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International spillover of central bank swap lines - Evidence from the COVID-19 experience of Korea

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ABSTRACT

Dollar funding cost rose significantly worldwide during the early stage of the COVID-19 pandemic. Against the dollar shortage, the Fed provided liquidity to 14 other central banks through central bank swap lines. I find significant liquidity spillover into Korea by comparing foreign banks from the swap network countries with banks from the other regions in their borrowing from parent banks. The spillover amounts to 11 billion dollars, half of the maximum amount Korea has drawn from the swap line. The result highlights the broad effects of the swap lines via cross-border spillover and foreign banks’ pivotal role in international shock transmission.

1. Introduction

The cost of borrowing in dollars increased abruptly worldwide at the early stage of the COVID-19 pandemic. Facing the global dollar liquidity shortage, many asked the Fed to take the international lender of last resort role (e.g., Bird, 2020; Jones, 2020; Levy, 2020). The Fed promptly reinstated the central bank swap line, which was proven to be useful during the global financial crisis (Goldberg et al., 2010; Rose and Spiegel, 2012); it made currency swap arrangements with 14 other central banks in March 2020 and provided dollar liquidity. Since the Fed does not extend the swap line to every country, whether the swap line has international spillover is a critical question.

This paper studies the international spillover effect of the central bank swap line by examining foreign banks in Korea. Korea is included in the Fed swap network. Nonetheless, spillover may happen to Korea as long as its dollar liquidity condition is worse than the other countries in the network. The dollar shortage in Korea was more severe and lasted longer than in other major countries. A representative indicator of the FX funding market is the covered interest rate parity (CIP) deviation against the U.S. dollar (Fig. 1). Euro and yen CIP deviations came down back to the end-February levels by late April, but Korean won CIP deviation hovered around 100 basis points even in June.

I ask whether the swap arrangement made foreign banks operating in Korea borrow more from their parent banks in the countries

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1 The Fed, of course, has its domestic mandates, and its action of providing dollars abroad was to bring positive spillback effects into the U.S. McCrone et al. (2020) find that the swap arrangement helped the U.S. corporate debt market and Aldasoro et al. (2020) document that the Fed swap line is essentially a policy tool to offer dollar credit to foreign banks operating in the U.S. without bearing credit risk.

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where the swap line reaches. I focus on foreign banks because they originate from many different countries around the world. Comparing banks from the swap network countries against banks from the other regions will clearly identify the causal effect of the swap line. Besides, the foreign banks’ borrowing from their parent banks is a major channel of dollar liquidity supply in Korea. The outstanding amounts of the foreign banks’ net-due account (i.e., borrowing from parent banks) take more than half of the total FX liability the Korean banking sector bear as a whole.\footnote{As of the end of September 2020, the total amounts of FX borrowing by the Korean banking sector is 85 billion dollars (excluding offshore borrowing 24 billion which does not flow into Korea). Out of this, 53 billion (62%) is the foreign banks’ borrowing from parent banks. See \cite{Yun2020} for the significance of foreign bank presence in Korea.}

The results suggest a spillover effect of significant size. I find that foreign banks from the swap network countries increased borrowing from parent banks by 9–11 percent to assets more than the banks from other regions. It amounts to 11 billion in dollar terms, and it is comparable to the maximum amount Korea has drawn from the swap line, 20 billion. The spillover must have played a significant role in stabilizing the FX market. The difference between the two groups of banks was significant over March, April, and May, but it has slowly eroded to zero over the next several months.

This paper contributes to the literature by documenting the cross-border spillover effect of the central bank swap line for the first time. The central bank currency swap is one major form of international policy cooperation. The evidence provided in this paper suggests that the swap line may have broader impacts on many countries through spillover effects. The paper also contributes to the literature on foreign bank behavior (e.g., \cite{CetorelliGoldberg2012a,CetorelliGoldberg2012b,Temesvary2018}). It adds another important evidence on foreign banks’ significant role in international shock transmission.

The next section briefly explains the central bank swap arrangement made during the COVID-19 crisis. Section 3 presents the analytical methodology used. Section 4 provides the results, and Section 5 concludes.

