

Policy responses to dislocations in the FX swap market: the experience of Korea¹

During the financial crisis, Korea responded to dislocations in the FX swap market by both drawing on its swap line with the Federal Reserve and using its own international reserves to provide dollars to domestic banks. We show that the Bank of Korea's use of the Fed swap line was very effective in alleviating dislocations in the won/dollar FX swap market, whereas the provision of funds using its own foreign reserves was not.

JEL classification: G12, G13, G18.

Like many other emerging market economies, Korea relies heavily on US dollar funding through foreign banks and investors but does not have a deep foreign exchange (FX) swap market.² This turned out to be a major vulnerability during the financial crisis, when Korea experienced the most severe dislocations in the FX swap market of any emerging market economy. In response, the Korean authorities took several measures to stabilise the foreign currency funding market. In particular, they both drew on Korea's swap line with the Federal Reserve and used the country's own foreign reserves to provide foreign currency liquidity to the private sector. The experience of Korea thus provides useful lessons on the effectiveness of these two different policies in mitigating foreign currency funding problems.

In this feature, we examine which of these two policies was more effective in alleviating deviations from covered interest parity (CIP deviations). We find that the Bank of Korea's US dollar loans of the proceeds of swaps with the Fed was effective, whereas the use of its own foreign reserves was not. Our model does not tell us why exactly this was so. However, we believe that a major reason was that the Bank of Korea's loan auctions funded by the Fed swap line effectively added to Korea's foreign reserves. When the auctions were conducted, Korea's foreign reserves were just enough to cover the short-term

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² In an FX swap, two parties exchange a set amount in two currencies for the tenor of the contract (which is mostly short-term). This is equivalent to a combination of an FX spot transaction and an FX forward transaction in the reverse direction, or to a collateralised loan.

foreign currency debt. Providing dollar liquidity from the official reserves would have reduced this coverage. Auctioning off the proceeds from the swap line with the Federal Reserve, by contrast, did not result in a reduction in the reserve coverage, which should have enhanced market confidence. That said, we do not know whether the estimation results would have been different had Korea had a higher level of reserves.

In the next section, we briefly review FX swap market dislocations in selected countries during the crisis. We then describe the dislocations in the Korean FX swap market and the policy responses, and go on to analyse the effectiveness of the two main policy measures adopted. The last section concludes.

Global deleveraging and FX swap markets

We compare the FX swap market dislocations in selected countries which either used their own foreign reserves or established swap lines with the Fed or other central banks. Specifically, we look at India, Korea and Singapore from Asia; Brazil, Chile and Mexico from Latin America; Hungary and Poland from central Europe; and Australia from the Pacific.

