Essays on Cross-border banking flows, Monetary policy, and the Business cycle

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Abstract

This thesis examines the influences of global banking flows and its implication on the monetary policy regimes and economic fluctuations in the recipient economies. This work is based on the view that monetary policy shocks in core countries could be transmitted to the recipient EMEs via cross-border banking flows.

Chapter 1 investigates influences of internal transactions within Asia-headquartered global banking group on the monetary policy effectiveness in selected Asian countries. It has been argued that global banks, when facing financial stress, reallocate their internal funds from their foreign affiliates in support of the parent banks. This action might help the parent banks to better protect their bank lending. In this spirit, the chapter investigates evidences suggestive of the operation of the channel for the Asian global banks.

In Chapter 2, the US monetary policy shock identified from narrative sources is applied to measure the responses of banking flows and US global banks that intermediate cross-border interbank funding. The results suggest that the responses of US global banks and the magnitude in banking outflows are much larger than previously thought.

Chapter 3 examines an interaction between exchange rate regimes and financial crisis in EMEs triggered by a US monetary policy shock. First, an empirical evidence on the magnitude in banking outflows in EMEs in response to a US monetary policy shock is suggested. Then, an open economy model equipped with a banking sector is estimated and analyzed. The model predicts the well-known wisdom in the literature on sudden stops episodes: countries in the position of having to defend an exchange rate peg are more likely to suffer severe Sudden Stops and financial distress.

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Chapter 1

Global banks and monetary policy transmission

Abstract

In this chapter, we investigate the role of global banks headquartered in eight Asian countries in monetary policy transmission using bank-level panel data. We find that the Asian global banks were less responsive to domestic monetary policy (hampering effects), considering the bank-lending channel perspective. We investigate the role of internal transactions between headoffices and their subsidiaries in this procedure as Cetorelli and Goldberg have argued: global banks, when facing financial stress, reallocate their internal funds from their foreign affiliates in support of the parent banks. This action might help the parent banks to better protect their bank lending (Cetorelli and Goldberg 2012a, Jeon and Wu 2014). To examine if the channel they suggest operates, we perform three additional identifications: (1) Examine the relationship between the size of foreign subsidiaries that Asian global banks have and the magnitude in the hampering effect, (2) loan supply of Asian global banks during $2008-2009$ financial crisis period, and (3) financial interconnection between Asian global banks and its subsidiaries. These findings are suggestive of the operation of the channel for Asian global banks.

1.1 Introduction

After the recent financial crisis in 2008-2009, more attention from academics and policymakers has been paid to globalized banking and its role in the internal capital market, especially between the head offices of global banks and their foreign subsidiaries. Recent studies appear to have reached a conclusion that global banks could raise funds from their foreign subsidiaries to relieve their liquidity constraints in the face of financial stress in the home market, and this helped the global banks cope better with the liquidity shock during the recent financial crisis.[1]

The existing studies on the issue can be divided broadly into two strands: (i) studying the role of United States (US) headquartered global banks and its consequences on shock propagation and monetary policy effectiveness from the US perspective (Cetorelli and Goldberg 2012a, 2012c; Correa et al. 2014) and (ii) examining the behaviour of foreign banks (foreign subsidiaries of global banks) operating in non-US host countries (Wu et al. 2011; Jeon et al. 2013, 2014). This might be due to the fact that the recent financial crisis originated in the US, while non-US countries, especially emerging market economies, have long held concerns about the destabilizing effects of sudden outflows of foreign capital, when international financial markets are unstable.[2] For example, Jeon and Wu (2014) found that foreign-owned banks operating in seven Asian countries reduced their bank lending significantly during the 2008-2009 crisis period, despite an eased monetary policy in those Asian countries. One explanation for this is that the foreign-owned banks were being forced to direct finances from Asia to the US or Europe, where the headquarters of the bank group are located.

In this chapter, we present the first study of the lending behaviour of Asian global banks. More specifically, we review banks that are headquartered in the selected eight Asian countries ($Parents$), but that have operations ($Juniors$) in other countries. We aim to examine whether these Asian global banks

[1] See Section 1.2.2 for recent empirical evidences.

[2] There have been long-held concerns about the destabilizing effects that foreign banks (or foreign finance - financial openness, in a broader context) might bring about in the emerging (or recipient) countries (Kose et al. 2009). On the one hand, it has been argued that foreign finance enhances the efficiency, competitiveness, and stability of the banking systems in the host economies (Summers 2000, McCauley et al. 2010). On the other hand, foreign banks have also been observed to act as a destabilizing force, as short-term profit seeking speculators, or as a source of contagion, by transmitting adverse shocks from the home country to the host countries, especially when the banks in home countries face serious financial stress (Bhagwati 1998, Rodrik 1998, Stiglitz 2002).

are less affected by domestic monetary policy shocks, and thus lowering the effectiveness of the policy, and the internal capital markets does play a role in this mechanism. This necessitates the classification of banks based on their ownership types.

We classifiy commecial banks as follows. Among the domestically-owned banks, we define a *global banks* as a bank that has at least one foreign subsidiary abroad for which the parent bank has a 50% or higher controlling equity; otherwise, it is classified as a *domestic bank*. A bank is defined as a $foreign$ *bank* if the capital owned by the overseas banks or firms is higher than 50% of the capital; these are the banks previously studied by Jeon and Wu (2014). Hereafter, we term global banks headquartered in the eight selected Asian countries as $Parents$[3]; their foreign subsidiaries are termed $Juniors$, to help distinguish them from $Foreign$ *banks*, which are the subsidiaries of foreign global banks operating in the Asian region (foreign banks have been the focus of previous research). We call domestically-owned banks that do not have a subsidiary abroad and are not owned by a foreign firm *Domestic banks*. Based on this classification, it is interesting to study $Parents$, not $Foreign$ *bank*, considering the fact that $Foreign$ *bank* is only a small percentage of Asian bank assets, while $Parents$ constitute the majority of total bank assets.

We construct bank-level panel data for 271 commercial banks in eight Asian countries: Hong Kong, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand. Data were obtained from $Bureau\ van\ Dijk's\ BankScope$. Except for indicators that distinguish banks based on ownership type, the model we use is standard in estimating the bank-lending channel in that we control the possible effect of other bank-level characteristics (e.g. size, liquidity and capital) as well as overall economic activities (e.g. real GDP growth rate, unemployment rate) affecting loan demand pressure. We estimate our specification models using an Ordinary Least Squares estimator with clustered standard errors for robustness and bank-level fixed effects. To relieve a possible endogeneity problem, we adopt one-year lag bank characteristic variables, as is commonly used in the relevant literature.

To answer our questions, we measure the marginal responsiveness of $Parents'$ bank lending to monetary policy in comparison with other types of banks. We analyze observations from 2000 to 2007 at first (Section 1.5.1 and Section

[3]Since Asian global banks ($Parents$) have relatively few and very small foreign subsidiaries ($Juniors$), where many are located in the same Asian region, it might not appropriate to call them global banks. However, we follow this terminology, as it is in line with the previous literature. For more detail, refer to Section 1.3.

1.5.2.1), and then move to include all observations from 2000 to 2014 with a focus on the banking behaviours in the 2008-2009 crisis periods (Section 1.5.2.2).[4] We find that *Parents* are less affected by monetary policy than different types of banks[5], with other bank characteristics and loan-demand pressure controlled. This finding suggests that *Parents* lower the effectiveness of monetary policy that affect real economic activity via the bank lending channel. The theory of the bank lending channel predicts that banks have to (at least to some extent) shrink their loan supply growth to keep total assets in line with the reduced volume of liabilities in the face of monetary tightening. The literature has aimed to find relevant bank characteristics that affect the extent to which banks adjust their loan supplies in reaction to monetary policy changes.[6] Based on our findings, we conjecture that having a global network could serve as an additional feature that help banks better shield their loan growth in the bank lending channel perspective.

One concern we have on our strategy is selection bias. It might be the case that the largest and most successful banks tend to become global banks (*Parents*) by launching new subsidiaries abroad and, at the same time, being better able to deal with financial stress by easily accessing external funds, as compared to smaller and less successful banks. If this is the case, the hampering effect the *Parents* have against monetary policy tightening might just reflect their size or successfulness and not be an intrinsic feature of the globalized banking network and internal capital market. To relieve this concern, we control the effects of other banking characteristics, including measurement

[4]In contrast to the existing literature, which mainly focuses on the financial crisis period, we aim to determine the behaviour of global banks during the normal period, which we believe is more appropriate to measure the impacts of the globalized network on monetary policy transmission, excluding anomalies and distortions. In this sense, we examine bank lending from 2000 to 2007, with both the pre-2000 and post-2008 periods being excluded. During the 1997-1998 Asian financial crisis, Asian countries experienced a significant restructuring of their banking industry. After 2008, Asian countries were significantly affected by the international financial turmoil that initially was generated by the US subprime mortgage lending crisis and the sovereign debt crisis in Europe. Then, we extends the observations to include the financial crisis and recent periods from 2008-2014 in Section 1.5.2.2.

[5]In baseline regressions, in which we have *Parents* dummy, the reference groups are both *Domestic banks* and *Foreign banks*. In robustness test, we also introduce a dummy indicative of *Foreign banks*, where *Domestic banks* is the only constitute of the reference group.

[6]Researchers have tried to determine what bank characteristics help banks protect their loan growth in the face of a negative monetary policy shock for many years. The magnitude of this adjustment might depend on the banks characteristics (e.g. size of liquid assets, total assets and equity) (Kashyap and Stein 1995, 2000; Kishan and Opiela 2000; Ashcraft 2006 among others). The previous literature have found supporting evidence that these bank characteristics actually affect the extent to which banks adjust loan growth. For more detail on the bank lending channel and the relevant evidence, see Section 1.2.1.

of size, liquid assets and capital, and the interacting effects of these characteristics with monetary policy changes on bank lending.

The remaining identifications are devoted to determining whether the hampering effect that *Parents* have actually comes from (at least partially) its operational internal capital market. We provide two sets of indirect evidence supporting the role of the internal capital market. Firstly, we distinguish *Parents* into two subgroups, based on the total size of all the *Juniors* they have: those with relatively larger *Juniors* and those with relatively smaller *Juniors* (Section 1.5.2.1). We then measure the difference of the hampering effects between the two *Parents* subgroups. The rationale is that if *Parents* have relatively larger *Juniors*, then it is more likely that they depend more on the internal capital market to raise funds and depend less on other external sources in the face of financial stress. If the *Juniors* they have are small, in contrast, the extent to which *Juniors* can support their *Parents* would be limited. We find that the size of the *Juniors* does matter for the magnitude of the *Parents* hampering effect; this supports the role of the internal capital market for the hampering effects that *Parents* have.

Secondly, we move our attention from the normal periods of time to the 2008-2009 financial crisis, and examine the response of bank lending during 2008 and 2009 with extended sample periods from 2000 to 2014 (Section 1.5.2.2). We find *Parents* that have relatively larger foreign subsidiaries (*Juniors*) could better shield its bank lending during the financial turmoil. This findings complements Jeon and Wu (2014)'s finding; they found that *Foreign banks* operating in the Asia region had reduced its loan supply during the crisis period to a larger extent, and they postulated that this might be due to the liquidity reallocations from foreign subsidiaries to headquarters of global banks. We find that these opposite responses of *Parents* and *Foreign banks* (many of the *Foreign bank* are the *Juniors* of the *Parents*) invigorates the proposition that global banks could better protect their loan supply by raising funds from their subsidiaries, thus causing a decline in bank lending in the subsidiaries. Based on our findings, we conclude that there is evidence supporting the existence of the operational internal capital market between the Asian global banks (*Parents*) and their foreign subsidiaries (*Juniors*). This might play a role (at least partially) in the hampering effect on the monetary policy transmission. These results have important policy implications that we discuss in the conclusions section.

Then, we investigate the more direct relationship between the bank lending of *Juniors* and their *Parents'* financial conditions, following the specification strategies adopted in Jeon et al. (2013) in Section 1.5.3.[7] The primary idea is that the significant connectedness between the loan growth of the *Juniors* and the financial conditions of their *Parents* can be regarded as supporting evidence of the operational internal capital market between the *Parents* and the *Juniors*. Based on this strategy, we find that when *Parents* are in better financial conditions, their *Juniors* become less dependent on their own internal funds in expanding its loan growth, and vice versa, though the evidence is weak. We believe that this evidence supports our argument that the internal capital market plays a role in helping its *Parents* better protect its bank lending in the face of monetary policy tightening.

Our approach contributes to the relevant research in several ways. Firstly, opposite to the conventional approach, this paper focuses on Asian-headquartered global banks (*Parents*), not *Foreign banks* operating in the Asia region. This work provides the evidence for Asia that parallels the Cetorelli and Goldberg (2012a) work for the US. Asian global banks deserve more attention in that they constitute a financially significant and important institution in the region, and thus, play a larger role in monetary policy transmission, as compared to domestic banks or foreign banks.[8] In addition, this approach enlightens us in that the internal capital market could work between Asian global banks and their subsidiaries, not merely between foreign banks operating in Asia and their parent banks. To our best knowledge, no previous study on this issue in Asia (and other emerging markets) has examined whether this mechanism works for Asian global banks. Therefore, we believe that our findings would fill the gap in the literature and help us to have a better understanding on how the globalized banking network in the region affects shock propagation and monetary policy effectiveness.

[7]The dataset used for this is different from that used in other sections. For this, we use 26 *Parents* (global banks) headquartered in the eight selected Asia countries and 82 *Juniors* affiliated with them operating in the Asia region or somewhere else around the world. In other parts of this paper, basically we analyze 271 commercial banks operating in the 8 Asia countries by distinguishing them one of three types: 26 *Parents*, 157 *Domestic banks* and 113 *Foreign banks*. See Figure 1.2 in Section 1.3.2 for further explanation.

[8]In 2010, the 26 Asian global banks took 41.2% of the total banks assets in the eight selected countries. In contrast, 81 foreign banks operating in the region at this time had asset share of 31.9%. With Hong Kong excluded, 57 foreign banks only had 10.1% of assets share in the region. Hong Kong is an exception in that foreign banks occupy the majority market share of the banking industry, possibly due to its historical backgrounds. Detailed information on the structure of the banking industry is discussed in Section 1.3.