2. Background

In early March 2020, the financial markets around the globe began to observe increased volatilities as the COVID-19 spreads rapidly and uncertainty rises. After the U.S. treasury market experienced extreme turbulence on March 9th, dollar funding costs soared globally, as reflected in the increasing FX swap basis spread. Against this background, on March 15th, the Fed strengthened its existing standing swap lines with five other central banks (BOC, BOE, BOJ, ECB, and SNB). The price was lowered (OIS rate $+\,25$ bp), and 84-day swaps were added to the existing 7-day swaps.

On 19th, the Fed further extended the swap line to nine more countries (Australia, Brazil, Mexico, Denmark, Korea, Norway, New Zealand, Singapore, and Sweden). Unlike the standing swap with the five central banks, the swap arrangement with these nine central banks is temporary and has maximum quantities predetermined (30 billion for Denmark, Norway, New Zealand, and 60 billion for the others). This program was extended twice after then on July 29th and on December 16th by six months each.

Fig. 2 shows the amounts of dollar liquidity drawn from the swap lines by each country over 2020. The total amount increases rapidly over March and April to reach a max of 450 billion total in May. Since the wholesale price is set to be 25 basis points higher than the OIS rate, however, the amount shrinks as the market condition improves. It becomes a quarter of the peak by the end of July and shrinks further to 8 billion in November. Korea is one of the nine countries that joined the swap network on March 19th. The first auction was executed on March 31th (the fund was drawn in April), and the last auction took place on May 6th. In total, 20 billion dollars are supplied to Korea by May.
3. Methodology

The identification strategy is to compare banks from the swap network countries with banks from other regions (differences-in-differences). Monthly balance sheet data of 36 foreign bank branches are examined. There have been 43 foreign bank branches operating in Korea over the year 2020, but seven among them do not have a remaining balance at the net-due account, which records

Table 1

| Banks from the swap network countries other than the U.S. | Banks from other regions |
|--------------------------------------------------------|--------------------------|
| Euro area                                              | U.S.                     |
| Japan                                                  | China                    |
| Singapore                                              | India                    |
| Australia                                              | Indonesia                |
| Canada                                                 | Philippines              |
| Switzerland                                            | Pakistan                 |
| U.K.                                                   |                          |
| sum                                                    | 19                       |
| sum                                                    | 17                       |

Notes: Total 36 banks are shown, excluding seven banks that do not have a remaining balance with their parent banks.

Fig. 2. U.S. dollar liquidity swap amounts drawn by each central bank. Notes: This figure shows the amounts of dollar liquidity drawn from the Fed swap line by each central bank in the network over the year 2020. Settled positions at the end of each month are shown in billion USD. Data from the New York Fed.
borrowing and lending with parent banks.

Table 1 shows the number of foreign banks by their origin countries. The banks are divided into two groups according to the influence of the swap line. The treatment group is the 19 banks from the swap network countries excluding the U.S. We have eight banks from the Eurozone countries, four from Japan, and three from Singapore. The control group is the 17 banks from the other regions. The U.S. is included in this group because no dollar liquidity is directly supplied to the U.S. financial market by the swap arrangements. We have seven U.S. banks and six Chinese banks in this group.

Fig. 3 shows the sum of net-due account outstanding by the banks’ origin. The blue line above is the net-due of banks whose parent banks are located in the countries where the swap line reaches. The black line below is the net-due of the other banks. We see a significant rise of the blue line after March 2020, but not in the black line. The increase is about 10 billion dollars and seems to last long until the end of the year.

I examine growth rates of the net-due account outstanding from the end of 2019. Eq. (1) is the baseline regression specification. It is a cross-sectional regression, and I estimate it for each month of 2020 (except December). The set-up is similar to the local projection regression (Jorda, 2005).

\[
100 \times \frac{\text{netdue}_{i,t} - \text{netdue}_{i,2019}}{\text{asset}_{i,2019}} = c + \beta_{\text{network}} + X'_{i,t-1} \gamma + \varepsilon_i
\]  

(1)

nettue_{i,t} is the bank i’s net borrowing from its parent bank at the end of month t. The regressand is, therefore, a growth rate of nettue from the end of 2019. network is a dummy variable equal to one if bank i’s parent bank is located in one of those 14 regions where the Fed swap line reaches. X is a vector of control variables, including log asset size, capital ratio, and security ratio. The coefficient \( \beta \) measures the additional nettue growth rate of the banks from the swap network countries vis-à-vis the other banks. Table 2 provides basic statistics for the regression variables.

