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Financial Frictions, UIP Premium, and the Integrated Policy Framework: The Case of Korea

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Emerging markets and developing economies (EMDEs) are vulnerable to external shocks. In the literature, it is well-documented that financial frictions are the key sources of this vulnerability. Using panel data of 17 countries, this paper shows that the impact of global risk-off shocks is larger for the economies with shallower financial markets. With the estimated Integrated policy framework (IPF), it argues that FX intervention (FXI) and macro-prudential measure (MPM) are needed in addition to the conventional interest rate policy to address external shocks. The key contributions of the paper are the followings.

① A new measure for market depth is provided. It is empirically measured as the responsiveness of uncovered interest parity (UIP) premium to the global risk-off shock. This measure summarizes inefficiencies due to financial frictions in domestic financial market and FX market.

② Using panel dataset composed of 17 countries, it is empirically shown that when global risk-off shock hits, (i) domestic currency depreciates more; and (ii) domestic credit condition becomes tighter in the countries with shallow markets.

③ To incorporate this empirical finding in a DSGE model, the paper builds on the IPF framework à la Linde et al. (2024) and assume that global risk-off shock induces not only capital outflows but also spikes in domestic credit spreads. It is shown that the shallower the market, the more contractionary the effect.

④ The model is estimated to reflect the Korean economy to show that it is welfare-improving to implement FXI and MPP together with the conventional interest rate policy to insure the economy against the shock.

The rest of the paper is organized as follows. Section 1 explains the background of the study. Section 2 introduces our measure for market depth with the connection to the UIP premium. Specifically, we describe the Korea's case and show panel analysis result of how the impact of global risks depends on each country's market depth. Section 3 presents quantitative results based on the IPF framework estimated with Korean data. It reports impulse responses to the global risk shock and provides welfare analysis under the baseline and alternative policy scenarios.

■ We would like to express our sincere appreciation to Kyoungsoo Yoon, Jaehyun Yoo, Yong O Kwon, Yanghyeon Yang, Ki-Dok Park, for their comments and suggestions. We are also grateful to IMF staff, Jesper Lindé and Rebecca Huang, for their technical support in IPF model estimation. Any remaining errors are solely the responsibility of the authors.

Bank of Korea

I. Background of the Study

In the countries with floating exchange rate regime like Korea, the exchange rates and interest rates must satisfy the UIP condition described as below.

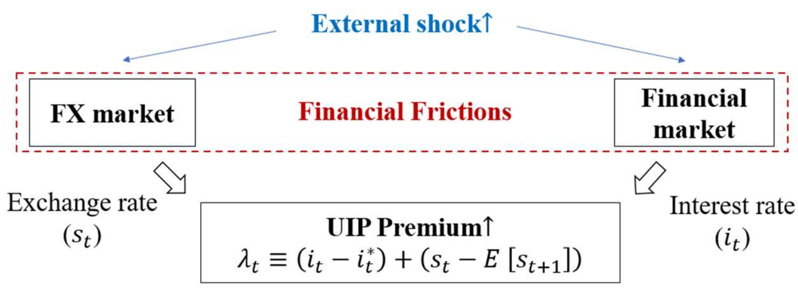
$$i_t - i_t^* + (s_t - E_t[s_{t+1}]) = 0$$

where i_t, i_t^* are domestic and foreign interest rates and s_t is the log value of exchange rate (i.e., s_t increases when domestic currency depreciates). Yet, in real world, it is empirically observed that the UIP condition does not hold. This is because EMDE is far from the textbook frictionless one due to various frictions in the domestic financial market and FX market.[1] As a result, the exchange rates and interest rates are determined away from the ones pinned down by the UIP condition. Hence, the UIP premium arises in equilibrium.[2,3]

$$\underbrace{\lambda_t}_{UIP\ Premium} \equiv i_t - i_t^* + (s_t - E_t[s_{t+1}]) \quad (1)$$

Importantly, in EMDEs, exchange rates and interest rates are sensitive to global risk-off shocks, leading to widen UIP premium. This is because FX market and domestic financial market are shallow due to financial frictions, amplifying the responses of price variables. Figure 1 below describes this external shock transmission channel.

Figure 1. External Shock Transmission



II. The Effects of External Shock and Market Depth

1. Measuring Market depth

EMDEs are sensitive to global risk-off shocks more than the advanced economies that issue reserve currencies. These shocks may be driven by the heightened risk aversion of global investors and/or the global shortage of dollar liquidity. The sensitive reactions typically manifest as large currency depreciations and interest rate hikes, which may lead to a severe market turmoil in the domestic economy.

More importantly, the studies have found that the impact of shocks is greater for the countries with

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[1] Financial frictions refer to the various factors that collectively result in imperfect substitutability between domestic asset and foreign asset (for example, the limited risk-bearing capacity of global banks arising from the regulatory constraint).

[2] The causal link could also go in the opposite direction. Since UIP premium is an arbitrage opportunity for foreign investors, it may attract foreign capital, thereby contributing to fluctuations in exchange rates and interest rates. This paper does not consider such case and focuses on the endogenous UIP premium fluctuations arising from the external shocks.

[3] The UIP premium can be interpreted as an additional compensation required by foreign investors when a country borrows externally. Such compensation reflects various risks faced by foreign investors, including default risks and exchange rate fluctuation risks.

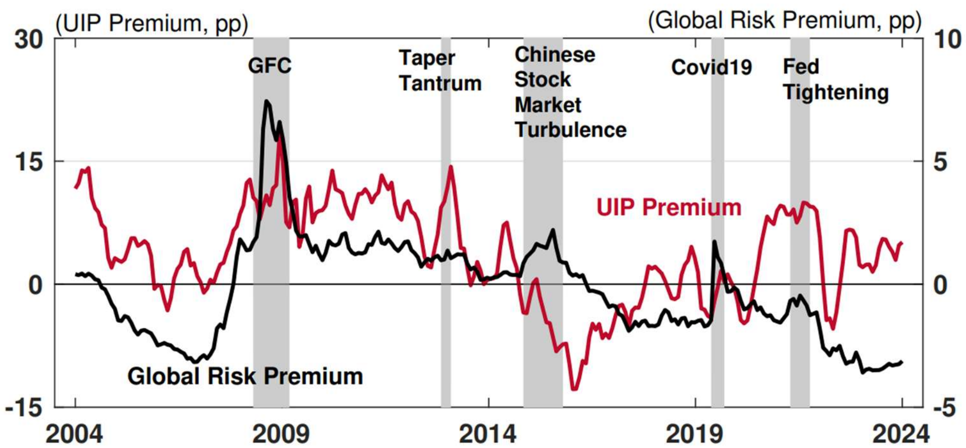
shallow market. affecting, the real economy more severely.[4] In a country with deep markets, the external shocks would be absorbed within the market, resulting in limited fluctuations in exchange rates and interest rates. In contrast, in a country with shallow markets, such shocks would not be absorbed as much, leading to greater fluctuations in exchange rates and interest rates. Consequently, a larger increase in the UIP premium would be observed in countries with shallow markets.

