



IMF Working Paper

FX Funding Risks and Exchange Rate Volatility—Korea's Case

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Asia and Pacific Department

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Abstract

This paper examines how exchange rate volatility and Korean banks’ foreign exchange liquidity mismatches interacted with each other during the Global Financial Crisis, and whether the vulnerability stemming from this interaction has been reduced since then. Structural and cyclical changes after the crisis, including decreasing demand for currency hedges and the diversifying investor base for bonds, point to a possible weakening of the interaction mechanism; and we find evidences are strongly supportive of this.

JEL Classification Numbers: F31, G01, G15, G21

Keywords: Foreign exchange liquidity mismatch, exchange rate volatility, capital flows, macroprudential measures, dollar funding market

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I. INTRODUCTION

There are two well-known sources of external vulnerabilities in Korea's financial system. First, its capital markets, which are large and open, are sensitive to global risk factors. The liquidity and openness of these markets have exposed them to capital flow volatility as foreign investors have rushed in and out depending on swings in global risk appetite. Combined with vulnerabilities in foreign currency funding, this has often resulted in high price volatility, particularly during bouts of financial stress.

Second, Korean banks had sharply increased their short-term external debt in the run-up to the Global Financial Crisis (GFC), exposing themselves to rollover risks. Even though the bulk of the short-term external debt constituted interoffice loans owed by foreign bank branches (hence less susceptible to a sudden stop) and were matched with forward hedging activities mainly by exporters (hence little currency mismatch), Korean banks experienced a major disruption in wholesale funding during the GFC.

This paper examines how these two vulnerabilities interacted with each other during the GFC and bouts of post-Lehman risk aversion, and whether the interaction mechanism has weakened over time.

There have been important cyclical and structural changes in the Korean financial market since the GFC: exporters' demand for medium- to long-term foreign exchange hedging has declined; offshore entities have increasingly replaced foreign bank branches as the investor base of the local currency bonds; and international reserves have substantially increased relative to short-term debt.

For a given magnitude of external shocks, these changes point to: (i) a possible decline in the stress level of the domestic FX funding market, and (ii) a similar decline in exchange rate volatility. This paper finds overall supportive evidence on these possibilities. Most notably, we find that the sensitivity of exchange rate volatility to changes in VIX has declined very significantly since the GFC, mainly reflecting lower FX liquidity mismatches.

The rest of the paper is organized as follows: after looking into the causes of, and interactive dynamics between, the accumulation of short-term external debt (Section II) and exchange rate volatility (Section III), we review changes affecting the two vulnerabilities since the GFC (Section IV). Regression and simulation results are presented to see if the system has become more resilient to shocks affecting these vulnerabilities (Section V), and the paper concludes with a discussion of policy implications.

II. WHY WERE KOREAN BANKS HIT SO HARD DURING THE GFC?

The Lehman Brothers bankruptcy in September 2008 and the resulting sudden stop in capital flows caused a loss of funding to cope with current account deficits for most capital flow recipient countries. While Korea's current account position prior to the crisis had comfortably remained in surplus, Korea was among the hardest hit country in Asia during the GFC. This section presents three stylized facts regarding Korea's financial system that explain the large impact engendered by the crisis despite the Korean economy's positive saving-investment gap.

Fact 1: The link between banks' external borrowing and lending is weak.

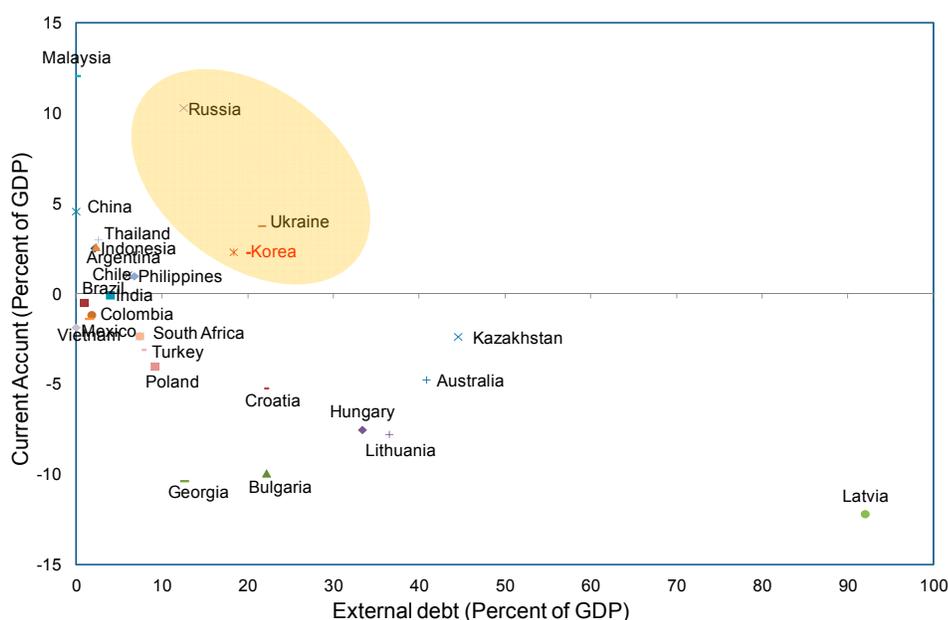
Banks' external borrowing is frequently linked with their domestic lending activities. Banks' needs (or desire) to raise overseas borrowing tend to increase, the higher the demand for credit, for given amount of deposit flows and domestic wholesale funding; alternatively their needs (or desire) to extend credits will increase, the easier and cheaper it gets to raise funds overseas. Banks' external borrowing is generally made in foreign currency (except for a handful of countries with international currencies), with the ensuing exposure to currency risks passed on to their borrowers, as seen in pre-Lehman credit boom episodes in many emerging market economies.

This link underpins, at the macroeconomic level, a tie between banks' external borrowing and current account deficits (i.e., saving-investment gap). Current account deficits need to be financed by either capital inflows or asset draw-downs. Hence, larger current account deficits generally increase the need for banks' external borrowing, although the strength of the link depends on the availability of other channels of funding.

In light of the above, the large build-up of external debt by the banking sector in Korea was somewhat particular.

- *First, as a current account surplus country, Korea did not need to have its banks to borrow externally for the purpose of augmenting its overall credit availability.* In fact, every dollar brought onshore to Korea ended up adding to its savings excess (rather than relieving savings shortage), and was either sent back offshore as an overseas investment (particularly equity) or held as reserve assets (this is a mere accounting identity!). A cross-country comparison between banks' external short-term debt and current account positions on the eve of the GFC (Figure 1) show that Korea was among a few outliers (Korea, Russia, and Ukraine) that had built up large amount of external bank debt (above 10 percent of GDP) and were making current account surpluses since early 2000s.

Figure 1. Bank External Debt and Current Account



Source: IMF World Economic Outlook database.

Note: Short-term debt is for 2007; and current account is an average for 2000 to 2007.

- ***Second, the link between Korean banks' external borrowing and domestic lending was weak***, with a threefold pre-GFC increase in the former paired up with only a one half increase in the latter (see Box 1 for details).
- ***Third, the link between the banks' external borrowing and currency mismatch also appears to have been weak***. In countries where internationalization of currency is lacking, increased reliance on external funding tends to cause the same on foreign currency loans. In the case of Korea, however, a one dollar increase in external borrowing prior to the GFC was accompanied by only a 20 cent increase in foreign currency lending.

Fact 2: Banks' external borrowing was mainly driven by the demand for FX hedging.

In the years leading up to the GFC, expectations of trend appreciation in exchange rates had created large demands for hedging by exporters and asset management companies that were rapidly expanding overseas securities investment.² These demands were spearheaded particularly by shipbuilders who saw their order books rapidly expanding on a cyclical upswing of the global demand for ships (Table 1). Moreover expectations of currency appreciation, lengthy production cycles, and increasingly lower import contributions (hence less room for natural hedging) had led them to raise the hedge ratios.