### 4. Estimation results

Fig. 4 presents the cross-sectional regression result for each month in 2020. The solid line is the estimate of \( \beta \) from Eq. (1), and the shaded area are confidence intervals. Before the policy shock, in January and February, the net-due growth rate difference between the network banks and the other banks is close to zero and insignificant. In March, however, the coefficient jumps to ten, and becomes

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Table 2
Summary statistics.

|                          | Mean  | st.dev. | p25   | Median | p75   |
|--------------------------|-------|---------|-------|--------|-------|
| net-due growth rate from 2019 (%) | 1.63  | 13.98   | −3.93 | 0.17   | 3.91  |
| total asset (trillion won) | 8.69  | 8.03    | 0.97  | 7.53   | 13.82 |
| capital / asset           | 0.12  | 0.17    | 0.04  | 0.06   | 0.11  |
| security / asset          | 0.18  | 0.14    | 0.08  | 0.17   | 0.26  |

Notes: Basic statistics for the variables included in the regression Eq. (1).
statistically significant. The difference stays until May, and it slowly decreases to zero from then. By July, the difference shrinks to the pre-swap arrangement level.

From the results, I estimate that the central bank swap arrangement supplied 12.5 billion, 9.9 billion, and 10.0 billion dollars to Korea through international spillover in March, April, and May, respectively. The numbers are obtained by applying the regression coefficients to the asset size of each bank. The magnitude is significant compared with the 60 billion dollars, the maximum amount of the swap fund agreed by the Bank of Korea and the Fed. Korea used 20 billion out of this 60 billion dollars, and I find an additional 11 billion dollars (average for the first three months) supplied to Korea via spillover from the other swap network countries.

There can be a couple of reasons why the spillover effect lasts only for the first several months. From the liquidity supply side, it may be because the push pressure dies out after June. As shown in Fig. 2, the amount of liquidity supplied through swap arrangement decreases significantly from June in most of the network countries. Bahaj and Reis (2020a) analyze that the swap arrangement takes effect of reducing CIP deviation only during the time of liquidity auctions. Bahaj and Reis (2020b) further support the argument using COVID-19 examples. Since there was less to no auction from June in the swap network countries, it may be that the swap arrangement has no further effect on the sender country FX markets, and therefore no spillover being observed in Korea. Second, from the demand side, it may be because the dollar liquidity condition in Korea improves significantly in May and June, as shown in Fig. 1. The FX market is mostly stabilized by late June, and there was no more demand for the relatively expensive swap funds after the last auction on May 6th. As the CIP deviation shrinks, there have been fewer arbitrage opportunities for foreign banks, hence no spillover effect.

Table 3 provides additional panel regression results that explore the supply and demand side hypotheses. I use monthly net-due growth rates in terms of asset $\left(100 \times \Delta \text{netdue}_{i,t}/\text{asset}_{i,t-1}\right)$ as regressand. Hence, the dependent variable is first-differenced, but to further account for possible autocorrelation, I cluster the standard errors at the bank level. In the first column, the main regressor is the auction$_{i,t}$ dummy, which is equal to one if there has been a net draw of the swap fund in month $t$ in the origin country of bank $i$. The positive and significant coefficient to auction$_{i,t}$ means that the swap effect is significant only during the time of auction in the foreign banks’ origin countries, hence supporting the supply side hypothesis that spillover shrinks as there are fewer auctions in the sender countries.

Columns (2)–(4) investigate how the net-due is associated with the CIP deviation (KRW-USD pair). The sample period is extended to begin from January 2018. It is to have more variation in the CIP deviation and compare the period after the swap arrangement with the period prior to the policy. First, in column (2), I do not include the time fixed effect yet and check the direct effect of CIP deviation on net-due. The CIP deviation is the monthly average of the daily series. The positive and significant coefficient shows that the net-due is closely related to the CIP deviation. Foreign banks’ borrowing from their headquarters increases in the month when the CIP deviation is large. Column (3) checks whether there is a difference in the degree of association of net-due with the CIP deviation between the two groups of banks. network dummy is interacted with the CIP deviation, and the monthly fixed effect is now included. Note that the direct terms of network and CIP deviation are absorbed by bank fixed effects and time fixed effects, respectively. The result is that there is no difference in net-due responses to the CIP deviation between the banks from network countries and the others.