Secondly, this paper covers both the non-crisis periods and crisis periods. The existent literature primarily focuses only on the crisis periods, not both. In contrast, we explore the role of global banks in comparison with other types of banks with the bank lending channel perspective for the normal period, and expand our analysis for the recent financial crisis period. We conjecture that the monetary policy contractions are the main sources of liquidity shock during normal periods, whereas international financial turmoil dominates eased monetary policy to relieve the financial stress that banks faced during the 2008-2009 crisis period. For this reason, we distinguish the two periods, but our findings from these different periods provides consistent evidence in a complementary way. During normal periods, our finding supports that Asian global banks have hampering effects against monetary policy, while they shield their loan supply better and keep their loan price lower than other types of banks in face of financial turmoil in 2008 and 2009.

The remainder of this paper proceeds as follows. In Section 1.2, we introduce the previous studies on the bank lending channels and recent research that focuses on the global banking network. Section 1.3 investigates the structure of the banking industry in the selected Asian countries and the features of the Asian global banks. In Section 1.4, we explain the construction of the dataset used. We suggest our identification strategies and estimation results in Section 1.5. Section 1.6 concludes.

1.2 Relevant studies

In Section 1.2.1, we introduce the theory of the bank-lending channel and the relevant literature as one of the monetary policy transmission mechanisms. In Section 1.2.2, we review the recent literature that examines the role of the globalized bank network, which we hypothesize may be regarded as new bank characteristics that possibly affect the effectiveness of the bank lending channel, as well as the cross-border shock propagation.

1.2.1 Bank lending channel: Theory and relevant evidence

Bank lending channel is one of monetary policy transmission mechanisms in which monetary policy is transmitted through the banking system.[9]

[9] The other two channels through which monetary policy is transmitted via banking system are traditional interest rate channel and broad credit channel (Bernanke and Gertler 1995, Mishkin 1996, Peek and Rosengren 2013).

This channel activates as follows (Bernanke and Gertler 1995, Kashyap and Stein 2000, Peek and Rosengren 2013). When available bank reserves reduce due to monetary policy tightening since central banks reduce liquidity supply to the markets during a policy contraction either directly or indirectly (in the case of an interest rate setting policy), banks can respond to this by either replacing the reservable customer deposits with nonreservable debts, or shrinking their assets such as loans and securities in order to keep total assets in line with the reduced volume of funding liabilities, or more realistically combining the two to some extent (Figure 1.1). If banks are unable or unwilling to fully insulate their loan portfolio, this reduction in the availability of bank loan stemming from loan-supply side decreases aggregate demand in the economy, and overall economic activity slows down.

Figure 1.1: Procedure of bank lending channel in a simplified balance sheet

Asset	**Liability**
Loan	Reservable deposits
Securities	External funds / Nonreservable debts
Cash / Reserves	Net worth (equity capital)

In face of a contractionary monetary policy shock, banks lose their reservable deposits. To keep their balance sheet insulated from the policy tightening, the banks should raise other components in liability sides such as nonreservable liabilities (e.g. time deposits) or external finance. In the case where banks cannot substitute all of their losses in reservable deposits towards other forms of finance, then the asset sides of their balance sheets must shrink. Furthermore, if they cannot fully absorb the shock by reducing their liquid assets such as securities, cash and reserves in asset sides, then they have to reduce their loan supply, thus shrinking bank lending (Bernanke and Gertler 1995, Kashyap and Stein 2000, Peek and Rosengren 2013).

The dependency of banks on the adjustment of loan might differ across

The traditional interest rate channel works in two stages: at first, a contractionary monetary policy lead to an increase in short-term policy rates, and this in turn cause a rise in long-term interest rates based on term structure of yield curve. An increase in the long-term interest rates raises the cost of capital, thereby causing a decline in investment spending, and thus aggregate demand declines.

The broad credit channel (balance sheet effect or financial accelerator) focus on credit market imperfections associated with asymmetric information and moral hazard problems, and the magnification, or propagation, of monetary policy shocks to frictions in the credit markets (Bernanke, Gertler, and Gilchrist 1999). An increase in interest rates associated with a tightening of monetary policy causes a deterioration in firm health, in terms of both net income and net worth. The reduction in the collateral value of the firm's assets, in turn, cause an increase in the external finance premium that must be paid by the firm for all sources of external finance. This additional increase in the cost of borrowing causes a reduction in aggregate demand.

banks based on their intrinsic features. Empirical studies on bank lending channel thus have investigated bank characteristics that might play a role as a reasonable proxy for the degree of access to nonreservable liabilities or external finance that possibly alleviates the impact of monetary policy tightening on the reduction on bank lending. This is because the extent to which banks adjust their loans instead of other components in their balance sheet depends heavily on how well they can access external funds. Kashyap and Stein (1995) hypothesized that smaller banks have more limited access to external finance and thus their loan portfolio are more impacted by a tightening of monetary policy. They found empirical evidence supporting the proposition that small banks are more responsive (shrink their loan portfolios by more) than large banks to a monetary policy tightening. They also found that banks with large securities holdings have an option of adjusting to the shrinkage of reservable deposits by selling some of their securities, and thus less liquid banks are more responsive to monetary policy tightening (Kashyap and Stein 2000). Kishan and Opiela (2000) used the capital-to-asset ratio as the proxy for a bank's ability to raise external finance, finding that the loan portfolios of well capitalized banks are less sensitive to monetary policy shocks. Campello (2002) distinguished smaller banks based on whether the bank is affiliated with a large multibank holding company, and found that the lending of small banks affiliated with large multibank holding companies react less to a tightening of monetary policy than does the lending of similar sized standalone banks. In a similar context, Ashcraft (2006) found that affiliation with a multi-bank holding company gives a subsidiary bank better access to external funds than otherwise similar stand-alone banks. Holod and Peek (2007) utilized the distinction between publicly traded and non-publicly traded banks to classify banks by the ease with which they can access external funds. Considering recent developments in financial markets, Loutskina and Strahan (2009) found that growth in loan securitization, in particular the expansion of the secondary mortgage market, has weakened the transmission of monetary policy through the lending channel by increasing bank balance sheet liquidity. Bluedorn, Bowdler and Koch (forthcoming) stressed that the realized interest rate that is commonly used in the literature is endogenous to expected future macroeconomic conditions, which are likely to exert separate effects on both loan demand and loan supply. They argued this might cause a bias in the estimated impact conditional upon bank characteristics, and provided a comparison of the heterogeneity in bank lending responses to an explicitly identified monetary policy measure (Romer and Romer 2004) and the realized interest rate.

1.2.2 Global banks and monetary policy transmission

After the recent financial crisis, many studies have been conducted on the globalized banking system and its internal capital market between the parent banks and their foreign subsidiaries.[10]

US evidence The empirical research aiming to find supporting evidence for the operational internal capital market between head offices and their foreign subsidiaries has been led by studies of US-headquartered global banks, using the regulatory banking database.[11] Using US bank-level regulatory data from 1980 to 2005, Cetorelli and Goldberg (2012a) found that having global operations insulates US global banks from changes in monetary policy, while banks without global operations are affected by US monetary policy to a larger extent than previously found. They also found evidence that the internal capital market between the head offices and their foreign subsidiaries plays a role, by examining the internal transactions between them.[12] In a separate study, Cetorelli and Goldberg (2012c) illustrated that parent banks, when hit by a funding shock, reallocate liquidity in the organization according to a locational pecking order. Affiliate locations that are important for the parent bank revenue streams are relatively protected from the liquidity reallocations in the organization, while traditional funding locations are more extensively

[10] One earlier study before the recent financial crisis is Peek and Rosengren (1997, 2000). They examined how the financial crisis in Japan in the early 1990s affected the lending of the Japanese banks in the US.

[11] US global banks has been most actively studied. The reason for this might be that the recent financial crisis originated in the US, thus, the role of banks in the US during the crisis and the recovery period attracted a lot of attention. In addition, there is an effective number of banks that could be categorized as global banks in the US. As of 2005 Q4, there exist 107 global banks in the US according to Cetorelli and Goldberg (2012a). In other advanced countries, however, there is a small number of global banks, making it difficult to analyse their behaviour in comparison to other types of banks. More specifically, the number of global banks, as of 2013, according to *BankScope* is: Canada (5), France (10), Germany (5), Italy (6), Japan (7), and the United Kingdom (12).

[12] They defined a bank as *global* in each period if it had foreign assets greater than zero, thus identifying banks that have actual offices in foreign countries. They categorized banks into four types: large domestic banks, large global banks, small banks affiliated with a domestic bank holding company and small banks affiliated with a global bank holding company. They measured the differences in the responsiveness to the monetary policy indicators of the different bank groups in separate regressions. They also found evidence supporting the existence of an active internal capital market by examining the aggregate value of the internal transactions between the head offices and their foreign affiliates (*Net Due* item in the US regulatory databases so called *call report*).

used to buffer shocks to the parent bank balance sheets. With a host country perspective, Cetorelli and Goldberg (2012b) analysed the activity of foreign banks in the US through the operations of their local branches. They found that internal capital markets are at play in response to parent-bank funding shocks, and this causes a sizeable impact on the branch lending supply. Correa et al. (2014) found that the intra-firm borrowing in US global banks resulting from liquidity management strategies across the global organizations serves as a shock absorber and affects the lending patterns to domestic and foreign customers.

Non-US evidence Consistent empirical results are found in non-US region or emerging countries. The literature on non-US countries examines the role of the internal capital market and its consequences on domestic monetary policy effectiveness from the foreign banks perspective, not the domestically-owned global banks, as in the US-cases. Cetorelli and Goldberg (2011) argued that the loan supply in the emerging markets could be significantly affected through a contraction in the local lending by domestic banks owned by foreign banks. They analysed 17 country bank lending databases from 2007 to 2009, and found that the loan supply in the emerging markets could be significantly affected through three separate channels: a contraction in the direct, cross-border lending by foreign banks; a contraction in the local lending by the foreign banks affiliates in emerging markets; and a contraction in the loan supply by domestic banks resulting from the funding shock to their balance sheet induced by the decline in interbank, cross-border lending.

From data on the cross-border banking flows of 25 advanced and emerging market economies, Reinhardt and Riddiough (2014) found that parent banks in an advanced-economy benefit from inflow during episodes of heightened global risk. It has been also suggested that the internal capital markets are at play in foreign banks working in France (Bussire et al. 2014) and Poland (Pawlowska et al. 2014). Case-studies for Canada, Germany, Ireland, Italy and the UK are currently in progress as a joint research project.[13] From the emerging economies data of Asia, Latin America, and Central and Eastern

[13]Researchers from eleven central banks and the Federal Reserve Bank of New York formed the IBRN (International Banking Research Network) to jointly analyse issues pertaining to global banks. As a research agenda in 2013, they are currently studying how funding shocks affecting parent banks are transmitted into foreign countries through their cross-border banking activities. The primary advantage of this cooperation is that each researcher from each central bank utilizes their own regulatory database of the banks operations in its territory; they share standardized methodologies.

Europe during the period from 1996 to 2003, Wu et al. (2011) found that the bank lending channel in the emerging economies is declining in strength, as foreign banks adjust their outstanding loan portfolios and interest rates to a lesser extent than that of domestic banks in the face of a monetary policy change.

Jeon and Wu (2014) studied bank lending for seven Asian countries, focussing on foreign-owned banks during the recent financial crisis period. They incorporate two dummy variables, one to distinguish foreign banks from domestic banks, and the other to segregate the 2008-2009 financial crisis periods from the normal period, into an otherwise standard bank lending channel model. They focus on the marginal responsiveness of foreign banks during the crisis period and find that foreign banks operating in seven Asian countries reduced their bank lending significantly during the financial crisis period. From this finding, they postulate that this is due to the reallocation of funds from foreign banks (subsidiaries) to their head offices through the internal capital market.

In their earlier study, Jeon et al. (2013) attempted to find more direct evidence supporting the existence of internal capital markets, using bank-level data for 368 foreign subsidiaries of 68 multinational banks in 47 emerging economies during the period of 1994-2008. They measured how parent banks′ financial conditions affect their subsidiaries′ dependence on their own funds in expanding real loan growth. They find that when parent banks (head offices) are in a good financial condition, the real loan growth of the subsidiaries become less dependent on their own funds.

Our specifications in this chapter broadly follow those of Jeon et al. (2013, 2014). The primary difference to Jeon and Wu (2014) is that we distinguish domestically-owned global banks ($Parents$), and measure asymmetric response of $Parents$ to monetary policy shocks both in normal periods from 2000 to 2007, and crisis periods with an extended periods from 2000 to 2014. We also measure how a $Parents'$ financial conditions affect their subsidiaries′ ($Juniors$) lending, using the specification strategy adopted by Jeon et al. (2013). The salient difference to this reference is the scope of the analysis, in that they analysed 368 foreign subsidiaries of 68 multinational banks in 47 emerging economies, while we only examine 26 $Parents$ headquartered in the eight Asian countries and their 82 foreign subsidiaries ($Juniors$). We will discuss these in detail in Section 1.5.

1.3 Structure of the banking industry

We examine the primary features of the *Parents* (global banks headquartered in the eight Asian countries) and investigate the relative size of their *Juniors* (foreign subsidiaries affiliated with *Parents*). The figures in this section were constructed based on the annual bank-level data of the 271 commercial banks of the eight selected Asian countries from *BankScope*, which we will discuss in more detail in Section 1.4.

1.3.1 Banking industry structure and global banks

The most salient feature in the banking structure of the eight Asian countries is that the banking industry is highly concentrated. It is dominated by a few of the largest banks, in relation to asset size. Table 1.1 illustrates that the largest 10% of banks in number occupy approximately one third to two thirds of the total assets in the country. The upper half banks account for almost 90% of the total assets.

