Cross-Border Bank Flows through Foreign Branches: Evidence from Korea*

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Abstract

Global banks play an important role in international monetary transmission by allocating funds across the world through their foreign affiliates. Using monthly data on individual foreign bank branches in Korea from 2004 to 2018, this paper investigates the effects of foreign monetary policies and Korean macroprudential policy on the cross-border capital flows between global banks' headquarters and their Korean branches. I find that foreign branches reduce borrowing from their headquarters by 2.4% of their assets after a one percentage point hike in the home-country policy rates. The effect is more significant for the branches with higher loan-to-asset ratios as their asset maturities are longer. Korea introduced leverage caps on banks' FX derivative positions in 2010, and has been adjusting the cap depending on the macroeconomic situation. I find that lowering the cap makes foreign branches increase capital by receiving long-term capital from headquarters. The branches with higher bond-to-asset ratios respond more as they trade heavily in FX derivatives.

Keywords: Foreign Bank, Bank Flows, Monetary Policy, Macroprudential Policy

JEL Classification: G21, F34, F38

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1 Introduction

In the past decade following the Global Financial Crisis, the literature has revealed that banking has become global, and international banks are now the key to understand the international transmission of shocks. Internationally active banks operate branches and subsidiaries in many countries, and they function as a channel of international shock propagation. The literature has focused on the role of global banks and their affiliates in international capital flows, and many researchers have concluded that we need to better understand the behavior of foreign banks over the business cycle.

This paper dissects the operation of foreign bank branches in Korea to learn how monetary policy and macroprudential policy affect the branches' borrowing and lending with their headquarters. Borrowing and lending between a global bank head office and its branch are financial transactions within a banking group, but they are also cross-border capital flows that may transmit shocks from one country to another. This paper considers whether the effect of foreign monetary policy is imported through foreign bank branches, and examines whether macroprudential policy is an effective tool to cope with international spillovers.

Foreign bank branches play an important role in Korea by providing foreign capital. They are major suppliers of foreign currency liquidity in the Korean financial market. Their foreign borrowing in the form of net-due-to accounts for around 20% of the banking sector's total external liabilities and 10% of the whole nation's. The funds they channel from abroad are eventually utilized in Korea as lending to firms, banks and the government, thus bringing real impacts. Not only is their presence significant, but they also provide a useful laboratory to study international capital flows. More than 40 foreign bank branches from 17 different countries around the world are operating in Korea at any given time. One can exploit the regional differences in monetary policies to tease out the effects on capital flows.

I use regulatory data on individual foreign bank branches in Korea. The data cover the 15 years from March 2004 to February 2018 in monthly frequency. The primary variable of concern is the net cross-border borrowing of the branches through the internal capital markets of global banking groups. First, I estimate the effects of home (origin) country monetary policy on the branches' borrowing from mother banks, exploiting the differences in the national origins of each branch. The identification, then, comes in a given month from the differences of monetary policies among the countries from which the branches originate. We can also count on the exogeneity of the origin country monetary policy from the foreign branch operation in Korea. In doing this analysis, I group the foreign branches by different business models and investigate bank heterogeneity. I posit that banks with long-term assets, like loans, would respond to the policy rate more than banks with short-term assets.

Next, I examine the effect of macroprudential policy. Korea introduced FX derivative position leverage cap regulation in October 2010. Banks are mandated to keep their FX derivative positions below several multiples of their capital bases. I ask how this policy influences foreign bank branches' capital (or long-term borrowing from parent banks). The identification in this analysis comes from a differences-in-differences framework. I estimate different responses of banks with different bond-to-asset ratios before the policy. For branches focused on security trading, FX derivative transactions are essential. Those banks would make more efforts to recapitalize compared to banks with less bonds and more long-term assets.

The main findings are: First, a foreign bank branch responds to monetary policy tightening in its home country by reducing borrowing from the head office. Second, lowering the leverage cap on FX derivative positions makes foreign branches capitalize more by receiving long-term capital from head offices. Lastly, there is substantial underlying heterogeneity among branches with different business models: loan-making branches are sensitive to policy rate changes, while macroprudential policy has greater

effects on branches specialized in security trading.

A number of recent studies have analyzed foreign bank affiliates' role in the cross-border bank flows. Cetorelli and Goldberg (2012a) is the first to document the importance of internal capital markets between the global bank head offices and their foreign affiliates. They analyze data on U.S. banks and their affiliates outside the U.S. to find that the cross-border internal capital markets are actively used to satisfy the funding needs of home and foreign offices of global banks. Borrowing and lending among the head office and its branches contribute to international shock spillovers. Hoggarth et al. (2013) analyze foreign bank branches in the U.K. and find that they rely on fickle forms of funding from abroad, amplifying domestic credit cycles. Kwan et al. (2014) find that global banks used their branches in Hong Kong as a funding source during financial crises in the U.S. and Europe, so they transmitted the credit crunch to Hong Kong. Cetorelli and Goldberg (2012b) tell the same story with a different country. They find that U.S. branches of foreign banks experienced a 12 percent net internal fund "withdrawal" by their parent banks during the Great Recession. All these papers find that the internal capital markets within global banking groups play an important role in international spillover effects by exporting and importing shocks across borders. The current paper contributes to this literature by presenting new direct evidence on the significance of cross-border borrowing and lending by foreign branches with their parent banks.

This paper is also related to the literature of the cross-border spillover effects of monetary policy. This literature does find significant international spillovers of monetary policy, but different studies find different directions of such spillovers, and the channels through which the spillovers occur are not well understood either. Using BIS banking data, Bruno and Shin (2015) find that contractionary U.S. monetary policy leads to a decrease in cross-border bank flows as banks' financing costs rise. In contrast, Correa et al. (2015) find from the same data that tighter monetary policy in a

country makes banks in that country allocate more funds abroad. They explain this as an effect of the portfolio channel. Monetary tightening makes domestic borrowers riskier, and hence banks invest more abroad. Avdjiev and Hale (2018) reconcile the two findings and argue that the direction of flows depends on international capital flow regimes. They argue that in the boom regime, macroeconomic fundamentals reflected in policy rate moves in concert with international lending, and researchers see a positive relationship between policy rates and international lending. However in a stagnant regime, the other components of the policy rate dominate the relationship, and one sees a negative correlation between policy rates and lending. The International Banking Research Network also delves into the spillover effects of monetary policy. See Buch et al. (2018) and other contributing papers in this project. Their conclusions also vary: some countries observe positive effects of the foreign monetary policy rate on bank lending, but some others find negative effects. My paper contributes to this literature by adding another result which is in line more with Bruno and Shin (2015). As funding costs rise after policy rate hikes, foreign bank branches reduce borrowing from headquarters. My paper also documents a specific channel of the spillover effects, foreign bank branches.

