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ASSESSING MACROPRUDENTIAL POLICIES: CASE OF KOREA

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One of the authors (Shin) was involved in the design of the macroprudential policy tools introduced in Korea in 2010, and hence is not a disinterested party in the findings reported in this paper. We are grateful to Maurice Obstfeld and two referees for the symposium issue on capital flows of the Scandinavian Journal of Economics for their comments and guidance on an earlier draft. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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ABSTRACT

This paper develops methods for assessing the sensitivity of capital flows to global financial conditions, and applies the methods in assessing the impact of macroprudential policies introduced by Korea in 2010. Relative to a comparison group of countries, we find that the sensitivity of capital flows into Korea to global conditions decreased in the period following the introduction of macroprudential policies.

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1 Introduction

Beginning in June 2010, Korea introduced a series of macroprudential measures aimed at building resilience against external financial shocks, especially against its well-known vulnerability to capital flow reversals in the banking sector and the associated disruptions to domestic financial conditions. Korea was one of the countries hardest hit in the 1997 Asian financial crisis, and was again at the sharp end of the financial turmoil unleashed after the failure of Lehman Brothers in September 2008. In recognition of the sources of Korea's vulnerabilities (on which more below), the macroprudential measures introduced from 2010 were aimed at moderating the procyclicality of the banking sector by dampening the fluctuations in the growth of so-called "non-core" bank liabilities, especially cross-border banking sector liabilities.

The purpose of our paper is to give a preliminary empirical assessment of the impact of the measures introduced by the Korean authorities, and to revisit the rationale behind their design so as to refine the thinking behind capital flows and financial stability. In this respect, the case of Korea represents a natural experiment for investigating the impact of new macroprudential policies. Our assessment is based on the framework developed in our earlier paper on global liquidity (Bruno and Shin (2011)) where global financial conditions drive banking sector capital flows through the funding and lending operations of international banks. Our empirical proxies for global financial conditions draw on the institutional structure of cross-border banking and the status of the US dollar as the currency that underpins the global banking system, as explained below.

Our assessment of the performance of Korea's macroprudential tools is based on a panel study where Korea is one of 48 countries in a sample that encompasses both advanced and emerging economies. Our approach is to treat the countries other than Korea as a comparison group and ask, first, how Korea's susceptibility to the global factors in capital flows compares to the other countries during the entire sample period. Then, having obtained a benchmark for comparison from this cross-country panel study, we ask whether the empirical relationship between Korea and the comparison group changed in any noticeable way following the sequenced introduction

of macroprudential measures in Korea from June 2010. We exploit the panel structure by reviewing the evidence both across time and in the cross-section, as well as examining the full complement of interaction dummies to test for structural changes.

To anticipate our main conclusion, we do indeed find evidence that capital flows into Korea became less sensitive to global factors after the introduction of its macroprudential measures. Interestingly, this change in Korea's sensitivity to global conditions is in contrast to the other countries in the region. We find that Korea's experience is the opposite of other comparable countries in Asia, whose sensitivity to global liquidity conditions actually *increased* after June 2010. Specifically, when we examine the same set of regressions applied one by one to the "Big Five" ASEAN countries (Indonesia, Malaysia, Philippines, Thailand and Vietnam) as well as to Australia, we find that their incremental sensitivity to global liquidity conditions was higher after June 2010. Thus, Korea's lower sensitivity to global liquidity conditions after June 2010 stands out in contrast.

More broadly, we see the contribution of our paper as offering a simple but useful methodology for examining the impact of macroprudential policies by identifying variables that are known proxies for global liquidity, and then investigating how the sensitivity of a particular aggregate to global conditions varies over time, before and after the introduction of the new policies.

Although our empirical methodology cannot fully control for other events in the capital-recipient economy that occur at the same time as the introduction of the new policy regime, the use of country fixed effects and country-level control variables account for country-specific shocks. Our method is a useful first step when searching for instances that deserve more careful scrutiny through micro empirical investigations.

The outline of the paper is as follows. We begin by describing the background to our study by outlining the rationale for why the "non-core" liabilities of the banking sector are a good proxy for the underlying financial conditions and the vulnerability to a reversal. We further explain how, in the context of cross-border banking, capital flows through the banking sector are closely related to the fluctuations in non-core liabilities. We then describe the institutional background for Korea and outline the timing and sequencing of the macroprudential measures

introduced in Korea. The core empirical investigation of the paper then follows in two sections. We conclude by drawing implications for the relationship between capital flows and financial stability.

2 Background

2.1 Global Banking System

Banking activity is a key driver of financial conditions both within and across borders. Rapid growth of bank lending is mirrored on the liabilities side of the balance sheet by shifts in the composition of bank funding. As banks are intermediaries who borrow in order to lend, they must seek funding in order to lend to their borrowers. In an economy with domestic savers, the primary source of funding available to the bank is the retail deposits of the household sector - the "core" funding. During a credit boom, however, the bank resorts to alternative, non-core liabilities to finance its lending when its access to core deposit funding does not keep pace with the growth of its lending.[1] Cross-border bank financing where banks draw on wholesale funding supplied by the global banks is likely to be an important component of non-core funding when the financial system has an open banking sector as in Korea. Given the close connection between procyclicality and capital flows, there are close parallels between *currency crises* and *credit crises* in countries that operate with open banking sectors. Hahm, Shin and Shin (2011) find in their panel probit study of financial crisis indicators that the ratio of non-core to core funding (especially the non-core liabilities to foreign creditors) is the most consistently reliable indicator of vulnerability of a country, both to a currency crisis and to a credit crisis.

Elsewhere (Bruno and Shin (2011)), we have explored the role of global "supply push" factors as key determinants of cross-border bank capital flows. In particular, variables that determine the risk-taking behavior of global banks through their leverage decision turn out to be useful in explaining the "supply push" forces in cross-border capital flows. Here, we build on these earlier findings by examining how macroprudential policies may mitigate such global supply

[1] The distinction between core and non-core funding is discussed in more detail in Shin and Shin (2010).

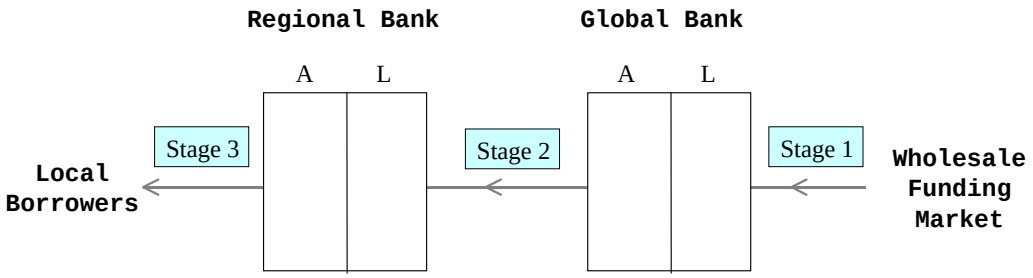

Figure 1. Three stages of cross-border banking sector flows.

push forces by moderating the procyclicality of the banking sector.

As a background to our study, we reiterate briefly the institutional backdrop that motivates our approach to cross-border banking as well as provide some additional institutional background for Korea.[2] Our empirical investigation rests on the interaction between local and global banks depicted in Figure 1. The direction of financial flows goes from right to left, to stick to the convention of having assets on the left hand side of the balance sheet and liabilities on the right hand side. In stage 1 in Figure 1, global banks raise wholesale funding and supply wholesale funding to local banks in other jurisdictions. The local banks draw on the cross-border funding (stage 2) in order to lend to their local borrowers (stage 3). Stage 1 corresponds to the activity of global banks borrowing in financial centers.

A BIS (2010) study describes how the branches and subsidiaries of foreign banks in the United States borrow from money market funds and then channel the funds to their headquarters. Baba, McCauley and Ramaswamy (2009), McGuire and von Peter (2009), IMF (2011) and Shin (2012b) note that in the run-up to the crisis, roughly 50% of the assets of U.S. prime money market funds were obligations of European banks. The funds channeled by the branch to headquarters (interoffice assets) constitute gross capital outflows from the United States.

Figure 5 plots the assets and liabilities of foreign banks in the United States (left panel) and their net interoffice assets (right panel). Net interoffice assets measure the net claim of the

[2]Readers interested in further details may consult Bruno and Shin (2011) and Shin and Shin (2010) for the background on the global banking system and for Korea's experience, respectively.