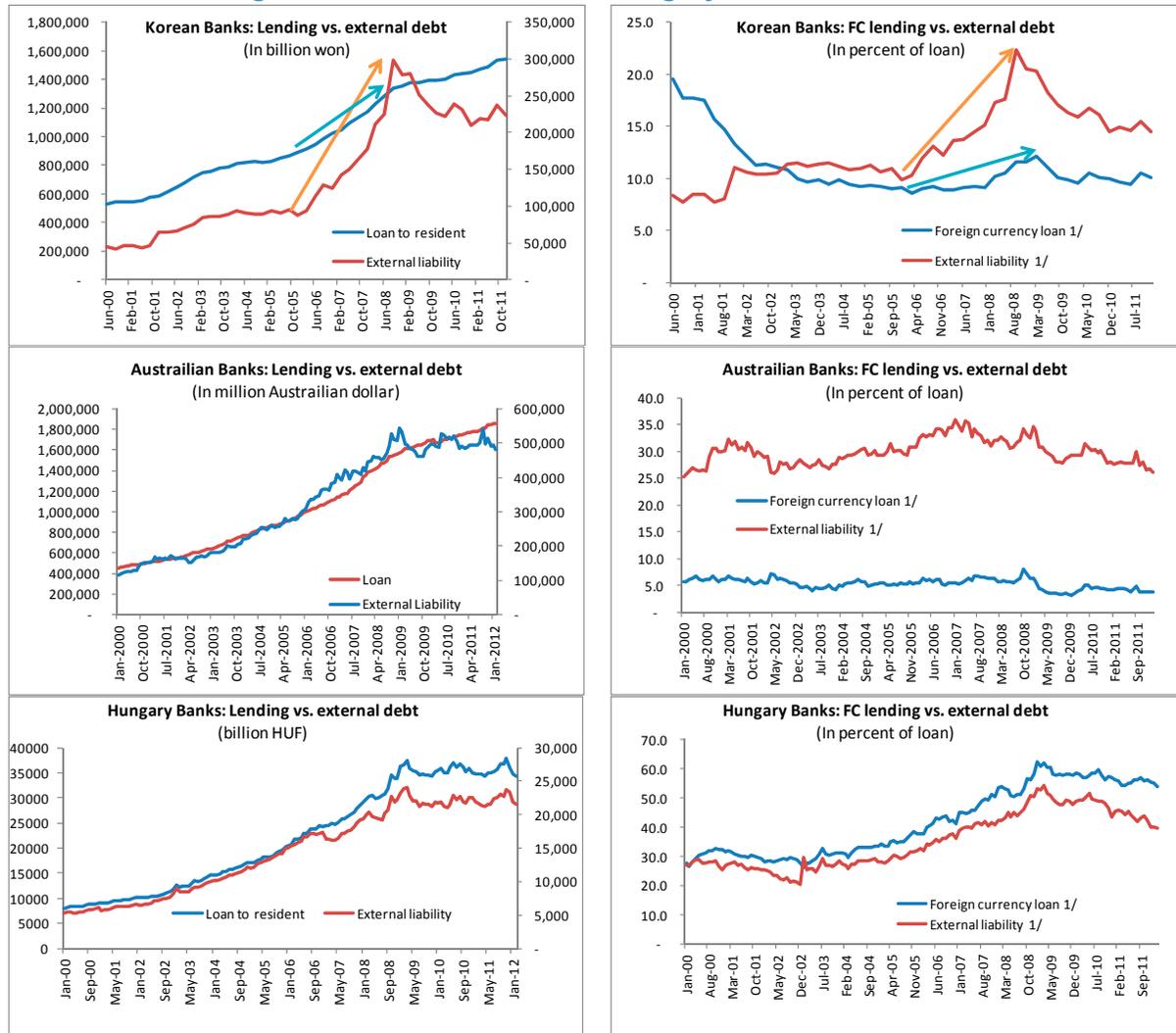
² See Baba and Shim (2010), Park (2011), Park and Kwon (2010), Ryu and Park (2008), Shin and Jang (2006), Yang and Lee (2008).

Box 1. External Borrowing and Lending: Korea, Australia, and Hungary

Overall lending

Bank external borrowing has closely tracked total lending in both Australia and Hungary, but for Korea that was clearly not the case. In Hungary (as in many other emerging market economies that experienced capital flow-induced credit booms prior to the GFC), the direction of causality appears to have been from easier access to foreign finance (mainly through foreign bank branches and subsidiaries) to increased availability of domestic credit. In Australia, increased reliance on wholesale funding and capital inflows boosted by carry-trade motives seem to have underpinned the sharp pre-GFC run up in external borrowing and domestic lending.

External Borrowing of Korea, Australia, and Hungary



Source: CEIC.

In Korea, however, a threefold run up in external borrowing in 30 months leading to the GFC was associated with only a 50 percent increase in overall lending. Then the GFC saw a quarter of the total external debt stock knocked down. Despite this, however, the overall lending kept on growing albeit on a sharply moderated path.

Foreign currency lending

Hungary is an intriguing case exemplifying a close tie between banks' external borrowing and currency mismatches, which is explained by banks' tendency to denominate loans in foreign currency when the associated funding is also made in one. In case of Australia, in contrast, the link between external borrowing and foreign currency lending appears as weak as in Korea. The weakness reflects Australia's unique ability to raise external borrowing in local currency, or have foreign currency-denominated debt swapped into local currency ones.

Modality of Externally-Financed Lending: Australian Banks

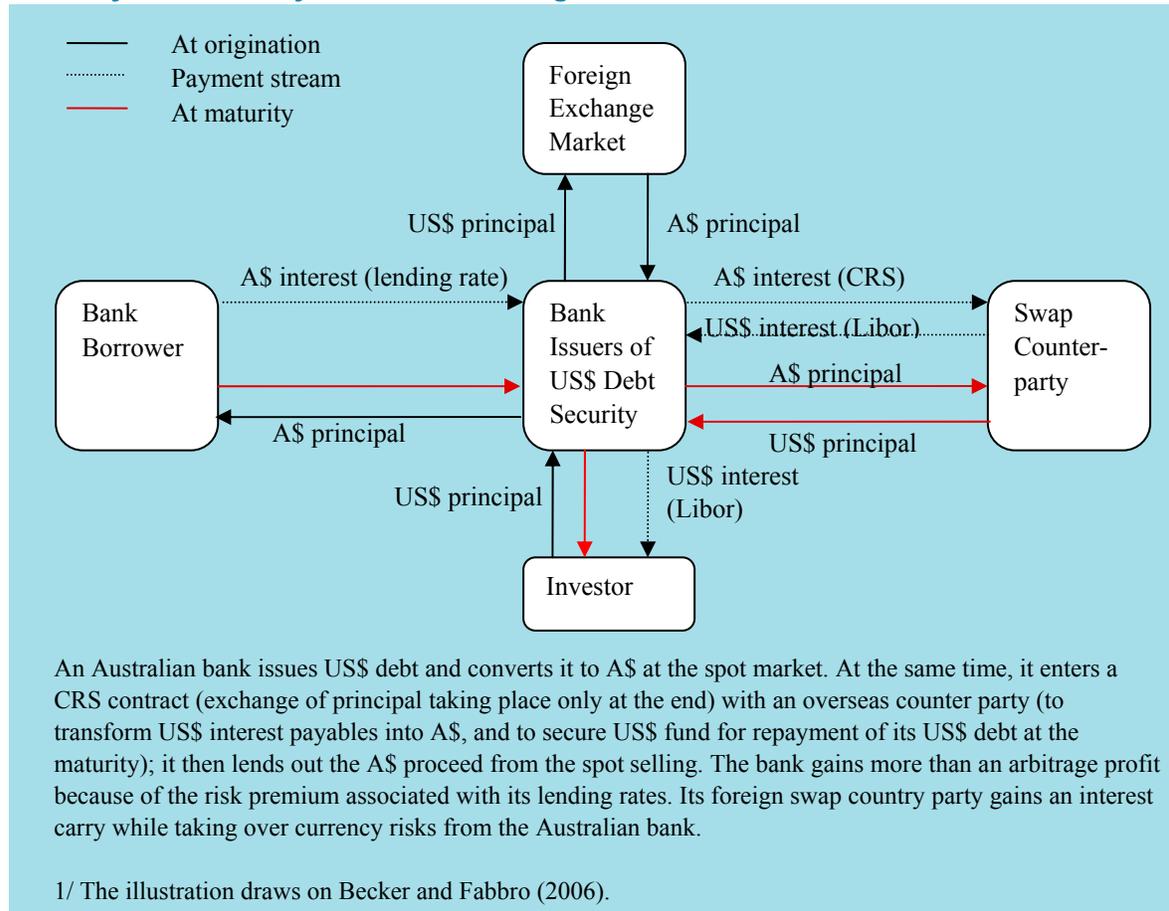


Table 1. Companies' FX Forwards Selling and Buying

(In billions of U.S. dollars)

	2005	2006	2007	2008	2008		2009	2010	2011
					1 st	2 nd			
FX Forwards sold(A)	71.7	99.7	126.0	136.6	92.8	43.8	70.9	103.2	112.5
Shipbuilders	22.3	43.1	62.3	40.9	33.5	7.4	15.7	21.9	27.7
(Orders)	35.2	54.6	97.4	69.8	51.5	18.4	14.4	34.6	49.3
FX Forwards bought(B)	42.5	50.4	54.2	74.6	34.4	40.2	49.8	70.3	98.2
Oil refineries	6.1	1.0	2.5	3.5	1.8	1.7	3.0	4.3	12.8
(Oil imports)	42.5	55.8	60.5	85.0	44.4	40.6	50.7	68.6	91.1
Net selling(=A-B)	29.2	49.3	71.8	62.0	58.3	3.7	21.1	33.0	14.4

Sources: Bank of Korea; Ministry of Knowledge Economy.