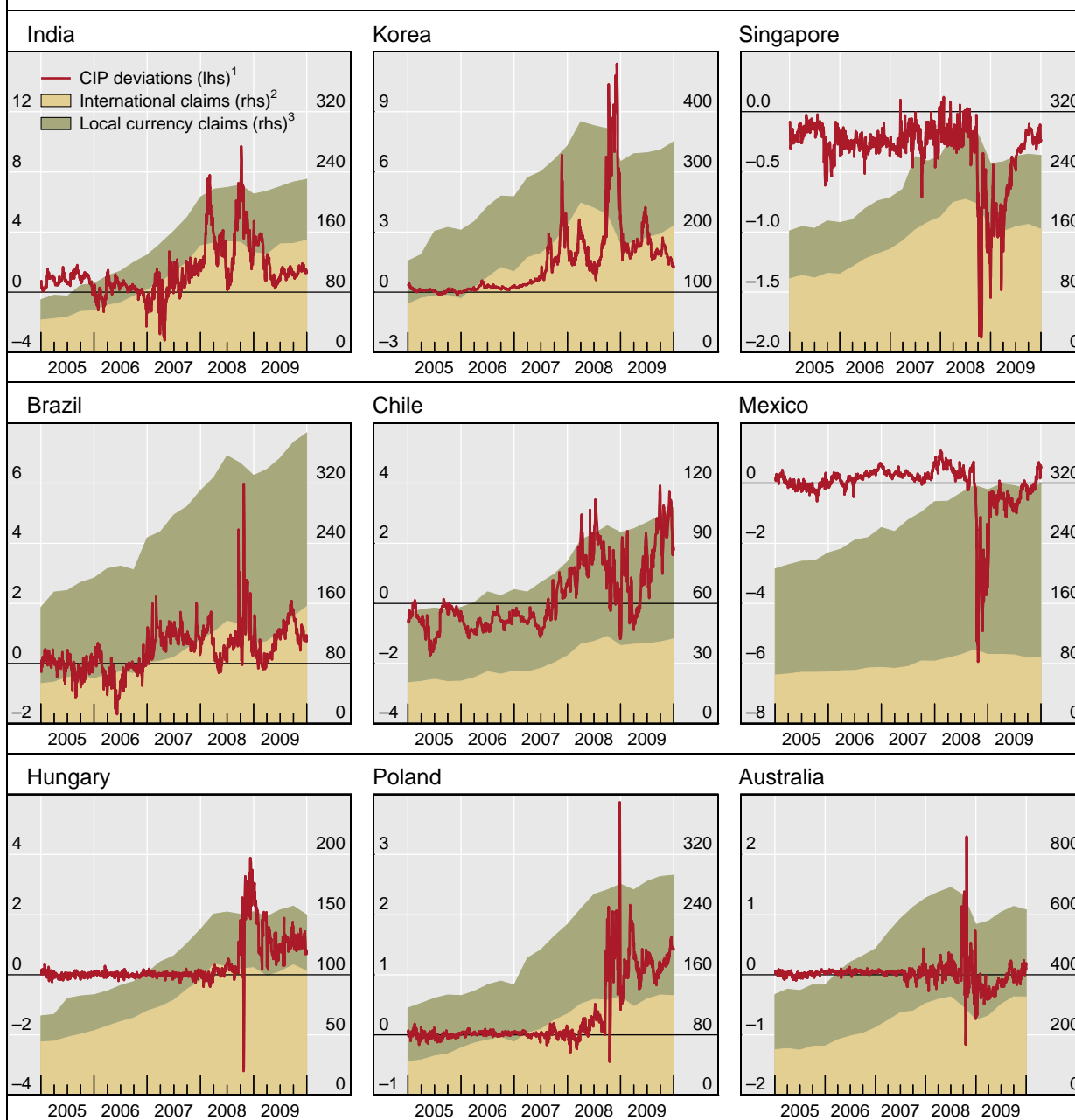
Many countries experienced dislocations in the FX swap market

When foreign banks' lending to these countries contracted sharply around the fourth quarter of 2008, domestic banks faced difficulties in borrowing in the interbank market and much higher costs of obtaining short-term dollar (or euro or Swiss franc in central Europe) financing through FX swaps (Graph 1). In particular, there was an abrupt drop in gross international claims (the sum of cross-border claims in all currencies and local claims in foreign currencies of international banks) on many of these countries. Korea experienced a severe retreat of global banks' lending, which led to the most significant dislocations in the FX swap market during the financial crisis in terms of CIP deviations.³

By contrast, fewer countries exhibited a sharp reduction in local claims in local currency extended by foreign banks' offices, after adjusting for exchange rate movements (McCauley et al (2010)). In particular, most of foreign banks' lending to Latin American countries was conducted by their local subsidiaries in local currency funded by the domestic deposit base. This partly explains why the FX swap markets of these countries were relatively less affected by the deleveraging of global banks.

³ We denote by S_t the FX spot rate (US dollar/Korean won) at time t , and by $F_{t,t+s}$ the FX forward rate contracted at time t for exchange at time $t+s$. Covered interest parity in the won/dollar FX swap market states that the interest rate differential ($r_{t,t+s}^{USD} - r_{t,t+s}^{KRW}$) should be perfectly reflected in the forward discount rate ($\ln F_{t,t+s} - \ln S_t$). This condition is equivalent to the equality of the FX swap-implied dollar rate from Korean won and the dollar cash rate, ie $\frac{F_{t,t+s}}{S_t} (1 + r_{t,t+s}^{KRW}) = 1 + r_{t,t+s}^{USD}$. The difference between these two rates defines the CIP deviations.