The remainder of the paper is organized as follows. Section 2 discusses the role of foreign bank branches in Korea, and explains macroprudential policy targeting them. Section 3 describes the data and lays out the empirical framework. Section 4 analyzes the effect of monetary policy, and Section 5 investigates the effect of macroprudential policy. Finally, Section 6 concludes.

2 Foreign Bank Branches in Korea

Foreign bank branches play an important role in the Korean financial market by bringing foreign capital into Korea. Although they are small in terms of asset size, their cross-border borrowing is significant. The total asset size of foreign branches as of December 2016 is 278.1 trillion won, which is 12.4% of that of domestic banks. However, the branches' borrowing from head offices (net-due-to) sum up to 40 billion dollars, accounting for 23% of all external debt of depository banks, and 10% of the national external debt.

We focus on the net-due position of the foreign branches in this paper. Net-due-to occurs when the branch borrows from its head office, and net-due-from occurs when the branch lends to the head office. Foreign branches fund their investment in Korea through net-due-to accounts. They bring the funds they receive from the parent banks into Korea, swaps them with Korean won, and eventually invest them in securities or loans. Foreign branches prefer risk-free public bonds, and loans are mostly directed to firms from their origin countries. Many foreign branches engage in risk-free arbitrage in this fashion, and hence FX derivative trading is a very important part of their operations.

Figure 1 shows the fluctuations of net-due-to and net-due-from separately. Net-due-to is significantly larger than net-due-from, and hence one can see that foreign branches mainly supply foreign capital to Korea rather than borrowing from Korea. Also, we see that the fluctuation is massive. For instance, just within the last five years, net-due-to went on a large swing from 40 trillion to 60 trillion and then back to 40 trillion won. I examine how this fluctuation is associated with the monetary policies of the home and host countries, and whether macroprudential policy is an effective tool to deal with the fluctuation.

FIGURE 1 HERE

Figure 2 shows the size of net-due-to in comparison with Korea's liabilities measured in the locational banking statistics (LBS) of the BIS. The left panel shows the breakdowns of the liabilities by country at the end of 2017. The blue bar is the size of Korea's liabilities to foreign banks recorded in the LBS, and the red bar is sum of net-due-to as reported in the Korean branches' balance sheets. For instance, Japanese foreign bank branches' borrowing from their parent banks in Japan accounts for around half of Korea's total liabilities to the Japanese banking sector. The relative sizes of net-due-to are small in financial hub countries like the U.S. or U.K, but for some other countries like Switzerland or the Netherlands, net-due-to accounts for almost all of Korea's liabilities to the banks in the corresponding countries. The right panel shows the time-series variation of the relative size of net-due-to compared with Korea's external liabilities as shown in the LBS. In general, around 20% of Korea's external liabilities to foreign banks are in the form of net-due-to of foreign bank branches, and the fluctuation is also large.

FIGURE 2 HERE

At any given time, around 40 branches are operating in Korea. Table 1 shows the list of countries and the number of global banks that originate from them and have branches in Korea over the sample period. There are a total of 55 foreign bank branches from 17 countries around the world. Many of the branches are from countries linked tightly with the Korean economy, such as the U.S. (15), China (6), and Japan (5). The monthly observations of all branches sum up to 6,285.

TABLE 1 HERE

In 2010, Korea introduced a series of macroprudential policies to make its economy resilient to capital flow reversal in the banking sector.[1] Among the measures introduced in 2010, the policy that directly affects foreign bank branches is the leverage cap on the foreign exchange derivative contracts (mainly currency swaps and forwards). Beginning in October 2010, foreign bank branches were required to maintain their net FX derivative position below a level of 2.5 times their capital. Later the limit was adjusted to 2.0, 1.5, and then back to 2.0 in July 2011, January 2013, and July 2016, respectively. This regulation works against the business of foreign branches as they use FX swaps to convert the funds they borrow from headquarters to Korean won and invest in Korean currency denominated assets.

In principle, the branches could maintain their asset sizes and businesses by increasing capital. The leverage cap regulation is applied to the sum of Tier 1 capital (Capital A) and Tier 2 capital (Capital B). Capital A is the usual paid-in capital, and it is not easy to adjust it frequently due to legal restrictions. Capital B, however, is essentially a long-term borrowing from the head office. If the branch borrows from its mother bank in the long term (longer than one year), then the fund is treated as Capital B on which the branch can leverage. Therefore, this regulation must have significant implications for foreign branches' long-term borrowing from their mother banks. Later, we estimate the effect of this regulation on Capital B in the section 5.

3 Empirical Framework

Our main source of data is the Financial Analysis Information Retrieval System (FAIRS) of the Bank of Korea. FAIRS provides detailed monthly balance sheet information of fi-

[1] Those measures and their effect on capital flows are well summarized in Bruno and Shin (2014) and Kang et al. (2016).

nancial intermediaries in Korea. The data in FAIRS is originally collected by the Bank of Korea or by the Financial Supervisory Service for the purpose of monetary policy and bank supervision. The available data start from March 2004, and the analysis sets the sample period as the 15 years from March 2004 to February 2018.

I also rely on other sources of data for macroeconomic variables for the 17 countries in the sample. The industrial production index data is obtained from Bloomberg, and the policy rates of the countries are from CEIC data and the central banks of each country. The macroeconomic data on Korea are sourced from the Bank of Korea. To identify the origin countries of each bank, I used the bank ownership database of Claessens and Van Horen (2015).

In the regression analyses following this section, I control for banking crises by including a dummy variable. It is documented in Kwan et al. (2014) that foreign branches withdraw funds from the host country during crisis in their home country. It is also common for central banks to lower policy rates during a banking crisis. Therefore, while in a banking crisis, a positive correlation between net-due-to and policy rates would be observed, but the causation is coming from the crisis, not from policy rates. The normal time effects of home policy rates on net-due are likely to be negative but would be obscured if one did not control for the crisis properly. Over the sample period, we have the Global Financial Crisis (GFC) and European Debt Crisis (EDC). The GFC was global as its name suggests, so every country in the sample lowered its policy rate, while the EDC affected mainly European countries. I set dummy variable $Crisis_{b,m}$ to be 1 for every branch during GFC, and set it to be 1 for only those branches from European countries during the EDC. The GFC period is set to be one year following the Lehman bankruptcy (from September 2008 to August 2009) and the EDC period is set to be the one year preceding the introduction of the European Central Bank's long-term refinancing operation (from January 2011 to December 2011).