Table 1.1: Concentration of the banking industry

	HHI[1)]	Share of Asset[2)]		
		10th	25th	50th
Hong Kong	0.258	77.3	88.8	98.1
Indonesia	0.085	63.0	81.2	93.5
Korea	0.125	35.6	63.4	90.0
Malaysia	0.102	47.5	68.2	91.0
Philippines	0.104	46.8	69.2	91.8
Singapore	0.315	40.8	94.8	97.9
Taiwan	0.111	33.7	68.1	90.4
Thailand	0.053	33.4	63.7	86.2

Notes: 1) Herfindahl-Hirschman Index: $HHI = \sum_{i=1}^{N} s_i^2$ where, s_i is market share of bank i operating in the country ($s_i = asset_i / \sum_{i=1}^{N} asset_i$), 2) Asset share of the largest 10th, 25th, 50th percentile banks in size in each domestic banking sector, 3) As of 2010

To investigate the banking structure in detail, we classify 271 commercial banks operating in the eight Asian countries based on their ownership type as below. Domestically-owned banks are classified either global banks or domestic banks, based on whether they have at least one foreign subsidiary abroad. Foreign banks are foreign-owned banks operating in the region. For the banks operating in the eight Asian countries, we term global banks as *Parents*, the foreign banks as *Foreign banks*, and the domestic banks as *Domestic banks*.

- Global bank: A domestically-owned bank that has at least one foreign subsidiary abroad for which the head office has 50% or higher controlling equity
- Foreign bank: A bank owned by foreign banks or firms; the capital owned by overseas banks or firms is higher than 50% of the capital
- Domestic bank: A domestically-owned bank that does not have a foreign subsidiary abroad

According to this classification, Table 1.2 shows the composition of the banking sector in numbers, total assets, and average asset per bank in years 2000 and 2010. The high degree of concentration in the banking sector, as illustrated in Table 1.1, is driven by the *Parents*, as the *Parents* constitute the largest banks in each country. More specifically, *Parents* are a few in number, but they occupy the majority of the banking sector in size. In 2010, the *Parents* in the eight countries consisted of 26 out of the total 212 banks (12.3%), but they occupied 41.2% of the total assets. The average assets of the *Parents* is 83.4 billion US dollars, far exceeding those of the *Domestic banks* (13.5 billion US$) and the *Foreign banks* (20.8 billion US$).

This contrast becomes more enlarged when we exclude Hong Kong, where *Foreign banks*, not *Parents*, constitute the largest bank group, possibly due to its historical background.[14] With Hong Kong excluded, 24 *Parents* (13.3%) occupy 53.7% of the total assets, while 57 *Foreign banks* (31.5%) take up only 10.1% of the total assets in seven out of the eight Asian countries investigated in 2010. It is also clear that from 2000 to 2010, the difference in asset shares between *Parents* and *Foreign banks* enlarged. These results illustrate that *Foreign banks* are still relatively small in the Asian region compared to the regional domestic banks.

Consequently, we deduce that the *Parents* (Asian headquartered global banks) in our sample constitute the largest banks in each country, with a significant market share.[15] This necessitates research in this area. If *Foreign bank*

[14]Hong Kong has a high penetration of foreign banks, both in number of banks and in assets; only one domestic bank was ranked as one of the largest 10 banks. In Hong Kong, the largest banks are either UK or China originated foreign banks; this might be due to its close economic relationship with both countries, based on historic backgrounds.

[15]With the exceptions of Hong Kong, Taiwan and the Philippines, the biggest bank in each country is a global bank (*Parents*). As explained previously, foreign banks constitute the largest banking group in Hong Kong. The largest banks operating in Taiwan and the

Table 1.2: Structure of the banking industry

	All countries[1)]		Excluding HK[2)]	
	2000	2010	2000	2010
Number of banks				
Parents	18	26	16	24
Domestic bank	133	105	125	100
Foreign bank	85	81	52	57
All banks	236	212	193	181
Share of assets (%)				
Parents	25.0	41.2	32.2	53.7
Domestic bank	46.9	26.8	62.7	36.1
Foreign bank	28.0	31.9	5.2	10.1
All banks	100.0	100.0	100.0	100.0
Asset per bank[3)]				
Parents	27.8	83.4	29.5	86.8
Domestic bank	7.1	13.5	7.3	14.0
Foreign bank	6.6	20.8	1.5	6.9
All banks	8.5	24.8	7.6	21.4

Notes: 1) Include all the eight selected Asian countries, 2) Seven countries with Hong Kong excluded, 3) billion US$, 4) See APPENDIX A.2 for detailed information on banking industry structure by country and by year.

(foreign-owned banks) lending behaviour differs from that of other banks, it might not cause significant differences, in that they control only a small portion of the total assets. However, if the *Parents* have a different lending practice, this could cause an important implication on the effectiveness of the monetary policy transmission and shock propagation via the banking sector.

1.3.2 Global banks and their foreign subsidiaries

In this section, we examine the composition of banks in the selected countries, and information on the *Juniors* (foreign subsidiaries affiliated with *Parents*) more in detail. As explained previously, our primary regressions examine banks operating in eight selected Asian countries, classified as *Parents*, *Foreign bank* and *Domestic bank*. Though *Juniors* are not included in our main specification model, it is necessary to pay careful attention to properly identify the *Juniors* for several reasons.[16] Firstly, our distinction of *Parents*

Philippines are domestic banks that do not have foreign affiliates; however, global banks still constitute the largest banks. In Taiwan, all four global banks rank in the top eight banks. In the Philippines, all three global banks rank within top five banks in size.

[16] In this sense, in our basic specification, only these three types matter; *Junior* does not matter. In Section 1.5.2.2, however, we only utilize the observations of the 26 *Parents* headquartered in the eight countries and their 82 *Juniors* operating in 19 countries; hence,

from other types of banks is based on the existence of the *Juniors* affiliated with them. Secondly, one of our strategies is based on the size of the *Juniors*, since we conjecture that the extent that the *Parents* utilizes their internal capital market with their *Juniors* can be proxied by the *Juniors'* size. Thirdly, we make use of pairs of 26 *Parents* and their corresponding 82 *Juniors* to examine how financial conditions of one side affect bank lending of the other side in Section 1.5.3.

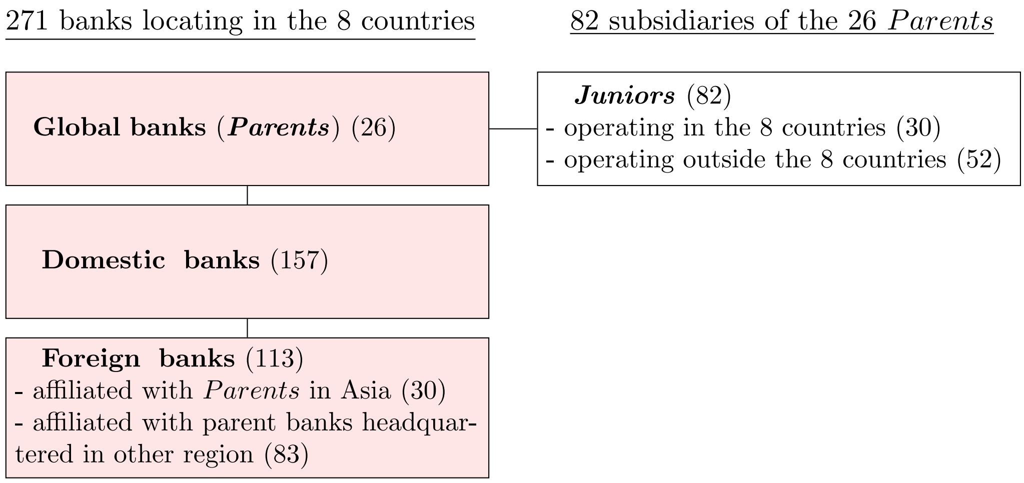
Figure 1.2 illustrates the composition of the banking sector by type of ownership. In the territories of the eight countries, there exists 26 *Parents*, 157 *Domestic banks* and 113 *Foreign banks*. These banks constitute the first dataset for examining the asymmetric responses in the lending behaviours of these three different types of banks (Section 1.5.1 and Section 1.5.2).

If we move our focus to the *Parents*-*Juniors* context, 26 *Parents* have 82 *Juniors*, in total, operating in other economies. Each *Parent* has 3.2 Juniors, on average, ranging from 1 to 7; these *Juniors* are located in 19 countries.[17] This is our second dataset. We utilize the pairs of the *Parents* and their *Juniors* to examine the more direct relationship between the financial conditions, on the one hand, and bank lending, on the other hand, in Section 1.5.3. It is noteworthy to mention that among these 82 *Juniors*, 30 are located in one of the other countries within the eight countries considered. These 30 banks are the *Juniors* in the parent subsidiary context in the second dataset; at the same time, they are classified as *Foreign banks* in the host country perspective in the first dataset.

this is not necessarily the Asian region in terms of when we examine the relationship between the bank lending of *Juniors* and their *Parents* financial conditions. It is noteworthy to state that 30 out of 113 *Foreign banks* are affiliates of their *Parents*. Thus, they could be classified as *Juniors* at the same time.

[17]By region, the majority of subsidiaries (63 out of 82) are located in other Asian countries, while 8 and 1 are located in the European Union (EU) and the US, respectively. Among the 63 Asian subsidiaries, 30 are located in the 8 selected countries; thus, they are classified as *Foreign banks* in the host economies. 33 *Juniors* are primarily located in China and the southern Asian countries of Vietnam and Cambodia.

Figure 1.2: Composition of the banks based on their type of ownership



This diagram illustrates the scope of banks used in our analysis based on their type of ownerships. One dataset examines 271 banks operating in the 8 selected Asia countries, while the second dataset investigates 26 *Parents* banks and their 82 *Juniors*. Figures in parenthesis is the number of banks.

• **Banks in the 8 countries**: 271 commercial banks in the eight Asian countries (shaded area) constitute the first dataset used throughout Section 1.5 (except for Section 1.5.3). We categorize these 271 banks based on the type of ownership into *Parents* (global banks), *Domestic* (domestically-owned banks that do not have a foreign subsidiary) and *Foreign bank* (foreign-owned banks). One caveat is that sum of the number of banks in each of the sub-categories exceeds total number of banks (271), reflecting that some of the banks experienced a change in type during 2000-2014.

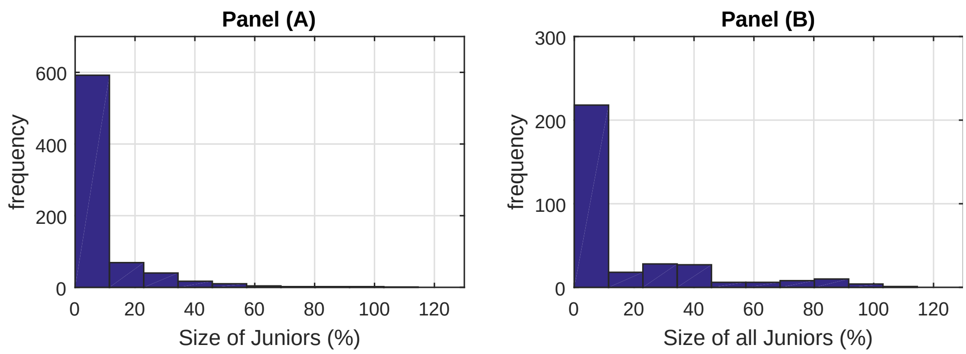
• **26 Parents and their 82 Juniors**: In Section 1.5.3, we build upon the second dataset. This dataset consists of the 26 *Parents* and their 82 *Juniors* (foreign subsidiaries affiliated with the 26 *Parents*) operating in 19 countries. One caveat is that 30 out of these 82 *Juniors* are located in one of the 8 Asian countries (but not the country where its *Parents* are located). Thus, they are included in both datasets (classified as *Foreign bank* in the first dataset).

Relative size of the subsidiaries As stressed previously, the most interesting feature of the *Juniors* is their size. We think the most relevant characteristics of foreign subsidiaries in regard with the magnitude of hampering effects that their parent banks have is their relative size. This is because the larger the *Juniors* are, the more likely that *Parents* can utilize its internal capital market to relieve the financial stress they face. In this regard, we examine the relative size of 82 *Juniors* compared to their *Parents*.

Figure 1.3 delivers information on the relative size of *Juniors*, as compared to their *Parents*. At first, Panel A provides the distribution of the relative size of the *Juniors* based on 739 observations from 2000 to 2014. The x-axis represents the relative size of a single *Junior* as a ratio to its *Parents* size (total assets) in each year ($= asset_j^J / asset_i^P \times 100$). The y-axis represents its frequency. The distribution of the *Juniors* size is very left-skewed, with its median 1.31% and mean 7.38% (Std Dev. 13.88, Min 0.00%, Max 114.57%). This illustrates that an individual subsidiary is quite small, when compared to its parent banks.

Secondly, we sum the size of the individual subsidiaries in Panel A across its parent banks, to calculate the total size of all subsidiaries that each global parents banks have in a specific year ($= \sum_{j=1}^{n} asset_j^J / asset_i^P \times 100$). Panel B shows the distribution of this aggregated size, based on 326 bank-year observations from 2000 to 2014.[18] The X-axis represents the ratio and the Y-axis represents the frequency. This distribution is left-skewed as well, with its median of 1.99% and mean of 16.00% (Std Dev. 24.70, Min 0.00%, Max 114.57%). This measure might be more relevant in that from the *Parents'* perspective, it could better represent the potential capacity of their *Juniors* to provide enough sufficient liquidity to help its *Parents* shield its loan in the face of financial stress.

Figure 1.3: Division of *Parents*, based on the size of their *Juniors*



Notes: 1) In Panel (A) presents distribution of *Juniors* in its size. The x-axis represents the ratio of a single *Juniors* assets to its *Parents* assets for a specific year ($= asset_j^J / asset_i^P \times 100$). The y-axis represents its frequency based on 739 bank-year observations from 2000 to 2014 (Median 1.31%, Mean 7.38%, Std Dev. 13.88, Min 0.00%, Max 114.57%).
2) Panel (B) presents Distribution of the *Parents* by the total assets of all the *Juniors* that they have. The x-axis denotes the ratio of total assets of all *Juniors* affiliated to each *Parents* ($= \sum_{j=1}^{n} asset_j^J / asset_i^P \times 100$) based on 326 bank-year observations from 2000 to 2014 (Median 1.99%, Mean 16.00%, Std Dev. 24.70, Min 0.00%, Max 114.57%).