CIP deviations and foreign claims for selected economies



¹ Calculated as the difference between the three-month FX swap-implied US dollar interest rate and three-month US dollar Libor, in per cent. The former is derived from the covered interest parity condition based on the following domestic three-month interest rates: India, Mumbai interbank rate; Korea, 91-day certificate of deposit rate; Singapore, interbank rate; Chile, 90-day DISCTB promissory note rate; Mexico, TIIE interbank rate; Hungary, interbank rate; Poland, Warsaw interbank rate; Australia, bank bill rate. For Brazil, the "cupom cambial" is used as the three-month FX swap-implied US dollar interest rate. ² Consolidated cross-border claims in all currencies and local claims in foreign currencies, in billions of US dollars. ³ Local currency claims of reporting banks' foreign offices on local residents, calculated at constant end-Q4 2009 exchange rates, in billions of US dollars.

Sources: Bloomberg; Datastream; BIS; authors' calculations.

Graph 1

FX swap market dislocations in Korea and policy responses

After examining why there were persistent CIP deviations in the FX swap market in Korea even before August 2007, we describe the problems faced by Korean banks in obtaining foreign currency funding during the crisis and how they showed up in the FX swap market. Finally, we review various policy

measures Korea took to stabilise the foreign currency funding market, focusing on two types of dollar-supplying operations.

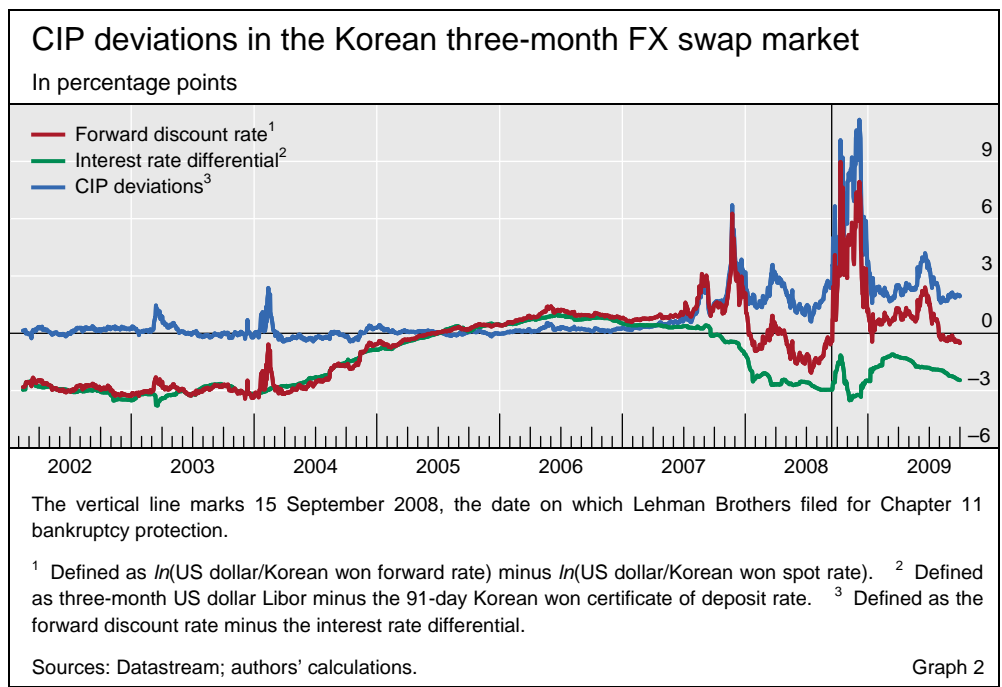
Dislocations in the Korean FX swap market