Foreign bank branches have different business models, according to which they hold

different assets. Some branches specialize in making loans, while others are focused more on trading securities. This results in different maturity of assets among banks. Typically, loans have longer maturity than securities, and loan-making branches tend to hold bonds for the long term whereas security trading branches rarely hold bonds to maturity. Therefore, loan-type branches' assets are of longer term than those of security-type branches. These different branch types may respond differently to monetary policy and macroprudential policy changes.

To analyze business model heterogeneity, I set two subsamples, L group and B group, based on branches' loan-to-asset and bond-to-asset ratios averaged over the sample period. L group comprises the 14 banks with above-median loan-to-asset ratios and below-median bond-to-asset ratios. B group includes the 13 banks with below-median loan-to-asset ratios and above-median bond-to-asset ratios. Figure 3 displays a foreign bank branch as a dot on the loan-to-asset and bond-to-asset plane. The banks are notated with the country abbreviations. There is a clear negative correlation between the two ratios. The red squares are the L group banks, and the blue diamonds are the B group banks. The asset compositions of L group are very different from those of B group.

Figure 3 Here

Summary statistics for key variables are given in Table 2. We can see the differences in balance sheet composition between L group and B group clearly. The mean loan amount is 0.35 trillion won in L group, while it is 0.03 trillion won in B group. The mean public bond holdings are 2.0 trillion in B group and 0.19 trillion in L group. Also, B group trades FX currency derivatives heavily compared to L group.

Table 2 Here

Table 3 presents the average security holdings of different groups of banks decomposed by maturity. For B group, most of their securities are short-term trading securities (85.8%). Held-to-maturity securities account for only 0.6% of holdings. This is in stark contrast with L group. Trading securities account for only 0.1%, and the L group banks hold 32% of their securities to maturity. Given that L group holds a lot of loans and B group does not, we can conclude that the effective maturity of bank assets is much longer for L group than B group.

Table 3 Here

I drop the observations with an asset growth rate of below -50% or above 200%, and also exclude the outlying 1% (the top 0.5% and bottom 0.5%) of key variables to avoid influences of possible outliers. The balance sheet items are deflated using the Korean CPI and are measured in 2015 Korean won. All regressions are weighted by bank sizes to prevent a large number of small banks from altering the regression results in opposition to the aggregate effects. Standard errors are clustered at the bank level to allow arbitrary serial correlations of error terms within a bank. (Bertrand et al., 2004)

4 Monetary Policy

In this section, I study how foreign monetary policies cross borders through foreign bank branches. We are mainly interested in the foreign monetary policy spillover, but we also examine the effect of Korean monetary policy after dropping time fixed effects.

4.1 Origin Country Monetary Policy

I begin by asking how home country monetary policy affects the cross-border borrowing of foreign bank branches from their mother banks. The baseline model includes bank fixed effects as well as monthly fixed effects which control for most of the unobserved macroeconomic factors. The origins of the foreign bank branches are widely spread throughout the world as presented in Table 1. I exploit the differences in monetary policies in origin countries in a given month. The main dependent variable is $NetDue$, which I define as net-due-to minus net-due-from. Therefore, a positive $NetDue$ means that the branch owes funds to its head office. The following is the baseline estimating equation:

$$\begin{aligned} Y_{b,m} &= \mu_b + \lambda_m + \sum_{j=1}^{2} \delta_j Y_{b,m-j} + \sum_{j=0}^{2} \beta_j \Delta HQMP_{b,m-j} \\ &\quad + \sum_{j=0}^{2} \phi_j \Delta HQMP_{b,m-j} \times Crisis_{b,m} + \psi Crisis_{b,m} + X'_{b,m}\gamma + \epsilon_{b,m} \end{aligned} \tag{1}$$

where subscript b indexes banks, and m indexes months. The regressand is the change in $NetDue$ normalized by the beginning of the period total assets. More than 5% of $NetDue$ is negative in the sample. Rather than taking the differences of log $NetDue$, I normalize the change in $NetDue$ with the bank's asset size of the previous month.[2] The terms μ_b and λ_m denote bank fixed effects and monthly fixed effects. δs are the autoregressive coefficients.[3]

The main regressor $\Delta HQMP_{b,m}$ is the change in the monetary policy rate of the country where the headquarters of branch b is located. The data is monthly and I get quarterly effects by including two lags of the policy rate changes and doing an F-test

[2]This form of regressand was used in other studies, such as those published by the International Banking Research Network.

[3]We use monthly data for 15 years and $T = 180$. There is little concern of the Nickell bias.

on the sum of all three coefficients. The null hypothesis is that the sum is equal to zero, and I report p-value from the test. I do the same for the other regressors with lags. A negative and significant sum of β_j implies that foreign bank branches reduce borrowing from parent banks after home country monetary tightening. $Crisis_{b,m}$ is the dummy variable for banking crises as explained in the previous section. Its interaction term with the policy rate changes is included to control for banking crises. $X_{b,m}$ is a vector of control variables, which includes growth rates in industrial production of origin countries and its two lagged terms, bank capital ratio and log of bank total assets.

Table 4 Here

Table 4 presents the results. Columns (1) and (2) cover the full sample. There is less variation in the monetary policy rates of advanced countries after the GFC due to quantitative easing. Therefore, in column (2) I use Wu-Xia shadow rates for the U.S., U.K., and Eurozone countries as a robustness check. (Wu and Xia, 2016) In both of the regressions, the sums of coefficients on home country monetary policy changes are negative and significant, meaning that branches reduce borrowing from head offices after policy rate hikes in the home countries. The size of the coefficient is also economically significant. After a one percentage point hike in the home policy rate, the branches reduce borrowing by 2.4% of their assets over the following three months. Applied to the sum of all branches' assets at the end of 2016, this means 5.6 billion USD reduction.[4] The results confirm that Korea imports foreign monetary policy effects via foreign bank branches.

The sum of coefficients on the interaction term is positive and significant. Also, the coefficient is larger in absolute value than the coefficients on home country monetary

[4]This is the effect of the shock that all 17 countries raise their interest rate by a one percentage point. For the effect of a specific country, one need to consider the bank heterogeneity.

policy changes. Therefore, during banking crises, the coefficients on home monetary policy changes are overall positive. We know that central banks lowered policy rates during crises, and hence the results imply that foreign branches reduced borrowing from head offices significantly during crises. This is consistent with the findings of Kwan et al. (2014).

Columns (3) and (4) show the results from the same regression on the subsamples, L group and B group. The policy rate coefficients are negative and significant for L group but not for B group. The branches making significant loans are sensitive to the borrowing cost changes from home, while the branches concentrating on security trading are not sensitive to home country policy rate changes. As discussed with Table 3, loan-making branches have longer effective maturities of assets. Interest rate changes directly affect their profits. Security-trading branches tend to hold bonds only for short periods, and they trade heavily in FX derivatives. It seems that their profits are less sensitive to policy rate changes for this reason.