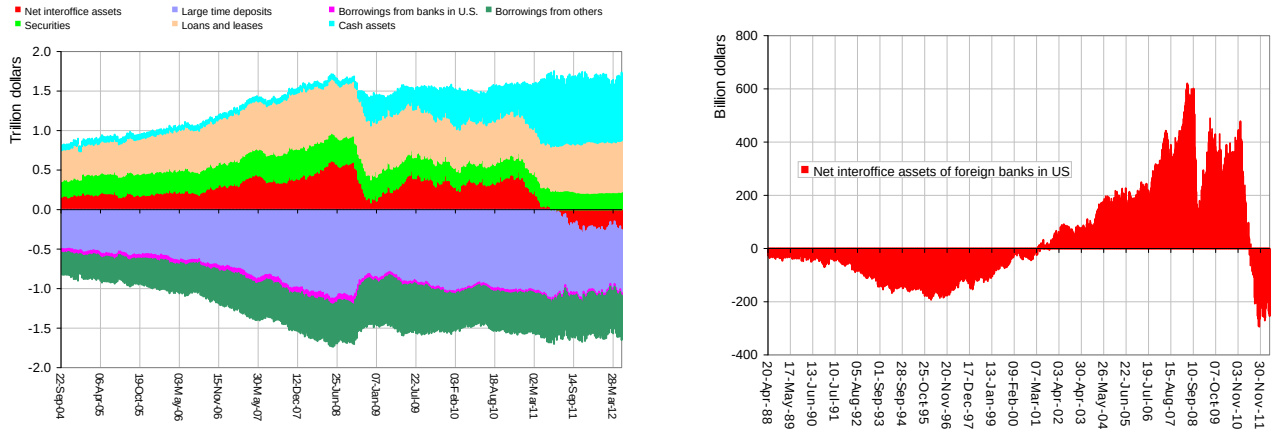

Figure 2. The left hand chart shows the assets and liabilities of foreign bank branches and subsidiaries ("foreign-related institutions") in the US on their parent. The right hand chart shows the net interoffice assets of foreign banks in the US, given by the negative of the "net due to foreign-related offices". (Source: Federal Reserve H8 series)

branch or subsidiary of the foreign bank on its parent. Normally, net interoffice assets would be negative, as foreign bank branches act as lending outposts. However, we see that the decade between 2001 to 2011 was exceptional, when net interoffice assets turned sharply positive, before reversing into negative territory during the height of the European crisis in 2011. In effect, during the decade between 2001 and 2011, foreign bank offices became *funding sources* for the parent, rather than lending outposts. As noted by the BIS (2010) report, many European banks use a centralized funding model in which available funds are deployed globally through a centralized portfolio allocation decision. Cetorelli and Goldberg (2009, 2010) provide extensive evidence using bank level data that internal capital markets serve to reallocate funding within global banking organizations.

The net interoffice position of foreign banks in the US therefore reflects the extent to which global banks were engaged in supplying US dollar funding to other parts of the world. In our empirical investigation below, we will use the growth of the net interoffice account position of foreign banks in the US as a key empirical proxy for the availability of wholesale funding provided to borrowers in the capital-recipient economy - a key "supply push" factor.

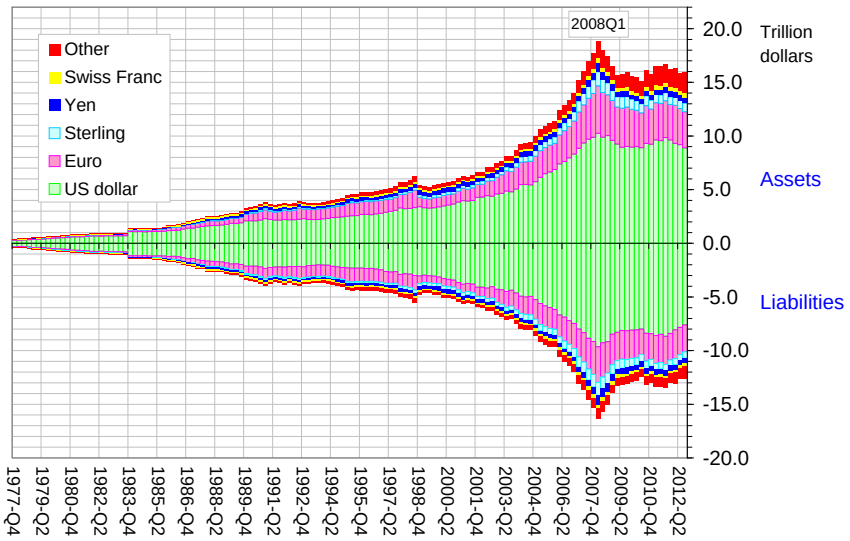

Figure 3. Foreign currency assets and liabilities of BIS reporting banks, classified according to currency (Source: BIS Locational Banking Statistics Table 5A)

The reason for our focus on US dollar-denominated bank flows stems from the dominant role played by the US dollar in the global banking system. Figure 3 plots the foreign currency assets and liabilities of banks globally, as measured by the BIS locational banking statistics. Locational data are organized according to the residence principle, and so the US dollar series in Figure 3 show the US dollar-denominated assets and liabilities of banks outside the United States. The Euro series show the corresponding Euro-denominated assets and liabilities of banks that are outside the Euro area, and so on.

What is clear from Figure 3 is that the US dollar is the dominant currency for international banking, and has been the currency behind the growth of gross capital flows highlighted by Borio and Disyatat (2011) and Obstfeld (2012). The US dollar asset series exceeded 10 trillion dollars in 2008Q1, briefly exceeding the total assets of the US chartered commercial bank sector (see Shin (2012b)). The role of the other currencies are much smaller in comparison. For this reason, we may expect the net interoffice assets of foreign banks in the United States to be a

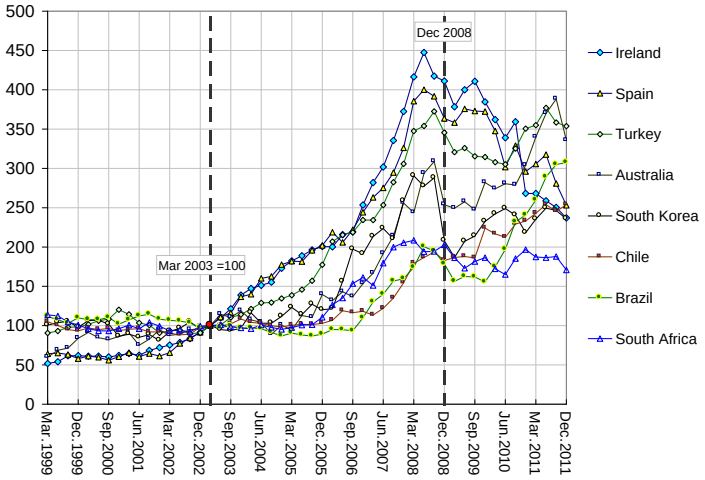

Figure 4. External claims (loans and deposits) of BIS reporting country banks on borrowers in countries listed. The series are normalized to 100 in March 2003 (Source: BIS Locational Banking Statistics, Table 7A)

key indicator of the availability of US dollar funding for cross-border transactions, and we pay special attention to this variable in our empirical investigation.

Stage 2 in Figure 1 corresponds to the cross-border capital flows through the banking sector. The empirical counterpart of Stage 2 in Figure 1 in our paper will be the cross-border claims of the banks in countries that report loan amounts to the Bank for International Settlements (BIS). Figure 4 plots the cross-border claims of BIS-reporting banks on counterparties listed in the countries on the right. The series have been normalized to equal 100 in March 2003. Although the borrowers have wide geographical spread, we see a synchronized boom in cross-border lending before the recent financial crisis.

The observed capital flows reflect the interaction of the supply and demand for wholesale funding between global and local banks. When local and global banks interact in the market for wholesale bank funding, the liabilities of local banks serve as the assets of the global banks, and the lending by global banks is the supply of wholesale funding, while the borrowing by local banks is its demand. The distinction between the demand and supply of wholesale funding harks back to Calvo, Leiderman and Reinhart (1996), who distinguished the "push" and "pull"

factors that drive capital flows into emerging economies. Nevertheless, to the extent that global "supply push" factors are important determinants of capital flows that affect all capital recipient countries, macroprudential policies that mitigate the procyclical response of an economy to such factors may have stabilization benefits. The fact that global factors affect all countries also allows us to exploit the panel structure of the data and examine how the sensitivity of capital flows into a particular country varies before and after the introduction of new policies by treating the other countries in the sample as a comparison group.