Based on this observation, we provide a new measure for market depth and demonstrate how it is related to the impact of global risk-off shocks. Specifically, our measure gauges the depth of markets by the sensitivity of the UIP premium to the global risk-off shocks. This measure summarizes both exchange rates and interest rates responses, representing additional costs for external borrowing.

2. UIP Premium, Exchange Rate, and Interest Rate Spread in Korea

Before moving on to the panel analysis using this measure, we provide motivating evidence using the case of Korea. In Korea, it has been observed that there is a tendency of widening UIP premium during the global risk-off episodes. The global risk-off episodes are defined as the periods where the global risk premium displays large spikes.[5] Figure 2 shows that UIP premium increases during the five major global risk-off episodes: 2008–09 Global Financial Crisis (GFC), 2013 Taper Tantrum, 2015–16 Chinese stock market crash, COVID-19 outbreak in 2020, and the sharp rate hikes by the Federal Reserve in 2022. The correlation between UIP premium and the global risk premium is 0.53 during the risk-off episodes, significantly higher than the one during the tranquil periods, 0.12.

Figure 2. UIP Premium during the global risk-off episodes



Notes: Shaded areas denote major episodes of large hikes in the global risk premium. The UIP premium is the six-month moving average of the monthly series computed as the interest rate differentials between 3-month Monetary Stabilization Bond in Korea and the 3-month U.S. government bond minus the annualized expected three-month-ahead exchange-rate change.

Sources: Bloomberg, Consensus Economics.

Figure 3 describes the exchange rate and short-term interest rate spreads during the global risk-off episodes. The spreads are measured with two indicators. (i) Market-Policy Rate Spread: interest rate spread

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[4] Gabaix and Maggiori (2015), Rey (2015), Obstfeld et al. (2019)

[5] The global risk premium is the first principal component of five risk premium indicators, including the Gilchrist and Zakrajšek (2012) credit spread, the Moody's Aaa and Baa spreads over the U.S. policy rate and the U.S. 10-year Treasury yield.

of 91-days Monetary Stabilization Bonds (MSB) over the policy rate of the Bank of Korea, and (ii) CP Spread: interest rate spread of 91-days commercial paper over 91-days MSB.[6] The figure shows that the Korean won (KRW) depreciated against the U.S. dollar (Figure 3-1) and, at the same time, the interest spreads also went up (Figure 3-2) during the episodes. The correlation of the global risk premium with exchange rate depreciation rate is 0.42, while the ones with CP Spread and Market-Policy Rate Spread are 0.36 and 0.29, respectively.

Figure 3. Exchange Rate and Interest Rate Spread during the Global Risk-off Episodes

Figure 3-1. Exchange Rate

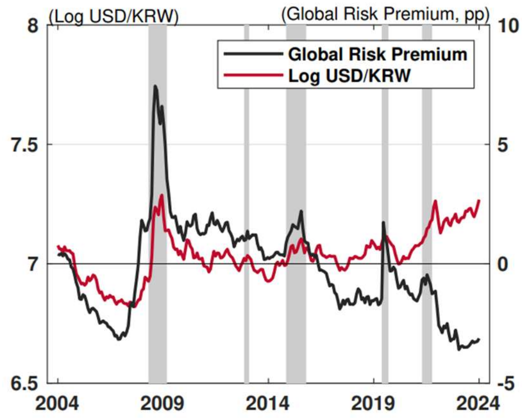
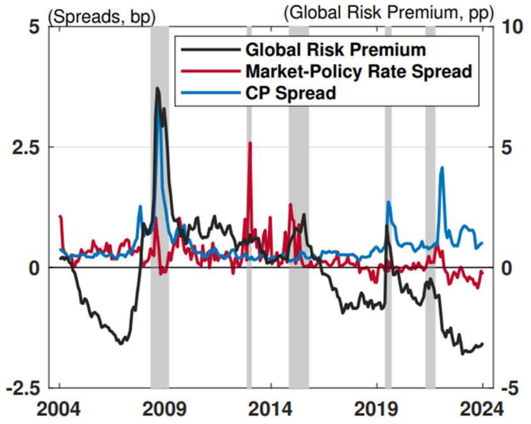


Figure 3-2. Interest Rate Spread (Short-term)



Notes: The global risk premium is the first principal component of five risk-premium indicators, including the Gilchrist and Zakrajšek (2012) credit spread, the Moody's Aaa and Baa spreads over the U.S. policy rate and the U.S. 10-year Treasury yield. Shaded areas denote major episodes of large swings in the global risk premium: in order, the 2008–09 Global Financial Crisis (GFC), the 2013 Taper Tantrum, the 2015–16 China stock market turbulence, the 2020 COVID-19 shock, and the 2022 Fed tightening. The exchange rate is depicted as the log of the monthly average USD/KRW exchange rate. Market-policy rate spreads are spread of 3-month Monetary Stabilization Bond (MSB) yield over policy rate, and CP spreads are calculated as 91-day commercial paper (CP) yield minus the 91-day MSB yield.

Sources: Bloomberg, Consensus Economics.

Korea's case suggests that the global risk-off shocks tend to deteriorate not only the FX market condition but also the domestic short-term financial markets. Would this be the case in other countries as well? If so, would the impact of the shocks be different depending on the market depth?

3. Global Risk-off Shocks, UIP Premium, and Market Depth

To answer these questions, we build a dataset of 17 countries, including Korea, and perform panel analysis. The dataset consists of 17 countries: eight advanced economies—Japan, Germany, the UK, Canada, Denmark, Norway, Sweden, and Switzerland—and nine emerging markets with a floating exchange rate system, including Korea, Israel, South Africa, India, and Indonesia. The dataset covers monthly observations from January 2004 to December 2024.