4.2 Korean Monetary Policy

The next question is on the effect of host country monetary policy. Korean monetary policy is common to all branches in the sample, so time fixed effects compete with Korean monetary policy in regressions. To estimate the effect of Korean monetary policy, I drop all time fixed effects. Instead, I control further for macroeconomic changes in Korea. The growth rate of the Korean industrial production index and its two lagged terms are included to control for the host country business cycle. Swap rates play an important role in the foreign bank branches' financial intermediation as explained in the section 2. Changes in the monthly average of daily swap rates are included in the regression.

We also need to control for the macroprudential policy introduced in 2010. Since the government has been adjusting the leverage cap depending on the macroeconomic circumstances, I generate a time-series vector rather than a dummy variable out of it. The policy changes were announced several months earlier than their effective dates, and the branches adjusted their balance sheets before the policies became effective. Therefore, I use the announcement dates of the leverage cap changes rather than the effective dates. The average FX derivative leverage ratio was 301% (April 2010) right before the first policy announcement, and it is reported that the leverage ratios of foreign branches rarely exceeded 400% before the introduction of the cap. Hence, I set the leverage cap variable, $Macropru_m$, to be 4.0 before the introduction of the policy. Including the change of $Macropru_m$ and its two lags as covariates, the following estimating equation is derived:

$$\begin{aligned} Y_{b,m} &= \mu_b + \sum_{j=1}^{2} \delta_j Y_{b,m-j} + \psi Crisis_{b,m} \\ &\quad + \sum_{j=0}^{2} \beta_j \Delta HQMP_{b,m-j} + \sum_{j=0}^{2} \phi_j \Delta HQMP_{b,m-j} \times Crisis_{b,m} \\ &\quad + \sum_{j=0}^{2} \alpha_j \Delta KRMP_{m-j} + \sum_{j=0}^{2} \theta_j \Delta KRMP_{m-j} \times Crisis_{b,m} \\ &\quad + \sum_{j=0}^{2} \eta_j \Delta MacroPru_{m-j} + \sum_{j=0}^{2} \zeta_j \Delta SwapRate_{m-j} + X'_{b,m}\gamma + \epsilon_{b,m} \end{aligned} \tag{2}$$

where $\Delta KRMP_m$ is the change in Korean monetary policy. These terms are also interacted with the crisis dummy.

Table 5 shows the results. In columns (1) and (2), the coefficients on home country monetary policy changes are negative as in the previous regressions, but the p-values slightly exceed 0.10. The sum of coefficients on Korean monetary policy changes are positive and significant. This means that Korean policy rate hikes induce foreign bank

branches to borrow more from mother banks. After a one percentage point rise in the Korean policy rate, the branches increase their borrowing from headquarters over the next quarter by 4.8% of their assets. This effect is null during banking crises in home countries. The sum of coefficients on the interactions of Korean monetary policy change and the crisis dummy is -4.86, and hence the effect of Korean monetary policy during crisis is close to zero. This means that the host country monetary policy has no effect on foreign branches' borrowing during crisis. This is consistent with the finding of Jeon and Wu (2014). They find that foreign banks' lending are less sensitive to host country monetary policy during crisis. The coefficients to changes in swap rates are negative, meaning that the branches borrow more when the swap rates are more favorable to them.

The results are heterogeneous among different banks. Columns (3) and (4) show that L group banks are sensitive to the policy rate changes of home and host countries, but B group banks are not. It also shows that following the tightening of the leverage cap, L group banks increase their borrowing from mother banks, but B group banks do not.

Table 5 Here

4.3 Interest Rate Differentials

Since the foreign branches are lending in Korea and borrowing from their headquarters, it might be the interest rate differential that matters for them in the end. The coefficients in Table 5 also imply this possibility: the coefficients on liability-side interest rate are negative and the coefficients on the asset-side interest rate are positive. This can be tested by setting a restriction that the coefficients for the policy rates of the

home and host countries sum up to zero. From the estimating equation (2), the null hypothesis can be written as $\sum \beta + \sum \alpha = 0$. Table 6 shows the test results based on the regressions in Table 5. The numbers are the p-values from the test of the null hypothesis. Tests from the regressions with normal policy rates do not reject the null, implying that the interest rate differential is the variable to which the foreign branches are responding. Only the test from the regression with shadow rates rejects the null. This means that the effects of home and Korean policy rate are different in magnitudes.

Table 6 Here

I proceed to the regressions using interest rate gaps instead of home and host country monetary policies. Every other setting is the same as with the regressions in Table 5, but home and host country monetary policies are now replaced with interest rate differentials between Korea and the branches' origin countries.

Table 7 Here

Table 7 presents the results, which are not very different from the results in Table 5. Column (1) indicates that, following a one percentage point increase in the interest rate gap, foreign branches increase their borrowing from parent banks by 2.7% of their assets. The impact is large for L group, but B group is not responsive to interest rate differentials at all.

5 Macroprudential Policy

Beginning in October 2010, foreign bank branches were mandated to maintain their FX derivative positions below 250% of their capital. In response to this regulation,

the foreign bank branches could increase their Capital B by borrowing from the headquarters in the long term. Figure 2 shows Capital B and the leverage cap together. For comparison, the leverage cap is set to 4.0 before the introduction of the regulation in 2010.[5] The figure shows that the foreign branches significantly increased Capital B prior to the introduction of the leverage cap regulation. The figure also hints at a negative correlation of the aggregate Capital B with the follow-up changes in the cap.

FIGURE 4 HERE

To evaluate the effect of macroprudential policy on the long-term borrowing of branches, I regress the log growth rates of Capital B on the change in the leverage cap.[6] I adjust the sample period to be after the GFC only: from September 2009 to February 2018. The main regressor is the changes in the leverage cap recorded at the announced dates and its two lagged terms. First, I quantify the direct effects of macroprudential policy without time fixed effects, controlling for the swap rate, interest rate differential, and its interaction with the crisis dummy. I do the same regression on the subsamples as before.

To be more rigorous, I set up a differences-in-differences specification. I estimate different changes in Capital B after the macroprudential policy changes by banks with different pre-policy bond-to-asset ratios. The bond business branches trade public bonds frequently and they tend to trade lots of FX derivatives along with the bonds. Therefore, I posit that the behavior of bond business branches and loan business branches would be different after the regulation. Since the macroprudential policy is first introduced in October 2010, I use the average bond-to-asset ratio of 2009 to

[5] As explained earlier, even before the introduction of the policy, the FX derivative leverage ratios of foreign branches rarely exceeded 400%. The average ratio before the announcement of the policy was 301% (April 2010).