In our empirical investigation, we make use of two global factors. The first is the growth of the net interoffice assets of foreign banks in the United States (the series shown in the right hand panel of Figure 5), reflecting the activities of international banks that engage in the supply of wholesale bank funding. A rapid increase in the net interoffice assets series reflects an expansion of cross-border banking activities of global banks. We will see that the run-up in cross-border lending in Figure 4 closely mirrors the increase in wholesale funding raised by the global banks in Figure 5 In effect, Figure 5 reflects the liabilities side of global banks' balance sheets (Stage 1 in Figure 1), while Figure 4 traces the movements on the asset side of global banks' balance sheets (Stage 2 in Figure 1).

The second set of global factors we employ in our empirical investigation are those associated with the VIX index of implied volatility of equity index options in the United States. There is well-documented evidence that banking sector leverage is closely associated with fluctuations in the VIX index (see, for instance, Adrian and Shin (2010, 2012)). Leverage of the banking sector - both global and local - are important determinants of cross-border claims. When leverage is high, an additional unit of bank capital will translate into a higher level of cross-border claims. In addition, any *increase* in bank leverage will mean that existing bank capital will support higher amounts of lending. Therefore, since VIX is correlated with bank leverage, the theory predicts that both the *level* of the VIX, as well as the *change* in the VIX will show up as being determinants as capital flows (see Bruno and Shin (2011)).

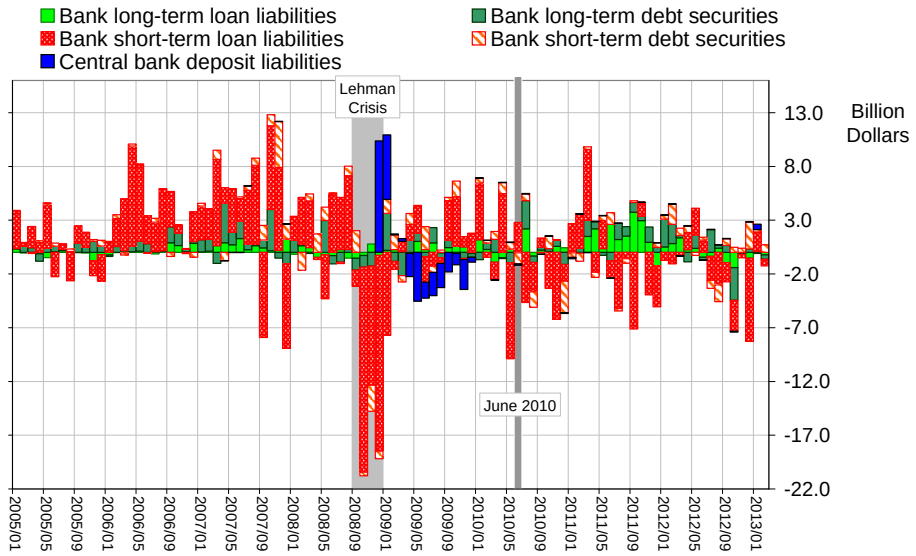

Figure 5. Capital flows to the Korean banking sector, Jan 2005 - Feb 2013 (monthly) (Source: Bank of Korea)

2.2 Case of Korea

The procyclicality of the banking sector and its use of cross-border funding is a useful lens through which to view Korea's experience. Korea was one of the countries hardest hit during the 1997 Asian financial crisis, and its experience leading up to the 2008 financial crisis is revealing in several respects. From 2005 to 2007, locally-owned Korean banks and the foreign bank branches in Korea saw rapid increases in short-term foreign currency liabilities, which then subsequently reversed abruptly after the bankruptcy of Lehman Brothers in September 2008. The severity of the 2008 crisis for Korea can be attributed largely to the rapid deleveraging that took place by the banking sector (both domestic and foreign) with the onset of the 2008 financial crisis. Figure 5 plots the capital flows to the Korean banking sector from the Bank of Korea's monthly balance of payments statistics.

We see that the Korean banking sector saw rapid inflows in the form of short-term loan liabilities which turned into substantial outflows once the crisis hit in September 2008, associated

with the kind of deleveraging of the banking sector that has become the hallmark of the global financial crisis in 2008. Deleveraging sets off amplifying effects through price changes, where the depreciation of the Korea won against the US dollar increases the size of external liabilities relative to domestic currency assets. In addition, the creditor banks in global capital markets are similarly shrinking their lending in response to heightened measures of risk. The feedback loop generated by such reactions to price changes can lead to amplification of shocks.[3] In the three months following the Lehman bankruptcy, the outflow of short-term liabilities from the banking sector was in excess of 50 billion dollars and largely accounts for the net decrease in Korea's foreign exchange reserves from over 240 billion dollars before the Lehman crisis to 200 billion at the end of 2008. We also see in Figure 5 the operations of the Bank of Korea, which entered into a 30 billion dollar swap agreement with the Federal Reserve in October, which was subsequently unwound following the acute stage of the crisis.

During the period of rapid capital inflows, the banking sector in Korea (including the foreign bank branches) also held dollar assets, but the counterparties were local borrowers, such as exporting companies who held long-term dollar assets arising from their export receivables. Although the overall currency mismatch on the consolidated balance sheet consisting of the corporate and banking sectors would then cancel out, a maturity mismatch between long-term dollar claims and short-term dollar liabilities took its place. In effect, the currency mismatch was replaced by a maturity mismatch which left the Korean financial system vulnerable to the global financial crisis in 2008 that followed in the wake of the bankruptcy of Lehman Brothers. Chung, Park and Shin (2012) give more detailed discussion of the role of hedging by exporting companies as a contributory factor in the rapid growth of short-term foreign currency bank liabilities.

These lessons led to a concerted policy initiative on the part of Korean policy makers to mitigate some of the known vulnerabilities. The IMF Background Paper on macroprudential

[3] Theoretical developments of such feedback effects through prices and heightened risks can be found in Xiong (2001), Brunnermeier and Pedersen (2009), Danielsson, Shin and Zigrand (2011) and Brunnermeier and Sannikov (2011).

policies (IMF (2012)) provides information on the timing and rationale of the macroprudential policies in Korea. Beginning in June 2010, the authorities in Korea introduced a sequence of macroprudential measures aimed at building resilience against its well-known vulnerability to capital flow reversals in the banking sector and the associated disruptions to domestic financial conditions. The policy initiative was widely reported in both the domestic and international press at the time, and the press reports are useful in dating the sequence of events.[4]

The first policy measure announced by the Korean authorities (in June 2010) was a leverage cap on the notional value of foreign exchange derivatives contracts (encompassing currency swaps and forwards) that banks could maintain (see IMF (2012, p. 50)). For foreign bank branches, the leverage cap was set at 2.5 times their capital, while for domestic Korean banks, the cap was set at 50% of their capital. Foreign banks could in principle increase their positions by allocating greater capital to their branches in Korea, but the leverage cap lowers the return to capital for banks engaged in this segment of their business, thereby serving as a disincentive on expansion of derivatives positions.

The second component was the levy on the non-core liabilities of the banks (the "macroprudential levy"), applied to the foreign exchange-denominated liabilities of the banking sector. The Korean non-core liabilities levy was relatively unfamiliar compared to the standard bank capital-related tools or standard capital control tools such as the unremunerated reserve requirements (URR). For this reason, the roll-out took more time. Although the policy was discussed from February of 2010 (Shin (2010)) and press coverage trailed the introduction of the non-core levy from early in 2010,[5] the measure was announced formally in December 2010, after the conclusion of the G20 Seoul summit in November. The legislation was passed in April of 2011, and the levy began its operation in August 2011 (see IMF (2012)).

The levy consists of an annualized 20 basis point charge on the wholesale foreign exchange denominated liabilities of the banks of maturity up to 12 months. Lower rates are applied in a

[4]See, for instance, the June 2010 article in the Economist magazine, "The won that got away: a surgical strike in a volatile market" http://www.economist.com/node/16381310

[5]See Wall Street Journal, April 22, 2010:
http://blogs.wsj.com/economics/2010/04/22/is-obamas-bank-tax-plan-right-for-emerging-markets/

graduated manner to maturities of over one year.

The levy was designed so that the proceeds of the levy are paid into a special segregated account of the foreign exchange reserves, rather than going into the general revenue of the government. In this respect, the Korean levy was designed from the outset as a financial stability tool, rather than as a fiscal measure. The outwardly similar bank levies introduced by France and the UK in 2010 had the proceeds being paid into general government revenue, and were designed as fiscal measures to supplement government revenue. By targeting non-core liabilities only, the levy was also designed to address the procyclicality of the banking sector while leaving unaffected (as far as possible) the intermediation of core funding from savers to borrowers.