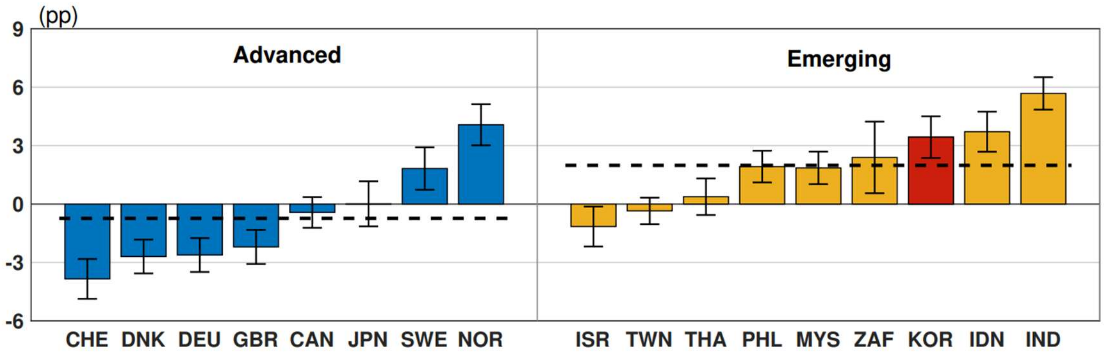
We first compute UIP premiums for each country as the sum of the domestic–foreign interest rate differential ($i_t^{\tau} - i_t^{us,\tau}$) and the annualized exchange rate appreciation rates based on the expected exchange

[6] Monetary Stabilization Bond (MSB) is the central bank security issued by the Bank of Korea as one of the primary tools for open market operations. As there is not government bond with maturities shorter than 1 year in Korea, the interest rates on MSB serve as a barometer for domestic funding market stress.

rate ($s_t - E_t[s_{t+\tau}] \times \frac{1}{\tau}$) for a given maturity ($\tau$). For our analysis, we use the three-month UIP premium. Interest rates are three-month government bond yields taken from Bloomberg, and expected exchange rates are based on three-month-ahead USD exchange rate forecasts from Consensus Economics. The exchange rates are the monthly average rates in log. The interest rate spread is the interest rate differentials between three-month government bond yields and policy rates. We define the global risk-off shocks as the residuals from AR(1) regression on the global risk premium to remove the predictable component.

Figure 4 shows that UIP premia of emerging markets are on average higher than those of advanced economies. Given the significant variations across countries within each group, it is difficult to uniformly conclude that advanced countries exhibit lower UIP premia. In case of Korea, UIP premium is higher than those of other countries on average during the sample period. It is 3.43 percentage points that surpass both the average of the 17 countries (0.70 percentage points) and the average of the nine emerging markets (1.98 percentage points).

Figure 4. UIP Premium (Three-month) for Advanced Economies and Emerging Markets



Notes: Each bar indicates the average values of UIP premium over the sample period (in percentage points). The horizontal dashed line denotes the average value of country group. Error bars are 95% confidence intervals. The sample period covers January 2004–December 2024.

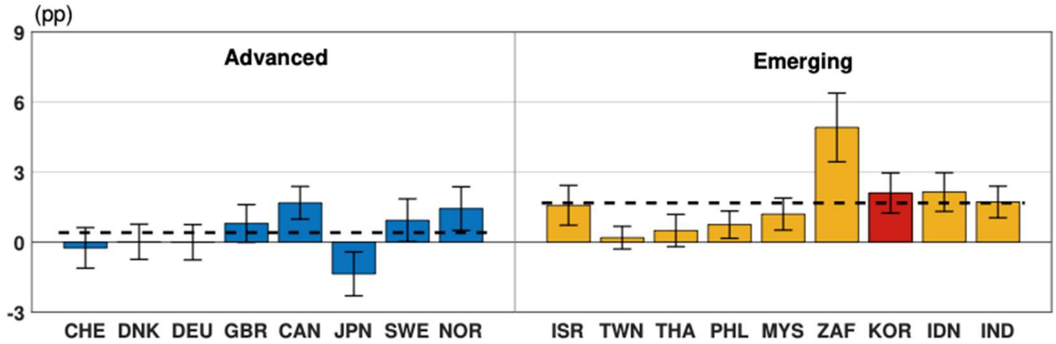
Figure 5 describes the measure of market depth for each country. Following our definition, in Equation (2) below, the coefficient (Γ_i) of the UIP premium ($\lambda_{i,t}$) to global risk-off shocks (η_t) measures the depth of each country's financial and foreign exchange markets. The larger the responses of the UIP premium, the greater Γ_i, the shallower the country's financial and FX markets.

$$\lambda_{i,t} = \underbrace{\Gamma_i}_{\substack{market \\ dept}} \eta_t + \rho_i \lambda_{i,t-1} + \epsilon_t \tag{2}$$

Figure 5 shows the estimation results of Equation (2), in particular, the estimated coefficients ($\hat{\Gamma}_i$) and its confidence intervals. The results show that emerging markets have significantly shallower markets compared to advanced economies. In most advanced countries, except for Canada and Norway, the estimates are not statistically significant. In contrast, most emerging economies exhibit statistically significant estimates. In particular, Korea shows a larger estimate (2.11 percentage points) than the average of emerging markets (1.68 percentage points), indicating that Korea's financial and FX markets are relatively shallow.[7]

[7] Meanwhile, countries and regions with a non-free floating exchange rate system—such as China, Singapore, and Hong Kong—show low UIP premiums on average with negligible responses to global risk-off shocks.

Figure 5. Market Depth for Advanced Economies and Emerging Markets



Notes: Each bar reports the estimated coefficient ($\widehat{\Gamma}_i$) based on equation 2. The horizontal dashed lines are the mean value for country groups. Error bars show 95% confidence intervals. The sample period covers January 2004–December 2024.

Next we examine whether the measured market depth effectively captures financial frictions in each country's financial and FX markets. Figure 6 demonstrates the results. Countries with shallower markets exhibit greater exchange rate volatility (Figure 6-1) and wider interest rate spreads (Figure 6-2). The figures show that one percentage point decline in market depth is associated with a 0.22 percentage points increase in exchange rate volatility and 11.73 basis points increase in interest rate spreads. In the case of Korea, exchange rate volatility is close to the country average, whereas interest rate spread is little higher than the country average. This result empirically validates our measure of market depth effectively captures the degree of financial frictions.