[6] I winsorize the top and bottom 2% of the Capital B growth rate given its long tail and fewer observations.

avoid simultaneity. Monthly fixed effects are included in this specification. To allow for different responses to the changes in policy rates, $HQMP$ is also interacted with the bond-to-asset ratio. Banking crisis is controlled by including triple interaction terms and all the necessary two-variable interaction terms. This yields the following regression equation:

$$\begin{aligned}
\Delta \ln CapB_{b,m} &= \mu_b + \lambda_m + \sum_{j=0}^{2} \beta_j \Delta MacroPru_{m-j} \times BondRatio_b \\
&\quad + \sum_{j=0}^{2} \zeta_j \Delta MacroPru_{m-j} \times BondRatio_b \times Crisis_{b,m} \\
&\quad + \sum_{j=0}^{2} \phi_j \Delta MacroPru_{m-j} \times Crisis_{b,m} + \theta BondRatio_b \times Crisis_{b,m} \\
&\quad + \sum_{j=1}^{2} \delta_j \Delta \ln CapB_{b,m-j} + \psi Crisis_{b,m} + X'_{b,m}\gamma + \epsilon_{b,m} \qquad (3)
\end{aligned}$$

where $BondRatio_b$ is the bond-to-asset ratio of bank b. The covariate X includes the triple interaction term $HQMP \times BondRatio \times Crisis$, and all the necessary auxiliary terms. We are mostly interested in the sign of $\sum \beta$ in this regression.

Table 8 presents the results. Since some of the branches do not have any Capital B, the observations and number of banks shrink to 2,414 and 36, respectively. In columns (1) and (2), the sum of coefficients on the leverage cap is negative and significant for the entire sample. When the government lowers the leverage cap by 100 percentage points, foreign bank branches increase their Capital B growth rate by 5.8 percentage points. Columns (3) and (4) show the results from the subsamples. It is mainly B group banks which increase their Capital B by borrowing more in the long term from parent banks. L group banks' Capital B do not respond to the leverage cap changes.

Table 8 Here

Column (5) is the direct estimation of the equation (3). L group banks have small bond-to-asset ratios and column (3) show that they do not adjust their Capital B responding to the macroprudential policy. Hence, the column (5) regression is essentially setting L group as a control group and estimate the effect of having higher bond-to-asset ratio on the adjustments of Capital B following leverage cap changes. The coefficient to the interaction term is negative and significant, meaning that high bond-to-asset ratio banks increased Capital B significantly more than low bond-to-asset ratio banks after the leverage cap is lowered. The interquartile range of *BondRatio* is 17.7 and the bottom 25 percentile bank's *BondRatio* is zero. Therefore, the result means that Capital B growth rate of a bank with a top 25 percentile bond-to-asset ratio is 7 percenatage points (=17.7 $\times$ 0.4) higher than a bank with zero bond holdings after the leverage cap is lowered by 100%. The economic magnitude is similar with columns (1) and (4).

The leverage cap regulation is aiming to reduce the procyclicality and volatility of cross-border bank liabilities. The previous results show that the policy induces branches to fund their investment in Korea from more stable long-term borrowing. This might help mitigate the volatility of cross-border bank flows. Indeed, Bruno and Shin (2014) analyze capital flows into Korea before and after the policy and conclude that it became less sensitive to global factors.

6 Conclusion

This paper documents the significance of the internal capital markets between global banks' head offices and their Korean branches. The amounts of cross-border borrowing and lending change actively in response to policy changes, thus working as an important channel of international shock spillovers. I find that home monetary policy tightening

reduces a foreign branch's borrowing from its mother bank. Foreign bank branches contribute to the Korean economy by supplying foreign capital to the needy domestic capital market, but such capital is accompanied by foreign monetary policy effects. Macroprudential policy may be used to deal with these spillover effects. I find that the leverage cap regulation induces foreign branches to recapitalize by receiving long-term capital from headquarters.

The results highlight that bank heterogeneity plays a crucial role in both monetary policy spillover effects and macroprudential policy effects. Branches with different business models respond differently to these shocks. While branches focused on lending are sensitive to policy rate changes, branches specialized in security trading respond more to macroprudential policy. The loan business branches have longer investment horizons, and therefore their profits are more sensitive to policy rate changes. On the other hand, the bond business branches tend to hold bonds for short periods, presumably generating profits by exploiting short-term deviations from the market equilibrium. As FX derivative transactions are essential in their arbitrage business, the bond business branches increase capital after the leverage cap is lowered. The bank heterogeneity need to be considered carefully in policy implementations.

References

Avdjiev, S. and Hale, G. (2018). U.S. monetary policy and fluctuations of international bank lending. *Federal Reserve Bank of San Francisco Working Paper*.

Bertrand, M., Duflo, E., Mullainathan, S., et al. (2004). How much should we trust differences-in-differences estimates? *The Quarterly Journal of Economics*, 119(1):249–275.

Bruno, V. and Shin, H. S. (2014). Assessing macroprudential policies: case of south korea. *The Scandinavian Journal of Economics*, 116(1):128–157.

Bruno, V. and Shin, H. S. (2015). Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics*, 71:119–132.

Buch, C. M., Bussiere, M., Goldberg, L., and Hills, R. (2018). The international transmission of monetary policy. *NBER Working Paper*.

Cetorelli, N. and Goldberg, L. S. (2012a). Banking globalization and monetary transmission. *The Journal of Finance*, 67(5):1811–1843.

Cetorelli, N. and Goldberg, L. S. (2012b). Follow the money: Quantifying domestic effects of foreign bank shocks in the great recession. *American Economic Review*, 102(3):213–18.

Claessens, S. and Van Horen, N. (2015). The impact of the global financial crisis on banking globalization. *IMF Economic Review*, 63(4):868–918.

Correa, R., Paligorova, T., Sapriza, H., and Zlate, A. (2015). Cross-border bank flows and monetary policy. *Manuscript, Federal Reserve Board of Governors. Washington DC*.

Hoggarth, G., Hooley, J., and Korniyenko, Y. (2013). Which way do foreign branches sway? Evidence from the recent UK domestic credit cycle. *Bank of England Financial Stability Paper*, (No. 22).

Jeon, B. N. and Wu, J. (2014). The role of foreign banks in monetary policy transmission: Evidence from asia during the crisis of 2008–9. *Pacific-Basin Finance Journal*, 29:96–120.

Kang, D., Jeong, D., et al. (2016). Investment patterns of foreign bank branches in Korea and their role in the foreign exchange market. *Macroprudential Regulation of International Finance: Managing Capital Flows and Exchange Rates*, page 201.