Lastly, in column (4), I check whether the difference in net-due association with CIP deviation between the two groups emerges after the swap arrangement. swap$_i$ is one after March 2020 and zero before. I make a triple interaction with it and include all the necessary auxiliary terms in the regression. Note that swap $\times$ CIP deviation is absorbed by the time fixed effects. The result is that the double interaction term of network and CIP deviation is insignificant as before, while the triple interaction coefficient is positive and significant. The difference in net-due responses to CIP deviation between the two groups does not exist before the swap arrangement, but it becomes significant after the arrangement. Overall, the results imply that foreign banks’ borrowing from parent banks is closely associated with the CIP deviation and that the difference between the network banks and the others is significant only after the swap arrangement. This is consistent with the demand side hypothesis that the spillover effect shrinks after June because the

Fig. 4. Cross-sectional regression results. Notes: The graph shows the estimation result of Eq. (1) for each month in 2020 from January to November. The solid line is the point estimate of the network dummy coefficient ($\beta$). The shaded areas are 1 S.D. and 90% confidence bands. Detailed results are provided in the appendix Table A.1.
This paper examines the international spillover effect of the central bank swap line for the first time. I find that the swap arrangement made during the COVID-19 crisis generated significant liquidity spillover into Korea. Korea drew 20 billion dollars from its own swap arrangement with the Fed. Besides, I find additional 11 billion dollars supplied into Korea from other swap network countries through international spillover. It was estimated by comparing foreign banks from the network countries with the other banks in their borrowing from parent banks. The effect lasted for a couple more months before it disappears gradually. In conclusion, central bank swap lines may have more broad effects on the global financial market via spillover, and foreign banks play a pivotal role in international shock transmission.

### Table 3
Panel regression results.

| Sample period: | (1) 2020.3–11 | (2) 2018.1–2020.11 | (3) 2018.1–2020.11 | (4) 2018.1–2020.11 |
|---------------|----------------|-------------------|-------------------|-------------------|
| auctioni,t     | 1.510*         |                   |                   |                   |
| CIP_deviationt | 2.190**        |                   |                   |                   |
| networki × CIP_deviationt | 2.178 | −1.245 |                   |                   |
| swapi × networki × CIP_deviationt | (0.284) | (0.728) | 7.165* | (0.098) |
| swapi × networki | −4.552**       |                   |                   |                   |
| log asseti,t−1 | −1.467         | −1.070            | −1.153            | −0.657            |
| capitalratioi,t−1 | −15.03         | 3.619             | 2.490             | 7.082             |
| securityratioi,t−1 | −18.74+        | −8.270**          | −7.081+           | −6.238+           |
| R^2-squared    | 0.162          |                   |                   |                   |
| observations   | 323            | 1205              | 1205              | 1205              |
| time fixed effect | yes             | yes               | yes               | yes               |
| bank fixed effect | yes             | yes               | yes               | yes               |
| number of banks | 36              | 38                | 38                | 38                |
| R^2-squared    | 0.162          | 0.018             | 0.070             | 0.077             |

Notes: The dependent variable is the net-due growth rate in terms of asset sizes \(100 \times \frac{\text{netdue}_{i,t}}{\text{asset}_{i,t-1}}\). auctioni,t is equal to one if the drawn amount of swap dollar in month t increases in the country where bank i’s parent bank is located. It is zero otherwise. CIP_deviation is for the KRW-USD pair, and a positive figure means it is profitable to borrow in USD and lend in KRW. networki is equal to one for banks originating from those countries the Fed swap line reaches. Zero otherwise. swap is a dummy variable that is equal to one after March 2020. Zero otherwise. capitalratio and securityratio are the capital-to-asset ratio and security-to-asset ratio, respectively. The regression is weighted by bank asset size. Standard errors are clustered at the individual bank level. Shown in parentheses are the p-values. +, * and ** indicate statistical significance at 15, 10 and 5 percent, respectively. Basic statistics for the variables are provided in Table 4.

### Table 4
Summary statistics for the panel regression variables.

|                      | N  | Mean | std.dev. | p25  | Median | p75  |
|----------------------|----|------|----------|------|--------|------|
| CIP deviation (%)    | 35 | 0.45 | 0.20     | 0.29 | 0.42   | 0.53 |
| net-due growth rate compared to asset size (%) | 1,209 | 0.11 | 6.14     | −1.73 | 0.00   | 1.75 |
| total asset (trillion won) | 1,250 | 8.07 | 7.82     | 0.96  | 6.83   | 11.93|
| capital ratio        | 1,249 | 0.12 | 0.18     | 0.04  | 0.06   | 0.11 |
| security ratio       | 1,245 | 0.17 | 0.14     | 0.07  | 0.15   | 0.23 |

Notes: This table provides descriptive statistics for the variables used in the panel regression of Table 3. The sample period for this table is from January 2018 to November 2020. The CIP deviation is for the KRW-USD pair, and a positive figure means it is profitable to borrow in USD and lend in KRW. It is calculated based on 3-month rates.