Figure 5 indicates the date of the introduction of the macroprudential policies by the dark grey bar at June 2010. We see some evidence from the chart that short-term bank liabilities continued to shrink, and was replaced with long-term liabilities, both in the form of long-term securities and long-term loans. However, just examining the series for Korea in isolation does not control for external conditions and other factors that affect the banking landscape more broadly. For a proper assessment of the policies, we need to examine Korea's experience in comparison with other countries. This is our task in the rest of the paper.

For the purpose of our empirical investigation, the exact dating of the impact of the non-core liabilities levy is complicated by the long gestation period between initial discussions of its adoption and its final implementation. Some anticipation of the new measure will have affected behavior before the formal introduction of the levy, but the quantification of the anticipation effect is difficult, and is not attempted here. The announcement of the cap of foreign exchange derivatives in June 2010 serves as a useful threshold point, but we will conduct a number of tests to enable us to identify the break point in the time series.

The Korean measures should be seen in the context of the broader debate on macroprudential policies. Galati and Moessner (2012) survey the recent literature, and Claessens and Ghosh (2012) discuss evidence on the effectiveness of macroprudential policies for moderating credit growth in emerging economies. As a policy tool, the Korean non-core liabilities measure is

distinctive in the way that it acts directly on cost of bank liabilities, unlike bank capital-related tools or direct restraints on credit growth, such as loan-to-value (LTV) or debt service-to-income (DTI) caps. Shin (2012a, section 4) discusses the advantages of such an approach and the broader tradeoffs involved in alternative macroprudential policies. We do not pursue the policy design implications here, but our empirical results may be useful in more detailed and comprehensive studies of the tradeoffs involved in macroprudential policy design.

3 Empirical Findings

3.1 Data Description

In conducting our assessment of the impact of Korea's macroprudential policies, our sample of countries includes all the developed countries, the "Big Five" countries in ASEAN (so as to provide the basis for a regional comparison for Korea) and a selection of emerging economies. The selection of developing countries is based on the Claessens, van Horen, Gurcanlar and Mercado (2008) database on foreign banks. We select countries where foreign banks play an economically significant role in the country's financial system but we exclude offshore financial centers.

The full list of countries included in our sample are Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Cyprus, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Indonesia, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Malaysia, Malta, Mexico, Netherlands, Norway, Philippines, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, Uruguay and Vietnam. Table 1 gives the main summary statistics of our sample of 48 countries.

Our measure of capital flows is the quarterly growth in external claims of BIS reporting country banks, as given by the BIS locational statistics (Table 7A). As explained above, the growth in the interoffice assets of foreign banks in the United States (from the Federal Reserve, series H8 on commercial banks) and the VIX (the CBOE index of implied volatility in S&P

Table 1. **Summary Statistics.** This table summarizes our key variables in terms of their, mean, standard deviation, minimum and maximum.

	Obs	Mean	Std. Dev	Min	Max
ΔInteroffice	65	0.072365	0.347339	-0.67924	0.785736
VIX	65	3.040451	0.346168	2.432736	3.787366
ΔVIX	65	0.003285	0.297389	-0.60753	0.955698
ΔRER	2812	-0.00261	0.062672	-0.25199	1.03038
ΔMoney stock	65	0.0137911	0.0294825	-0.047228	0.0863669
GDP Growth	691	0.075439	0.068993	-0.20757	0.415204
ΔDebt to GDP	691	-0.0016	0.100881	-0.17825	0.220988
BIS Loans growth	2812	0.025885	0.095853	-0.25857	0.340927

500 stock index option prices) are the two proxies reflecting the cross-border activities and the leverage of global banks. In addition to the VIX in log level, we also include the quarterly log difference of the VIX (denoted by ΔVIX). The VIX level is a proxy for the leverage of the global banks, and hence the rate at which each unit of new equity is translated into lending. On the other hand, ΔVIX is the proxy for the *change* in leverage, and hence the rate at which lending grows based on the existing level of equity (see Bruno and Shin (2011) for details).

We also include several control variables - both global and local - as possible determinants of capital flows. We include the log real exchange rate (RER), where RER is computed as the log of nominal exchange rate*(US CPI/local CPI). The nominal exchange rate is in units of national currency per U.S. Dollar (from the IMF's IFS database). The quarterly growth in the global money supply (ΔMoney stock) is calculated as the quarterly log difference of the sum of the M2 stock in the US, Eurozone and Japan and M4 in the UK (from the IFS). GDP growth is the country percentage change in GDP from the previous year (from the WEO). ΔDebt to GDP is the change in government gross debt to GDP (from WEO). All quarter variables (with the exception of ΔVIX) are lagged by one quarter to mitigate endogeneity issues. The sample period spans from the first quarter of 1996 (the first date covered in Table 7A of the BIS locational data) to the latest data at the time of writing, which is the first quarter of 2012.

3.2 Empirical Specification

Our empirical investigation is based on various modifications of the following benchmark panel regressions similar to Bruno and Shin (2011):

$$\begin{aligned} \Delta L_{c,t} &= \alpha + \beta_1 \cdot \Delta\text{Interoffice}_{t-1} + \gamma_1 \text{VIX}_{t-1} \\ &\quad + \delta_1 \Delta\text{VIX}_t + \text{ controls} + e_{c,t} \end{aligned} \tag{1}$$

Here, $\Delta L_{c,t}$ is banking sector capital inflow into country c in period t, as given by the quarterly log difference in the external claims of BIS reporting country banks on country c between quarters t and $t-1$; VIX_{t-1} is the log of end-quarter VIX index lagged by one quarter; $\Delta\text{Interoffice}_{t-1}$ is the growth in interoffice assets of foreign banks in the US from the quarter before given by the percentage growth and lagged by one quarter. The control set includes all the variables listed in Section 3.1. Regressions include country fixed effects, year dummies and clustered standard errors at the country level. Year dummies still leave scope for quarterly variations in our global variables, and they turn out to be highly significant, as seen below.

Our empirical approach is to include in the benchmark panel specification a dummy variable equal to 1 (0 otherwise) for the period from June 2010 ("Post 2010") and a dummy variable equal to 1 (0 otherwise) for Korea ("Korea"). We then interact each dummy variable with each global factors. Our focus is on the triple interaction terms given by

$$\text{Global factor} \times \text{Korea} \times \text{Post 2010} \tag{2}$$

which give the incremental sensitivity of capital flows to Korea to the global factor from June 2010. In addition, we also examine the coefficients of the pairwise interaction terms:

$$\text{Global factor} \times \text{Korea}, \qquad \text{Global factor} \times \text{Post 2010} \tag{3}$$

By comparing the coefficients between the triple interaction term (2) and the two double interaction terms (3), we can ascertain whether the change in sensitivity to the global factor in Korea after 2010 is due to a shift over time, or whether the change in sensitivity is Korea-specific. We also construct similar interaction terms and regressions for all the other variables included in the benchmark estimation.

4 Empirical Findings

4.1 Sensitivity to Global Financial Activities

Table 2 presents our first set of panel regressions. The structure of the interactions can be usefully summarized in the following 2×2 matrix for the case of the ΔInteroffice variable, which gives the total effects resulting from the impact of the ΔInteroffice variable for Korea and non-Korean countries for the periods before and after June 2010.

	Pre 2010	Post 2010
Korea	$\beta_1 + \beta_3$	$\beta_1 + \beta_2 + \beta_3 + \beta_4$
Others	β_1	$\beta_1 + \beta_2$

(4)

The coefficient β_1 in Table 2 measures the impact of ΔInteroffice before June 2010 on capital flows for all countries, except Korea, while β_2 measures the incremental impact of ΔInteroffice after June 2010. The coefficient β_3 measures the incremental impact of ΔInteroffice on Korea before June 2010 , while $\beta_3 + \beta_4$ is for the period after June 2010. There is an analogous set of interactions terms associated with the other two global factors - VIX (γ coefficients) and ΔVIX (δ coefficients). In Table 2, column (3) gives the β_i estimates for the interaction terms with the ΔInteroffice variable, and column (5) gives the γ and δ coefficients for the interaction terms involving the VIX and ΔVIX global factors.