1.4 Data description

We briefly introduce the standard model typically adopted to investigate the bank lending channel and what kind of indicators are included for the estima-

[18] In Section 1.5.2, we divide *Parents* into two sub-groups based on these statistics; (i) $Parents^{(1)}$ that have relatively larger *Juniors*, and (ii) $Parents^{(2)}$ that have relatively smaller *Juniors*.

tion of such a basic model. Then we explain how to construct the bank-level and country-level dataset that will be used in our empirical analysis. Our specification models, thought of as an extension of this basic model, will be explained in more detail in Section 1.5.

1.4.1 Bank-level data

We used *Bureau van Dijk's BankScope* database to construct the annual unbalanced panel data for the bank lending and bank characteristics.[19] *BankScope* provides information from individual bank balance sheets and financial statements in a standard format.[20] We only include commercial banks to exclude the possible bias due to the different nature and business scope of the different types of banks.[21]

The definitions of the bank-level variables (two dependent variables and five bank characteristics) used are as follows (See APPENDIX A.1 for more detail). We consider two dependent variables, real loan growth rate and real loan interest rate, representing a change in the loan quantity and a change in loan price in real terms, respectively. For the bank characteristic variables, we include five indicators that measure the size of the liquid asset, equity or total asset, and the degree of riskiness, as well as the profitability of the loans.

Dependent variables (bank lending):

Notes: See APPENDIX A.1 for detailed definitions of each of these variables.

[19] Most of the literature on this topic has used the regulatory database or BIS cross-border banking statistics. We do not utilize these sets of data, in that the former are not open to the public and the latter provides limited information on country-level bank lending to the public. The regulatory database has detailed information on individual bank characteristics and management status, including internal transactions between the head office and its subsidiaries, allowing us to directly test the existence of internal capital markets and its impacts on monetary policy transmissions (Cetorelli and Goldberg 2012a among others). The BIS cross-border banking database provides the cross-border banking transactions in aggregated level of its member countries. It possibly allows us to test the international movement of liquidity in response to monetary policy at the country-level (Cetorelli and Goldberg 2011, Reinhardt and Riddiough 2014).

[20] The overall quality of the *BankScope* database for its coverage for banks has been assessed as good. Cunningham (2001) observes that in 15 of 19 emerging market economies, banks listed in *BankScope* cover more than 90% of the total banking sector assets, with 1999 as a reference year. The countries examined in the paper embrace 6 countries out of 8 countries investigated in our study, with Hong Kong and Singapore excluded.

[21] *BankScope* classifies banks into 6 categories, based on specialization (except central banks): commercial banks, saving banks, cooperative banks, real estate and mortgage banks, investment banks and Islamic banks. As of 2014, commercial banks constituted 58.7% in number (283 out of 482 banks), and 88.1% in total assets (7.6 out of 8.6 trillion US$).

- Real loan growth rate (%) ($\Delta lnLoan$) : A change in the loan quantity in real terms, generated by deflating nominal loan in the local currency with the domestic price level (CPI).
- Real loan interest rate (%p) ($\Delta Loan\ rate$) : A measure of a change in the loan price, which is the difference in the ratio of the interest income to the total earning assets.

Bank characteristics variables:

- Liquidity (%) : A ratio of liquid assets to total assets.
- Capitalization (%) : A ratio of equity to total assets.
- Size (log) : A log of the total assets measured in US dollars.
- Riskiness (%) : A ratio of the loan loss provision to total loans.
- Profitability (%) : A ratio of the net income to total assets (ROAA).

To eliminate the impacts of abnormal observations, we excluded the highest and lowest 1 percentile of the growth rates of the assets and loans in real terms. We also excluded the highest and lowest 1 percentile of the bank characteristics, such as the liquidity, capitalization and riskiness.[22] After this procedure was conducted, we had an unbalanced dataset, consisting of 2,613 bank-year observations for 271 banks with 314 bank-year observations removed.

Table 1.3 illustrates the descriptive statistics of the bank lending variables and the bank characteristics by bank type group. Compared to the other types of banks, *Parents* have less liquid assets and equity, measured as a ratio to total assets. In size, measured in terms of assets, *Parents* are the largest, followed by the *Domestic banks* and *Foreign banks*. *Parents* have the most loan loss provisions, measured as a ratio to total assets. These characteristics of *Parents*, as compared to *Domestic banks* and *Foreign banks*, necessitate controlling for these factors to partial out the effects of these bank characteristics, and thus, isolating the effect of bank ownership on bank lending.

In addition, we examine the correlation structure among the bank-level

[22]We also exclude observations when the equity is negative, in that it does not represent normal business conditions. We do not remove the 1st and 99th percentile of the ROAA (profitability), considering that, unlike other characteristics, it has quite a concentrated distribution. In the case of size, we drop the outliers of the growth rate of real total assets (deflated by CPI). This is to exclude bank-year observations with rapid expansions or shrinkages, possibly due to the M&A (mergers and acquisitions), or other unusual managerial reasons, though we include the size of the bank (in level, not in growth rate) in the bank-characteristic variable. After this procedure, we lose 203 bank-year observations (for each variable to which the top 1% and bottom 1% removal rule is applied, about 32 observations are removed; 8 observations are removed where capital is negative. Observations that do not have full bank-level variable sets are also excluded.). We examine the alternative methods of dealing with the outliers in Section 1.5.4 Robustness tests. The results, when none of the outliers are excluded, will be presented, as well.

Table 1.3: Descriptive statistics

Type of Banks	All banks	*Parents banks*	*Domestic banks*	*Foreign banks*
Observations	2613	319	1392	902
Groups[2)]	271	26	157	113
$\Delta lnAsset^{3)}$ (%)	6.99	7.10	7.11	6.78
$\Delta lnLoan$ (%)	8.22	8.56	8.05	8.35
$\Delta Loan\ rate$ (% point)	-0.31	-0.28	-0.27	-0.39
Liquidity (%)	22.01	17.89	19.32	27.61
Capitalization (%)	11.24	8.47	10.00	14.12
$Size^{3)}$ (log)	8.50	10.67	8.40	7.90
Riskiness (%)	1.05	1.09	1.13	0.91
ROAA (%)	0.98	0.94	0.74	1.36

Notes: 1) Figures are mean value of total 2,613 bank-year observations. 2) Number of sub-groups exceeds total number reflecting that some banks experience a change of type of bank ownership during 2000 to 2014. 3) As size is dummy variable, there cannot be any size outliers. Instead we exclude outliers relevant to size based on growth rates of real assets ($\Delta lnAsset$). This is because we do not regard the largest and the smallest banks as outliers, rather we regard a significant change in asset size as abnormal observations possibly stemming from managerial changes such as M&A (mergers and acquisitions). 4) See APPENDIX A.3 for further information on descriptive statistics and pair-wise correlation coefficients.

variables (the pairwise correlation matrix in APPENDIX A.3). If some of the bank characteristics are highly correlated and included in the estimation model simultaneously, this might generate a problem of multicollinearity. We confirm that some of the bank characteristics are statistically significantly correlated; however, they do not have substantially high correlation coefficients.

1.4.2 Country-level data

The country-specific data consists of indicators representing monetary policy, overall economic activity and banking sector structure. For an indicator of monetary policy, we use annual difference of the overnight interbank loan rate, in that it reflects the primary price of the short term funds for banks and the overall changes in the monetary policy stance, regardless of the monetary policy operational regimes that each country adopts.[23] Among the total 2,613 bank-year observations from 2000 to 2014, 1,135 observations were related

[23] Among the eight countries, 6 countries (except for Hong Kong and Singapore) adopt inflation targeting as its monetary policy framework. Hong Kong and Singapore have exchange rate targeting as their monetary policy scheme; hence, they adjust their money base and their domestic interest rate, to maintain the exchange rate as relatively constant within a predetermined band.

to policy tightening ($MP > 0$), while 1,413 corresponded to policy easing ($MP < 0$). For 65 observations, the monetary policy is unchanged ($MP = 0$).

As a measure of the overall economic activity in the country, the growth rate of real GDP and the unemployment rate are adopted. For indicators of the banking sector conditions, the financial depth and HHI are included.[24] Financial depth, a measure of financial resources provided to the private sector, are measured as a ratio of the bank credit to the private sector to GDP. The degree of concentration, and thus, competitiveness in the banking sector is measured by the HHI (Herfindal-Hirschman index), calculated as the sum of the squares of each bank′s share of assets in the banking sector of the countries considered. We calculate this index using the bank-level data from *BankScope*. The macroeconomic conditions and banking sector indicators for the eight countries were collected from the International Financial Statistics (IFS) of the International Monetary Fund (IMF), except for the financial depth, which was provided by the World Bank database.

1.5 Identification strategies and estimation results

This section consists of three sub-sections. In Section 1.5.1, we compare the responsiveness of the bank lending of different types of banks to monetary policy changes. We find that *Parents* (global banks headquartered in the 8 Asian countries) have a hampering effect on the domestic monetary policy, as they were less affected by the monetary policy during the normal periods from 2000 to 2007.

The remaining sub-sections aim to determine indirect evidence supporting the relevance of the operational internal capital markets on the hampering effects. In Section 1.5.2.1, we compare *Parents* that have relatively larger *Juniors* with those that have smaller *Juniors*. In Section 1.5.2.2, we include all observations available from 2000 to 2014 and examine the bahaviour of bank lending with a focus of 2008-2009 crisis periods. Lastly, we examine whether the financial conditions of the *Parents* affect the loan growth of their *Juniors* in Section 1.5.3. Section 1.5.4 provides results of robustness tests.

[24] Though these are not indicators that are commonly included in the relevant literature, we include these variables because the overall availability of bank credit and competitiveness in the banking sector might affect the bank loan supply. This concept follows that of Jeon and Wu (2014). We also examine the estimation results of the regressions without these variables in the relevant sections and find that the primary results do not change.

1.5.1 Hampering effect of global banks on monetary policy

We measure the marginal responsiveness of *Parents* to the domestic monetary policy to examine whether *Parents* are less responsive to monetary policy. If they are less responsive, we interpret this finding; the existence of *Parents* hampers the effectiveness of monetary policy. Thus, monetary policy tightening cannot calm down the overall economic activities, as much as expected by the theory of the bank-lending channel, via the *Parents*.

Identification model We adopt Estimation Equation (1.4) to measure the asymmetric response to the monetary policy shock of Asia-headquartered global banks in comparison of reference groups. The main difference from a general model for bank lending channel as Equation (1.3) in Section 1.4.1 is that we introduce the dummy variable $Parents_{ijt}$, indicating the type of bank ownership and its interaction terms with the monetary policy indicator.[25]

$$\begin{aligned} Lending_{ijt} &= \alpha + \beta \cdot MP_{jt} + \gamma \cdot Parents_{ijt} + \delta \cdot Parents_{ijt} \times MP_{jt} \\ &+ \zeta \cdot BankChar_{ijt-1} + \eta \cdot Macro_{jt} + \theta \cdot BankSec_{jt} + bank_i + \epsilon_{ijt} \quad (1.1) \end{aligned}$$

where,

- $Lending$: bank lending, $\Delta lnLoan_{ijt}$ (for quantity), $\Delta Loan\ rate$ (for price)
- MP : monetary policy indicator, $\Delta Money\ market\ rate_{jt}$
- $Parents$: dummy variable indicating *Parents*
- $BankChar$: bank characteristics, [$Capitalization$, $Liquidity$, $Size$, $Riskiness$, $Profitability$]
- $Macro$: macroeconomic conditions, [$real\ growth\ rate$, $unemployment\ rate$]
- $BankSec$: banking sector environment, [$Financial\ depth$, HHI]

In Equation (1.4), subscript i denotes an individual bank, j denotes one of the eight countries where the bank operates, and t denotes the specific year. The dependent variable, $Lending_{ijt}$, represents a change in the bank lending of bank i in country j in year t. We adopt two different measures for $Lending_{ijt}$: (1) a change in the quantity of the loans ($\Delta lnLoan_{ijt}$), denoting the growth

[25] Jeon and Wu (2014) only examined *Foreign bank* in comparison with domestically-owned banks, while we expand their specification further by dividing the banks into three types: *Parents*, *Foreign banks* and *Domestic banks*. In addition, in the bank-level data, we change bank characteristics into a dummy variable. We do not include depreciation rate, because this overlaps the GDP growth rate and the unemployment rate; both reflect the overall economic activity, and thus, pressure on loan demands. These changes do not cause meaningful differences in the results. Our sample also includes banks in Taiwan that are not investigated in their study.

rate of a bank loan in real terms, and (2) a change in the interest rates that banks charge on their loans ($\Delta Loan\ rate_{ijt}$), standing for a change in the loan interest rate. Hereafter, we term Equation (1.4) as the loan quantity equation and loan price equation, corresponding to the two dependent variables used.[26]

MP_{jt} denotes the monetary policy shock of country j in year t, measured by the annual difference of the overnight interbank loan rate. A positive (negative) value of MP_{jt} represents tightened (eased) monetary policy stances.

$Parents_{ijt}$ is a dummy variable, indicating global banks. $Parents$ are Asia headquartered global banks that have at least one foreign subsidiary ($Juniors$) abroad for which the parent bank has a 50% or higher controlling equity.[27]

For a bank that experienced a change of ownership during the period, different types are applied for different time periods. To identify the bank type in each period, we utilize the relevant information from *BankScope*, annual reports and the bank history. The list of $Parents$ and the relevant information on them in our selected economies is presented in APPENDIX A.4.