From 2006 to 2007, exporting firms such as Korean shipbuilders as well as Korean investors in foreign stocks sold a large amount of US dollar forwards to domestic banks to hedge their currency exposures (McCauley and Zukunft (2008)). Korean banks sold these US dollar forwards to, and at the same time borrowed US dollars from, Korean branches of foreign banks, in order to hedge currency risk. The latter, in turn, invested the won they had acquired from these FX swap transactions in short-maturity Korean government and Bank of Korea (BoK) paper. The absence of natural buyers of FX forward exposures pushed up the FX forward rate, which drove the forward discount rate (red line in Graph 2) above the interest rate differential (green line) between the United States and Korea. In effect, US dollars traded at a premium yield in the won/dollar FX swap market, given strong borrowing demand.

Structural excess demand for US dollars ...

Deviations from CIP (blue line) widened sharply after the middle of 2007. The interest rate differential turned negative as the Fed cut policy rates by a total of 325 basis points between September 2007 and April 2008 while the BoK held its policy rate at 5%. At the same time, the structurally strong demand for US dollars in the Korean FX forward market and an increasing challenge for global banks to supply dollar funding to Korea for more than the shortest periods increased the FX forward rate, and in turn the forward discount rate. The Korean branches of foreign banks did not take advantage of the enlarged arbitrage opportunities, but began to decrease their investments in Korean bonds as funding from their headquarters dried up. Other foreign investors such as hedge funds only partly took their place (Yang and Lee (2008)).

... and a global dollar shortage ...



... caused severe dislocations in the Korean FX swap market

Following the Lehman failure, the cost of borrowing dollars by swapping Korean won skyrocketed. Korean banks were now completely shut off from the international market for US dollar funding, and the already strained FX swap market took the whole burden of supplying US dollars. International banks, deleveraging on a worldwide scale, sharply reduced their exposures to Korea (Graph 1). UK and euro area banks in particular repatriated their large dollar positions. This prompted drastic policy responses by the Korean authorities.

Policy responses

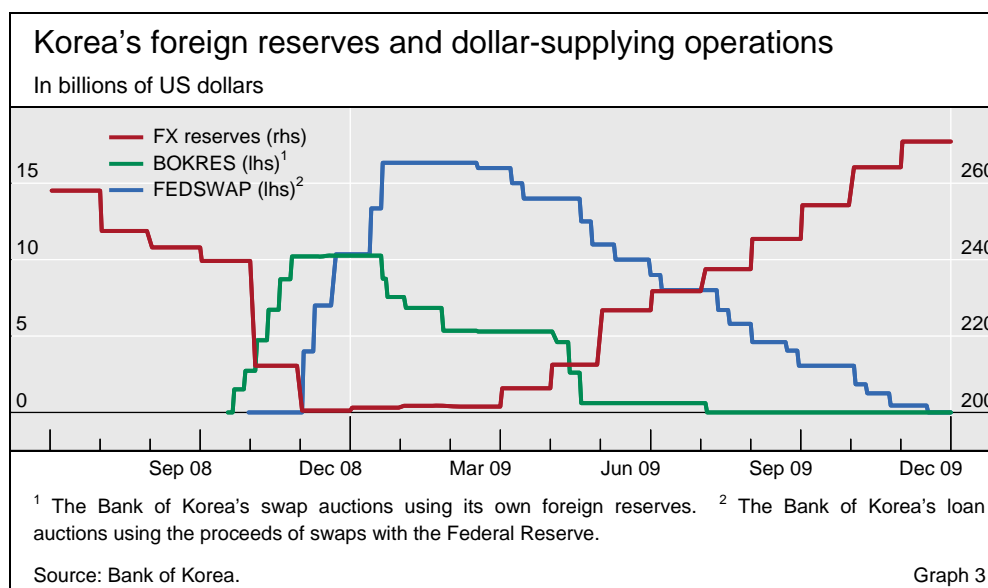
Korean authorities took various policy measures ...