Column (1) reports results from the benchmark regression (1). The VIX index in levels and log differences as well as the ΔInteroffice variables are highly significant and of the predicted sign as also shown in Bruno and Shin (2011). The significance of ΔInteroffice indicates that the activities of global banks (mainly European banks, as shown in Shin (2012b)) are correlated with the capital inflows into our sample of countries. In this context, fluctuations in the VIX index (both in the level as well as its quarterly log difference) are associated with shifts in the leverage of the banking sector and hence the capital flows through the banking sector.

Table 2. **Panel regressions on capital flows.** This table presents panel regressions for bank capital flows to 48 countries. The dependent variable is bank capital flows measured by the quarterly log difference of external loans (BIS Table 7A). Explanatory variables include the growth in interoffice assets, the VIX and the change in the VIX and their interactions with a time dummy for the period from June 2010 and a dummy for Korea. See text for explanation of methodology. Standard errors are clustered at the country level and are reported in parantheses. Data are for 1996Q1-2012Q1.

Coeff.		1	2	3	4	5
β_1	ΔInteroffice	0.0152***	0.0148***	0.0103*	0.0151***	0.0130**
		[0.0053]	[0.0054]	[0.0053]	[0.0053]	[0.0053]
β_2	ΔInteroffice*Post 2010			0.0569**		
				[0.0222]		
β_3	ΔInteroffice*Korea		0.0164***	0.0360***		
			[0.0048]	[0.0053]		
β_4	Δinteroffice*Korea*Post 2010			-0.1160***		
				[0.0160]		
γ_1	VIX	-0.0502***	-0.0503***	-0.0451***	-0.0490***	-0.0607***
		[0.0088]	[0.0088]	[0.0089]	[0.0088]	[0.0098]
γ_2	VIX*Post 2010					0.0139***
						[0.0038]
γ_3	VIX*Korea				-0.0674***	-0.0679***
					[0.0060]	[0.0058]
γ_4	VIX*Korea*Post 2010					-0.0082
						[0.0098]
δ_1	ΔVIX	-0.0217***	-0.0217***	-0.0171**	-0.0217***	-0.0160*
		[0.0077]	[0.0077]	[0.0079]	[0.0078]	[0.0087]
δ_2	ΔVIX*Post 2010					-0.0235**
						[0.0107]
δ_3	ΔVIX*Korea				-0.0063	-0.0231***
					[0.0059]	[0.0065]
δ_4	ΔVIX*Korea*Post 2010					0.0378***
						[0.0104]
	Korea*Post 2010			-0.0131		0.0321
				[0.0095]		[0.0331]
	ΔRER	-0.0765**	-0.0760**	-0.0791**	-0.0741**	-0.0736**
		[0.0299]	[0.0298]	[0.0296]	[0.0294]	[0.0289]
	ΔMoney stock	-0.0413	-0.0408	-0.0629	-0.0387	-0.0481
		[0.0659]	[0.0659]	[0.0660]	[0.0661]	[0.0665]
	GDP Growth	0.2230***	0.2227***	0.2230***	0.2250***	0.2248***
		[0.0821]	[0.0822]	[0.0821]	[0.0828]	[0.0829]
	ΔDebt to GDP	-0.0667**	-0.0669**	-0.0661**	-0.0686**	-0.0686**
		[0.0311]	[0.0311]	[0.0313]	[0.0315]	[0.0318]
	Constant	0.1493***	0.1495***	0.1439***	0.1502***	0.1356***
		[0.0273]	[0.0273]	[0.0270]	[0.0273]	[0.0269]
	Observations	2,812	2,812	2,812	2,812	2,812
	R-squared	0.127	0.127	0.13	0.129	0.134
	Number of countries	48	48	48	48	48
	Time and country fixed effects	Y	Y	Y	Y	Y

Columns (2) and (3) shows results of our augmented specification with the dummy Korea and the dummy Post 2010 and their interactions with ΔInteroffice. We see that $\beta_2 > 0$, indicating that the impact of the global factor ΔInteroffice is stronger after June 2010 than before. Also, we have $\beta_3 > 0$ indicating that Korea has traditionally been more sensitive to ΔInteroffice than other countries. However, we see that $\beta_4 < 0$, meaning that Korea's sensitivity to ΔInteroffice has fallen after June 2010, in spite of Korea's sensitivity in the past and in spite of the greater impact of ΔInteroffice for other countries.

Columns (4) and (5) show results of our augmented specification with the dummy Korea and the dummy Post 2010 and their interactions with VIX and ΔVIX. Column (5) shows that Korea has had greater sensitivity to the other global factors, VIX and ΔVIX, as seen from the fact that $\gamma_3 < 0$ and $\delta_3 < 0$ (recall that VIX and leverage are inversely related, and so more negative coefficients indicate greater sensitivity). Nevertheless, γ_4 is not significant and $\delta_4 < 0$ indicating that Korea hasn't become more sensitive to the VIX and actually has become less sensitive to VIX and ΔVIX after June 2010.

We also conduct a full set of F-tests on the incremental sensitivity and total effect over time and across countries. From the 2×2 table in (4), the columns indicate the cross-section dimension of Korea versus the rest of the sample, while the rows correspond to the time series dimension of pre- and post-2010. The key tests highlighting the difference in the ΔInteroffice effect pre and post 2010 for Korea and the difference pre and post 2010 between Korea and the rest of the countries are the following:

- $\beta_2 + \beta_4 = 0$ tests the null hypothesis that there has been no change in the sensitivity of Korea to ΔInteroffice before and after 2010 (comparing across rows in (4)).

- $\beta_3 + \beta_4 = 0$ tests the null hypothesis that there is no difference between Korea and the rest of the sample to ΔInteroffice after 2010 (comparing across columns in (4)).

We perform a similar set of tests also for VIX (coefficients γ) and ΔVIX (coefficients δ).Table 3 reports the full set of F-tests for ΔInteroffice, VIX and ΔVIX each corresponding to the

Table 3. **F tests for coefficient restrictions in Table 2.** This table presents F tests for coefficient restrictions in Table 2. The column labels refer to Table 2 and p-values are reported for each null hypothesis. The null $\beta_2 + \beta_4 = 0$ is the statement that there is no change in sensitivity of capital flows into Korea with respect to ΔInteroffice after June 2010. The null $\beta_3 + \beta_4 = 0$ corresponds to the statement that there is no difference between Korea and other countries in their sensitivity to ΔInteroffice after June 2010. γ and δ coefficients are for the other global factors VIX and ΔVIX, respectively.

Null hypothesis (p-values reported)	1	2	3	4	5
$\beta_2 + \beta_4 = 0$			0.0000		
$\beta_3 + \beta_4 = 0$			0.0000		
$\beta_1 + \beta_2 = 0$			0.0043		
$\beta_1 + \beta_3 = 0$		0.0000	0.0000		
$\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$			0.3162		
$\gamma_2 + \gamma_4 = 0$					0.5892
$\gamma_3 + \gamma_4 = 0$					0.0000
$\gamma_1 + \gamma_2 = 0$					0.0000
$\gamma_1 + \gamma_3 = 0$				0.0000	0.0000
$\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 = 0$					0.0000
$\delta_2 + \delta_4 = 0$					0.0387
$\delta_3 + \delta_4 = 0$					0.1151
$\delta_1 + \delta_2 = 0$					0.0005
$\delta_1 + \delta_3 = 0$				0.0000	0.0000
$\delta_1 + \delta_2 + \delta_3 + \delta_4 = 0$					0.8098

respective columns-specifications in 2. For instance, the tests of the null hypothesis that there is no difference for Korea's sensitivity to the global banking activities after 2010 from the rest of the sample are $\beta_3 + \beta_4 = 0$, $\gamma_3 + \gamma_4 = 0$, and $\delta_3 + \delta_4 = 0$.

While non-Korean countries became more sensitive to changes in Interoffice after June 2010, Table 3 column (3) shows that Korea became less sensitive ($\beta_2 + \beta_4$ negative and significant). Moreover, before 2010 the impact of ΔInteroffice was higher for Korea than for the rest of the world (β_3 positive and significant) and became lower after 2010 ($\beta_3+\beta_4$ negative and significant). The total resulting effect for Korea after 2010 is that global banks activities did no longer have a significant impact on capital flows for Korea ($\beta_1 + \beta_2 + \beta_3 + \beta_4 = 0$).