Figure 6-1. Exchange Rate Volatility

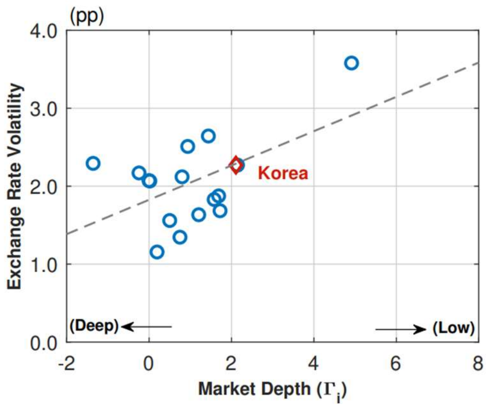
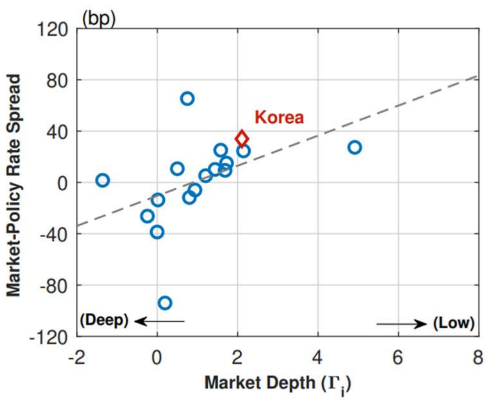


Figure 6-2. Interest Rate Spread



Notes: Market depth is measured as the estimated coefficient, $\widehat{\Gamma}_i$, from Equation 2. Exchange rate volatility is the standard deviation of monthly log differences multiplied by 100 and the fitted line is $\widehat{Volatility}_i$= 0.22 × $\widehat{\Gamma}_i$ + 1.83 (R^2 = 0.28). Market-policy rates spread is a difference between the 1-year government bond yield and the policy rate, and the fitted line is $\widehat{Spread}_i$= 11.73 × $\widehat{\Gamma}_i$ +10.44 (R^2 = 0.21).

Now we move on to our main empirical analysis. We classify countries into three groups—*Deep*, *Mid*, and *Shallow*—based on the estimated market depth and examine whether the responses of exchange rates and interest rate spreads to global risk-off shocks differ by market depth. Specifically, we estimate the following equation,

$$Y_{it} = \beta_{Deep}\eta_t + \beta_{Mid}1_i(Mid\Gamma)\eta_t + \beta_{Shallow}1_i(Shallow\Gamma)\eta_t + \delta_x X_{it} + \alpha_i + \tau_t + \epsilon_{it} \quad (3)$$

where Y_{it} is either exchange rate depreciations or interest rate spreads (denoted by ΔEXR or *Spread*), η_t is the global risk-off shock, $1_i(Mid\Gamma)$ is an indicator for countries with medium market depth, and $1_i(Shallow\Gamma)$ is an indicator for countries with shallow market depth. X_{it} is a vector of control variables, is a country fixed effect, and τ_t is a time fixed effect. The control variables for the regression of exchange rate depreciations include the interest rate differential between each country and the U.S., the U.S. Treasury yield 3-month and 1-year AR(1) residuals, the lagged expected exchange rate depreciation rate, and lagged CPI inflation. The control variables for the regression of interest rate spreads include the policy rate, the lagged inflation rate, and the lagged expected exchange rate depreciation.

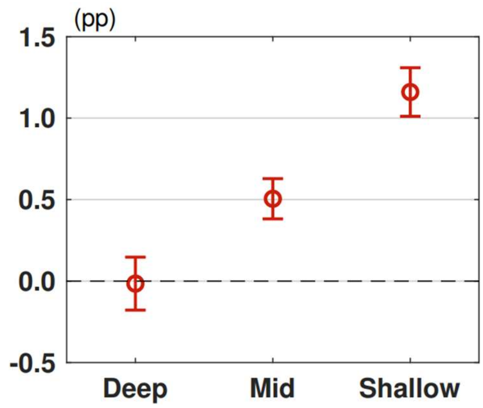
In this specification, the coefficient that captures response of Deep economies to the global risk-off shock is β_{Deep}, while the incremental differences relative to the *Deep* is group for *Mid* and *Shallow* groups are identified by β_{Mid} and $\beta_{Shallow}$, respectively. This setup allows us to assess how the response to global risk-off shocks increases as market depth becomes shallower, relative to the *Deep* group.

Table 1 and Figure 7 describe the estimation results for exchange rate depreciations. It is shown that β_{Deep} is statistically insignificant, which implies no significant exchange rate response for the *Deep* group. By contrast, β_{Mid} and $\beta_{Shallow}$ are positive and statistically significant. Also, one can see that $\beta_{Mid} < \beta_{Shallow}$, indicating larger depreciations as the market becomes shallow. Specifically, relative to the *Deep* group, exchange rates depreciate by 0.39 percentage points more in *Mid* group and by 1.05 percentage points more in *Shallow* group.

Table 1. Summary of Estimation Results for Exchange Rate Depreciation

Coeff	Variables	Δ EXR (%)
β_{Deep}	η_t	0.11
		(0.09)
β_{Mid}	$\eta_t \times \mathbb{1}(Mid\ \Gamma)$	0.39***
		(0.09)
β_{Low}	$\eta_t \times \mathbb{1}(Shallow\ \Gamma)$	1.05***
		(0.09)
	R^2	0.09

Figure 7. Exchange Rate Depreciation by Market Depth



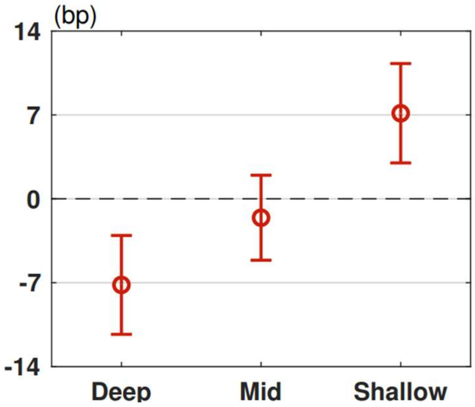
Notes: Standard errors are in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. ΔEXR is monthly log differences multiplied by 100. In a right panel, Deep (β_{Deep}) denotes the exchange-rate response for countries with deep market depth (reference group). Mid ($\beta_{Deep} + \beta_{Mid}$) and Shallow ($\beta_{Deep} + \beta_{Shall}$) denote the responses for countries with middle and shallow depth, respectively (i.e., the reference-group response plus the incremental effects). Error bars represent 95% confidence intervals.

Table 2 and Figure 8 summarize the estimation results for interest rate spread. It is shown that the estimate for β_{Deep} is statistically significant and negative, reflecting demand for global currencies such as the Japanese yen and the Swiss franc. By contrast, the estimates for β_{Mid} and $\beta_{Shallow}$ are positive and statistically significant, with $\beta_{Mid} < \beta_{Shallow}$, implying greater spread widening as market becomes shallow. Specifically, in response to a one standard deviation global risk-off shock, the spread falls by 7.18 basis points in *Deep* group, and the change in spreads is statistically indistinguishable from zero in *Mid* group. By contrast, spreads rise by 7.14 basis points in *Shallow* group.