$BankChar_{ijt}$ consists of bank-level characteristics that measure idiosyncratic features, other than their ownership types, and are included to partial out the effects of the bank characteristics on the loan supply. This includes relevant indicators measuring the degree of $Liquidity$ and $Capitalization$, $Size$, $Riskiness$ and $Profitability$, as defined in Section 1.4.2.1. They are included in line with the empirical evidence from the relevant literature, as explained in Section 1.3.1. The literature suggests that banks that are more liquid, more capitalized and larger in size, are better able to access alternative options to finance their loans, and thus, would be less responsive to monetary policy shocks. The riskiness of borrowers (of loans) and profitability are also controlled for in that the perception of riskiness on their loans and profits realized would also affect their management, and thus, the supply of bank loans.[28] We transform each bank characteristic variable into dummy variables equal to

[26]Most of the relevant literature usually examines the quantity of lending, but not the price of lending. As in Jeon and Wu (2014), we also examine the change in the lending price. We expect that banks adjust their interest rate, as well as the volume of the quantity, in line with the changes in the overnight call rates and the overall liquidity availability they faces.

[27]In baseline regression, we do not include $Foreign$ that is a dummy indicative of foreign-owned banks operating in the Asia countries. We expand the basic model to include this $Foreign$ dummy and its interaction terms with relevant variables. A bank is defined as a $Foreign\ bank$ if the capital owned by the foreign parent banks or firms is higher than 50% of the total capital.

[28]According to Van den Heuvel (2008), changes in bank profitability affect bank lending through the bank capital channel. According to this view, if bank profits decline especially when the equity capital is low and it is costly to issue shares, banks may reduce lending.

one if the variable is above the median value in the distribution of the variables of all observations of each country in each year, and zero otherwise. To avoid reverse causation, we include a one-year lag of these bank characteristic variables.

$Macro_{jt}$ includes a set of country-specific variables of country j in year t that are relevant to macroeconomic conditions. It includes the real GDP growth rates and the unemployment rate to control for the demand-side effect in determining a bank loan quantity or price. $BankSec_{jt}$ represents the conditions of the banking industry, which possibly affects the bank management on their lending and includes the $Financial\ depth$ and the HHI. $Financial\ depth$ denotes the overall size of the financial resources provided to the private sector; HHI stands for the degree of competition or competitiveness in the banking industry. $bank_i$ indicates bank-fixed effects.

We interpret the negative and significant coefficient on MP_{jt} in the loan quantity equation would support the existence of the bank lending channel, controlling all possible bank characteristics and loan demand influences.[29] A coefficient close to zero would imply that banks could respond to the reduction of reservable deposits with components other than loans in their balance sheet, thus weakening the existence of the bank lending channel. In the loan price equation, the coefficient measures how well the banks shift the change in the market interest rates on the interest rates they charge on their bank loan, and thus, a large positive coefficient would indicate that banks are more responsive to a change in monetary policy. Our primary interest is whether $Parents$ are less vulnerable to monetary policy tightening. If they are, they could shield their bank lending, either in quantity or price, as compared to other types of banks. Positive coefficients on $Parents_{ijt} \times MP_{jt}$ in the loan quantity equation and the negative coefficients on $Parents_{ijt} \times MP_{jt}$ in the loan price equation would imply that $Parents$ are less responsive to monetary policy shocks, thus they have hampering effects, offsetting the effectiveness of the monetary policy transmission via the bank-lending channel.

Estimation method We use the Ordinary Least Squares estimator to estimate Equation (1.4), as this is widely used in the relevant literature (Ashcraft

[29]We know that the results should not be regarded as an evidence for direct causal relationships. The identification scheme we use provides only suggestive evidences on the responses of bank lending to monetary policy actions. However, this is a standard methodology in investigating empirical evidences for the existence of the bank lending channel (See Section 1.2.1 for relevant studies.).

2006, Cetorelli and Goldberg 2012a, jeon and Wu 2014, among others). It might be the case that the error terms are not independent and identically distributed, but might be clustered (e.g. observations within each bank group are correlated, but banks from different groups are not correlated). Considering the incorrect inferences due to this, we cluster the standard errors at the bank-level, so that the standard errors are asymptotically robust to both the heteroscedasticity and the serial correlation.[30] We also consider bank-fixed effects to control bank-level heterogeneity, other than characteristics included that possibly affect the management of the loan supply and bank lending. We basically include the bank-fixed effects in the baseline regression based on the Hausman test results of the loan quantity equation. We also examine the estimation results from the OLS regression without the fixed effects and from the random effects estimator model (in the robustness test).

One primary concern that might be raised on our strategy is selection bias. It might be the case that the largest and most successful banks tend to become global banks ($Parents$) by launching new subsidiaries abroad and, at the same time, they might be better able to deal with financial stress by easily accessing external funds, when compared to smaller and less successful banks. If this is the case, the bank lending behaviour of $Parents$ might just reflect their size or successfulness, not the intrinsic feature of the globalized banking network and the internal capital market. To cope with this concern, we control the effects of other bank characteristics, including the measurement of size, liquid assets and capital, and the interactions of these characteristics with the monetary policy effects.

Another problem generated by including all of these bank characteristic variables is simultaneity, which is the reverse causation between the dependent variables and the bank characteristic variables. Bank characteristics (e.g. size, liquidity and capitalization) might affect a bank′s loan supply decision. That being said, these characteristics can be modified as a result of bank lending at the same time. To relieve the endogeneity problem and the resulting inconsistent estimates, we include bank characteristic variables in a one-year lag, as this technique is common in the relevant literature (Aschraft 2006 among others). This is to explicitly control for the impact of the bank characteristics on bank lending, while excluding the possibility of the reverse causation from the bank lending to the bank characteristics. For the country-specific

[30] We use STATA to generate the clustered standard errors.

variables, we assume that there is no instant feedback from bank lending to the macroeconomic conditions or policies.

Estimation results Table 1.4 shows the estimation results of Equation (1.4) with $\Delta lnLoan_{ijt}$ (Panel A) and $\Delta lnLoan\ rate_{ijt}$ (Panel B) as dependent variables. Table 1.4 and the subsequent tables in Section 1.5 present the estimated coefficients and their corresponding p-values that are corrected for heteroscedasticity and clustered at the bank-level. To save space, we present the coefficients on MP_{jt}, and its interaction terms with the bank type indicator: $Parents_{ijt} \times MP_{jt}$. Regression (1) is the baseline model.

Table 1.4: Result (1): Hampering effect (2000 − 2007)

	Panel A. Loan quantity equation Dependent: $\Delta lnLoan_{ijt}$				*Panel B. Loan price equation* Dependent: $\Delta Loan\ rate_{ijt}$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
MP	-1.090***	-1.130***	-1.174***	-1.223***	0.442***	0.440***	0.392***	0.413***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Parents \times MP$	1.395	1.436*	1.253	1.305*	-0.093	-0.088	-0.123	-0.077
	(0.120)	(0.099)	(0.142)	(0.081)	(0.320)	(0.351)	(0.190)	(0.397)
R^2	0.246	0.236	0.254	0.041	0.329	0.328	0.351	0.281
Observation	1354	1354	1354	1354	1354	1354	1354	1354
Groups	252	252	252	252	252	252	252	252
wald test								
$MP + Parents \times MP$	0.304	0.306	0.079	0.082	0.349***	0.352***	0.269***	0.337***
	(0.720)	(0.710)	(0.924)	(0.908)	(0.000)	(0.000)	(0.005)	(0.000)
$AR(1)$ in residual[3)]	-0.120***	-0.117***	-0.116***	0.147***	-0.289***	-0.287***	-0.301***	-0.134***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hausman test[4)]								
H_0: RE is preferred to FE,	*Panel A.* $\chi^2(12)$=32.26 (p-value: 0.001);				*Panel B.* $\chi^2(12)$=14.22 (p-value: 0.287)			
H_0: OLS is preferred to FE,	*Panel A.* $\chi^2(12)$=43.13 (p-value: 0.000);				*Panel B.* $\chi^2(12)$=18.33 (p-value: 0.106)			

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)**: baseline regression, **Regression (2)**: *Financial depth* and HHI are excluded, **Regression (3)**: time-fixed effects is included, **Regression (4)**: bank-fixed effects is excluded.
3) Coefficients on AR(1) term are generated by regressing the residual on one-year lagged dependent variable by Ordinary Least Squares estimator.
4) Based on baseline **Regression (1)**.

In Panel A, the loan quantity equation, we find that the bank lending channel exists for the reference groups (*Domestic banks* and *Foreign banks*), while *Parents* have hampering effects on monetary policy transmission, lowering the magnitude of the bank lending channel effect. The coefficients on MP_{jt} are consistently negative and significant, implying that the bank lending channel exists in the reference group. From the baseline model, Regression (1), it can be observed that reference groups reduce the real loan growth rates by about 1.090 percentage points, in response to a 1 percentage point increase in the money market rates. In contrast, the coefficient on $Parents_{ijt} \times MP_{jt}$ is 1.395; it is larger than the coefficient on MP_{jt} in absolute value. The sum of the coefficients on MP_{jt} and $Parents_{ijt} \times MP_{jt}$ is 0.304, implying that *Parents* do not reduce the growth of their loan quantity, as was expected by bank lending channel theory. This indicates that *Parents* do have hampering effects on monetary policy, weakening the effectiveness of monetary policy, and this implies that the bank lending channel does not exist for *Parents*. The coefficient on MP_{jt} never exceeds the coefficient on $Parents_{ijt} \times MP_{jt}$. This implies that the bank lending channel is fully offset in the case of *Parents*.

In Panel B, the loan price equation, the reference groups appear to adjust loan interest rates in line with a change in domestic monetary tightening, supporting the existence of the bank lending channel. In the baseline model, Regression (1), the coefficient on MP_{jt} is 0.442 and highly significant. This means that the reference group increases the real loan interest rate by 0.442 percentage points when the monetary policy rate rises by 1 percentage point. We interpret this evidence as being consistent with the finding in the loan quantity regression, suggesting that in the face of monetary policy tightening ($MP_{jt} > 0$), the reference groups reduce their loan quantity, while increasing their loan price. However, in contrast to the loan quantity equation, we do not find significant hampering effects of *Parents*. The coefficient on $Parents_{ijt} \times MP_{jt}$ is consistently negative, but small and insignificant.

Regression (2) through Regression (4) provides the estimation results of the variated models. Regression (2) excludes the banking sector indicators, *Financial depth* and HHI, in that these are not widely used indicators in the relevant literature. Regression (3) includes the time-fixed effects. In the baseline regression, we do not include the time-fixed effects in that the time-fixed effects hold constant the change in monetary policy that is common across countries. We relax this assumption in Regression (3). Regression (4) excludes the bank-fixed effects on the assumption that all bank-level heterogeneity is captured in the bank characteristic variables included. All results from these are essentially the same as the baseline regression results, though, in some cases, the estimated hampering effect is not significant at the conventional levels.

To recap, the evidence suggests that Asian global banks (*Parents*) are better able to shield their bank lending growth against monetary policy contractions, as compared to other types of banks, though there is no significant difference in the loan rate adjustment. This implies that global banks might have better access to overseas funding to protect their lending volume, but do not offset the changes to the cost of finance.

1.5.2 Division of Parents into two subgroups

The results in Section 1.5.1 do not tell anything about whether the internal capital market functions for the hampering effects the *Parents* have. We conduct two additional identifications in Section 1.5.2 and 1.5.3 aimed at finding indirect evidence supporting that the hampering effect of *Parents* is related to their operational internal capital market.

In this section, we examine the relationship between the size of *Juniors* affiliated with *Parents* and the degree of hampering effects that the *Parents* have. At first, we analyze the same periods from 2000 to 2007 (Section 1.5.2.1), and then we extend the time periods to include all observation from 2000 to 2014 with a focus on the behaviour of *Parents* during the financial crisis periods (Section 1.5.2.2).

1.5.2.1 Normal periods, Year 2000-2007

At first, we divide *Parents* into two subgroups based on the total assets of all *Juniors* that each *Parents* have, and examine whether this distinction matters for the magnitude of the hampering effects. We conjecture that the extent to which *Parents* can raise funds from its *Juniors* might depend on the relative size of its *Juniors*. More specifically, *Parents* with relatively larger *Juniors* might be better able to raise funds from its *Juniors*, as compared to *Parents* with smaller *Juniors*. If *Juniors* are small, compared to the *Parents*, then the scope that they can raise funds in support for the *Parents* would be limited. If *Parents* that have relatively larger *Juniors* (or small, but many *Juniors*) have a greater hampering effect, we interpret this as an evidence supporting that hampering effects (at least partially) are related to the internal transactions with their $Juniors$.

Estimation model We expand Estimation Equation (1.4) in Section 1.5.1 by dividing $Parents$ into two subgroups: $Parents^{(1)}$ denotes $Parents$ with relatively larger $Juniors$, and $Parents^{(2)}$ denotes those with relatively smaller $Juniors$. Thus, we now have two separate dummy variables that are indicative of the bank ownership types: $Parents^{(1)}_{ijt}$ and $Parents^{(2)}_{ijt}$. For the distinction of $Parents$, we use the ratio of total assets of all $Juniors$ affiliated to the $Parents'$ asset size. As a threshold, we initially use the median value (1.99%), as is explained in Section 1.3.2, and examine the cases of different thresholds in Section 1.5.4 (Robustness tests).

We expect that the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt}$ is larger than that on $Parents^{(2)}_{ijt} \times MP_{jt}$ if $Parents$ with relatively larger $Juniors$ have a greater hampering effect, thus implying that the magnitude of the hampering effect is related to its $Juniors$, and thus, the internal capital markets. We use OLS with clustered standard errors to estimate the specification, as in Section 1.5.1.

Estimation results The estimation results for the loan quantity equation and loan price equation are shown in Panels A and Panel B of Table 1.5, respectively. In Panel A, the loan quantity equation, the coefficient on $Parents^{(1)}_{ijt} \times MP$ is 2.035 and is larger in magnitude than the coefficient on MP_{jt} (-1.085) and larger than the coefficient on $Parents^{(2)}_{ijt} \times MP_{jt}$ (0.642) in the baseline regression. This indicates that the hampering effects of $Parents$ on monetary policy is larger amongst $Parents$ having relatively larger $Juniors$.