And this had caused a large build-up of short-term external debt in the banking system. The aggregate amount of short-term external debt owed by Korean banks rose to US\$160 billion in the third quarter of 2008 from US\$60 billion in the first quarter of 2006. The Bank of Korea's internal data suggest that the increase in banks' net forward positions (after netting out portions backed by swaps) can explain up to 60 percent of the increase in the short-term external borrowing during this period. A joint thematic examination by the BOK and Financial Supervisory Services (January 2008) also found that banks tend to square about three quarters of their forward overbought positions by external borrowing and 20 percent by swap transactions.

To corroborate these, we estimated a panel data model of short-term external debt using GMM (sample period 2004Q4-2011Q4, 15 domestic banks and 27 foreign bank branches included; Tables 2, 3). The estimation shows that a one percentage point increase in net forward position (scaled by the total asset size) of a foreign bank branch is associated with a 0.3 percentage point increase in the short-term external debt (scaled the same way) in the same quarter, followed by a 0.3 percentage point total additional increase in the subsequent periods. Domestic banks' short-term external debt, however, did not show a significant link with their forward overbought positions.

In the face of a rapid increase in forward selling, and given a shortage of commensurate increase in forward buying by the importers, banks sought to square their positions by taking short positions (Figure 2). This was done by either:

- Borrowing foreign currency, selling it into Korean won, and investing the proceeds in domestic bonds (typically foreign bank branches), or
- Creating a short FX position by combining cross-currency (or FX) swap and a spot selling of foreign currency (typically domestic banks).

Table 2. Determinants of Korean Banks' ST External Debt 1/

		Dependent variable: ST external debt/ total asset			
		Foreign bank branches		Domestic banks	
		Coefficient	Robust St.err	Coefficient	Robust St.err
ST external debt(-1)/ total asset(-1)		0.4424***	0.0960	0.6962***	0.0611
Bank-Specific factor	FX derivatives positions /total asset	0.3186***	0.0558	0.1110	0.0704
	BIS capital adequacy ratio	-0.0740**	0.0352	-0.0431**	0.0208
Domestic factor	GDP growth(-1)	-0.1482	0.2078	0.0128	0.0112
	Inflation(-1)	-3.9555***	0.7462	-0.1493	0.1077
	$\Delta \text{Log}(\text{exr})(-1)$	-0.1272*	0.0750	0.0087	0.0096
	Exr volatility(-1)	0.1242***	0.0260	-0.0023	0.0023
	CA(-1)/GDP(-1)	-0.5967**	0.2313	-0.0395	0.0268
	Reserve(-1)/GDP(-1)	0.3312**	0.1326	-0.0824	0.0977
	Incentive	2.0640***	0.6774	0.0004	0.0910
International factor	VIX	-0.3836***	0.0988	0.0087	0.0171
Constant		9.3058	9.4283	2.8430***	1.0715
AR (1) <p-value>		-2.5596	<0.0105>	-2.0906	<0.0366>
AR (2) <p-value>		0.6172	<0.5371>	1.3315	<0.1830>

Source: Authors' estimations.

Note: 1/ ***, **, * denotes significance in 1, 5, and 10 percent range.

Table 3. Variables Used in the Estimation

Variable names	Explanation	Data sources
ST external debt/ total asset (%)	Banks' short-term external debt denominated in foreign currency / Banks' total asset	FSS
FX derivatives position/ Total asset (%)	Banks' net derivatives position/ Banks' total asset	Bank of Korea, FSS
BIS capital adequacy ratio (%)	Banks' risk weighted asset/ Banks' capital	FSS
GDP growth (%)	Korea's GDP growth rate	Bank of Korea
Inflation (%)	CPI inflation rate	Bank of Korea
$\Delta \text{Log}(\text{exr}) (\%)$	Change of period average KRW/USD exchange rate	Bloomberg
Exr volatility (%p)	Standard deviation of daily exchange rate change during the period	Bloomberg
CA / GDP (%)	Korea's current account / GDP	Bank of Korea
Reserve / GDP (%)	Foreign reserve / GDP	Bank of Korea
CIP deviation (%p)	Monetary Stabilization Bonds rate(3m) - Libor(3m) - Swap rate	Bloomberg
VIX	VIX index	Bloomberg

Source: The authors.

Figure 2. Foreign Bank Branches' Typical Positioning

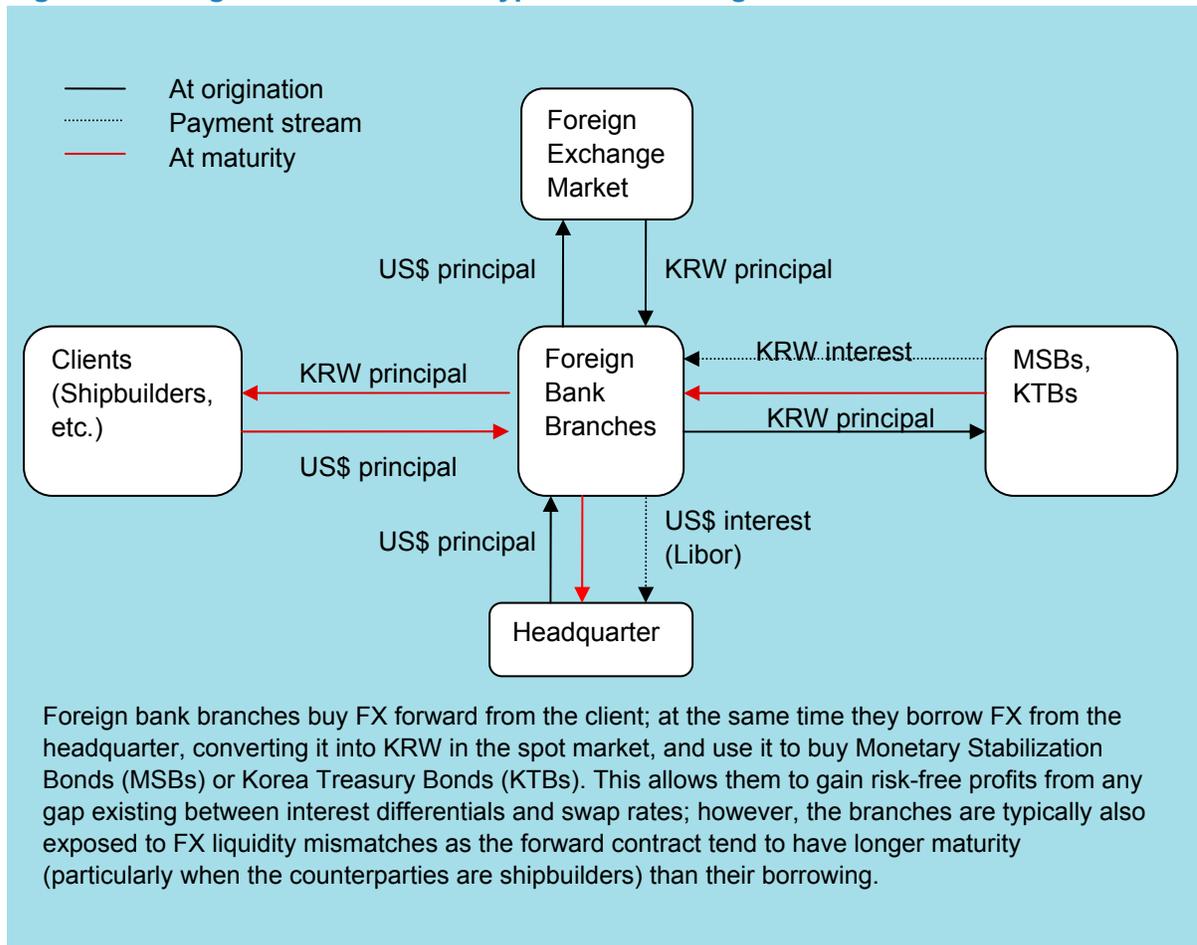
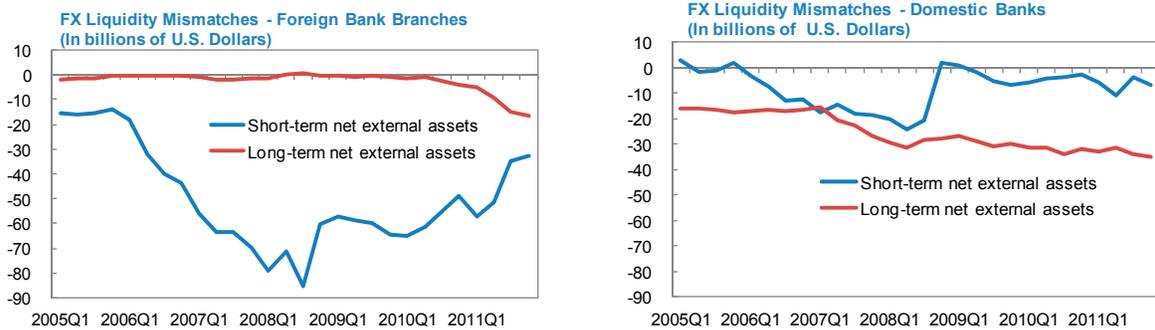