Table 2. Summary of Estimation Results for Interest Rate Spread

Coeff	Variables	Spreads (bp)
β_{Deep}	η_t	-7.18***
		(2.10)
β_{Mid}	$\eta_t \times \mathbb{1}(Mid\ \Gamma)$	5.60**
		(2.65)
β_{Low}	$\eta_t \times \mathbb{1}(Shallow\ \Gamma)$	14.32***
		(2.87)
	R^2	0.06

Figure 8. Interest Rate Spread Responses by Market Depth



Notes: Standard errors are in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. ΔEXR is monthly log differences multiplied by 100. In a right panel, Deep (β_{Deep}) denotes the exchange-rate response for countries with deep market depth (reference group). Mid ($\beta_{Deep} + \beta_{Mid}$) and Shallow ($\beta_{Deep} + \beta_{Shallow}$) denote the responses for countries with middle and shallow depth, respectively (i.e., the reference-group response plus the incremental effects). Error bars represent 95% confidence intervals.

III. Quantitative Results

The empirical findings in the previous section suggest that countries with shallow markets experience greater currency depreciations and wider short-term interest rate spreads in the global risk-off episodes. In this section, we first rationalize such findings with a theoretical framework in order to clarify the propagation channel of the global risk-off shock. We then conduct impulse response analysis to see how the domestic macro variables respond. Finally, we provide policy implications based on welfare analysis.

1. Model

We build on two-country New Keynesian model based on Lindé et al. (2024), an extended version of the quantitative IPF framework (Adrian et al., 2021; Chen et al., 2023) and impose additional assumptions. First, we impose a domestic credit spread shock to the domestic interest rate that the household is facing (i_t^b).

$$i_t^b = i_t + \phi_t$$

where i_t is the policy rate chosen by the Taylor rule and the spread (ϕ_t) follows AR(1) process, $\phi_t = \rho_\phi \phi_{t-1} + \varepsilon_{\phi,t}$.[8] Second, to reflect our empirical findings, we assume that the spread shock $\varepsilon_{\phi,t}$ is correlated with the capital outflow shock $\varepsilon_{b_p,t}$ when the markets are shallow. Specifically, assume that

[8] This is an ad-hoc way of imposing financial friction. See Adrian et al. (2021) for the micro foundation assuming domestic banks.

$$Cov\left(\varepsilon_{\phi,t},\varepsilon_{b_p,t}\right)=\begin{cases}0 & if\ \Gamma<\bar{\Gamma}\\ \Sigma_{\phi,b_p}\in(0,1] & if\ \Gamma\geq\bar{\Gamma}\end{cases}$$

for some threshold value $\bar{\Gamma}\in(0,1)$. Note that this assumption imposes non-zero covariance between the two shocks in a shallow market (i.e., $\Gamma\geq\bar{\Gamma}$). Due to these additional assumptions, the equilibrium condition that governs the UIP condition modified.[9] Specifically, in nominal terms, the modified retail-rate based UIP premium is given as

$$\underbrace{\lambda_t^b}_{UIP\ Premium}\equiv i_t^b-i_t^*+(s_t-E_t[s_{t+1}]) \tag{4}$$
$$=\Gamma b_{F,t}+\phi_t$$

2. Impulse responses

We study the effects of global risk-off shock by examining the impulse response functions (IRF).[10] When global risk shock hits in a country with shallow market, it initiates both capital outflow shock $\varepsilon_{b_p,t}$ and domestic credit spread shock $\varepsilon_{\phi,t}$.

When the shock hits, domestic agents increase their borrowing from global financial institutions ($b_{F,t}\uparrow$), due to capital outflows by global portfolio investors ($b_{P,t}\downarrow$).

$$b_{F,t}+b_{P,t}=\underbrace{(-b_t)}_{\substack{Net\ External\\ Liability}}$$

Moreover, the shock increases interest rate spreads (ϕ_t), resulting in greater responses of the UIP premium (λ_t^b).

Our simulation considers three scenarios depending on the size of correlations between $\varepsilon_{b_p,t}$ and $\varepsilon_{\phi,t}$, i.e., $corr(\varepsilon_{b_p,t},\varepsilon_{\phi,t})\in\{0,0.3,0.5\}$.[11]

Figure 9 shows that global risk-off shock is contractionary. The greater the correlation between the two shocks, the severe the effect. Importantly, the figure shows that the interest rate policy alone cannot completely offset the influence of global risk.

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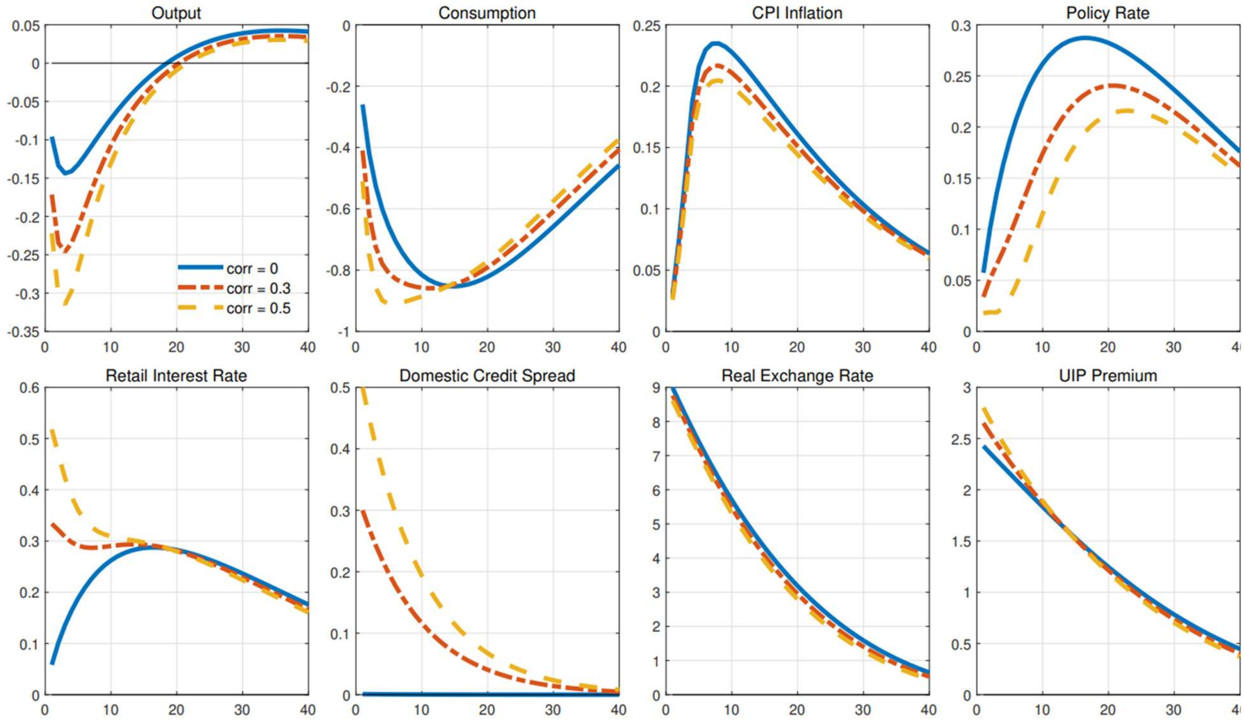
[9] See "Box 1: Overview of the Model" for the details.