Table 1.5: Result (2): Two *Parents* groups ($2000-2007$)

	Panel A. Loan quantity equation Dependent: $\Delta lnLoan_{ijt}$				Panel B. Loan price equation Dependent: $\Delta Loan\ rate_{ijt}$			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
MP	-1.085***	-1.125***	-1.172***	-1.218***	0.441***	0.439***	0.391***	0.412***
	(0.001)	(0.001)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Parents^{(1)} \times MP$	2.035*	1.949	1.756	1.707	-0.234***	-0.226***	-0.244***	-0.217***
	(0.091)	(0.118)	(0.148)	(0.109)	(0.002)	(0.004)	(0.000)	(0.004)
$Parents^{(2)} \times MP$	0.642	0.839	0.647	0.626	0.087*	0.094**	0.039	0.117***
	(0.317)	(0.165)	(0.288)	(0.369)	(0.053)	(0.038)	(0.394)	(0.003)
R^2	0.245	0.235	0.253	0.041	0.329	0.328	0.351	0.282
Observations	1354	1354	1354	1354	1354	1354	1354	1354
Groups	252	252	252	252	252	252	252	252
wald test								
$MP + Parents^{(1)} \times MP$	0.950	0.823	0.584	0.489	0.206***	0.213***	0.147**	0.195***
	(0.419)	(0.501)	(0.626)	(0.639)	(0.004)	(0.004)	(0.026)	(0.005)
$MP + Parents^{(2)} \times MP$	-0.443	-0.287	-0.525	-0.592	0.528***	0.532***	0.429***	0.530***
	(0.428)	(0.578)	(0.358)	(0.356)	(0.000)	(0.000)	(0.000)	(0.000)
$AR(1)$ in residual[3)]	-0.120***	-0.118***	-0.116***	0.146***	-0.288***	-0.286***	-0.300***	-0.134***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hausman test[4)]								
H_0: RE is preferred to FE,	*Panel A.* $\chi^2(16)$=32.64 (p-value: 0.003);				*Panel B.* $\chi^2(16)$=13.99 (p-value: 0.451)			
H_0: OLS is preferred to FE,	*Panel A.* $\chi^2(16)$=43.98 (p-value: 0.000);				*Panel B.* $\chi^2(16)$=18.16 (p-value: 0.200)			

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation. 2) **Regression (1)**: baseline regression, **Regression (2)**: *Financial depth* and HHI are excluded, **Regression (3)**: time-fixed effects is included, **Regression (4)**: bank-fixed effects is excluded.
3) Coefficients on AR(1) term are generated by regressing the residual on one-year lagged dependent variable by Ordinary Least Squares estimator.
4) Based on baseline **Regression (1)**, 5) Number of $Parents^{(1)}$ and $Parents^{(2)}$ are 13 and 10, respectively (The sum of these exceeds total number of *Parents* (22), reflecting that some *Parents* experienced changes in their groups during the period).

In Panel B, the loan price equation, the difference of the hampering effects between $Parents^{(1)}$ and $Parents^{(2)}$ becomes more pronounced. In the baseline regression, Regression (1), the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt}$ is -0.234, roughly half of that on MP_{jt} in absolute value. This implies that *Parents* with larger *Juniors* adjust loan interest rates by only half in magnitude, as compared to reference groups. The results are consistent with our finding in the real loan growth equation, thus supporting that *Parents*, especially those having larger *Juniors*, reduce the real loan growth rate while increasing loan interest rates in response to domestic monetary tightening.

Regression (2) through Regression (4) provides the estimation results of the variated models, and they are constructed in the same way in the previous regression estimation without the division of *Parents*. We find that the results from these variated models are essentially the same as the baseline results in both loan quantity and loan price equations. The results remain essentially the same in both the loan quantity and loan price equations.

Our findings suggest that *Parents* that have relatively larger *Juniors* have greater hampering effects, though they are not consistently significant. These findings lend support to the proposition that the hampering effects that *Parents* have are related to the intrinsic features of globalized banking network, at least to some extent. It is not merely representing that *Parents* could better access to external capital markets, either because they have a global banking network or because they are the largest, most successful bank groups in the country. If hampering effects stem merely from the fact that global banks have better access to external financial resources, possibly due to its higher credit ratings, or if the hampering effects just reflect the fact that *Parents* constitute the largest banking group in each country, we expect that both *Parents* groups would have a comparable degree of hampering effects. Our findings suggest that this is not the case.

Table 1.6 illustrates that the asset sizes of the two *Parents* groups are comparable. Instead, we can say that $Parents^{(2)}$ that have smaller *Juniors* are actually larger than $Parents^{(1)}$ that have larger *Juniors*. Combined with the estimation results in Table 1.5, this tells us that larger groups ($Parents^{(2)}$) have smaller hampering effects than smaller groups ($Parents^{(1)}$) in adjusting their loan quantity, while no hampering effect at all occurs in adjusting their loan price, suggesting that the hampering effect does not reflect the size of the *Parents* banks. We believe that this strengthens our argument that the hampering effects of *Parents*, that is especially larger for $Parents^{(1)}$, are likely to be related to internal transactions with their *Juniors*, proxied by the size of the *Juniors* that clearly contrasts between the two groups.

Table 1.6: Comparison of two *Parents* groups in size

Two *Parents* groups[1)]	*Parents'* size (bill. US$)		*Juniors'* size[2)](%)
	2000	2014	
$Parents^{(1)}$	27.7 (25.5)	108.8 (78.1)	31.30 (25.71)
$Parents^{(2)}$	34.1 (25.9)	114.8 (89.8)	0.70 (0.68)

Notes: 1) *Parents* are divided into two subgroups based on the total asset size of all *Juniors* they have as a ratio to the *Parents'* asset. $Parents^{(1)}$ is the group of *Parents* that have relatively larger *Juniors* and $Parents^{(2)}$ is the group of *Parents* that have relatively small *Juniors*. The threshold for this distinction is median value (1.99%), as explained in Figure 1.3 in Section 1.3.2. 2) Size of total assets of all *Juniors* affiliated with $Parents^{(1)}$ and $Parents^{(2)}$, respectively (as a ratio to the *Parents'* asset), 3) mean value (median in parentheses)

1.5.2.2 Financial crisis and recent years

In this section, we extend the sample periods to 2014 such that we include observations of 2008-2009 financial crisis and recent years. In the previous sections, we examined the response of bank lending to monetary policy during the normal period from 2000 to 2007 in that the financial turmoil during 2008-2009 crisis might have brought different kinds of financial stress to banks. In this section, we include all observations available from 2000 to 2014, bearing in mind that the banking behaviour during the crisis might be different from those in normal periods.

The findings in this section might provide complementary evidence for Jeon and Wu (2014). Jeon and Wu (2014) found that *Foreign banks* operating in Asia reduced bank lending (quantity) to a larger extent, as compared to domestically-owned banks, during the 2008-2009 financial crisis period. They argue that this is indirect evidence supporting that global banks reallocate their liquidity from foreign subsidiaries to head offices in the face of financial stress. In particular, they claim that monetary easing in 2008-2009 in the Asian countries did not boost lending amongst *Foreign banks* in Asia, since those banks were being forced to lend funding to their foreign bank owners. We find that their findings are limited, in that they only examine one side of the mechanism (foreign banks) that they believe might have raised funds for their head offices, but they do not provide any evidence on the other side (global banks).[31]

For completion of this interpretation, it must be the case that Asian *Parents* have been better able to shield their bank loans during the same period. If one side (foreign subsidiaries) reduced its loan supply in support of the head office, then the other side (head office of global banks) must have utilized the additional funds coming from its foreign subsidiaries, and thus, have been better able to shield its bank lending. In this sense, we expect that *Parents* in Asia could increase (or decrease, to a lesser extent) their bank lending, as compared to *Foreign banks* and *Domestic banks* in the face of monetary easing during the financial crisis period. We find empirical evidence consistent with these expectations; hence, this provides a complete understanding of the bank lending in the *Parents* - *Juniors* context.

Estimation model We extend Equation (1.4) in Section 1.5.1, such that the estimation model includes additional observations of 2008-2014. We introduce an additional dummy variable ($Crisis$) indicative of 2008-2009 crisis periods and its interaction terms with MP_{jt}, $Parents^{(1)}_{ijt}$ and $Parents^{(2)}_{ijt}$. To be specific, we additionally include $MP_{jt} \times Crisis$, $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ and $Parents^{(2)}_{ijt} \times MP_{jt} \times Crisis$. Sum of coefficients on MP_{jt} and $MP_{jt} \times Crisis$ captures responsiveness to monetary policy of reference group in the crisis period. Sum of coefficients on MP_{jt}, $MP_{jt} \times Crisis$ and $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$, and sum of those on MP_{jt}, $MP_{jt} \times Crisis$ and $Parents^{(2)}_{ijt} \times MP_{jt} \times Crisis$ measure effects that $Parents^{(1)}$ and $Parents^{(2)}$ have in the crisis period, respectively.

Thanks to possible reallocation of liquidity towards headquarters, we expect that $Parents^{(1)}$ could better shield their loan supply, while maintaining the price of the lending relatively low in face of shortage of liquidity in the financial turmoil. To be specific, in loan quantity equation, we expect that $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ be negative, implying $Parents^{(1)}_{ijt}$ shield its lending in line with monetary easing ($MP < 0$) during the crisis periods, while this effect is smaller or not existant for $Parents^{(2)}$ that cannot utilize the internal capital market due to small size of their *Juniors*. In loan price equation, we expect $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ positive, and this means that $Parents^{(1)}$

[31] In robustness test (Section 1.5.4), we include *Foreign* dummy and relevant interacting terms so that we examine the opposite behaviour between *Parents* and *Foreign*.

could have maintained its loan price relatively low in spite of worsened liquidity condition possibly because it could have provided relatively profuse amount of loan supply. We use OLS with clustered standard errors to estimate the specification as in Section 1.5.1.

Estimation results The estimation results are presented in Table 1.7 and Table 1.8 for the loan quantity equation and loan price equation, respectively. Since we already examined the results for the non-crisis periods (2000-2007) in Section 1.5.1, we focus on interpreting the results of the crisis periods here.

In Table 1.7, the loan quantity equation illustrates that $Parents^{(1)}$, parents with relatively larger $Juniors$, increase the real loan growth rate. In the case of $Parents^{(1)}$, the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ is -3.128. This is larger than the sum of the coefficients on MP_{jt}, $MP_{jt} \times Crisis$ in absolute value, implying that $Parents^{(1)}$ could keep their real loan growth in contrast to the reference banking groups. The result, however, is only suggestive, as the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ is insignificant. However, in case of $Parents^{(2)}$, the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ is 1.368 (though not significant), implying that $Parents$ that have very small $Juniors$ could not have shield their loan growth rates as $Parents^{(1)}$ had. The sum of MP_{jt}, $MP_{jt} \times Crisis$ and $Parents^{(2)}_{ijt} \times MP_{jt} \times Crisis$ is 2.705. This implies that $Parents^{(2)}$ shrank the loan supply during this crisis period, in spite of monetary easing, to a larger extent, as compared to reference groups during the same period (the sum of coefficients on MP_{jt} and $MP_{jt} \times Crisis$ is 1.518).

In Table 1.8, in loan price equation, we observe that the coefficient on $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ is 0.284 and significant, exceeding the sum of coefficients on MP_{jt} and $MP_{jt} \times Crisis$. This implies that $Parents^{(1)}_{ijt}$ could maintain their loan interest rate relatively low in spite of shortage of funds. $Parents^{(2)}_{ijt} \times MP_{jt} \times Crisis$, on the other hand, is quite small and insignificant. The sum of MP_{jt}, $MP_{jt} \times Crisis$ and $Parents^{(2)}_{ijt} \times MP_{jt} \times Crisis$ is very small (0.054) and insignificant, and this implies that $Parents^{(2)}$ couldn't have lowered its its loan interest rates in line with domestic monetary easing.

To recap, our results suggest that Asia-headquartered global banks, $Parents$ could maintain their loan growth rates during the crisis period while lowering the interest rates they charge on loans, and this effect mainly comes from $Parents^{(1)}$ that have relatively larger $Juniors$. This is in line with our conjecture that $Parents$ with larger foreign subsidiaries could be better able to shield its loan supply in face of liquidity shock.

Then, why did *Parents* (more specifically, $Parents^{(1)}$) with hampering effects against the monetary policy in normal periods not have the hampering effects during the crisis period any longer (coefficients on $Parents^{(1)}_{ijt} \times MP_{jt}$ and $Parents^{(1)}_{ijt} \times MP_{jt} \times Crisis$ have opposite sign)? Our answer to this question reconciles these seemingly contradictory behaviours from the different sources of shocks that *Parents* face. During normal periods, monetary policy tightening is a source of financial stress, and thus, *Parents* could better protect its bank lending in the face of monetary policy tightening. In the crisis periods, however, banks are exposed to serious financial stresses and uncertainty that are not sufficiently offset by eased monetary policy aiming to relieve the financial stress. In this sense, we do not think that the behaviour of *Parents* are different for the two periods. Instead, their ways of responding to the financial shock (either from the monetary policy or from other non-policy shocks) are fundamentally the same, but the sources of the shocks are different. It could also be the case that the crisis period is featured with an eased monetary policy ($MP < 0$), and thus, seemingly different responses to monetary policy changes between this crisis period and a normal period might reflect the asymmetric responses of the bank lending to the monetary tightening and easing.