A similar trend occurs for the change in VIX. Korea became less sensitive to changes in the VIX after 2010 ($\delta_2 + \delta_4$ positive and significant), whereas non-Korean countries became more sensitive (δ_2 negative and significant). The total effect for Korea after 2010 is that changes in VIX did no longer have a significant impact on capital flows for Korea ($\delta_1 + \delta_2 + \delta_3 + \delta_4 = 0$). However, after June 2010 Korea continued remaining more sensitive to the level of the VIX than the rest of the world ($\gamma_3 + \gamma_4$ negative and significant). Taken together, the weight of the evidence points to a structural shift in Korea's sensitivity to global banking flows, with the effect being stronger through the lens of the funding activities (interoffice assets) of global banks.

4.2 Sensitivity to Additional Factors

So far we have examined the impact of global banking activities and how they influence capital flows. We now turn to the additional explanatory variables listed in Table 2. In particular, we see that ΔRER coefficient is negative and highly significant. Hence, when the local currency appreciates against the dollar from quarter $t-1$ to quarter t, there is an acceleration of capital flows into that country from quarter t to quarter $t+1$. This feature is a natural consequence of a setting where borrowers from the local banks have a currency mismatch, as shown in Bruno and Shin (2011). When the local currency appreciates, the borrowers' balance sheets become stronger, thereby reducing the credit risk on the bank's loan book, which in turn increases the

capacity of local banks to lend. The increased lending is financed with capital inflows.

Capital flows are also increasing in the growth of the global M2 money stock worldwide, which reflects the greater demand for funding by banks, as well as the increased capital flows through non-financial firms, who hold the proceeds of any increased funding operation by holding cash in the banks.

In Table 4, we conduct an analysis of the structural change in the capital flows with respect to the RER, M2, GDP growth and change in DEBT/GDP similar to that in Table 2. We follow the analogous method of defining triple interactions between each local factor with the time dummy that takes the value 1 if the date is June 2010 or later, and with the country dummy that takes the value of 1 for Korea and zero otherwise. The F-tests for structural change with respect to each of the four variables are presented in Table 5 , where (1), (2), (3), (4) corresponds to the coefficients listed in 4 for each of the four variables ΔRER, ΔM2, GDP growth and ΔDEBT/GDP growth.

In particular, testing the null hypothesis (3) + (4) = 0 corresponds to the testing the different behavior of Korea with respect to the other countries after June 2010. This null is not rejected for ΔRER, suggesting little evidence that the relationship between currency appreciation and capital inflows is different for Korea relative to other countries after 2010. However, since capital flow sensitivity has moderated in Korea after 2010 (from our earlier findings), a possible explanation is that exchange rate volatility itself has been subdued since the introduction of the macroprudential measures in 2010. In this sense, the failure to reject the null (3) + (4) = 0 may suggest additional benefits to the macroprudential policies that work through exchange rate stabilization.

In Korea, capital flows increases became less dependent on increases in global money stock or GDP growth and on decreases in government debt. In particular, Korea was more sensitive to global money (Money stock) before June 2010 and becomes less sensitive after June 2010, whereas the effect for the rest of the world is unchanged. An increase in GDP was a significant local pull factor before June 2010 for all countries and even more for Korea, but it is actually reversed after June 2010. Symmetrically, an increase in Debt to GDP was a significant push

Table 4. **Panel regressions with interaction dummies for local variables.** This table summarizes panel regressions for bank capital flows to 48 countries. The dependent variable is bank capital flows measured by the quarterly log difference of external loans (BIS Table 7A). Explanatory variables include local "demand pull" factors, M2 growth and their interactions with a time dummy for the period from June 2010 and a dummy for Korea. Standard errors are clustered at the country level and are reported in parantheses. Data are for 1996Q1-2012Q1.

Coeff.		1	2	3	4
	ΔInteroffice	0.0139***	0.0154***	0.0146***	0.0154***
		[0.0052]	[0.0054]	[0.0054]	[0.0054]
	VIX	-0.0610***	-0.0530***	-0.0534***	-0.0492***
		[0.0104]	[0.0091]	[0.0093]	[0.0089]
	ΔVIX	-0.0259***	-0.0244***	-0.0238***	-0.0210***
		[0.0079]	[0.0079]	[0.0081]	[0.0077]
1	ΔRER	-0.0890***	-0.0808***	-0.0707**	-0.0786**
		[0.0325]	[0.0300]	[0.0300]	[0.0303]
2	ΔRER*Post 2010	0.2398***			
		[0.0830]			
3	ΔRER*Korea	-0.1917***			
		[0.0334]			
4	ΔRER*Korea*Post 2010	0.1072			
		[0.0681]			
1	ΔMoney stock	-0.0184	-0.0304	-0.0339	-0.044
		[0.0687]	[0.0741]	[0.0672]	[0.0660]
2	ΔMoney stock*Post 2010		-0.2803		
			[0.2175]		
3	ΔMoney stock*Korea		0.6394***		
			[0.0586]		
4	ΔMoney stock*Korea*Post 2010		-0.9889***		
			[0.1949]		
1	GDP Growth	0.2240***	0.2231***	0.1993**	0.2219**
		[0.0822]	[0.0821]	[0.0852]	[0.0840]
2	GDP Growth*Post 2010			0.2800**	
				[0.1119]	
3	GDP Growth*Korea			0.4477***	
				[0.0824]	
4	GDP Growth*Korea*Post 2010			-2.3514***	
				[0.1996]	
1	ΔDebt to GDP	-0.0662**	-0.0658**	-0.0615**	-0.0501
		[0.0317]	[0.0313]	[0.0299]	[0.0326]
2	ΔDebt to GDP*Post 2010				-0.1111
					[0.0862]
3	ΔDebt to GDP*Korea				-0.1579***
					[0.0328]
4	ΔDebt to GDP*Korea*Post 2010				1.6839***
					[0.2073]
	Korea*Post 2010	0.005	0.0170**	0.1668***	-0.0121
		[0.0086]	[0.0080]	[0.0151]	[0.0077]
	Constant	0.1772***	0.1542***	0.1440***	0.1493***
		[0.0318]	[0.0277]	[0.0270]	[0.0276]
	Observations	2,812	2,812	2,812	2,812
	R^2	0.131	0.129	0.132	0.129
	Number of countries	48	48	48	48
	Year and country fixed effects	Y	Y	Y	Y

Table 5. **F tests for coefficient restrictions in Table 4.** This table presents F tests for coefficient restrictions in Table 4 for the local variables ΔRER, ΔM2, GDP growth and ΔDebt/GDP. The null (2) + (4) = 0 corresponds to the statement that the sensitivity of capital flows into Korea with respect to the local variable does not change after June 2010. The null hypothesis (3) + (4) = 0 is the statement that there is no difference in sensitivity to that variable between Korea and the other countries after June 2010. *p*-values are reported for each null hypothesis.

	(1)	(2)	(3)	(4)
Null hypothesis	Variable			
	ΔRER	ΔM2	GDP Growth	ΔDebt/GDP
(2) + (4) = 0	0.0000	0.0000	0.0000	0.0000
(3) + (4) = 0	0.1876	0.0588	0.0000	0.0000
(1) + (2) = 0	0.0624	0.1190	0.0001	0.0637
(1) + (3) = 0	0.0000	0.0000	0.0000	0.0000
(1)+(2)+(3)+(4)=0	0.1855	0.0000	0.0000	0.0000

factor for Korea before June 2010 and it has a reversed effect affect after June 2010, with the other countries unaffected. Overall, these tests strongly show that Korea has indeed a different sensitivity to global and local variables than the rest of the world after June 2010.

4.3 Alternative Test of the Sensitivity to Capital Flows

An alternative approach to testing for the moderation of sensitivity of capital flows is to investigate the reduced co-movement between capital flows into Korea and the aggregate capital flows to all countries. We implement this test with the following two step procedure.[6]

In the first step, we compute the variable $Beta\,(i,t)$ by regressing the capital flows into country i on the aggregate capital flows to all countries on a rolling eight quarter window $\{t-7,\cdots,t-1,t\}$. The estimation window of $Beta\,(i,t)$ starts in 1999 and it excludes the period of the Asian crisis 1997 and 1998 to mitigate endogeneity problems.

In the second step, we use $Beta\,(i,t)$ as the dependent variable in an OLS regression. The right hand side variables are the Korea dummy, the Post 2010 dummy and the interaction term Korea*Post 2010. Other explanatory variables are VIX, ΔVIX. We include the full set of year

[6]We are grateful to a referee for suggesting this procedure.