[10] The model is calibrated and estimated to generate IRF. Besides the ones that are calibrated following the literature, the parameters are estimated using Bayesian method with the U.S. and the Korean data (2004Q1 – 2024Q4). We first estimate the model without assuming the covariance structure of the shocks. We then take the posterior mean for the estimated parameters when simulating the model. At this step, we impose the assumption on covariance in generating impulse responses. See "Box 2: Calibration and Bayesian Estimation of the Model" for details.

[11] To implement the baseline case where correlation is 0, we instead impose a small positive number close to zero.

Figure 9. Impulse responses to global risk-off shock



Notes: The figure describes impulse responses to global risk-off shock for three cases where $Cov\left(\varepsilon_{\phi,t}, \varepsilon_{b_p,t}\right) \in \{0, 0.3, 0.5\}$, each corresponding to blue, red, and yellow lines, respectively.

Now we consider the case of $Cov\left(\varepsilon_{\phi,t}, \varepsilon_{b_p,t}\right) = 0.3$ with additional policy tools. In addition to interest rate policy, the consolidated government is endowed with MPP and FXI. Under MPP, the domestic credit spread decreases, i.e., $i_t^b = i_t + \delta^{MPP}\phi_t$ for some $\delta^{MPP} \in (0,1)$. In other words, it is assumed that macroprudential policy mitigates the increase in the interest rate spreads by dampening the financial turmoil on the market.[12] The policy rule for FXI is the same as in Lindé et al. (2024).

Under this policy mix, the UIP premium can then be expressed as follows:

$$\lambda_t^b = \Gamma\left(-b_t + b_{M,t} - b_{P,t}\right) + \delta^{MPP}\phi_t \qquad (5)$$

The above equation indicates that, in response to a global risk-off shock ($b_{P,t} \downarrow$ and $\phi_t \uparrow$), a policy mix combining FXI ($b_{M,t} \downarrow$) and macroprudential policy (δ^{MPP}) can mitigate excessive fluctuations in the exchange rate and interest rate, while limiting the increase in the UIP premium

Figure 10 compares IRFs with and without these additional policy tools. It shows that the economy experiences less contractionary effects from the shock with MPP and FXI. Note also that the MPP lowers the retail interest rate, giving more room for the policy rate hikes to target inflations.

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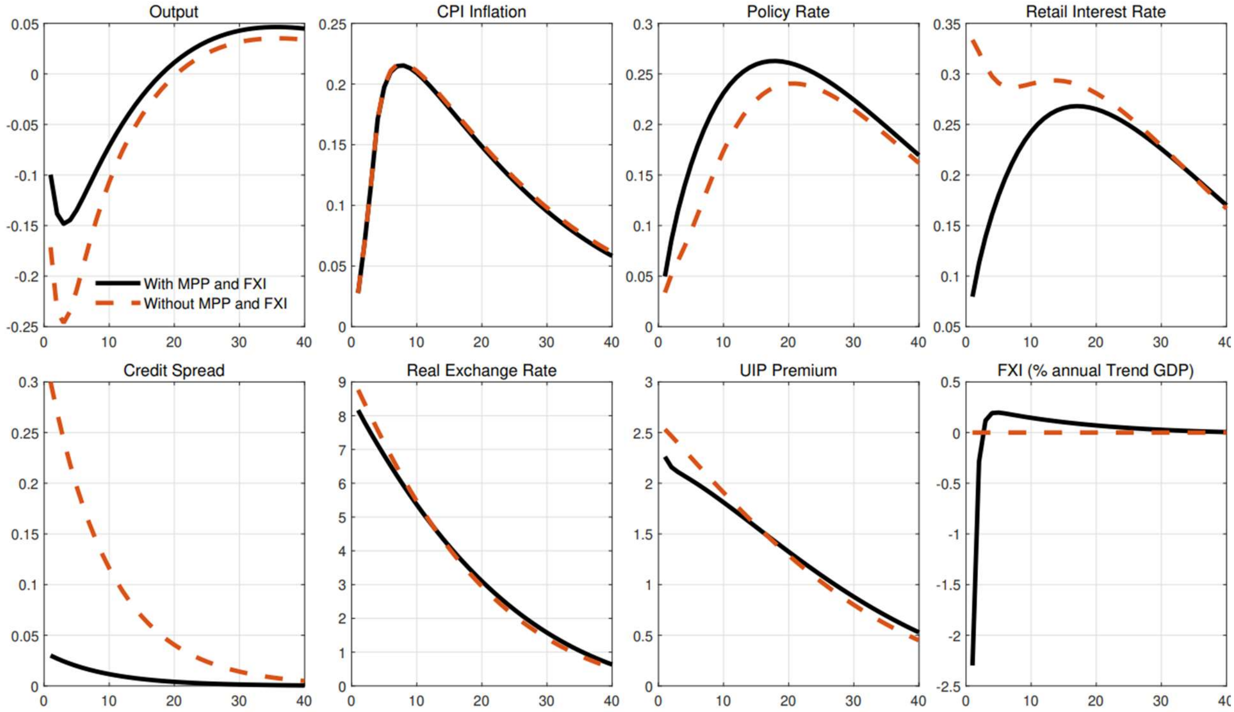
[12] In this paper, MPP refers to a set of policy measures aimed at reducing the overall financial vulnerability ex ante and enhancing its resilience to domestic and external shocks ex post, to maintain macroeconomic stability (Yoon, 2006) and prevent credit crunch in the financial market (IMF, 2023). A specific example is the Countercyclical Capital Buffer (CCyB). By flexibly adjusting capital requirements in response to global risk-off shocks, this measure enables domestic banks to maintain adequate lending capacity during periods of stress, thereby alleviating the widening of interest rate spreads in the domestic financial market.

Figure 10. Impulse responses to global risk-off shock with and without MPP and FXI



Notes: The figure describes impulse responses to global risk-off shock for $Cov\left(\varepsilon_{\phi,t}, \varepsilon_{b_p,t}\right) = 0.3$. The red dashed line is the same as the one in Figure 9 in which only interest rate policy is operating.

The above results suggest that a policy mix that combines FXI and MPP with interest rate policy can be a more effective policy response to the global risk-off shock. In particular, as the increases in the exchange rate and interest rate are contained, the decline in domestic consumption becomes smaller. This implies that the policy mix can effectively absorb the effects of shocks on the financial and FX markets, thereby limiting its spillover to the real economy.