Figure 3. Korean Banks: Liquidity Mismatch



Source: Bank of Korea.

Fact 3: Foreign bank branches have built up liquidity mismatches.

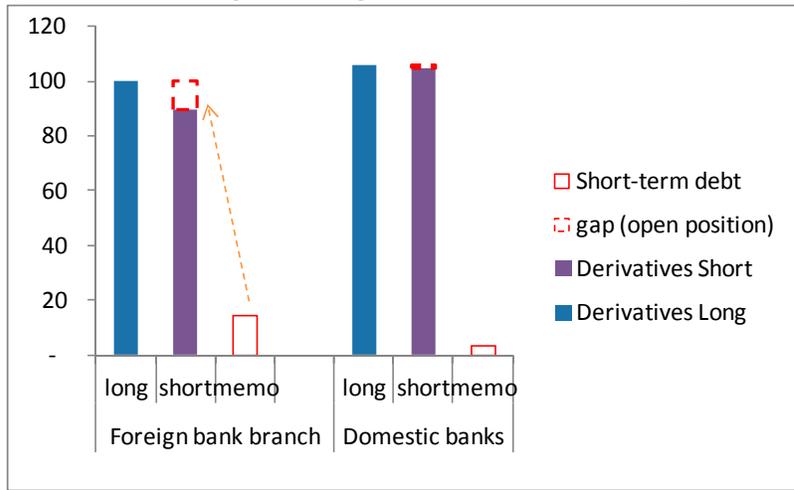
With their natural advantages in access to offshore wholesale funding, foreign bank branches have traditionally acted as intermediaries of dollar funding for domestic banks. And they were also the ones that were mainly accountable for FX liquidity mismatches in the banking system—an Achilles heel of Korea’s financial system before Lehman (Figure 3).

According to the BOK (Figure 4), the FX derivative positions of foreign bank branches prior to the GFC can be broken down, in net amounts, to FX forwards (a bulk of which is of maturity exceeding 1 year) and FX swaps (maturing in 1 to 3 months) on the long, and cross-currency swaps (maturing in 1 to 3 years) on the short side.³ The branches had raised short-term external debt to offset net open positions created in relation to their (i)

hedging services provided to nonbank clients (i.e., the gap between their net long forward position and net short CRS position; accounting for about one half of their net open positions); and (ii) intermediary roles in the FX swap market (i.e., their net long FX swap position, which pairs up with net short FX swap position by the domestic banks; accounting for most of the remaining half). Because foreign bank branches’ net long FX swap positions represented short-term foreign currency cash flows in train (hence, were liquid), it was the their hedging operation (i.e., net long forward positions) that was the main source of liquidity mismatches.

Why did the branches use ‘short-term’ external debt to offset their ‘longer-term’ exposures in FX forwards? The reason appears twofold: a cheaper interest cost of funding; and a low perceived liquidity risk given the affluence of global liquidity in the run up to the GFC.

Figure 4. Composition of Forward Book (Q3 2008) 1/ (Derivatives long of foreign bank branches = 100)



Source: Bank of Korea.

Note: 1/ Forward+FX swap+CRS+Others. Trading positions in gross amount.

³ Both foreign bank branches and domestic banks were in net short positions in cross-currency swaps. This indicates that offshore arbitrageurs, mainly global banks, had provided dollar funding in this market, with a view to forming hedged positions in domestic bonds.

While domestic banks were also substantially engaged in FX hedging activities, they took on more conservative positioning, offsetting bulk of their net long forward exposures by net short CRS positions (which are long term). While they also obtained FX swap funding (mainly from foreign bank branches), domestic banks seem to have done so to offset their short-term net long forward positions (e.g. those contracted with asset management companies). Moreover, domestic banks had incurred little net open positions in their forward books.

To recap, foreign bank branches' intermediary functions were well confined to short-term swap operations (contrary to a common perception that foreign bank branches provided long-term dollar funding to domestic banks); and their liquidity mismatches were mainly attributed to the maturity gaps between their forward positions (particularly forward selling by shipbuilders) and short-term on-balance sheet borrowing (usually interoffice loans from their headquarters). The branches sold the dollars obtained through short-term borrowing in the spot FX market, and then parked the proceeds in Korean government or BOK bonds.

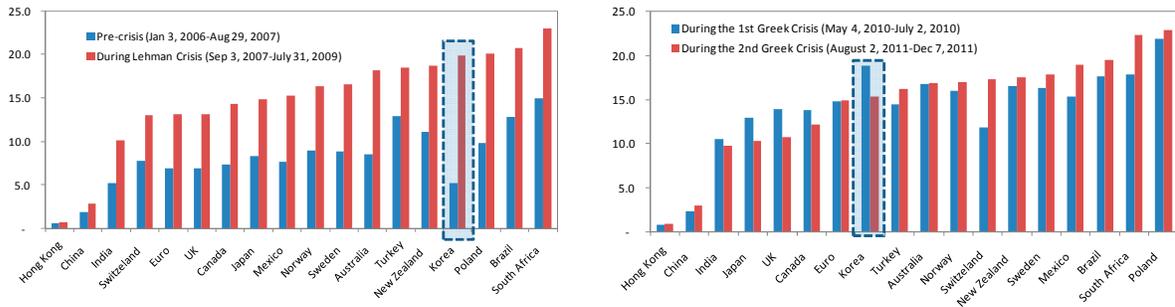
Their FX liquidity mismatches generated an important vulnerability to tail risks. Foreign banks' world-wide operation (hence a liquidity mismatch in one jurisdiction can be easily offset by those in others in the opposite direction) and high access to liquidity backstops made it highly unlikely for the mismatches to overtake their operations except in very unlikely contingencies in which interbank dollar funding freezes up globally. With the Lehman bankruptcy, the unlikely suddenly turned into a reality, taking Korea's entire banking system down the drain of stress.

III. WHY IS THE KOREAN WON SO VOLATILE?

Since adopting free floats in late 1997, the Korean won tended to show moderate degrees of volatility during periods when risk-on sentiments dominated. When sentiments turned risk-off, however, the Korean won tended to underperform comparable currencies and demonstrate volatility surges (Figure 5). With significant foreign investor shares in both holding and trading, volatilities of the Korean stock prices have also demonstrated a similar behavior, although the roller-coaster ride of their volatilities was less pronounced (Figure 6).