Table 6. **Covariation between individual country and aggregate capital flows.** This table reports results of the two step procedure where first, we compute $Beta\,(i,t)$ by regressing capital flows to country i on aggregate capital flows over a rolling eight quarter window $\{t-7,\cdots,t-1,t\}$. In the second step, $Beta\,(i,t)$ is the dependent variable in an OLS regression with global explanatory variables and dummies for Korea and Post-2010 period and their interaction. A full set of time and country dummies are also included. Robust standard errors clustered at the country level are reported in parantheses.

Dependent variable: Beta(i,t)		
γ_1	Korea	0.2681***
		[0.0406]
γ_2	Korea*Post 2010	-0.7295***
		[0.1727]
	Post 2010	0.0606
		[0.1213]
	VIX	0.1623*
		[0.0860]
	ΔVIX	0.0549
		[0.0606]
	Constant	0.4132
		[0.2767]
	Observations	1,632
	R^2	0.308
	Number of countries	48
	Time and country dummies	Y
	$\gamma_1+\gamma_2=0$ (p-value)	0.0011

and country dummies, and compute robust standard errors clustered at the country level.

The results are presented in Table 6. The coefficient γ_1 of the Korea dummy indicates the additional sensitivity of capital flows into Korea relative to the other countries in the sample before June 2010. We see from Table 6 that the coefficient γ_1 is positive and significant. However, we see from the negative coefficient γ_2 on the interaction dummy Korea*Post 2010 that the sensitivity of capital flows into Korea dropped sharply after June 2010.

Even more dramatically, we have $\gamma_1+\gamma_2<0$, so that the sensitivity of Korea flips from being more sensitive relative to the whole sample to *less* sensitive. The null hypothesis $\gamma_1+\gamma_2=0$ can be rejected with a p-value of 0.0011. This finding casts the macroprudential policies into an even more favorable light.

Overall, the conjunction of the findings from the analysis of sensitivity to the global variables and the local variables point to the moderation of capital flows. We interpret our findings as providing some preliminary evidence that the newly introduced macroprudential policies in Korea have seen some initial success in moderating the sensitivity of capital flows to external factors.

5 Robustness Checks

5.1 Evidence from Other Countries in Asia.

Evidence of change in incremental sensitivity cannot be taken as conclusive proof of the effect of the macroprudential policy, since the experiment is simply to look before and after June 2010. However, we complement our incremental sensitivity analysis for Korea by comparing the results for Korea with those of other countries in the region, as well as examining evidence for any structural breaks in the way that our variables of interest impact capital flows, so that we may place the results on Korea into context. Through this exercise, we may ascertain the extent to which the results for Korea are shared by other Asian countries, and hence give clues on any regional variations in our sample.

We therefore run panel regressions analogous to those in Table 2 but for each of the following countries: Australia (AUS), Indonesia (IDN), Malaysia (MYS), Philippines (PHL), Thailand (THA) and Vietnam (VNM).

The choice of Australia follows from the similarity of Australia's banking sector in its openness and its reliance on wholesale funding. Australia also has a similar sized economy to Korea, a fellow member of the G20 grouping of countries and the Australian dollar has some of the same attributes as the Korean won as a barometer of the risk-taking behavior in global capital markets. The other countries (Indonesia, Malaysia, Philippines, Thailand and Vietnam) are chosen as they are collectively known as the "Big 5" ASEAN countries and share some similarities to Korea in terms of openness to similar regional forces.

We focus on the ΔInteroffice variable as the main global factor capturing the funding ac-

Table 7. **Sensitivity of bank capital flows to other Asian economies.** This table reports panel regressions for capital flows designed to identify incremental sensitivity of a particular country. Separate specifications are run for Australia (AUS), Indonesia (IDN), Malaysia (MYS), Philippines (PHL), Thailand (THA) and Vietnam (VNM). In each case, the dependent variable is bank capital flows as measured by the quarterly log difference of external loans (BIS Table 7A). Expanatory variables include the global and local variables in Table 2, interactions of ΔInteroffice with the time dummy for the period from June 2010 and with the dummy for the particular country examined. Standard errors are clustered at the country level and are reported in parantheses.

Coeff.		1	2	3	4	5	6
1	ΔInteroffice	0.0122**	0.0112**	0.0108**	0.0117**	0.0118**	0.0109**
		[0.0053]	[0.0053]	[0.0053]	[0.0053]	[0.0054]	[0.0053]
2	ΔInteroffice*Post 2010	0.0526**	0.0539**	0.0529**	0.0502**	0.0514**	0.0534**
		[0.0220]	[0.0222]	[0.0220]	[0.0222]	[0.0223]	[0.0223]
3	ΔInteroffice*AUS	-0.0509***					
		[0.0053]					
4	ΔInteroffice*AUS*Post 2010	0.0860***					
		[0.0159]					
	AUS*Post 2010	0.0410***					
		[0.0099]					
3	ΔInteroffice*IDN		-0.0091*				
			[0.0053]				
4	ΔInteroffice*IDN*Post 2010		0.0228				
			[0.0162]				
	IDN*Post 2010		0.0737***				
			[0.0086]				
3	ΔInteroffice*MYS			0.0083*			
				[0.0049]			
4	ΔInteroffice*MYS*Post 2010			0.0696***			
				[0.0157]			
	MYS*Post 2010			0.0687***			
				[0.0090]			
3	ΔInteroffice*THA				-0.0314***		
					[0.0053]		
4	ΔInteroffice*THA*Post 2010				0.1965***		
					[0.0162]		
	THA*Post 2010				0.1665***		
					[0.0084]		
3	ΔInteroffice*PHL					-0.0333***	
						[0.0047]	
4	Δinteroffice*PHL*Post 2010					0.1394***	
						[0.0160]	
	PHL*Post 2010					0.0931***	
						[0.0085]	
3	ΔInteroffice*VNM						0.0165***
							[0.0052]
4	ΔInteroffice*VNM*Post 2010						0.0464***
							[0.0165]
	VNM*Post 2010						0.0342***
							[0.0088]
	Controls	Y	Y	Y	Y	Y	Y

Table 8. **F tests for coefficient restrictions in Table 7.** This table presents F tests for coefficient restrictions in Table 7 for the interaction of ΔInteroffice with the time dummy for the period from June 2010 and with the dummy for the particular country examined. We examine Australia (AUS), Indonesia (IDN), Malaysia (MYS), Philippines (PHL), Thailand (THA) and Vietnam (VNM). The null hypothesis (2) + (4) = 0 corresponds to the statement that the sensitivity of capital flows to that country with respect to ΔInteroffice does not change after June 2010. The null hypothesis (3) + (4) = 0 corresponds to the statement that there is no difference in sensitivity to ΔInteroffice between the country and the other countries in the 48 country sample after June 2010. *p*-values are reported for each null hypothesis.

	(1)	(2)	(3)	(4)	(5)	(6)
Null hypothesis	Country					
	AUS	IDN	MYS	THA	PHL	VNM
(2) + (4) = 0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(3) + (4) = 0	0.0278	0.3798	0.0000	0.0000	0.0000	0.0003
(1) + (2) = 0	0.0057	0.0055	0.0060	0.0084	0.0071	0.0063
(1) + (3) = 0	0.0000	0.3711	0.0000	0.0000	0.0000	0.0000
(1)+(2)+(3)+(4)=0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

tivities of global banks, and follow the empirical procedure reported in Table 2 using the country dummy and Post 2010 dummy, as well as the interaction between the two. The results are reported in Table 7. For economy of presentation, we report only the key interaction coefficients. For each country, we report the coefficient on ΔInteroffice*Country and on ΔInteroffice*Country*Post 2010. We assign the same numbering to the interaction dummies coefficients as we did for Table 2 and Table 3.

The evidence on Δ*Interoffice* is striking. In contrast to Korea, all countries in Table 7 except Indonesia show positive coefficients on the triple interaction term ΔInteroffice*Country*Post 2010, meaning that Australia, Malaysia, Thailand, Philippines and Vietnam became *more sensitive* to fluctuations in global bank funding conditions after June 2010. Even in the case of Indonesia, the coefficient is insignificant, rather than being negatively significant as in Korea.

We conduct *F*-tests for structural change, and the results are reported in Table 8. The numbering convention for the null hypotheses remains the same as before. The null hypothesis (2) + (4) = 0 corresponds to the statement that the sensitivity of the country to ΔInteroffice does not change after June 2010. We see that this hypothesis is resoundingly rejected for all

four local variables. However, unlike in the case of Korea, the null hypothesis (2) + (4) = 0 is rejected for the opposite reason from Korea. In these other Asian countries, capital flows became *more* sensitive to global factors after 2010, rather than less sensitive.