To provide welfare implications, we compute welfare losses as below.[13]

$$Welfare\ Loss = \sum \beta^t \left[\omega_y (y_t - y)^2 + (\pi_t - \pi)^2\right]$$

where ω_y is the weight on GDP gap $(y_t - y)$ relative to inflation gap $(\pi_t - \pi)$.

Table 3. Welfare Loss Comparison

Policy Response	MP	MP+FXI+MPP
Welfare Loss	**1.25 (100%)**	**1.00 (100%)**
GDP Gap	0.40 (32%)	0.18 (18%)
Inflation Gap	0.85 (68%)	0.82 (82%)

[13] Debortoli et al. (2019) show that the weight on GDP gap (ω_y) is sufficiently large, the welfare of the economy can be approximated with GDP gap and inflation gap. In our analysis, it is assumed to be 1.

Notes: 1) Based on the impulse response functions to a global risk shock (one standard deviation), the deviations from the steady-state values are computed. Numbers in parentheses indicate the contribution of each component.

2) MP, FXI, and MPP denote interest rate policy, foreign exchange market intervention, and macroprudential policy, respectively.

Source: Authors' calculations.

Table 3 shows that the policy mix reduces the welfare loss associated with the global risk-off shock. When the policy mix is adopted, the welfare loss decreases by 18.3 percent compared to the case in which only monetary policy is used, and this improvement is found to be mainly attributable to the reduction in the GDP gap.

IV. Conclusion

In this paper, we conduct an empirical analysis using panel data for 17 countries, including Korea, and the quantitative analysis using an extended IPF model estimated with Korean data.

We find that countries with shallower financial and FX market experience larger adverse effects from global risk-off shocks. This is attributable to frictions in the financial and FX markets that amplify the impact of the shocks. With shallow markets, shocks that are not sufficiently absorbed and spill over to the domestic real sector.

Based on the overall results presented in this paper, two key policy implications can be drawn. First, enhancing the depth of financial and FX markets is essential. In this regard, the recent policy changes on Korea's FX market contributed positively to deepening the market by increasing FX spot trading volumes.[14] In addition, Korea's scheduled inclusion into the WGBI in 2026 is also expected to enhance the depth of market by attracting greater foreign capital inflows. Meanwhile, given that Korea's relatively shallow markets, it is suggested to use a policy mix combining MPP and FXI with interest rate policy can help achieve policy objectives more effectively.

[14] Following the policy changes, the average daily FX spot trading volume between July 2024 and June 2025 reached USD 12.31 billion, representing an increase of 16.3 percent (up by USD 1.73 billion) year-on-year and 44.6 percent (up by USD 3.79 billion) compared with the five-year average (from 2019 to 2023), indicating a gradual expansion in market size. See the press release by the Bank of Korea (https://www.bok.or.kr/portal/bbs/B0000502/view.do?menuNo=201265&nttId=10092335)

Box 1 **Overview of the Model**

The model is a two-country, open-economy New Keynesian DSGE model, consisting of a domestic economy and a foreign economy. The following equations represent the equilibrium conditions for the domestic economy, covering aggregate demand, aggregate supply, the financial and foreign exchange sector, and the policy sector.

(1) [Aggregate Demand] The GDP of the domestic economy is allocated to consumption (c_t), government spending (g_t), and net exports ($m_t^* - m_t$). Consumption is determined by Euler equation that incorporates the real market interest rate ($r_{b,t}$). Both exports and imports are denominated in the importer's currency, and the share of imported intermediate goods used in the production of exports is denoted by ω_x.

$$y_t = c_y c_t + g_y g_t + m_y(m_t^* - m_t)$$
$$\lambda_{c,t} = \delta_c E_t \lambda_{c,t+1} + r_{b,t}$$
$$\lambda_{c,t} = -\left(\frac{1}{\hat{\sigma}}\right)(c_t - \Xi_c c_{t-1} - \Xi_c \mu_{z,t} - v_{c,t})$$
$$m_t^* = (1-\omega_x) m_{d,t}^* + \omega_x m_{m,t}^*$$
$$m_t = (1-\omega_x) m_{c,t} + \omega_x m_{m,t}^*$$
$$m_{c,t} = c_t - (1-\omega_c)\eta_c(p_{m,t} - p_t) + v_{m,t}$$
$$m_{m,t}^* = y_t^* - \tilde{z}_t - (1-\omega_x)\eta_x(p_{m,t} - p_t) - \eta_f(p_{x,t} - p_t^*) + v_{m^*,t}$$
$$m_{d,t}^* = y_t^* - \tilde{z}_t + \eta_x \omega_x (p_{m,t} - p_t) - \eta_f(p_{x,t} - p_t^*)$$

(2) [Aggregate Supply] Under the assumption of price and wage stickiness, inflation in producer prices (π_t) and inflation in wages ($\pi_{w,t}$) are each determined by Phillips curves that include past inflation. Inflation in consumer prices ($\pi_{c,t}$) is derived by incorporating inflation in import prices ($\pi_{m,t}$) into producer prices.

$$\pi_t - l_p \pi_{t-1} = \beta\delta_c(E_t[\pi_{t+1}] - l_p \pi_{t-1}) + \kappa_p mc_t + \varepsilon_{\pi,t}$$
$$\pi_{m,t} - l_m \pi_{m,t-1} = \beta\delta_c(E_t[\pi_{m,t+1}] - l_m \pi_{m,t-1}) + \kappa_m mc_{m,t} + \varepsilon_{\pi_m,t}$$
$$\pi_{x,t} - l_x \pi_{x,t-1} = \beta\delta_c(E_t[\pi_{x,t+1}] - l_x \pi_{x,t-1}) + \kappa_x mc_{x,t}$$
$$\pi_{c,t} = (1-\omega_c)\pi_t + \omega_c \pi_{m,t}$$
$$\pi_{w,t} - \widetilde{\pi_{w,t-1}} = \beta\delta_c(E_t[\pi_{w,t+1}] - l_x \widetilde{\pi_{w,t}}) + \kappa_w(mrs_t + \zeta_{c,t}) + \varepsilon_{w,t}$$
$$\widetilde{\pi_{w,t}} = \iota_w \pi_{w,t} + (1-\iota_w)\pi_{L,t}$$
$$\pi_{L,t} = (1-v)\pi_{L,t-1} + v(\Delta s_t - E_{t-1}\Delta s_t)$$
$$y_t = (1+\phi_p)(\tilde{\epsilon}_t - \alpha\mu_{z,t} + (1-\alpha)n_t)$$
$$\zeta_t = \omega_c(p_{m,t} - p_{d,t}) + \zeta_{c,t}$$
$$\zeta_t = \zeta_{t-1} + \pi_{w,t} - \pi_t - \mu_{z,t}$$