Table 1.7: Result (3): Including the financial crisis and afterwards (1)

	Dependent: $\Delta lnLoan_{ijt}$			
	(1)	(2)	(3)	(4)
MP	-1.128***	-1.277***	-1.290***	-1.180***
	(0.000)	(0.000)	(0.000)	(0.000)
$MP \times Crisis$	2.464***	2.407***	1.897*	2.952***
	(0.001)	(0.002)	(0.053)	(0.000)
$Parents^{(1)} \times MP$	1.725	1.647	1.590	1.758*
	(0.104)	(0.121)	(0.139)	(0.059)
$Parents^{(1)} \times MP \times Crisis$	-3.128	-3.072	-2.956	-2.146
	(0.132)	(0.143)	(0.133)	(0.290)
$Parents^{(2)} \times MP$	0.063	0.281	0.149	-0.095
	(0.940)	(0.745)	(0.843)	(0.917)
$Parents^{(2)} \times MP \times Crisis$	1.368	1.241	0.938	1.443
	(0.289)	(0.353)	(0.435)	(0.285)
R^2	0.186	0.181	0.192	0.055
Observations	2613	2613	2613	2613
wald test				
Non-crisis period$^{2)}$				
$Parents^{(1)}$	0.597	0.369	0.300	0.578
	(0.561)	(0.719)	(0.775)	(0.521)
$Parents^{(2)}$	-1.065	-0.996	-1.141	-1.275
	(0.173)	(0.222)	(0.125)	(0.145)
Crisis period$^{3)}$				
$Parents^{(1)}$	-1.791	-1.943	-2.348	-0.375
	(0.357)	(0.325)	(0.213)	(0.840)
$Parents^{(2)}$	2.705**	2.371**	1.546	3.215***
	(0.016)	(0.043)	(0.206)	(0.006)

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation. 2) **Regression (1)**: baseline regression, **Regression (2)**: *Financial depth* and HHI are excluded, **Regression (3)**: time-fixed effects is included, **Regression (4)**: bank-fixed effects is excluded.

2) $Parents^{(1)}$: sum of coefficients on $MP, MP \times Parents^{(1)}$,
$Parents^{(2)}$: sum of coefficients on $MP, MP \times Parents^{(2)}$

3) $Parents^{(1)}$: sum of coefficients on MP, $MP \times Crisis$, and $Parents^{(1)} \times MP \times Crisis$,
$Parents^{(2)}$: sum of coefficients on MP, $MP \times Crisis$, and $Parents^{(2)} \times MP \times Crisis$

4) Number of $Parents^{(1)}$ and $Parents^{(2)}$ are 18 and 16, respectively (The sum of these exceeds total number of *Parents* (26), reflecting that some *Parents* experienced changes in their groups during the period).

Table 1.8: Result (4): Including the financial crisis and afterwards (2)

	Dependent: $\Delta Loan\ rate_{ijt}$			
	(1)	(2)	(3)	(4)
MP	0.426***	0.428***	0.387***	0.412***
	(0.000)	(0.000)	(0.000)	(0.000)
$MP \times Crisis$	-0.367***	-0.364***	-0.323***	-0.345***
	(0.000)	(0.000)	(0.001)	(0.000)
$Parents^{(1)} \times MP$	-0.174**	-0.172**	-0.203***	-0.149**
	(0.024)	(0.023)	(0.002)	(0.045)
$Parents^{(1)} \times MP \times Crisis$	0.284***	0.275***	0.323***	0.257***
	(0.004)	(0.005)	(0.002)	(0.005)
$Parents^{(2)} \times MP$	0.125***	0.122***	0.088**	0.132***
	(0.002)	(0.002)	(0.017)	(0.001)
$Parents^{(2)} \times MP \times Crisis$	-0.005	-0.008	0.044	-0.008
	(0.969)	(0.949)	(0.785)	(0.941)
R^2	0.255	0.255	0.280	0.215
Observations	2613	2613	2613	2613
wald test				
Non-crisis period$^{2)}$				
$Parents^{(1)}$	0.252***	0.256***	0.183***	0.263***
	(0.001)	(0.000)	(0.003)	(0.000)
$Parents^{(2)}$	0.551***	0.551***	0.474***	0.544***
	(0.000)	(0.000)	(0.000)	(0.000)
Crisis period$^{3)}$				
$Parents^{(1)}$	0.343***	0.339***	0.386***	0.324***
	(0.000)	(0.000)	(0.000)	(0.000)
$Parents^{(2)}$	0.054	0.056	0.107	0.059
	(0.604)	(0.587)	(0.505)	(0.524)

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation. 2) **Regression (1)**: baseline regression, **Regression (2)**: *Financial depth* and *HHI* are excluded, **Regression (3)**: time-fixed effects is included, **Regression (4)**: bank-fixed effects is excluded.

2) $Parents^{(1)}$: sum of coefficients on $MP, MP \times Parents^{(1)}$,
$Parents^{(2)}$: sum of coefficients on $MP, MP \times Parents^{(2)}$

3) $Parents^{(1)}$: sum of coefficients on MP, $MP \times Crisis$, and $Parents^{(1)} \times MP \times Crisis$,
$Parents^{(2)}$: sum of coefficients on MP, $MP \times Crisis$, and $Parents^{(2)} \times MP \times Crisis$

4) Number of $Parents^{(1)}$ and $Parents^{(2)}$ are 18 and 16, respectively (The sum of these exceeds total number of *Parents* (26), reflecting that some *Parents* experienced changes in their groups during the period).

1.5.3 Interdependence on financial conditions

To find more concrete evidence for the operational internal capital market between *Parents* and *Juniors*, we examine whether the bank lending of *Juniors* is affected by the financial conditions of their *Parents*. We conjecture that if *Parents* could allocate its financial resources, considering the financial conditions of the entire banking group, the loan growth of the *Juniors* would be less dependent on its own internal funds when *Parents* are in good financial conditions. If this is the case, we regard this as supporting evidence for the existence of the operational internal capital market within the globalized banking network. The specification is based on the identification model used in Jeon et al. (2013), as introduced in Section 1.2.2.2.

Data description For this section, we construct a new bank-level annual panel dataset that only includes pairs of 26 *Parents* and the corresponding 82 *Juniors* affiliated with them, for 548 bank-year observations, from 2000 to 2014.[32] In previous sections, the scope of the banks we analysed covered 271 banks operating in the eight Asian countries. In this section, we only examine the 26 *Parents* among them and their 82 *Juniors* operating in 19 countries, either in the Asian region or in other countries.[33] (See Figure 1.2 in Section 1.3.2) One caveat is that 30 out of the total 82 *Juniors* operate in one of the eight Asian countries; thus, these are classified as *Foreign banks* in our previous regressions.

In addition to the bank-level variables described in the first dataset, we include an additional bank-level indicator, *Internal funds* (IF), that is defined as the ratio of net income to loans outstanding. It measures the size of the internally generated funds available (net income), as compared to its size of lending. All other bank characteristics are constructed in the same manner as in the previous sections (explained in Section 1.4.2.1 and APPENDIX A.1). In this specification, however, we do not transform bank characteristics variable into dummy varibles as in previous sections in that we only examine pairs of *Parents* and *Juniors*, not entire banks operating in each country.

[32] The total number of *Juniors* effectively used is restricted to 62 because of a lack of data availability. This might reflect that many *Juniors* are small, not full-fledged banks in the host countries.

[33] *Juniors* that operate in one of the eight Asian countries (e.g. a subsidiary operating in Hong Kong that is affiliated with the Korean-headquartered *Parents*) are classified as *Foreign banks* in our previous dataset; they are termed as *Juniors* in this second dataset.

The country-level macroeconomic indicators include the overnight money market rate, the real GDP growth rate and unemployment rate for both the 8 home countries where *Parents* operate and the 19 host countries where the *Juniors* are located. For the countries where the money market rates are unavailable, we alternatively use either the central bank policy rate or the discount rate. All of the macroeconomic data were collected from the International Financial Statistics (IFS) of International Monetary Funds (IMF).

Estimation model Using the specification model of Equation (1.5), we measure how $Juniors'$ dependence on its own internal funds for lending are affected by the $Parents'$ financial conditions.[34] We regress the real loan growth rate of *Juniors* on its own internal funds and its interaction terms with the $Parents'$ financial conditions.

$$\begin{aligned}\Delta lnLoan^J_{jkpt} &= \alpha + \beta \cdot MP_{kt} + \gamma \cdot IF^J_{jkpt} + \delta \cdot IF^J_{jkpt} \times FC^P_{pt-1} + \theta \cdot FC^P_{pt-1} \\ &+ \kappa \cdot BankChar^J_{jkpt-1} + \lambda \cdot Control + bank_j + \epsilon_{jkpt} \qquad (1.2)\end{aligned}$$

where,

- $\Delta lnLoan^J$: real loan growth rate of *Juniors*
- IF^J : $Juniors'$ internal funds (*Net Income*)
- FC^P : $Parents'$ financial condition, [*Internal funds (IF), Liquidity, Capitalization*]
- $BankChar^J$: bank characteristics *Juniors* in $t-1$
- $Control$: $[GDP_{kt}, Unem_{kt}, GDP_{mt-1}, Unem_{mt-1}, MP_{mt-1}]$

In Equation (1.5), j denotes *Juniors* and p denotes the *Parents* that the *Junior* j is affiliated with. k stands for the host country where *Junior* j operates in; t denotes time. The dependent variable $\Delta lnLoan^J_{jkpt}$ represents the real loan growth rate of *Junior* j operating in host country k, affiliated with the parent bank j in the home country m in year t. IF^J_{jkpt} denotes *Junior* j's internal funds in year t , while FC^P_{pt-1} denotes the *Parent* p's financial conditions in year $t-1$.

For the $Juniors'$ internal funds, we adopt *Net Income*, defined as the ratio to the total loans outstanding at the end of the previous year. As a

[34] The model basically follows Jeon et al. (2013), as explained in Section 1.2.2.2. The main difference is that the model used here does not include 1-year lag of dependent variable and is estimated in OLS with fixed effects in line with the models in previous sections. In addition, they only measure how the financial health of the *Parents* affects their $Juniors'$ bank lending. We also measure the opposite direction, considering that the reallocation of global banks could work in both ways, depending on their financial conditions and economic situations in the home and host countries.

measure of the financial conditions of the $Parents$, we consider three variables: *Internal funds (Net income)*, *Liquidity* and *Capitalization*. Both *Liquidity* and *Capitalization* are defined as the ratio to total assets. $BankChar^J_{jkpt}$ includes bank-level characteristics of $Juniors$, including *Liquidity*, *Capitalization*, *Size*, *Riskiness* and *Profitability*, as defined in Section 1.4.2.1. $Control$ includes macroeconomic conditions (real GDP growth rate and unemployment rate) of both home in t and host countries in $t-1$, and monetary policy indicator of host countries in $t-1$. In case of host countries, we adopt a one-year lag of macroeconomic variables in line with a one-year lag of $Parents'$ bank-level indicators. $bank_j$ is bank-level fixed effects.

We expect that the coefficients on IF^J_{jkpt} and FC^P_{pt-1} are positive, implying that ample internal capital, either of their own or of their $Parents'$, helps increase the real loan growth of $Juniors$. The coefficient of the interaction term $IF^J_{jkpt} \times FC^P_{pt-1}$ would capture how the marginal dependence of the $Juniors$ on its internal funds are affected by the $Parents'$ financial conditions. The negative coefficient would imply that the strong financial conditions of the $Parents$ helps their $Juniors$ depend less on their own internal funds when $Parents$ are in a good financial condition. We interpret this as an evidence for the operational internal capital market.

In a symmetric way, we regress $Parents'$ real loan growth on their internal funds and the interaction term with their $Juniors'$ financial conditions, as in Equation (1.6). In this equation, m stands for the the home country where $Parents$ p operate in. The rationale is the same as in Equation (1.5), aiming to examine whether $Juniors$ financial conditions affect $Parents$ dependence on their own internal funds. We use OLS, with clustered standard errors, to estimate the specification, Equations (1.5) and (1.6), as before.

$$\begin{aligned}\Delta lnLoan^P_{pt} = \alpha + \beta \cdot MP_{mt} + \gamma \cdot IF^P_{pt} + \delta \cdot IF^P_{pt} \times FC^J_{jkpt-1} + \theta \cdot FC^J_{jkpt-1} \\ + \kappa \cdot BankChar^P_{pt-1} + \lambda \cdot Control + bank_p + \epsilon_{pt}\end{aligned} \tag{1.3}$$

Estimation results We first estimate Equations (1.5) and (1.6) using observations from 2000 to 2007, and the results are shown in Panels A and Panel B of Table 1.9, respectively. In Panel A (dependent: $Juniors'$ real loan growth rate), the interaction terms between the $Juniors'$ internal funds and three measures indicating the $Parents'$ financial conditions (*Internal funds (IF), Liquidity, Capitalization*) are our most primary interests. In Regression (1), we include all of these three variables simultaneously. We include only one of them separately in Regressions (2), (3) and (4). In all regressions, it is clear that $Juniors'$ own internal funds have very stong and significant impacts on its loan supply. Our question is then, how $Parents'$ financial conditions lower the $Juniors'$ dependence on own internal funds. We find that all coefficients of the three interaction terms are negative as expected. To be specific, the coefficient on $IF^J_{jkpt} \times Liquidity^P_{pt-1}$ is negative and significant in Regressions (1) and (3), suggesting that the higher liquidity of the $Parents$ helps its $Juniors$ depend on its internal funds, to a lesser extent. $IF^J_{jkpt} \times Capitalization^P_{pt-1}$ also have negative and significant coefficient in regression (4). The coefficient on MP_{kt} is -0.644, suggesting that $Juniors$ reduce their loan growth rates in the face of the monetary policy tightening of host countries, though this value is not significant.

In Panel B (dependent: $Parents'$ real loan growth rate), we find that all coefficients on the three interaction terms are negative, in line with our expectation. In this case, $IF^P_{pt} \times IF^J_{jkpt-1}$ has a significant coefficient in Regression (2), suggesting that if $Juniors$ have more internally generated funds, their $Parents$ are dependent on its internal funds (net income), to a lesser degree. The coefficient on MP_{mt} is quite small and insignificant. This implies that the bank lending channel does not exist for the $Parents$ banks, as we find in previous sections.

Table 1.10 shows the estimation results of the same specification with extended time periods, from 2000 to 2014. We find that in overall, the results in Table 1.9 holds in essentially the same way.

These findings suggest that $Juniors'$ dependence on own internal funds for the loan supply are affected by their $Parents'$ financial conditions, and vice versa. We interpret that this lends support to the proposition that global banks reallocate their internal funds, considering the overall financial conditions of the head offices and subsidiaries. Thus, this affects the overall loan supply available to either the $Parents$ or their $Juniors$.

