and Sunghyun H. Kim, "Spurious Welfare Reversals in International Business Cycle Models," *Journal of International Economics*, Vol. 60, No. 2, 2003, pp. 471-500.

27. Kose, M. Ayhan, Eswar Prasad, Kenneth Rogoff and Shang-Jin Wei, "Financial Globalization: A Reappraisal," *IMF Working Paper*, No. WP/06/189, 2006.

28. Kreps, David and Jose Scheinkman, "Quantity Precommitment and Price Competition Yield Cournot Outcomes," *Bell Journal of Economics*, Vol. 14, No. 2, 1983, pp. 326-337.

29. Levi, Maurice, *International Finance*, Fourth Edition, 2005.

30. Monacelli, Tommaso, "Monetary Policy in a Low Pass-through Environment," *ECB Working Paper*, No. 227, 2003.

31. Prasad, Eswar and Raghuram Rajan, "A Pragmatic Approach to Capital Account Liberalization," *IZA Discussion Paper*, No. 3475, 2008.

32. Skinner, Frank, "Covered Interest Rate Parity in Emerging Markets," presented at Financial Management Association (FMA) European Conference, Prague, Czech Republic, June 2008.

33. Stiglitz, Joseph, "Capital-Market Liberalization, Globalization, and the IMF," *Oxford Review of Economic Policy*, Vol. 20, No. 1, 2004, pp. 57-71.

34. Taylor, Mark, "Covered Interest Arbitrage and Market Turbulence," *Economic Journal*, Vol. 99, 1989, pp. 376-391.

35. Thornton, Daniel, "Test of Covered Interest Rate Parity," *Federal Reserve Bank of St. Louis Review*, July/August 1989, pp. 55-66.

36. Svensson, Lars, "What's Wrong with Taylor Rules? Using Judgment in Monetary Policy through Targeting Rules," *Journal of Economic Literature*, Vol. 41, 2003, pp. 426-477.

37. Yie, Myung-Soo and Byung Hark Yoo, "The Role of Foreign Debt and Financial Friction in a Small Open Economy DSGE Model," *mimeo*, 2011.

# Appendix : Steady State

**Household :**

$$R = \frac{1}{\beta} \tag{50}$$

$$\phi \frac{l^{\tau}}{C^{-\sigma}} = w \tag{51}$$

$$C_H = \theta_H p_h^{\psi} C \tag{52}$$

$$C_F = (1-\theta_H)\left(\frac{p_f}{p_h}\right)^{-\psi} C \tag{53}$$

$$p_h = \left(\theta_H + (1-\theta_H) p_f^{1-\psi}\right)^{\frac{1}{1-\psi}} \tag{54}$$

**Domestic Producer :**

$$w p_h = mc_H \tag{55}$$

$$mc_H = \frac{\varepsilon_H - 1}{\varepsilon_H} \tag{56}$$

**Importer :**

$$mc_F = \frac{S P_F^f}{P_F} \tag{57}$$

$$mc_F = \frac{\varepsilon_F - 1}{\varepsilon_F} \tag{58}$$

**Foreign Country :**

$$C_H^f = \left(\frac{P_H^f}{P^f}\right)^{-\psi} y^f \tag{59}$$

$$P_F^f = P^f \tag{60}$$

$$S P_H^f = P_H \tag{61}$$

**Swap Market :**

$$R = R^f + \chi\left(1 + \frac{1}{n}\right) Q \tag{62}$$

$$CRS = R^f + \chi Q \tag{63}$$

**Market Clearing Conditions :**

$$y = C_H + C_H^f \tag{64}$$

$$(R^f - 1) Q p_h + (R - CRS) Q p_h + \frac{\chi}{2} Q^2 p_h = C_H^f - mc_F p_f C_F \tag{65}$$