Kwan, S., Wong, E. T., and Hui, C.-h. (2014). The international transmission of shocks: Foreign bank branches in Hong Kong during crises. *Federal Reserve Bank of San Francisco Working Paper*, (2014-25).

Wu, J. C. and Xia, F. D. (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking*, 48(2-3):253–291.

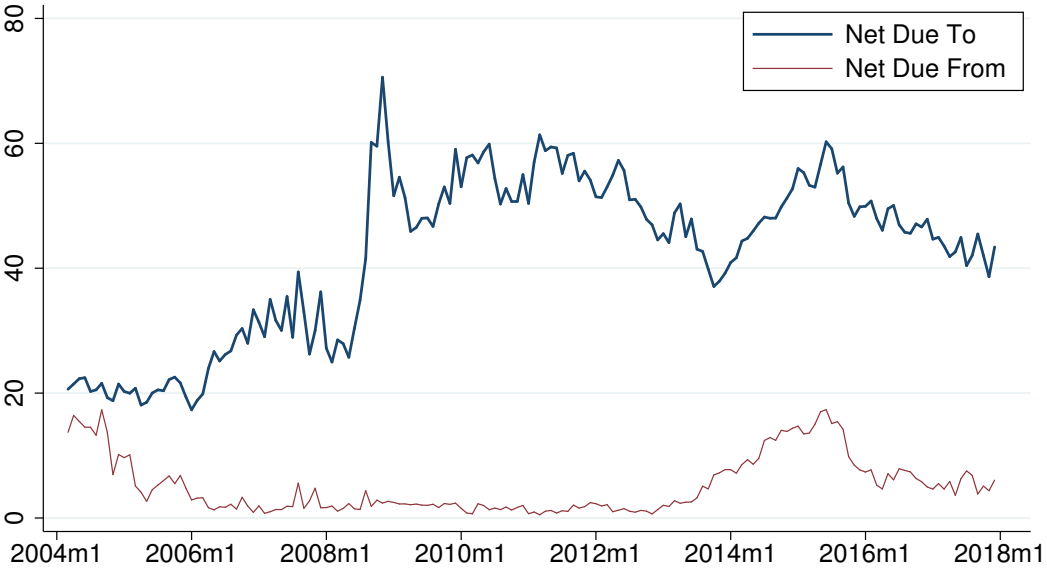
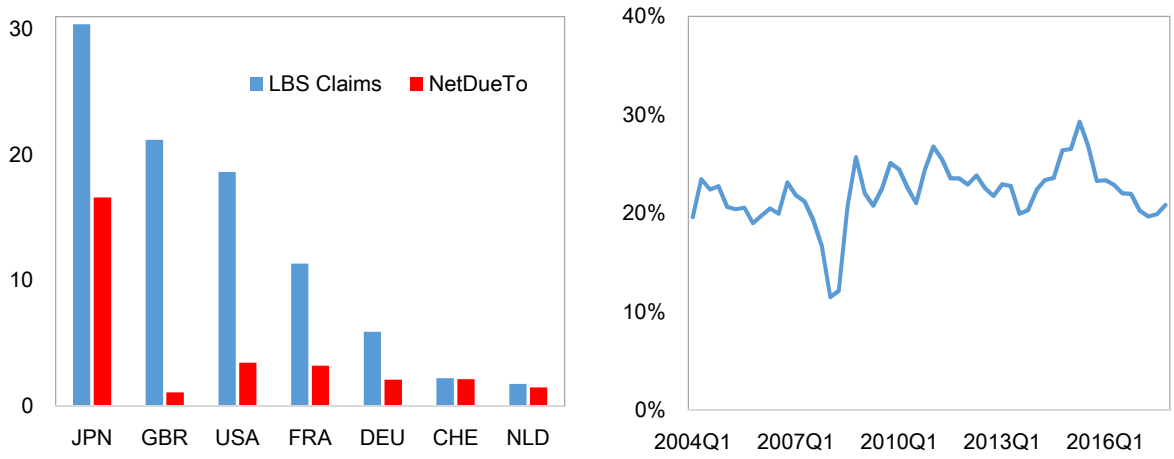


Figure 1: Net-due-to and net-due-from

NOTES: Data is from FAIRS. The two lines show the sum of net-due-to and net-due-from of all foreign bank branches. The unit is in trillion Korean won.



(a) Comparison by country (Dec. 2017)

(b) Comparison over the sample period

Figure 2: Net-due-to and LBS claims

NOTES: Data are from the FAIRS and the BIS LBS. The figures compare net-due-to from the FAIRS with claims to Korea in the LBS. Panel (a) compares them by country at the end of 2017. The figures are in billion USD. Panel (b) shows the relative size of total net-due-to compared to the LBS claims over the sample period.

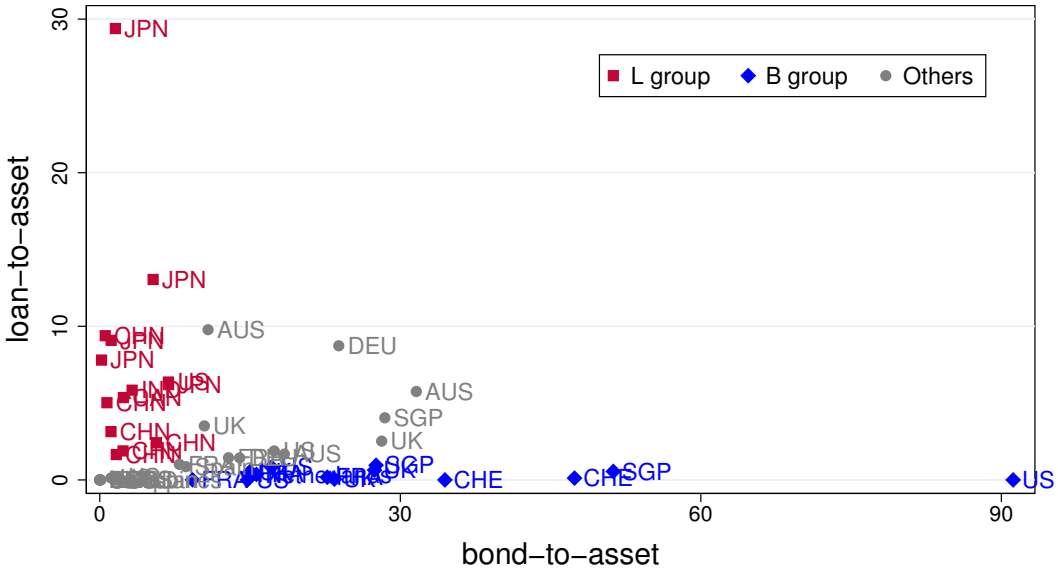


Figure 3: Loan- and bond-to-asset ratios of branches

NOTES: The loan-to-asset ratio and bond-to-asset ratio are the averages over the sample periods.(March 2004 - February 2018) Banks are notated with the name of the countries where their head offices are located. Squares in red color are the 14 banks with an above-median loan-to-asset ratio and below-median bond-to-asset ratio. Diamonds in blue color are the 13 banks with a below-median loan-to-asset ratio and above-median bond-to-asset ratio.