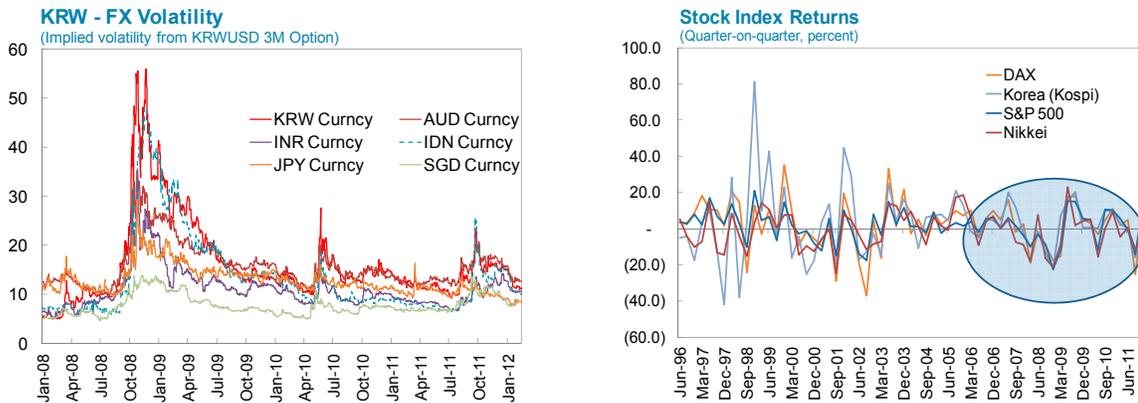
Why has the Korean won been so volatile? Previous studies generally point to Korea's high degree of capital market openness, a flexible exchange rate regime, a weak microstructure of the FX market, and linkages with FX funding markets.

Figure 5. Korean Won's Volatility



Source: Bloomberg.
 Note: Period average of option implied daily volatilities of exchange rates against dollar.

Figure 6. Korea's FX and Equity Volatilities



Sources: Bank of Korea; Bloomberg; and IMF staff estimates.

Capital market openness and depth

The won's high volatility has often been related to the high openness of Korea's deep and liquid capital markets, which combined with relatively liberal capital account regulations, has exposed the economy and financial system to volatile swings in capital flows. Commonly used measures of capital market openness, however, show varying pictures about Korea, depending on different aspects of openness that they are designed to capture.

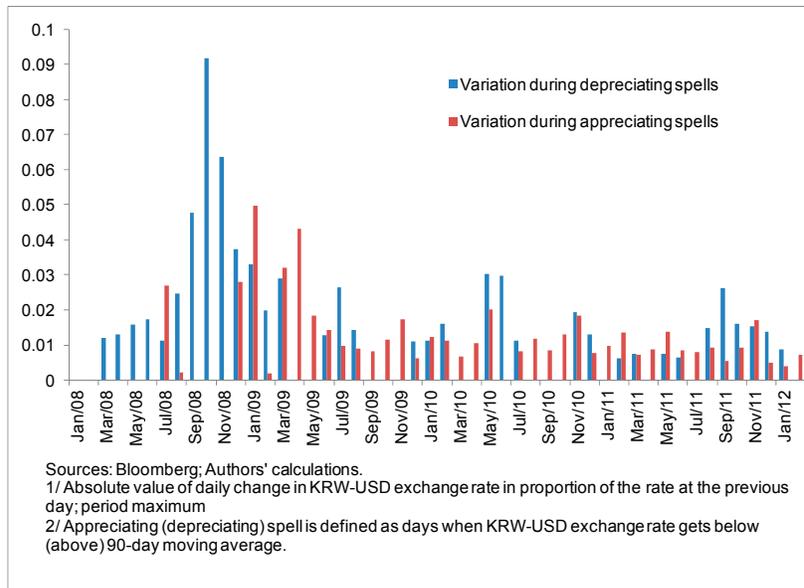
For example, Chinn-Ito index (Chinn and Ito (2008)) puts Korea in the upper middle percentile range (from 50 to 75 percentile in the index value; out of 181 countries) in the cross-country index distribution, focusing on de jure restrictions on capital account transaction (the less restrictions, the higher the index; based on IMF's AREAR). However, several other indicators (that more directly assess ease of capital flows in and out of a country) place Korea at the top end of the emerging market countries (Investment Freedom Index, Wall Street Journal and Heritage Foundation), or even the world (Capital Access Index, Milken Institute). While capital market development can be beneficial for both economic growth and macro-financial stability over a longer horizon, Korea's experience since 1997

currency crisis highlights the importance of a careful management of the risks engendered by capital flows.

Exchange rate regime

Since adopting floating exchange rate regime, Korean authorities have been perceived by the market as more accommodative to market forces during depreciating spells (Figure 7) than in the appreciating ones. This perception, justifiable or misled, often led to expectations of gradual but sustained appreciation of the Korean won, particularly during upswings in global capital flows (Box 2).

Figure 7. Daily Exchange Rate Variation During Appreciating and Depreciating Spells
(Average KRW-USD daily volatility in each spell 1/, 2/)



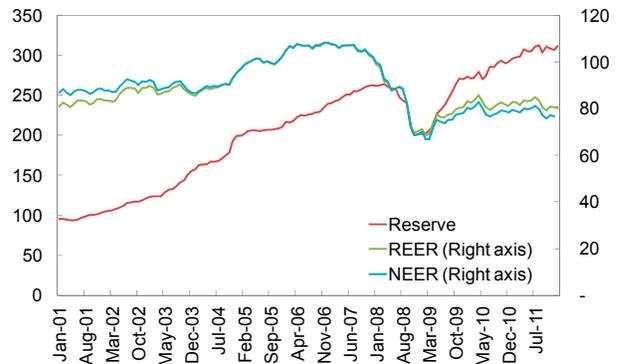
This was the case in the run-up to the GFC, when the expectations of trend appreciation led to increasing imbalance in the market for currency hedging. In this respect, Korea's exchange rate regime could have contributed to Korean won's volatility both directly, through overall flexibility, and indirectly, by engendering potential vulnerabilities (i.e., imbalance in hedging and a build-up of short-term debt) in the financial system.

Box 2. Were There Expectations of a Trend Currency Appreciation?

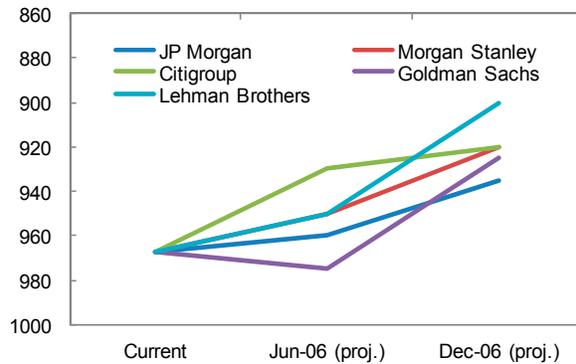
There is some evidence supporting expectations of currency appreciation during the run-up to the GFC:

- Trends in the exchange rate and reserves.** The real effective exchange rate of the won had shown a trend appreciation from 2001 up to the GFC (a cumulative 30 percent), accompanied by a three-fold increase of reserves. From 2005 to the GFC, the appreciation of the won had gained pace along with a slowing of reserve accumulation, reflecting a shift to more flexible exchange rate management.
- Undervaluation.** The won was also widely assessed to be undervalued by market analysts. Exchange rate forecasts before the GFC were skewed toward appreciation.
- Market positioning.** The trends in hedge ratios by Korean exporters and importers also revealed market positionings which anticipated a further appreciation of the won. While FX forwards sold by exporters rose to 32.3 percent of exports in 2007 from 24.7 percent in 2005, FX forwards bought by importers declined from 16.5 percent of imports to 15.4 percent during the same period. Widespread use of complicated FX derivative products (so called KIKOs) and the large associated losses incurred afterwards also illustrate the extent of directional positioning by the firms.

Korea: REER, NEER, and Reserves
(In billions of U.S. dollars, Index)



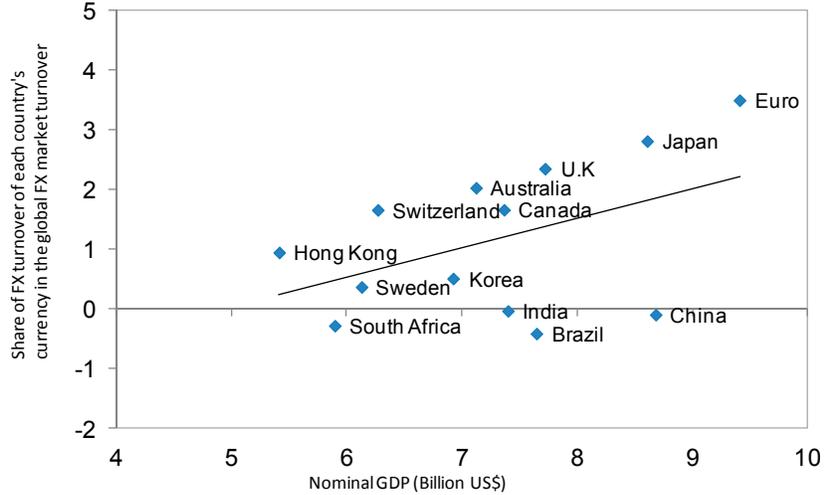
Korea: Market Forecasts of KRW
(Won per U.S. dollars)