From 2006 onwards, the Korean authorities became worried about the appreciation of the won, which was partly driven by the rapid increase in short-term foreign currency borrowing by foreign banks. They therefore announced a set of policy measures to promote domestic banks' investment in foreign securities and reduce short-term borrowing in foreign currency (Table 1). These measures seem to have contributed to a modest widening of CIP deviations in early 2007.

From the second half of 2007, however, the won/dollar FX swap market started to show signs of greater tension. In September 2007, the BoK intervened in the FX swap market for the first time by swapping dollars for won with selected banks. After this intervention, the FX swap market stabilised temporarily, but stress flared up again towards the end of the year. In early 2008, the BoK reacted by partially loosening restrictions on the use of foreign currency loans.

... to stabilise the foreign currency funding market

Immediately after the bankruptcy of Lehman Brothers, the Korean Ministry of Strategy and Finance (MoSF) used its foreign reserves to provide dollar liquidity to exporting small and medium-sized enterprises and banks. It also guaranteed the external debt issued by Korean banks to enable them to raise funding abroad. The BoK set up a swap auction facility in October 2008 and conducted competitive auctions swapping its own foreign reserves for won to provide up to \$10.27 billion of dollar funding to Korean banks. It also entered into a \$30 billion swap arrangement with the Fed on 30 October 2008 and



| Major policy measures to stabilise the foreign currency funding market in Korea | | |
|---|--|-------------------------------------|
| Announcement date | Description | Anticipated impact on CIP deviation |
| 15 Dec 2006 | From 1 January 2007, the BoK can provide foreign currency loans to domestic banks through currency swap arrangements. | (-) |
| 19 Apr 2007 | The Financial Supervisory Service requests 36 foreign banks operating in Korea to slow down short-term foreign currency borrowing. | (+) |
| 12 Jul 2007 | The MoSF announces a plan to regulate short-term foreign currency borrowing by lowering the ceiling for tax deductibility of interest expenditure resulting from foreign bank branches' borrowing from their headquarters, from six times their capital to three times, starting 1 January 2008. | (+) |
| 10 Aug 2007 | The BoK limits foreign currency lending to actual uses overseas by end users and domestic facilities investment funds for manufacturers. | (+) |
| 11 Sep 2007 | The BoK intervenes in the FX swap market for the first time to provide dollars. | (-) |
| 28 Jan 2008 | The BoK allows foreign currency lending for domestic facilities investment funds for non-manufacturers. | (-) |
| 14 Jul 2008 | The MoSF announces that the tax deductibility ceiling for foreign bank branches will be raised back to the previous level, effective the 2008 business year. | (-) |
| 26 Sep 2008 | The MoSF announces a plan to provide the private sector with at least \$10 billion by early October. | (-) |
| 17 Oct 2008 | The BoK announces a plan to introduce a competitive swap auction facility and to provide banks with \$10 billion using the official foreign reserves. | (-) |
| 19 Oct 2008 | The MoSF announces a plan to provide a foreign currency debt issuance guarantee, and an additional \$20 billion using the official foreign reserves. | (-) |
| 27 Oct 2008 | The BoK allows foreign currency borrowing by domestic exporters for payment of knock-in/knock-out and other currency option transactions. | (-) |
| 30 Oct 2008 | The BoK and MoSF announce the opening of swap lines with the Fed. | (-) |
| 13 Nov 2008 | The BoK announces a plan to introduce foreign currency loans secured by export bills purchased. | (-) |
| 27 Nov 2008 | The BoK announces a plan to conduct competitive US dollar loan facility auctions using the proceeds of swap transactions with the Fed. | (-) |
| 1 Dec 2008 | The BoK abolishes restrictions on the rollover of foreign currency lending for use as working capital procured before 10 August 2007. | (-) |
| 12 Dec 2008 | The BoK announces the opening of swap lines with the People's Bank of China and expansion of the current bilateral swap lines with the Bank of Japan. | (-) |
| 26 Feb 2009 | The MoSF announces the removal of withholding tax on bond interest income of non-residents, other tax benefits and relaxation of restrictions on foreign currency deposits by non-residents and foreign currency borrowing by residents. | (-) |
| Sources: Bank of Korea (BoK); Ministry of Strategy and Finance (MoSF); Financial Supervisory Service. | | Table 1 |

conducted competitive US dollar loan auctions using the dollar proceeds of swap transactions with the Fed to provide up to \$16.35 billion over the course of a year starting from December 2008. Graph 3 shows the total amount of Korea's foreign reserves as well as the outstanding amount of US dollar funds auctioned out by the BoK around the peak of the crisis.