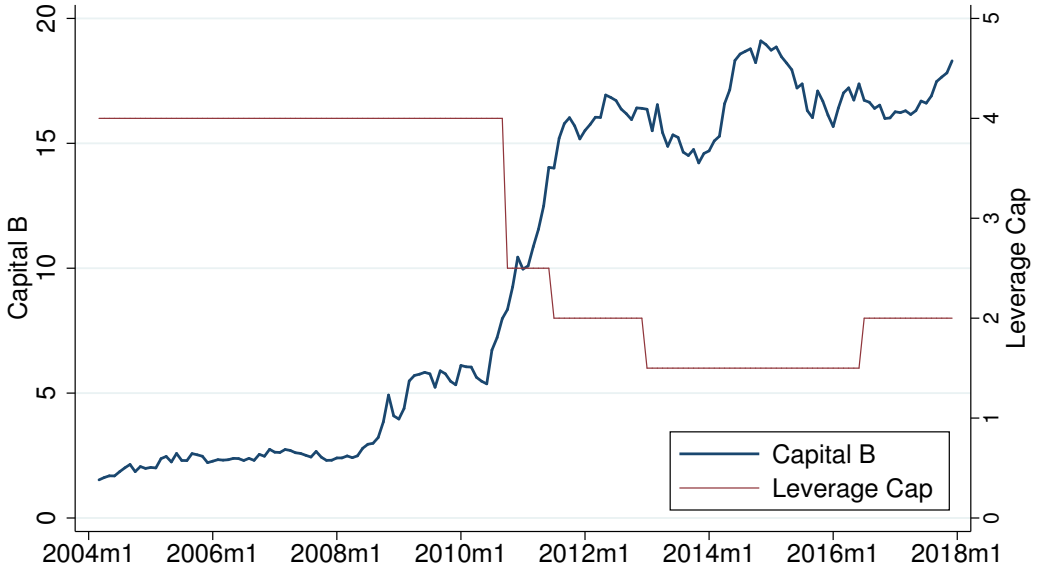


Figure 4: Capital B and the leverage cap regulation

NOTES: Data is from FAIRS. The unit is in trillion Korean won. The leverage cap is shown as 4.0 before its introduction in October 2010.

Table 1: Number of banks and observations by origin country

Origin	Banks	Observations	Origin	Banks	Observations
U.S.	15	1,275	Switzerland	2	336
China	6	762	Canada	1	164
France	5	681	Indonesia	1	28
Japan	5	689	Iran	1	70
U.K.	5	523	Netherlands	1	169
Australia	3	280	Pakistan	1	168
Singapore	3	509	Philippines	1	170
Germany	2	292	Spain	1	69
India	2	192	**Sum**	**55**	**6,377**

NOTES: The origin countries of banks are identified using the data from Claessens and Van Horen (2015). All foreign bank branches that operated during the sample period(March 2004 - February 2018) are included.

Table 2: Summary statistics

		All sample	L group	B group
n		55	14	13
total assets	mean	6.20	5.34	8.61
	median	3.98	2.53	7.69
	st.dev.	6.97	5.96	7.01
net-due-to	mean	1.21	1.87	1.15
	median	0.50	0.62	0.74
	st.dev.	1.77	2.49	1.31
net-due-from	mean	0.14	0.24	0.17
	median	0.00	0.01	0.00
	st.dev.	0.59	0.97	0.48
loan	mean	0.16	0.35	0.03
	median	0.02	0.08	0.00
	st.dev.	0.35	0.55	0.07
FX loan	mean	0.28	0.57	0.16
	median	0.06	0.29	0.02
	st.dev.	0.52	0.78	0.25
public bond	mean	1.08	0.19	2.00
	median	0.27	0.01	1.52
	st.dev.	1.72	0.46	1.72
Capital A	mean	0.13	0.15	0.17
	median	0.07	0.08	0.17
	st.dev.	0.16	0.19	0.14
Capital B	mean	0.28	0.45	0.24
	median	0.07	0.07	0.13
	st.dev.	0.56	0.89	0.33
derivatives/assets	mean	3.49	0.64	6.34
	median	2.16	0.27	6.51
	st.dev.	3.75	0.95	3.60

NOTES: Data are from the FAIRS and cover from March 2004 to February 2018. The figures are in trillion Korean won. The 14 banks in L group have an above-median loan-to-asset ratio and below-median bond-to-asset ratio. The 13 banks in B group have an above-median bond-to-asset ratio and below-median loan-to-asset ratio. Public bonds include treasury bonds and central bank bonds. The derivatives are currency related only.

Table 3: Security holdings by maturity

	Trading security	Avaiable for sale	Held to maturity	Sum
All	0.842	0.550	0.110	1.502
(n=55)	(56.1%)	(36.6%)	(7.3%)	(100.0%)
L group	0.001	0.725	0.340	1.066
(n=14)	(0.1%)	(68.0%)	(31.9%)	(100.0%)
B group	1.756	0.279	0.012	2.047
(n=13)	(85.8%)	(13.6%)	(0.6%)	(100.0%)

NOTES: Data are from FAIRS. The unit is trillion won in 2015 prices. The figures are the averages over the banks and the sample period.

Table 4: Effects of origin country monetary policy

	(1)	(2)	(3)	(4)
Group	All	All	L group	B group
HQ MP rate	-2.43*	-1.54**	-7.55*	1.24
	(0.076)	(0.023)	(0.099)	(0.562)
HQ MP rate × Crisis	5.41**	4.55***	13.43*	-1.06
	(0.011)	(0.001)	(0.071)	(0.736)
Crisis	-0.793	-0.587		-1.245
	(0.216)	(0.344)		(0.283)
Lags of Y	-0.17***	-0.17***	0.04	-0.29**
	(0.003)	(0.003)	(0.370)	(0.011)
Observations	5,631	5,631	1,675	1,796
Number of banks	53	53	14	13
R^2	0.078	0.078	0.188	0.202
Bank F.E.	yes	yes	yes	yes
Monthly F.E.	yes	yes	yes	yes
Shadow rate	no	yes	no	no