Market infrastructure

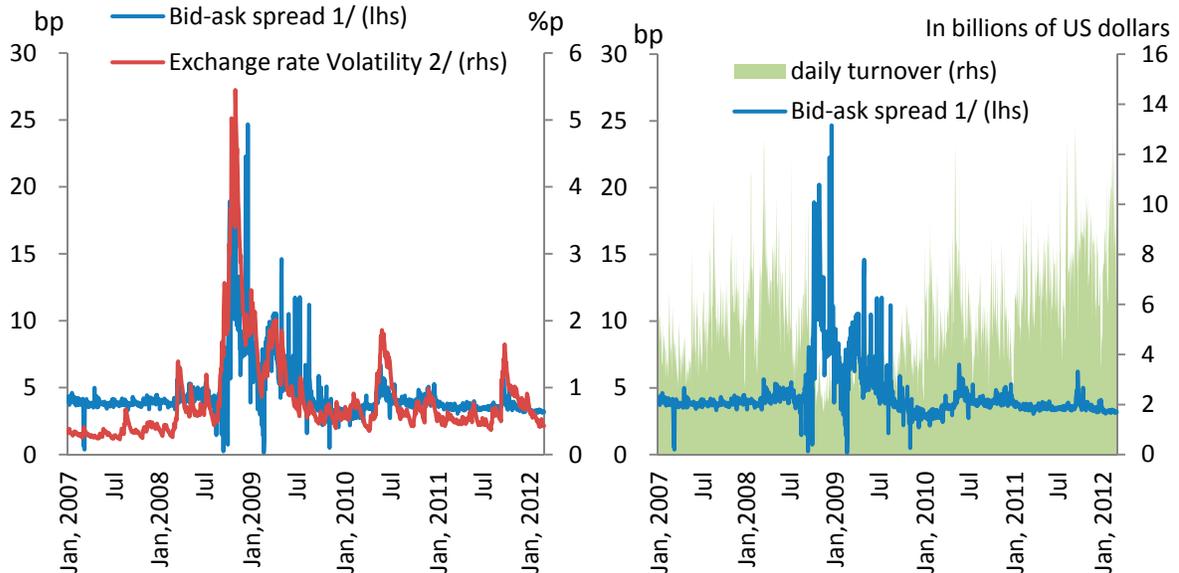
The Korean FX market has grown significantly in its size in part led by onshore swap and offshore NDF trading. Despite this, latest BIS data show that the share in trading of the won in the global FX markets still falls below what would be in line with the size of Korea's nominal GDP (Figure 8). Combined by expectations of trend appreciation, lack of internationalization could have hampered diversification of the trader base. Because of a relatively small size and the less diversified trader base, the FX market for the won has remained relatively shallow, often exposed to a drying-up of liquidity in the face of external shocks.

Figure 8. Global Turnover as % of GDP by Currency (2010)



Sources: Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2010; IMF WEO.
Note: Scales are in natural logs.

Figure 9. Bid-ask Spreads, Its Volatility, and FX Spot Turnover



Sources: Delton; and the Authors' calculations.

Note: 1/ Bid-ask spreads per one minute interval are averaged over a day, and they are divided by closing won/dollar exchange rates.

2/ Conditional standard deviation of growth rates of daily exchange rates, based on GARCH (1, 1).

In fact, previous studies (most notably Lee, 2009) have suggested that a confluence of sharp rise in bid-ask spread and an abrupt dissipation in trading volume may have driven the sharp increase in volatility during the GFC. Latest data show that bid-ask spread continues to be closely linked with spikes in volatility although the direction of causality is difficult to tell (Figure 9).

Linkages with FX funding market

One highly plausible explanation of the won's volatility surge relates to its linkage with FX funding liquidity stress—the focus of our paper. In the wake of the global liquidity squeeze after Lehman, stresses in the on-shore FX funding market and the FX market fed each other.

- Given the FX liquidity mismatches in the balance sheets, a sudden stop in capital flows hit foreign bank branches hard. The branches suddenly faced rollover difficulties, including from their head offices, on their short-term external debt; and were forced to convert their won liquidity into FX.
- The cost of onshore dollar funding increased sharply, reflecting the drying up of the main supply channel (i.e., foreign bank branches) particularly in short-term tenors. Offshore arbitrageurs, mainly global banks, also retrenched exposure, curtailing the supply of CRS funding. As the result, the market liquidity sharply dissipated in the dollar funding market.
- This forced the foreign bank branches to liquidate their bond positions to obtain foreign exchange despite losses implied by the distressed sales. These sales put downward pressures on the won.
- The depreciation of the exchange rate, in turn, could have stoked demand for dollar swap funding reflecting expectations that the exchange rate had overshot on the upside (e.g., with importers borrowing dollars for the purpose of making payments instead of purchasing them, with the expectation that the won would strengthen in the future).⁴

The positive association between exchange rate volatility and short-term external debt has been well documented in existing studies.⁵ In line with these studies, our regression analysis

⁴ A non-arbitrage condition (between FX and swaps) might have been instantaneously restored in an efficient market (i.e., without triggering sequential feedbacks), but the price discovery process seems to have been far from instantaneous and accompanied by a high volatility spell, given the abrupt dissipation of market liquidity and continual shocks arising from speculative positioning and the authorities' defensive interventions at the time.

⁵ See Sung (2011), and Park and Chang (2011).

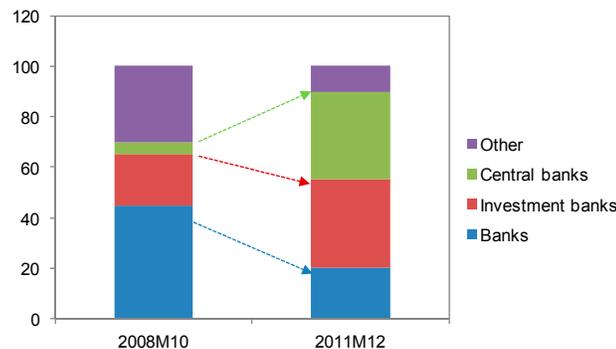
(see Section V) establishes the pre-crisis accumulation of short-term external debt as the cause of exchange rate volatility spikes seen during the GFC.

IV. WHAT HAS CHANGED SINCE?

There have been several important changes in the Korean financial market since the GFC, which could have led to a decline in vulnerabilities from banks' FX liquidity mismatches and their links to exchange rate volatility.

- ***Demand for medium- to long-term FX hedging particularly by the Korean ship builders has declined*** in the face of a sharp global decline in ship orders and the change in expectations over the direction of the won since the GFC. The decline has helped to reduce FX liquidity mismatches of the foreign bank branches.
- ***Macroprudential measures have been introduced.*** These include: ceilings on banks' foreign exchange derivative positions; tighter foreign exchange liquidity standards complemented by more frequent stress tests; a macroprudential levy on the foreign currency-denominated noncore bank liabilities; and a reinstated withholding tax on foreign investors' interest income on government bonds.
- ***Offshore entities, including real money and sovereign investors, are increasingly replacing foreign bank branches as investors of domestic bond.*** The relative prominence of these two groups of investors, as net buyers of domestic bonds, has been reversed since late 2009. This change has helped to stem an overshooting of exchange rate under a stress mainly by diversifying trader base of the FX market. Clearly, the foreign banks and sovereign investors have different investment objectives and horizons; hence, their responses to liquidity shocks will likely be different, which implies low correlation in behavior. The recent increase in the share of central banks in the overall foreign investor holding of domestic bonds to 35 percent by end-2011 is particularly noteworthy (Figure 10).