Effectiveness of policy responses

Among the policy measures ...

We investigate the effectiveness of different policy actions in reducing CIP deviations in the three-month won/dollar swap market using regression analysis (see box). Most recent work on dislocations in FX swap markets has focused on major currency pairs, with relatively little on emerging market currencies (Baba and McCauley (2009)).

To gauge the policy impact correctly, we control for variables representing global market uncertainty, counterparty risk of banks and tensions in interbank markets. We find that the CDS spreads of Korean banks play a significant role in explaining the movement of CIP deviations during the pre-crisis period. Also, over the crisis period, we find a significant role of the VIX⁴ in explaining changes in CIP deviations across various specifications (Table 2).

The most interesting result concerns the effectiveness of policy variables. We call BoK loan auctions funded by the Fed swap line FEDSWAP, and BoK swap auctions using its own foreign reserves BOKRES. In the regression, the key variables of interest are the following: FEDSWAP1 (BOKRES1) equals 1 on the date of each FEDSWAP (BOKRES) auction; FEDSWAP2 (BOKRES2) denotes the changes in US dollar balance outstanding from FEDSWAP (BOKRES).

... the supply of funds from the Fed swap line was very effective ...

The coefficients on both FEDSWAP1 and FEDSWAP2 are statistically significant, but those on BOKRES1 and BOKRES2 are not. The FEDSWAP auctions were not only statistically but also economically significant. CIP deviations fell by 13.2 basis points on average after each FEDSWAP auction, and every \$1 billion auctioned out decreased the deviation by a further 9.2 basis points. The cumulative effects of all FEDSWAP auctions are 2.83 percentage points, which is 30% of the total reduction in the CIP deviation of 9.32 percentage points from the peak in early December 2008 when the first auction was conducted to late September 2009 when the last auction was conducted. By contrast, CIP deviations decreased by 3.4 basis points on average after each BOKRES auction, and every \$1 billion auctioned out further reduced the deviation merely by 0.1 basis points.

... whereas the use of own foreign reserves was not

There are several possible explanations for the much greater effectiveness of the FEDSWAP auctions. The two facilities were similar in terms of counterparties, maturities, minimum bid amount and auction type. One source of difference was that the average amount of auctioned funds was larger for FEDSWAP than for BOKRES. The coefficients for FEDSWAP2 and BOKRES2 already capture this aspect. Another source of difference explaining the greater popularity of FEDSWAP was that the BoK announced the minimum bid rate before each FEDSWAP auction, while using an internal maximum

⁴ The Chicago Mercantile Exchange Volatility Index (VIX) is a 30-day implied volatility index based on S&P 500 index options. A high value of the VIX means investors anticipate the US equity market will move sharply. The VIX can be a proxy for uncertainty in the global market because (1) it is highly correlated with similar volatility indices in other countries (Lustig et al (2009)), and (2) it tends to jump up immediately after the onset of crises and to stay at a very high level for a prolonged period.

Regression analysis and data

This box presents the econometric model that analyses the drivers of CIP deviations in the three-month won/dollar FX swap market and the effectiveness of the various policy measures. Following Baba and Packer (2009a,b), we use an EGARCH(1,1) model, but also consider an EGARCH(1,1)-in-mean model to test whether volatility risk is priced in the won/dollar FX swap market (see Engel et al (1987) and Nelson (1991) for details on this model).

Our choice of variables is similar to Baba and Packer (2009a,b) and Baba (2009). Policy variables are also included in the variance equation to test whether they had stabilising effects in the won/dollar FX swap market in the crisis period.