### 5. Conclusion

This paper examines the international spillover effect of the central bank swap line for the first time. I find that the swap arrangement made during the COVID-19 crisis generated significant liquidity spillover into Korea. Korea drew 20 billion dollars from its own swap arrangement with the Fed. Besides, I find additional 11 billion dollars supplied into Korea from other swap network countries through international spillover. It was estimated by comparing foreign banks from the network countries with the other banks in their borrowing from parent banks. The effect lasted for a couple more months before it disappears gradually. In conclusion, central bank swap lines may have more broad effects on the global financial market via spillover, and foreign banks play a pivotal role in international shock transmission.

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3 Column (4) result is consistent with the cross-sectional regression results (Fig. 4). Putting the estimated significant coefficients, the interaction terms can be shown together as: \((7.165 \times \text{CIPdeviation}, \times 4.552 \times \text{swap}, \times \text{network})\). The average CIP deviation recorded 1.3 and 0.8 in March and April. Therefore the overall coefficient to the swap, × network, is positive over March and April, meaning that the monthly borrowing growth rates of the network banks are higher than non-network banks after the swap arrangement. The deviation then comes down to around 0.6 over May, June, and July. The overall coefficient is close to zero then, and it means that there was no difference between the two groups over the latter period.
Appendix A

Table A1
Cross-sectional regression results.

|                | Jan. | Feb. | Mar. | Apr. | May. | Jun. | Jul. | Aug. | Sep. | Oct. | Nov. |
|----------------|------|------|------|------|------|------|------|------|------|------|------|
| network\(_i\)  | 0.09 | 2.57 | 10.8** | 8.60+ | 8.85+ | 6.07 | 1.93 | 1.80 | 1.60 | 0.91 | -2.96 |
| log asset\(_{i,t-1}\) | (0.97) | (0.38) | (0.03) | (0.11) | (0.14) | (0.27) | (0.72) | (0.75) | (0.78) | (0.88) | (0.61) |
| cap ratio\(_{i,t-1}\) | 0.45 | -1.39+ | -1.90 | -0.87 | -0.32 | 1.00 | 1.23 | 1.99 | 1.67 | 1.37 | -1.26 |
| sec ratio\(_{i,t-1}\) | (0.63) | (0.15) | (0.22) | (0.62) | (0.87) | (0.56) | (0.51) | (0.32) | (0.41) | (0.54) | (0.53) |
| log asset\(_{i,t-1}\) | 2.15 | -14.41 | -14.66 | -7.49 | -5.15 | -2.88 | -8.83 | -8.07 | -13.47 | -22.22 | -14.99 |
| cap ratio\(_{i,t-1}\) | (0.85) | (0.20) | (0.42) | (0.70) | (0.82) | (0.89) | (0.67) | (0.71) | (0.55) | (0.34) | (0.45) |
| sec ratio\(_{i,t-1}\) | -10.69 | -7.97 | -6.10 | -3.60 | -3.54 | 1.98 | 6.87 | 5.77 | -0.35 | -15.07 | 9.18 |
| log asset\(_{i,t-1}\) | (0.27) | (0.45) | (0.74) | (0.87) | (0.89) | (0.93) | (0.73) | (0.78) | (0.99) | (0.47) | (0.64) |
| observations | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 35 |
| R-squared | 0.047 | 0.106 | 0.167 | 0.085 | 0.075 | 0.090 | 0.093 | 0.106 | 0.131 | 0.129 | 0.035 |

Notes: This table provides detailed results of the cross-sectional regressions, which are graphed in Fig. 4. It is the estimation result of Eq. (1) for each month in 2020. network\(_i\) is equal to one if the country bank \(i\) originates from is included in the Fed swap network. capratio and secratio are capital ratio (capital / asset) and security ratio (security / asset), respectively. P-values are shown in parentheses. + and ** indicate statistical significance at 15 percent and 5 percent, respectively.

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