Figure 10. Composition of Foreign Investors in Korean Bonds (Percent)

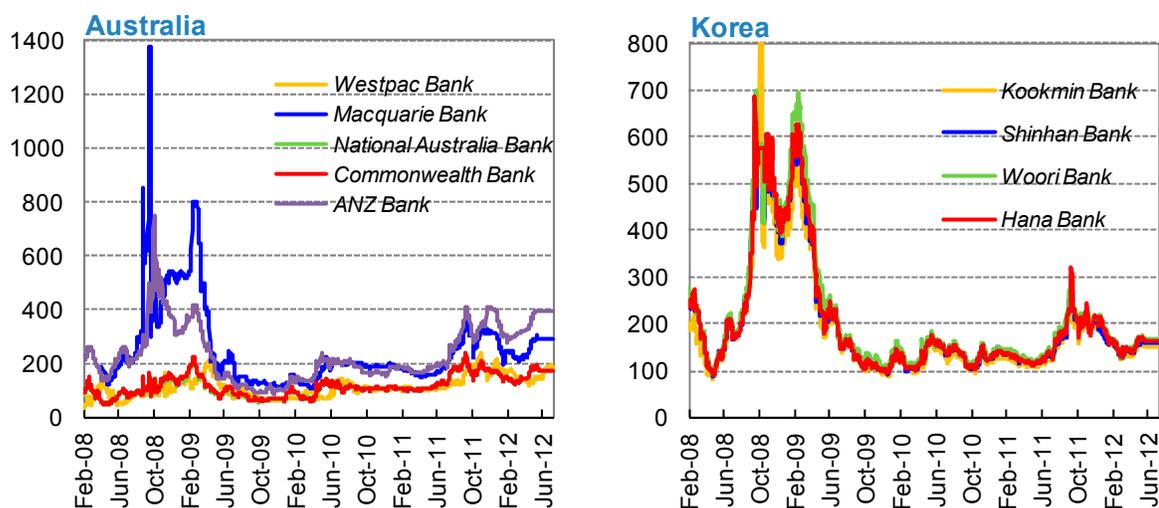


Source: Bank of Korea.

- ***Korea's reserve to short-term debt cover has also significantly improved.*** This means that the BOK now has more fire power to mitigate shocks both in the onshore dollar funding and FX markets.

These changes suggest a weakening of the feedback loop between banks' FX liquidity mismatches and exchange rate volatility. The May 2012 bout of risk aversion (after the first Greek election) is a case in point. During this period the onshore dollar funding market showed little signs of stress, with the one year cross-currency swap spread widening to minus 150 basis points, compared to minus 300 basis points at its trough during the third quarter of 2011. The CDS spreads for major Korean banks also widened to only 150 basis points, about half the peak reached during the third quarter of 2011, and compared with 700–800 basis points seen during the GFC (Figure 11). Furthermore, the spread widened significantly less than those of many international comparators (e.g., Australian banks). Clearly, in May 2012, Korean banks were riding out global shocks much better than they did three or four years ago.

Figure 11. Bank CDS Spreads (Basis points)



Source: Bloomberg.

V. HAS THE FX VOLATILITY BECOME LESS RESPONSIVE TO GLOBAL SHOCKS?

Despite the usual caveats (particularly given the likely structural break and limited accumulation of data points after the GFC), our regression analysis supports the hypothesis of increased resilience. One of our models tests the sensitivity of exchange rate volatility to external shocks (proxied by VIX), foreign currency liquidity risk of the banking system (proxied by the banking sector short-term external debt-to-GDP ratio), and the interaction between the two. In doing so, we included standard control variables used in existing studies,⁶ as well as a few new variables, with a view to capturing structural changes such as

⁶ See Sung (2011), Park and Chang (2011), and Suh and others (2011).

diversification of the investor base of domestic bonds. Three interesting points emerged from the regression (Table 4, Figure 12).

Table 4. Determinants of the Exchange Rate Volatility 1/, 2/

	Dependent : Won-Dollar Exchange Rate Volatility	
	Sample: Jan. 2006 to Dec. 2011	
	Coefficient	
Banks' short-term external debt/GDP	0.015**	(0.006)
Yield spread(US) (3Yr – FFR)	0.188**	(0.082)
Trade growth(-1)	-3.457**	(1.695)
Inflation(CPI)	-0.032	(0.059)
GDP growth(-1)	-0.025*	(0.014)
Foreigners' stock buying(net)(-1)	0.000	(0.000)
D(Foreigners' share in bond markets)	-0.415*	(0.240)
D(FBBs' share in bond markets)	-0.089	(0.117)
D(VIX)	-0.062**	(0.025)
D(VIX)*Short-term external debt/GDP	0.002***	(0.000)
Constant	0.083	(0.300)
R-squared	0.787	
Adjusted R-squared	0.752	

Source: Authors' estimates.

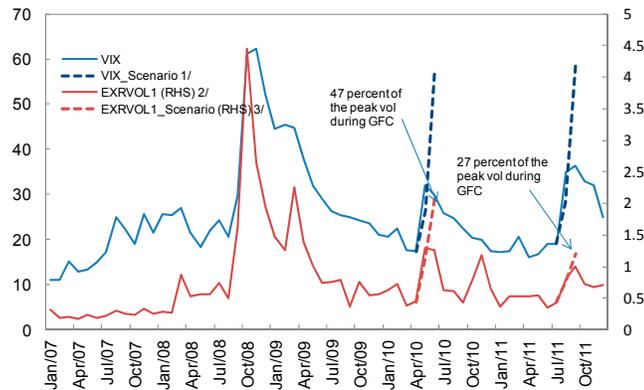
Note: 1/The values in parentheses are Newey-West standard errors.

2/***, **, * denotes significance in 1, 5, and 10 percent range.

- The sensitivity of exchange rate volatility to changes in VIX is a function of the external debt-to-GDP ratio. The sensitivity peaked at 0.08 (October 2008) on the eve of Lehman's fall, in line with the buildup of external debt; falling to 0.03 right before the first Greek crisis (April 2010); before further declining to 0.01 prior to euro deleveraging in the third quarter of 2011.
- Based on this estimation, a counterfactual historical simulation was run to see how exchange rate volatility would have reacted to shocks in VIX of the same magnitude as in the GFC's peak volatility period (August–October 2008). These shocks were assumed to replicate themselves during the first Greek crisis (April–June 2010) and the euro deleveraging in the third quarter of 2011 (July–September 2011). The simulation shows that the peak exchange rate volatility under such a stress test would have been 50 percent less than that shown during the GFC in the case of the first Greek crisis, and 70 percent less in the case of the euro deleveraging (Figure 12). The findings suggest that the FX market has become more resilient mainly because of smaller FX liquidity risk exposure.

- The regression also shows a significantly negative association between foreigners' share in the Korean bond market and the exchange rate volatility, suggesting that the diversification of the investor base in the bond market reduces the risk of market herding.

Figure 12. Korea: Exchange Rate Volatility and VIX



Sources: Bank of Korea; Bloomberg; and the authors' calculations.
 1/ The monthly changes in the VIX index value that happened during 2008M8-2008M10 are assumed to be replicated during 2010M4-2010M6 and 2011M7-2011M9.
 2/ Monthly standard deviation of daily percent changes in KRW/USD exchange rates.
 3/ Simulated path estimated based on authors' regression model of exchange rate volatility.

Another regression model examining the determinants of the deviation from the covered interest parity (CIP) condition corroborates the same finding (Annex): the domestic dollar-funding market seems to have become less responsive to the country risk factors, as captured by changes in the sovereign CDS spread, and net FX forward oversold positions by firms have lost significance in driving the CIP deviations, pointing to a weakening of the feedback mechanism between onshore dollar funding and FX markets.

VI. POLICY IMPLICATIONS

The paper examined if the Korean financial system has become more resilient since the GFC by analyzing two well-known vulnerabilities: banks' FX liquidity mismatches and exchange rate volatility. Through this exercise, we found evidence supporting increased resilience of the system, particularly with smaller short-term external debt weakening the link between exchange rate volatility and global risk factors. Our observations also suggest that excessive exchange rate volatility during the GFC had resulted from the massive buildup of short-term external debt reflecting expectations of a trend appreciation of the Korean won.

These findings have some important implications for the conduct of macroeconomic and macroprudential policies. On the macroeconomic policy side, they reveal difficult trade-offs faced by a recipient country with a sophisticated financial system in dealing with surges in capital inflows. If left unchecked, the surges can cause currency overshooting, hurting the recipient country's international competitiveness. However, if the central bank intervenes to prevent the overshooting, it will not only complicate the conduct of monetary policy but also

can lead to a build-up of downside tail risks to financial stability. The resulting policy calibration can later prove less than optimal because tail risks tend to be underappreciated *ex ante* (e.g., in the minds of policy makers globally before the GFC). In the case of Korea, these risks appeared as an excessive build-up of short-term debt prompted by the expectations of a trend appreciation.

On the macroprudential policy side, we take note that macroprudential measures can help improve this trade-off. Since the GFC, Korea has proactively introduced a set of macroprudential measures, mainly aimed at curbing short-term external borrowing. These measures have so far helped to mitigate FX funding risk associated with the build-up of short-term debt, and can act as speed bumps in moderating capital flow cycles. These measures thus can give policy makers additional space to optimize the same trade-off. However, macroprudential measures are not a panacea for dealing with surges in capital inflows and may have efficiency costs for the economy, thus leading to the need to optimize their use.⁷ This optimization could focus on strengthening the institutional framework, minimizing the risk of overkill, and closing loopholes.