(3) [Financial and Foreign Exchange Sector] The UIP condition, expressed in terms of the real exchange rate (q_t), and the equation for net foreign assets (b_t) are presented as follows.

$$\zeta_t = \zeta_{t-1} + \pi_{w,t} - \pi_t - \mu_{z,t}$$
$$q_{p,t} = \delta_c q_{p,t+1|t} + r_t^* - \frac{1+r}{1+r^*} r_{b,t} + \frac{1+r}{1+r^*}\Gamma[b_{F,t} + b_F r_{b,t}] + \frac{1}{1+r^*}(\phi_t^{MPP} - \pi_{t+1|t})$$
$$r_{b,t} = r_t + \phi_t^{MPP} - \pi_t$$
$$b_{F,t} = -b_t - b_{p,t} + b_{M,t}$$
$$\begin{aligned} b_t = {} & (\tilde{I}/\Pi_y)b_{t-1} + (b/\Pi_y)[(1-\omega)Ii_{t-1} + \omega I^*\Delta_S(i_{t-1}^* + \Delta s_t) - \tilde{I}(\pi_t + \mu_{z,t})] \\ & -((1-\omega)/\Pi_y)b_M[Ii_{t-1} - I^*\Delta_S(i_{t-1}^* + \Delta s_t)] \\ & -((1-\omega)(I - I^*\Delta_S)/\Pi_y)(b_{M,t-1} - b_M(\pi_t + \mu_{z,t})) + tb_t \end{aligned}$$
$$tb_t = m_y(m_t^* - m_t + \gamma_t^{x,*})$$

(4) [Policy Sector] The policy authorities employ fiscal policy (g_t), monetary policy (i_t), macroprudential policy (δ^{MPP}), and foreign exchange market intervention (fx_t) as policy instruments.

$$g_t = \rho_g g_{t-1} + \varepsilon_{g,t}$$
$$i_t = \gamma_i i_{t-1} + (1-\gamma_i)[(1+\gamma_\pi)\pi_{t+4|t}\gamma_y y_t + \varepsilon_t^i$$
$$\phi_t^{MPP} = \delta^{MPP}\phi_t$$
$$fx_t = \rho_{fx,1} fx_{t-1} - \gamma_{b_M} b_{M,t} - (1-\rho_{fx,1})\gamma_{\Delta_S}/(1-\gamma_{\Delta_S})\Delta s_t + 1/(1-\gamma_{\Delta_S})\varepsilon_t^{fx}$$
$$fx_t = b_{M,t} - b_{M,t-1}$$

The impulse response functions in our analysis illustrate the responses of variables to a one-standard-deviation exogenous shock to portfolio investors' capital outflows ($\varepsilon_{b_p,t}$), where $b_{p,t} = \rho_{b_p} b_{p,t-1} + \varepsilon_{b_p,t}$. In Figure 9, all policy variables except interest rate policy are constant (muted). The impulse is driven by $\varepsilon_{\phi,t}$, which is the exogenous shock to the interest rate spread ($\phi_t = \rho_\phi \phi_{t-1} + \varepsilon_{\phi,t}$), and $\varepsilon_{b_p,t}$, which is the exogenous shock to portfolio investors' capital outflows. The correlations between the shocks are set to 0, 0.3, and 0.5, respectively. Figure 10 further illustrates impulse response functions corresponding to the case of correlation being 0.3 but incorporating additional policy responses through macroprudential policy and foreign exchange market intervention.

Box 2 Calibration and Bayesian Estimation of the Model

The calibration and Bayesian estimation for the parameters in the model are conducted as follows. Table 4 below summarizes calibration for the key parameters. Other calibrated parameters are set in accordance with Chen et al. (2023) and related studies.

[Table 4] The Key Calibrated Parameters

Parameter	Value	Target[1)]
$\bar{b}$	0.60	Average of net foreign asset to GDP ratio
$\bar{b}_M$	0.91	Average of FX reserves to quarterly GDP ratio (quarterly)
$\bar{b}_P$	0.31	Derived from the steady-state equilibrium equation $-\bar{b}+\bar{b}_M-\bar{b}_F$[2)]
π	2.00	Long-run inflation rate
g_y	0.15	Average of government expenditure to GDP ratio (quarterly)
m_y	0.41	Average of exports and imports to GDP ratio (quarterly)
ω_x	0.14	Share of imported intermediate goods in total exports[3)]

Notes: 1) The averages are calculated based on data from the first quarter of 2009 onward.
2) $\bar{b}_F$ is set to be zero.
3) The ratio is calculated based on the input-output table (benchmark year 2022). (i) the ratio of intermediate demand to total demand from the import transaction table (producers), and (ii) the ratio of exports to total demand from the domestic transaction table (producers) are averaged across industries.

For the Bayesian estimation of the model, data for Korea and the U.S. from the fourth quarter of 2000 to the fourth quarter of 2024 are used. Following Linde et al. (2024), the posterior means obtained from the New Keynesian model estimated using U.S. data are first preset as parameter values for the foreign economy. The posterior distributions of 34 parameters for the domestic economy are estimated using data from Korea. For this purpose, the Metropolis–Hastings algorithm is employed using Dynare.

[Table 5] The Key Estimated Parameters

Parameter		Prior Distribution[1)]	Posterior Mean and HPD[2)]	
Γ	Depth of FX market	Beta (0.05)	0.036	[0.018 0.054]
$\gamma_{\Delta s}$	Responsiveness of FXI to exchange rate fluctuations	Beta (0.75)	0.811	[0.772 0.851]
$\rho_{fx,1}$	Autocorrelation coefficient of FXI	Beta (0.50)	0.201	[0.081 0.322]
σ_{fx}	Standard deviation of FXI shock	Inverse gamma (0.5)	2.939	[2.484 3.350]
σ_{b_p}	Standard deviation of capital outflow shock	Inverse gamma (10)	23.278	[14.548 31.498]

Notes: 1) The assumptions regarding the prior distributions follow Linde et al. (2024), and the values in parentheses denote the prior means.
2) The brackets [ ] indicate the 90% HPD (Highest Probability Density) intervals of the posterior distributions.

The estimation utilizes 16 macroeconomic variables as observed variables, including the real GDP growth rates of Korea and the U.S., government expenditure to GDP ratios, import and export growth rates, policy rates, Korea's population growth rate, the real exchange rates, foreign exchange intervention (FXI) to GDP ratios, labor input, inflation rates, and wage growth rates. The data are obtained from and compiled using the Economic Statistics System (ECOS), Statistics Korea (KOSTAT), the Ministry of Employment and Labor (MOEL), World Bank, and IMF's International Financial Statistics (IFS). Data on FXI are taken from Adler et al. (2024).

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