The null hypothesis (3) + (4) = 0 corresponds to the statement that there is no difference between the country and the other countries in the full sample after June 2010. We see that the null hypothesis (3) + (4) = 0 is strongly rejected for Australia, Malaysia, Thailand, Philippines and Vietnam. It is only for Indonesia that the null (3) + (4) = 0 cannot be rejected.

Taken together, the evidence suggests that there has been a markedly lower sensitivity to global funding on capital flows in Korea, even when all other comparable countries in the region saw the opposite effect - toward an increased sensitivity to global factors in the determination of capital flows. Our results are suggestive that the introduction of macroprudential policies in Korea served to mitigate the notorious sensitivity of Korea to external financial conditions.

5.2 Dating the Structural Change

So far, we have relied on the a priori knowledge of policy announcements and press reports to choose the threshold date for the macroprudential policies to June 2010. We will now adopt a more agnostic procedure in dating the structural break by examining at each date the evidence for structural break at that date, and then compiling the evidence for the whole period after the start of 2010.

Specifically, we run the following panel specification.[7] Starting from the benchmark panel regression, we introduce the interaction dummies:

$$\Delta\text{Interoffice*Korea*Pre}, \qquad \Delta\text{Interoffice*Pre}, \tag{5}$$

where Pre is the dummy variable that takes the value 1 if the date is before the end of 2009, and zero otherwise. We also introduce the interaction dummies

$$\Delta\text{Interoffice*Korea*}Q(n), \qquad \Delta\text{Interoffice*}Q(n), \tag{6}$$

[7] We are grateful to a referee for suggesting this specification.

Table 9. **Dating the structural break.** This table reports panel regressions with capital flows as the dependent variable. Explanatory variables include global and local variables in Table 2, and interaction dummies ΔInteroffice*Korea*Pre and ΔInteroffice*Pre, where Pre = 1 up to the end of 2009, and zero afterwards. Also included are ΔInteroffice*Korea*$Q(n)$ and ΔInteroffice*$Q(n)$ where $Q(n) = 1$ in the nth quarter from 2010:Q1 and zero otherwise. We run separate panel regressions for each n and report their coefficients below.

		Coefficient	std err	t	date
a_0	Δinteroffice*Korea*Pre	0.036456	0.005497	6.63	Pre Mar-10
a_1	Δinteroffice*Korea*Q1	-1.99128	0.302513	-6.58	Mar-10
a_2	Δinteroffice*Korea*Q2	-0.38397	0.078521	-4.89	Jun-10
a_3	Δinteroffice*Korea*Q3	-1.50035	0.20109	-7.46	Sep-10
a_4	Δinteroffice*Korea*Q4	-1.2222	0.288706	-4.23	Dec-10
a_5	Δinteroffice*Korea*Q5	0.64302	0.15142	4.25	Mar-11
a_6	Δinteroffice*Korea*Q6	-0.08409	0.014951	-5.62	Jun-11
a_7	Δinteroffice*Korea*Q7	-0.03439	0.025341	-1.36	Sep-11
a_8	Δinteroffice*Korea*Q8	-0.04917	0.020808	-2.36	Dec-11
a_9	Δinteroffice*Korea*Q9	0.082683	0.074849	1.1	Mar-12
b_0	Δinteroffice*Pre	0.013826	0.005207	2.66	Pre Mar-10
b_1	Δinteroffice*Q1	1.417899	0.300799	4.71	Mar-10
b_2	Δinteroffice*Q2	0.348851	0.080573	4.33	Jun-10
b_3	Δinteroffice*Q3	1.148828	0.194686	5.9	Sep-10
b_4	Δinteroffice*Q4	-0.69569	0.291348	-2.39	Dec-10
b_5	Δinteroffice*Q5	-0.02685	0.147972	-0.18	Mar-11
b_6	Δinteroffice*Q6	0.031209	0.014856	2.1	Jun-11
b_7	Δinteroffice*Q7	0.069443	0.026399	2.63	Sep-11
b_8	Δinteroffice*Q8	0.071907	0.019245	3.74	Dec-11
b_9	Δinteroffice*Q9	0.064104	0.06774	0.95	Mar-12

for quarter n starting from the first quarter of 2010, and where $Q(n)$ is the dummy that takes the value 1 in quarter n and zero otherwise. We then run the benchmark panel regression with the inclusion of the two triple interaction terms in (5) and (6), and report their coefficients in Table 9.

By examining the coefficients and the standard errors for these variables for each quarter beginning in 2010, the rationale of this procedure is to obtain a more precise dating of the structural break for Korea, and to examine how uniform the lower sensitivity to global factors

are over the post-2010 period.

From the t-statistics reported in Table 9, we see that $a_0 > 0$, and so the sensitivity of Korea to ΔInteroffice prior to 2010 was strongly positive. However, for the coefficients a_1 to a_9, we see that all but one is negative and significant. The only exception is March 2011. We observe the reverse pattern for the β_t coefficients, which are all positive and significant with the excpetion of β_4.

From this evidence, we can conclude that Korea became less sensitive compared to global factors compared to the other countries in our sample of 48 countries. The evidence is consistently present throughout the period after 2009. These results give some cause for reassurance that our earlier results that rely on the partitioning of the sample period into "before and after" subsamples does not rely on outlier observations to mask the overall effect. The evidence points to the impact of the macroprudential policies falling uniformly over the whole period from 2010.

6 Conclusions and Directions for Further Research

Given the accumulated evidence assembled in this paper, the following conclusions seem justified concerning the impact of Korea's macroprudential policies.

First, there is evidence from a variety of approaches that the sensitivity of capital flows to global factors reduced substantially in the case of Korea from 2010. We have seen this both through the signs of the interaction dummies, through F-tests of structural breaks, as well as the co-movement measurements using our Beta(i,t) variables.

Remarkably, the dampening of sensitivity in Korea sits side-by-side with evidence that Korea's experience is different from group of comparable Asian countries. For these Asian countries, they saw an *increase* in the sensitivity of their capital flows to global factors after 2010. Since the original findings for Korea were relative to the global comparison group, the increased sensitivity of Australia, and other Asian comparison countries is representative of global trends as a whole. Given such a backdrop, the conspicuous drop in the sensitivity of capital flows into Korea is all the more notable.

Finally, we have seen that the lower sensitivity of Korea's capital flows to global factors after 2010 is an effect that is uniformly present throughout the post-2010 period, rather than relying on one or two outliers to get the overall sign.

The results in our paper reiterate a number of broader lessons. The evidence in our paper suggests that the driving force behind banking sector capital flows is the leverage cycle of the banking sector, through the interaction of the supply and demand of wholesale bank funding. Our findings reinforce the argument in Borio and Disyatat (2011), Obstfeld (2012a, 2012b) and Gourinchas and Obstfeld (2012) on the importance of *gross* capital flows between countries in determining financial conditions, especially the gross flows intermediated by the banking sector.

Bank capital flows have also been pivotal in the European financial crisis. The credit boom in countries such as Ireland and Spain were financed primarily by capital flows through the banking sector (see Allen, Beck, Carletti, Lane, Schoenmaker and Wagner (2011) and Lane and Pels (2011)). Therefore, the mechanisms outlined here on the link between capital flows and leverage are relevant in understanding the European crisis, also.

Our findings highlight the role of financial intermediaries in driving fluctuations in risk premiums and financial conditions, especially in connection with the growing use of wholesale bank funding.

The procyclicality of banking sector capital flows poses challenges in setting policy and regulatory responses. The cross-border spillovers associated with banking sector flows highlights the importance of international coordination in banking regulation and in monetary policy, but such coordination is not straightforward to design or implement, even when the interests of the relevant countries are congruent. Moreover, even when coordination is globally optimal, it still may generate tensions with national governance.

In the absence of effective international coordination, a second best approach (that takes the spillovers as given) would be appropriate in designing a framework to mitigate the risks of cross-border flows at the national level. The recent report by the Committee on International Economic Policy Reform (CIEPR (2012)) describes the considerations that are relevant in setting policy on capital flows in a second best world. The macroprudential policies introduced in Korea

in 2010 can be viewed in this context. The Korean measures should also be seen in the context of the broader debate on the design of policies toward financial stability. Although the term "macroprudential" is now commonly encountered in the policy world, empirical studies on their effectiveness have been comparatively less common. In this context, our empirical results may be a useful input in more detailed studies of the tradeoffs involved in macroprudential policy design.

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