Our findings also point to a need for continuous surveillance of the financial markets, close monitoring and analysis of the balance sheets of the banks and corporate sector, and frequent stress tests to ensure that the economy and financial system are robust to shocks.

⁷ See International Monetary Fund (2011).

ANNEX. DETERMINANTS OF THE CIP DEVIATIONS

This annex reports results from our regression model on the determinants of deviations from covered interest parity (CIP). The CIP deviations were derived from three month won-dollar FX and 1 year won-dollar cross-currency swap markets; and regressed, by ordinary least squares (OLS), on VIX, TED, CDS spread (all in month-on-month changes), net forward exchanges sold by companies, net bond investment (KTBs and MSBs) by foreign investors, and net bond investment by foreign bank branches. In view of endogeneity problems, the net bond investment variables were given a lag. We also used some interaction terms to see how global risk factors interacted with various cyclical and structural post-crisis changes, such as the diversification of the investor base and declines in the demand for hedging. To measure the global risks, the first principal components of the changes in VIX and TED were used. The sample period was divided into three sub-periods: January 2003 to July 2007 (pre-crisis period), August 2007 to June 2009 (crisis period), and July 2009 to December 2011 (post-crisis period).

$$\begin{aligned} \Delta CIP_DEV_t = & \alpha_0 + \alpha_1 \Delta VIX_t + \alpha_2 \Delta TED_t + \alpha_3 \Delta CDS_t + \alpha_4 FORWARD_t + \alpha_5 NETBOND_FOREIGN_{t-1} \\ & + \alpha_6 NETBOND_BRANCH_{t-1} + \alpha_7 \Delta VIX_TED_t * FORWARD_t \\ & + \alpha_8 \Delta VIX_TED_t * NETBOND_FOREIGN_{t-1} + \alpha_9 \Delta VIX_TED_t * NETBOND_BRANCH_{t-1} + \epsilon_t \end{aligned}$$

CIP_DEV : three-month CIP deviation (three-month domestic CD rate – three-month U.S. Libor – three-month swap rate), one-year CIP deviation (the difference between the one-year Monetary Stabilization bond yield and the one-year CRS rate)

VIX: Chicago Board Options Exchange Market Volatility Index

TED: three-month U.S. Libor – three-month Treasury yield

CDS: five-year CDS spread of Korea sovereign bond

FORWARD: Net forward positions sold by companies

NETBOND_FOREIGN: Net bond investment (KGBs and MSBs) by foreign investors

NETBOND_BRANCH: Net bond investment (KGBs and MSBs) by foreign bank branches

VIX_TED: common factor of VIX and TED.

In the pre-crisis period, the sovereign CDS spread (representing the country risk) and the net forward positions sold by companies (representing the demand for hedging) proved positively and significantly associated with the CIP deviations. However, neither the global risk factors such as VIX and TED, nor the interaction terms, showed significance.

During the crisis period, in contrast, VIX became significantly positive; with their coefficients ranging from 0.127 to 0.165 for the three-month, and 0.045 to 0.066 for the one-year CIP deviation. This suggests that the global financial stresses had a larger impact on the FX market than the cross-currency swap market in Korea. Of the interaction terms, the net bond investment by the foreign investors was significantly negative, indicating their sell-offs exacerbated the impact of global risk aversion.

In the post-crisis period, neither the country risk factor nor the demand for hedging (both significant during the pre-crisis period), nor the global risk factors (significant during the crisis period) maintained their significance. Interestingly, however, net bond investments by both the foreign investors and foreign bank branches significantly affected the CIP deviation, at least in the three month FX swap market, with an increase in the investor share by the former, at the expense of the latter, bringing some stability to the market. The interaction terms were also significant.

In sum, the CIP deviations for the pre-crisis period were explained mainly by the country risk factors (CDS spread) and the demand for hedging (net forwards sold by companies); whereas those for the crisis period were explained by the global risk factors (VIX). Post crisis, neither the country nor the global risk factors affected the CIP deviations. Instead the changes in the supplier base, as well as the interaction terms, proved to be significant.

Table A-1. Determinants of FX Swap CIP Deviation 1/, 2/

	Dependent variable: change in three-month CIP deviation					
	pre-GFC period (2003:01-2007:07)		GFC period (2007:08-2009:06)		post-GFC period (2009:07-2011:12)	
CONSTANT	-0.042 (0.035)	-0.044 (0.036)	0.118 (0.374)	0.445 (0.448)	-0.029 (0.078)	-0.044 (0.072)
□ VIX	-0.006 (0.013)	-0.003 (0.018)	0.165*** (0.048)	0.127** (0.044)	0.019 (0.017)	-0.005 (0.018)
□ TED	-0.417** (0.194)	-0.401 (0.248)	0.049 (0.479)	0.648 (0.598)	1.944 (1.373)	0.949 (1.307)
□ CDS	0.999*** (0.233)	0.986*** (0.256)	-0.288 (0.611)	-0.153 (0.651)	-0.430 (0.373)	-0.278 (0.482)
FORWARD	0.021** (0.010)	0.021* (0.011)	-0.007 (0.061)	-0.075 (0.082)	0.015 (0.027)	0.013 (0.025)
NETBOND_FOREGIN(-1)	0.004 (0.012)	0.000 (0.022)	-0.021 (0.129)	-0.059 (0.109)	-0.056** (0.023)	-0.032 (0.024)
NETBOND_BRANCH(-1)	-0.001 (0.008)	0.004 (0.010)	-0.003 (0.087)	-0.032 (0.092)	0.034** (0.013)	0.035** (0.014)
□ (VIX_TED)*FORWARD		0.005 (0.036)		0.062 (0.059)		-0.090* (0.047)
□ (VIX_TED)*NETBOND_FOREIGN(-1)		0.005 (0.087)		-0.243* (0.119)		0.323** (0.125)
□ (VIX_TED)*NETBOND_BRANCH(-1)		-0.040 (0.046)		-0.088 (0.061)		-0.011 (0.093)
Adjusted R-squared	0.443	0.412	0.379	0.367	0.364	0.421

Source: Authors' estimations.

Note: 1/ The values in parentheses are Newey-West standard errors.

2/ *, **, *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

Table A-2. Determinants of CRS CIP Deviation 1/, 2/

	Dependent variable: change in 1-year CIP deviation					
	pre-GFC period		GFC period		post-GFC period	
	(2003:01-2007:07)		(2007:08-2009:06)		(2009:07-2011:12)	
CONSTANT	-0.034 (0.026)	-0.037 (0.026)	-0.025 (0.099)	0.123 (0.189)	-0.112* (0.058)	-0.114 (0.070)
□ VIX	-0.011 (0.010)	-0.012 (0.013)	0.066** (0.027)	0.045* (0.022)	0.007 (0.011)	0.014 (0.019)
□ TED	-0.121 (0.212)	-0.261 (0.323)	0.262** (0.116)	0.730 (0.499)	0.957 (0.726)	1.136 (0.939)
□ CDS	1.194*** (0.259)	1.195*** (0.273)	-0.085 (0.325)	0.027 (0.296)	0.416 (0.415)	0.393 (0.457)
FORWARD	0.015* (0.008)	0.018** (0.009)	0.019 (0.022)	-0.002 (0.026)	0.034 (0.023)	0.041 (0.029)
NETBOND_FOREGIN(-1)	0.002 (0.014)	-0.025 (0.017)	-0.012 (0.037)	-0.050* (0.027)	0.008 (0.023)	0.007 (0.031)
NETBOND_BRANCH(-1)	0.006 (0.007)	0.011 (0.009)	-0.035 (0.048)	-0.053 (0.068)	0.011 (0.013)	0.005 (0.020)
□ (VIX_TED)*FORWARD		0.030 (0.033)		0.005 (0.024)		-0.026 (0.031)
Δ (VIX_TED)*NETBOND_FOREIGN(-1)		-0.175** (0.074)		-0.105** (0.047)		0.023 (0.090)
□ (VIX_TED)*NETBOND_BRANCH(-1)		-0.042 (0.048)		-0.031 (0.042)		0.000 (0.075)
Adjusted R-squared	0.515	0.506	0.582	0.587	0.451	0.383

Source: Authors' estimations.

Note: 1/ The values in parentheses are Newey-West standard errors.

2/ *, **, *** indicate statistical significances at the 10%, 5%, and 1% levels, respectively.

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