NOTES: The sample period is from March 2004 to February 2018. The dependent variable is the change in net net-due-to relative to assets at the beginning of the period. The top and bottom 0.5% are trimmed. Variables are in 2015 Korean won. The reported coefficients are the sum of all coefficients of each respective variable and its lags. Reported in brackets are the p-values from the test of the null hypothesis that the sum of the corresponding coefficients is zero. The growth in the home country industrial production index, capital ratio and log asset size are included as covariates, but their coefficients are not reported. Regressions are weighted by bank asset size. Standard errors are clustered at the bank level. ***, **, and * indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 5: Effects of host country policy

	(1)	(2)	(3)	(4)
Group	All	All	L group	B group
HQ MP rate	-1.82	-1.01	-7.18*	1.82
	(0.106)	(0.116)	(0.057)	(0.321)
HQ MP rate × Crisis	4.99***	3.76***	13.86**	-0.51
	(0.006)	(0.002)	(0.036)	(0.882)
KR MP rate	4.82***	4.62***	4.66*	3.36
	(0.005)	(0.008)	(0.060)	(0.394)
KR MP rate × Crisis	-4.86**	-4.53**	0.17	-3.45
	(0.015)	(0.018)	(0.970)	(0.484)
Crisis	0.69**	0.78***	2.18*	0.327
	(0.014)	(0.009)	(0.070)	(0.405)
Macropru	0.74	0.74	-2.65**	-0.92
	(0.531)	(0.531)	(0.043)	(0.684)
Swap Rate	-3.77***	-3.60**	-7.97**	-3.83**
	(0.007)	(0.011)	(0.045)	(0.046)
Lags of Y	-0.16***	-0.16***	0.03	-0.29**
	(0.003)	(0.003)	(0.551)	(0.016)
Observations	5,631	5,631	1,675	1,796
Number of banks	53	53	14	13
R^2	0.029	0.029	0.074	0.072
Bank F.E.	yes	yes	yes	yes
Shadow rate	no	yes	no	no

NOTES: The sample period is from March 2004 to February 2018. The dependent variable is the change in net net-due-to relative to assets at the beginning of the period. The top and bottom 0.5% are trimmed. Variables are in 2015 Korean won. The reported coefficients are the sum of all coefficients of each respective variable and its lags. Reported in brackets are the p-values from the test of the null hypothesis that the sum of the corresponding coefficients is zero. The growth rate in industrial production index of home and host countries, capital ratio and log asset size are included as covariates, but their coefficients are not reported. Regressions are weighted by bank asset size. Standard errors are clustered at the bank level. ***, **, and * indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 6: F-test for interest rate differential restriction

	(1)	(2)	(3)	(4)
Group	All	All	L group	B group
H_0: HQMP+KRMP=0	0.142	0.048	0.417	0.181

NOTES: The figures show the p-values from the test of the null hypothesis that the coefficients for headquarter monetary policy rate and Korean policy rate sum up to zero in the regression of the table 5.

Table 7: Interest rate differentials

	(1)	(2)	(3)	(4)
Group	All	All	L group	B group
Interest Rate Differential	2.66***	1.56**	5.59**	0.01
	(0.006)	(0.014)	(0.028)	(0.995)
Interest Rate Differential × crisis	-4.01***	-3.24***	-4.41	0.15
	(0.003)	(0.001)	(0.324)	(0.962)
Crisis	0.283	0.37*	0.357	0.191
	(0.189)	(0.092)	(0.632)	(0.643)
Macropru	0.34	0.15	-2.43*	-1.51
	(0.777)	(0.902)	(0.077)	(0.516)
Swap Rate	-3.82***	-3.96***	-7.78**	-4.37*
	(0.006)	(0.005)	(0.020)	(0.060)
Lags of ΔY	-0.16***	-0.16***	0.03	-0.29**
	(0.003)	(0.003)	(0.582)	(0.017)
Observations	5,631	5,631	1,675	1,796
Number of banks	53	53	14	13
R^2	0.028	0.027	0.060	0.069
Bank F.E.	yes	yes	yes	yes
Shadow rate	no	yes	no	no

NOTES: The sample period is from March 2004 to February 2018. The dependent variable is the change in net net-due-to relative to assets at the beginning of the period. The top and bottom 0.5% are trimmed. Variables are in 2015 Korean won. The reported coefficients are the sum of all coefficients of each respective variable and its lags. Reported in brackets are the p-values from the test of the null hypothesis that the sum of the corresponding coefficients is zero. The growth rate in industrial production index of home and host countries, capital ratio and log asset size are included as covariates, but their coefficients are not reported. Regressions are weighted by bank asset size. Standard errors are clustered at the bank level. ***, **, and * indicate statistical significance at the 10%, 5% and 1% level, respectively.

Table 8: Macroprudential policy and capital B

	(1)	(2)	(3)	(4)	(5)
Group	All	All	L group	B group	All
Macropru	-5.80**	-5.86**	2.20	-8.59**	
	(0.047)	(0.041)	(0.758)	(0.015)	
Macropru×BondRatio					-0.40**
					(0.043)
Interest Rate Differential	3.85	2.50	0.39	0.72	
	(0.372)	(0.205)	(0.974)	(0.934)	
HQMP					2.57
					(0.523)
HQMP×BondRatio					0.20
					(0.145)
Swap Rate	-0.92	-1.86	-1.68	-2.85	
	(0.912)	(0.811)	(0.881)	(0.855)	
Lagged Capital B	-0.02	-0.01	0.00	0.00	-0.03
	(0.795)	(0.842)	(0.964)	(0.993)	(0.653)
Observations	2,414	2,414	825	773	2,287
Number of banks	36	36	12	12	32
R^2	0.016	0.017	0.036	0.028	0.076
Bank F.E.	yes	yes	yes	yes	yes
Monthly F.E.	no	no	no	no	yes
Shadow rate	no	yes	no	no	no

NOTES: The sample period is from September 2009 to February 2018. The dependent variable is the change in net net-due-to relative to assets at the beginning of the period. The top and bottom 2% are winsorized. Variables are in 2015 Korean won. The reported coefficients are the sum of all coefficients of each respective variable and its lags. Reported in brackets are the p-values from the test of the null hypothesis that the sum of the corresponding coefficients is zero. BondRatio is the average public-bond-to-asset ratio of 2009, and it is demeaned. The interactions of banking crises dummy $Crisis_{b,m}$ with Macropru×BondRatio and HQMP×BondRatio are included. All the necessary auxiliary terms are also included, but their coefficients are not reported. The growth in industrial production index of home countries, capital ratio and log asset size are included as covariates, but their coefficients are not reported. Regressions are weighted by bank asset size. Standard errors are clustered at the bank level. ***, **, and * indicate statistical significance at the 10%, 5% and 1% level, respectively.