CIP deviations and their squared values tend to be highly autocorrelated, suggesting the need to control for AR1 effects in the mean equation and for GARCH effects in the variance equation. All the variables have large excess kurtosis in both the pre-crisis and crisis periods, suggesting that it is appropriate to use fat-tailed distributions as well as larger standard deviations in the crisis period than in the pre-crisis period.

The standard unit root tests suggest that three-month CIP deviations are highly likely to be I(1). The results for other variables are mixed, particularly in the pre-crisis period, but we use first-differenced form for all the variables throughout the analysis to be on the conservative side except for the policy dummy (auction date dummy) and the lagged level of the dependent variable.

The mean equation and the variance equation are specified as follows:

$$dY_t = a_0 + a_1 dX_{t-1} + \lambda \sigma_t + \varepsilon_t,$$

$$\log(\sigma_t^2) = \omega + \beta \log(\sigma_{t-1}^2) + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \eta \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - E\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) \right| + b_1 dX_{t-1},$$

where

dY_t three-month CIP deviations (FX swap-implied US dollar rate from Korean won CD rate – US dollar Libor),

dX_{t-1} Own dynamics:

- (1) Lagged “level” of the dependent variable (Y_{t-1}) to control for the level effect following McAndrews et al (2008),
- (2) Lagged dependent variable (dY_{t-1}) to control for momentum and AR1 effects,

Global market uncertainty:

- (3) VIX (CME),

Counterparty risk:

- (4) five-year CDS spread of US banks (JPMorgan),[Ⓢ]
- (5) five-year CDS spread of Korean banks (Markit),[Ⓢ]

Tensions in the interbank market:

- (6) US dollar TED spread defined as Libor – Treasury bill rate (three-month),
- (7) Korean won TED spread defined as Koribor – Monetary Stabilisation Bond rate (one-year),

Bank of Korea policy:

- (8) FEDSWAP1 = 1 on the dates of competitive US dollar loan facility auctions using US dollar proceeds through swap lines with the Fed,
- (9) FEDSWAP2 = changes in US dollar balance outstanding of US dollar loan auctions,
- (10) BOKRES1 = 1 on the dates of competitive swap facility auctions using the Bank of Korea’s foreign reserves, and
- (11) BOKRES2 = changes in US dollar balance outstanding of US dollar swap auctions.

[Ⓢ] JPMorgan Bank CDS index is an equally weighted average of five-year CDS spreads of seven banks: Bank of America, Capital One Bank, Citigroup, JPMorgan Chase, Wachovia Corp, Washington Mutual and Wells Fargo & Co. [Ⓢ] We use an equally weighted average of five-year CDS spreads of six commercial banks: Kookmin Bank, Woori Bank, Hana Bank, Korea Exchange Bank, National Association of Agricultural Cooperatives and Shinhan Bank.

| Estimation results ¹ | | | | | | | | |
|---------------------------------|---|--------------------|--------------------|--------------------|--|----------------------|----------------------|----------------------|
| | Pre-crisis period (1 Apr 2005 – 8 Aug 2007) | | | | Crisis period (9 Aug 2007 – 30 Sep 2009) | | | |
| Constant | -0.001 (0.003) | 0.002 (0.001) | -0.000 (0.003) | 0.001 (0.001) | 0.084*** (0.018) | 0.082*** (0.018) | 0.025** (0.011) | 0.007 (0.006) |
| GARCH-M ² | 0.012 (0.115) | | 0.033 (0.111) | | 0.034 (0.081) | | -0.122** (0.062) | |
| Deviation level (-1) | -0.008 (0.007) | -0.005 (0.005) | | | -0.042*** (0.011) | -0.038*** (0.009) | | |
| d (deviation) (-1) | 0.038 (0.038) | 0.040 (0.039) | | | 0.124*** (0.042) | 0.123*** (0.041) | | |
| d (VIX) (-1) | -0.001 (0.001) | -0.000 (0.001) | -0.000 (0.001) | -0.000 (0.001) | 0.010*** (0.003) | 0.010*** (0.003) | 0.011*** (0.003) | 0.011*** (0.003) |
| d (US bank CDS) (-1) | 0.056 (0.132) | 0.063 (0.130) | 0.049 (0.128) | 0.053 (0.127) | 0.004 (0.031) | 0.004 (0.031) | 0.003 (0.031) | 0.004 (0.032) |
| d (KR bank CDS) (-1) | 0.243** (0.114) | 0.246** (0.114) | 0.248** (0.113) | 0.248** (0.113) | -0.146** (0.069) | -0.144** (0.068) | -0.097 (0.069) | -0.097 (0.069) |
| d (3M USD TED) (-1) | -0.011 (0.028) | -0.013 (0.028) | -0.018 (0.028) | -0.017 (0.028) | 0.061 (0.077) | 0.065 (0.077) | 0.077 (0.078) | 0.071 (0.078) |
| d (1Y KRW TED) (-1) | 0.050 (0.044) | 0.049 (0.044) | 0.051 (0.045) | 0.051 (0.045) | 0.030 (0.116) | 0.041 (0.116) | 0.024 (0.118) | 0.034 (0.119) |
| FEDSWAP1 | | | | | -0.132** (0.052) | -0.132*** (0.051) | -0.136*** (0.050) | -0.138*** (0.052) |
| FEDSWAP2 | | | | | -0.092** (0.046) | -0.091** (0.046) | -0.092** (0.045) | -0.098** (0.047) |
| BOKRES1 | | | | | -0.034 (0.053) | -0.038 (0.053) | -0.056 (0.050) | -0.051 (0.052) |
| BOKRES2 | | | | | -0.001 (0.021) | -0.001 (0.022) | 0.010 (0.029) | 0.008 (0.025) |

¹ Only the coefficients for the mean equation are reported. The numbers in parentheses are standard errors. ***, ** and * indicate that each parameter estimate is significantly different from zero at the 1%, 5% and 10% level, respectively. ² For the GARCH-M term, we use the standard deviation.

Source: Authors' calculations. Table 2

swap rate for each BOKRES auction. This difference could also be reflected in the difference in the coefficients for FEDSWAP and BOKRES. Moreover, the fact that the BOKRES auctions were conducted earlier than the FEDSWAP auctions does not seem to be a crucial source of difference in their effectiveness because we control for global factors such as VIX, US banks' credit and TED spreads as well as Korean banks' credit and TED spreads in our regression analysis. We believe that the most important driver of the different policy impact in this regression is that funds from FEDSWAP enhanced market confidence more effectively because they were adding to Korea's foreign reserves when the total size of Korea's short-term foreign currency debt almost reached the level of its official foreign reserves, while the provision of funds by BOKRES was not.

Conclusion

In this feature, we showed that BoK loans funded by the swap line with the Fed were more effective than BoK swaps using its own foreign reserves. As discussed in CGFS (2010), this result suggests far from perfect substitutability of a country's own foreign reserves and inter-central bank swap arrangements.

This result has an important implication for the current discussion in the G20 on the strengthening global financial safety net. Even though building up a large amount of foreign reserves has certain merits as self-insurance, once a country faces a foreign liquidity run, swap lines with other central banks can have a powerful effect of complementing the use of foreign reserves and thus stopping the run.

The Korean case also points to the dangers of relying on foreign currency borrowing as well as of maturity mismatch in foreign currency. In response to the crisis, the Korean authorities tightened the foreign currency liquidity regulation for domestic banks in 2010, by fine-tuning the regulation on the foreign currency liquidity ratio, introducing mandatory minimum holdings of safe foreign currency assets and raising the ratio of mid- to long-term borrowing to mid- to long-term lending. However, foreign bank branches in Korea are not subject to these liquidity ratios. Also, foreign currency liquidity risk turned out to be a systemic risk in Korea: all banks tended to face the same liquidity problem at the same time because they all relied on foreign bank branches for US dollar funding. It is crucial that foreign currency liquidity regulation and stress testing exercises take this systemic dimension of liquidity risk into account.

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