One concern from the result is that the effect of the financial conditions on the loan supply are quite small in both directions, though they are statistically significant. The marginal effect that the financial conditions of the $Parents$ have on the real loan growth of the $Juniors$ (or in the opposite direction) is smaller than 0.5 in absolute value. This might reflect the priority in the reallocation of funds and the relative size of the subsidiaries. To be specific, the reason why $Parents'$ financial conditions have limited impact on the real loan growth of their *Juniors* might be that *Parents* are of priority in the reallocation of the funds. The reason why $Juniors'$ financial conditions illustrate restricted impact on the real loan growth of their *Parents* can be attributed to the fact that *Juniors* are very small, on average, as compared to their *Parents*; thus, they can only have limited contributions to support the liquidity to protect the loan supply of their *Parents*.

Table 1.9: Result (5): Interdependence on financial conditions ($2000-2007$)

	Panel A. Juniors' real loan growth Dependent: $\Delta lnLoan^J_{jkpt}$					*Panel B. Parents' real loan growth* Dependent: $\Delta lnLoan^P_{pt}$			
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
MP_k	-0.644	-0.549	-0.615	-0.761	MP_m	-0.004	0.109	0.221	0.080
	(0.935)	(0.714)	(0.926)	(0.772)		(0.995)	(0.869)	(0.689)	(0.885)
IF^J	5.448**	2.031***	4.922***	5.143**	IF^P	8.738***	5.864***	4.927**	6.453**
	(0.014)	(0.002)	(0.001)	(0.012)		(0.001)	(0.001)	(0.012)	(0.011)
$IF^J \times IF^P$	-0.081	-0.269			$IF^P \times IF^J$	-0.363	-0.465**		
	(0.895)	(0.545)				(0.161)	(0.049)		
$IF^J \times Liquidity^P$	-0.142*		-0.159**		$IF^P \times Liquidity^J$	-0.029		-0.036	
	(0.071)		(0.030)			(0.655)		(0.579)	
$IF^J \times Capitalization^P$	-0.096			-0.401*	$IF^P \times Capitalization^J$	-0.141			-0.165
	(0.758)			(0.075)		(0.270)			(0.222)
R^2	0.355	0.324	0.362	0.342	R^2	0.188	0.189	0.171	0.179
Observations	217	217	217	217	Observations	222	222	222	222
Groups	49	49	49	49	Groups	50	50	50	50
$AR(1)$ in residual[3)]	-0.243***	-0.173**	-0.231***	-0.219***	$AR(1)$ in residual[3)]	-0.295***	-0.259***	-0.257***	-0.277***
	(0.001)	(0.023)	(0.002)	(0.004)		(0.000)	(0.001)	(0.001)	(0.000)
Hausman test[4)]									
H_0: RE is preferred to FE,	*Panel A.* $\chi^2(18)$=42.05 (p-value: 0.001); *Panel B.* $\chi^2(18)$=40.80 (p-value: 0.002)								
H_0: OLS is preferred to FE,	*Panel A.* $\chi^2(18)$=43.55 (p-value: 0.001); *Panel B.* $\chi^2(18)$=40.80 (p-value: 0.002)								

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)** includes all three variables indicative of *Parents* financial conditions simultaneously, while **Regression (2), (3), (4)** consider one of these indicators separately.
3) Coefficients on AR(1) term are generated by regressing the residual on one-year lagged dependent variable by Ordinary Least Squares estimator.
4) Based on baseline **Regression (1)**.
5) The regression results are robust to some variations of baseline regression. The results remain essentially the same when we include time-fixed effects, or we exclude bank-level fixed effects, or we estimate the baseline model with random effects estimator.

Table 1.10: Result (6): Interdependence on financial conditions (2000 − 2014)

	Panel A. Juniors′ real loan growth Dependent: $\Delta lnLoan^J_{jkpt}$					*Panel B. Parents′ real loan growth* Dependent: $\Delta lnLoan^P_{pt}$			
	(1)	(2)	(3)	(4)		(1)	(2)	(3)	(4)
MP_k	-0.698	-0.503	-0.540	-0.673	MP_m	0.021	0.043	0.015	-0.002
	(0.239)	(0.364)	(0.367)	(0.278)		(0.963)	(0.925)	(0.973)	(0.996)
IF^J	6.715***	1.771**	3.650**	5.894***	IF^P	4.773***	3.699***	3.745***	4.448***
	(0.000)	(0.019)	(0.011)	(0.000)		(0.000)	(0.000)	(0.002)	(0.001)
$IF^J \times IF^P$	0.198	-0.279			$IF^P \times IF^J$	-0.058	-0.069		
	(0.672)	(0.512)				(0.378)	(0.359)		
$IF^J \times Liquidity^P$	-0.060		-0.120**		$IF^P \times Liquidity^J$	-0.006		-0.010	
	(0.435)		(0.048)			(0.887)		(0.805)	
$IF^J \times Capitalization^P$	-0.512*			-0.511***	$IF^P \times Capitalization^J$	-0.050			-0.054
	(0.077)			(0.004)		(0.403)			(0.346)
R^2	0.214	0.176	0.189	0.212	R^2	0.171	0.172	0.171	0.174
Observations	539	539	539	539	Observations	548	548	548	548
Groups	59	59	59	59	Groups	59	59	59	59
$AR(1)$ in residual[3)]	-0.092**	-0.090*	-0.091*	-0.090*	$AR(1)$ in residual[3)]	-0.066	-0.063	-0.064	-0.066
	(0.048)	(0.058)	(0.054)	(0.053)		(0.153)	(0.171)	(0.167)	(0.158)
Hausman test[4)]									
H_0: RE is preferred to FE,	*Panel A.* $\chi^2(18)$=57.57 (p-value: 0.000); *Panel B.* $\chi^2(18)$=44.00 (p-value: 0.000)								
H_0: OLS is preferred to FE,	*Panel A.* $\chi^2(18)$=62.86 (p-value: 0.000); *Panel B.* $\chi^2(18)$=44.00 (p-value: 0.000)								

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)** includes all three variables indicative of *Parents* financial conditions simultaneously, while **Regression (2), (3), (4)** consider one of these indicators separately.
3) Coefficients on AR(1) term are generated by regressing the residual on one-year lagged dependent variable by Ordinary Least Squares estimator.
4) Based on baseline **Regression (1)**.
5) The regression results are robust to some variations of baseline regression. The results remain essentially the same when we include time-fixed effects, or we exclude bank-level fixed effects, or we estimate the baseline model with random effects estimator.

1.5.4 Robustness tests

We examine the robustness of our main results in Sections 1.5.1 and 1.5.2 to several changes in the estimation specifications and methods. Table 1.11 is the case in which we do not distinguish the *Parents* based on their $Juniors'$ size; Table 1.12 is the case in which we do. Panel A is the result of the loan quantity equation and Panel B is the result of the loan price equation in both tables. Table 1.13 and Table 1.14 are the cases in which the periods analyzed include 2000-2014 and we divide two *Parents* groups with a focus on the financial crisis period. In all tables, Regression (1) represents the baseline estimation results we have in the main regression results.

In Regression (2), we explicitly include all interaction terms between the monetary policy indicator and all of the bank characteristics. That is, we include $BankChar_{ijt-1} \times MP_{jt}$ as well as $BankChar_{ijt-1}$, in Equation (1.4), and examine if this causes any change in the marginal responsiveness of each of the bank types to the monetary policy. We find that our main results hold when we explicitly control the interacting effects of the bank characteristics with the monetary policy. This relieves the concern about the endogeneity problem, possibly stemming from selection bias or simultaneity. Since it might be the case that the most successful, and thus, the largest banks, are more likely to become global banks (*Parents*) by investing in foreign banks or directly launching new subsidiaries abroad, the hampering effect they have might reflect their successfulness or size, not the intrinsic features of the globalized banking network or the internal capital market. In this robustness test, however, we confirm our main findings in the baseline regression, that is, global banks have hampering effect against monetary policy tightening and this becomes more pronounced for global banks with larger subsidiaries, remain essentially the same, even after we explicitly consider selection bias.

In Regression (3), we then re-run the equation using the random effects estimator, considering that the Hausman test results provide us with a different preferred estimation method. We find that the estimation results from the random effects model are not different from that of the baseline results in an essential way.

In Regression (4), we include all of the observations, without removing any of the outliers (Regression 4). This increases the magnitude of bank lending channel, but also the degree of hampering effects.

We also include dummy variable ($Foreign$) that distinguishes foreign-owned banks from other types of banks ($Parents$) and its interaction terms with MP and $Crisis$ in Regression (5).[35] This enables us to compare the behaviour of global banks to foreign-owned banks operating in the Asia region, especially during the crisis periods, that was the focus of Jeon and Wu (2014). In the normal periods (Table 1.11 and Table 1.12), the marginal responsiveness of $Foreign$ to monetary policy is very small and highly insignifcant. In crisis periods, however (Table 1.13 and Table 1.14), the coefficients on $Foreign \times MP \times Crisis$ in loan quantity equation is positive and significant, while that in loan price equation is negative and significant. These imply that in the face of liquidity crisis, $Foreign$ reduced its loan supply in spite of monetary policy easing in the Asia countries, while they kept relatively higher loan price. This shows that $Foreign$ banks behaved in an opposite way to $Parents$ (especially $Parents^{(1)}$), supporting our hypothesis that Asia-headquartered global banks could better shield their loan supply possibly due to its reallocation of liquidity from their foreign subsdiaries to the headquarters, and this might have strengthened the reduction of loan supply of the foreign subsidiaries.

We interpret that these opposite responses of $Parents$ and $Foreign\ banks$, operating in the same region during the crisis period, as evidence supporting the proposition that global banks reallocate internal funds via the internal capital market to relieve the financial stress they face. In addition, considering that 30 out of 82 $Foreign\ banks$ in our sample are $Juniors$ affiliated with $Parents$ headquartered in the same region, the opposite and symmetric behaviours provide more concrete evidence for the proposition, as compared to the findings of Jeon and Wu (2014), who only examined the response of $Foreign\ banks$, not the $Parents$.

Lastly, for the case in which we have two separate $Parents$ groups (Table 1.12), we adopt different thresholds to distinguish the $Parents$ with larger $Juniors$ and those with smaller $Juniors$ (thus, these tests are only reflected in Table 1.10). In our baseline regressions in Section 1.5.2.1, we used the median value (1.99%) of the ratio of all $Juniors$ assets to the $Parents'$ assets as a threshold. In this section, we applied higher thresholds (5% and 10%) and checked whether the results of a basic regression are consistent with this

[35] When we include this *Foreign* dummy, the reference banking group changes: In the previous section, the reference groups were *Domestic banks* and *Foreign banks*, and now it is *Domestic banks* only.

change; the results are presented as Regressions (6) and (7) in Table 1.12, respectively, and show that our main findings are robust for these changes.

Table 1.11: Robustness test (1): Corresponding Table 1.4

	Panel A. Loan quantity equation Dependent: $\Delta lnLoan_{ijt}$				
	(1)	(2)	(3)	(4)	(5)
MP	-1.090***	-1.282	-1.150***	-1.692***	-1.098***
	(0.001)	(0.112)	(0.000)	(0.001)	(0.004)
$Parents \times MP$	1.395	1.576	1.356*	1.793	1.402
	(0.120)	(0.118)	(0.081)	(0.133)	(0.129)
$Foreign \times MP$					0.012
					(0.985)
R^2	0.246	0.248		0.107	0.245
Observations	1354	1354	1354	1563	1354

	Panel B. Loan price equation Dependent: $\Delta Loan\ rate_{ijt}$				
	(1)	(2)	(3)	(4)	(5)
MP	0.442***	0.467***	0.424***	0.442***	0.451***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Parents \times MP$	-0.093	0.011	-0.083	-0.098	-0.103
	(0.320)	(0.907)	(0.346)	(0.304)	(0.280)
$Foreign \times MP$					-0.018
					(0.782)
R^2	0.329	0.339		0.279	0.328
Observations	1354	1354	1354	1556	1354

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)**: baseline results in Table 1.4, **Regression (2)**: Include interaction terms between MP and bank characteristics, **Regression (3)**: Random effects estimator is adopted, **Regression (4)**: Include all observations (no outlier removal procedure), **Regression (5)**: Include *Foreign* and its interaction terms with MP.

Table 1.12: Robustness test (2): Corresponding Table 1.5

	Panel A. Loan quantity equation	Dependent: $\Delta lnLoan_{ijt}$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP	-1.085***	-1.278	-1.146***	-1.690***	-1.096***	-1.085***	-1.090***
	(0.001)	(0.113)	(0.000)	(0.001)	(0.004)	(0.001)	(0.001)
$Parents^{(1)} \times MP$	2.035*	2.352*	1.823	2.054	2.044*	1.985	1.432
	(0.091)	(0.059)	(0.100)	(0.240)	(0.097)	(0.102)	(0.223)
$Parents^{(2)} \times MP$	0.642	0.644	0.751	1.482	0.654	0.676	1.187
	(0.317)	(0.425)	(0.180)	(0.105)	(0.326)	(0.307)	(0.197)
$Foreign \times MP$					0.018		
					(0.977)		
R^2	0.245	0.247		0.106	0.244	0.246	0.245
Observations	1354	1354	1354	1563	1354	1354	1354

	Panel B. Loan price equation	Dependent: $\Delta Loan\ rate_{ijt}$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
MP	0.441***	0.466***	0.423***	0.441***	0.451***	0.441***	0.441***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Parents^{(1)} \times MP$	-0.234***	-0.120	-0.224***	-0.240***	-0.245***	-0.242***	-0.248***
	(0.002)	(0.147)	(0.002)	(0.006)	(0.002)	(0.002)	(0.005)
$Parents^{(2)} \times MP$	0.087*	0.182***	0.108***	0.091*	0.078	0.102**	0.018
	(0.053)	(0.002)	(0.009)	(0.090)	(0.117)	(0.047)	(0.840)
$Foreign \times MP$					-0.019		
					(0.770)		
R^2	0.329	0.339		0.279	0.328	0.330	0.329
Observations	1354	1354	1354	1556	1354	1354	1354

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)**: baseline results in Table 1.4, **Regression (2)**: Include interaction terms between MP and bank characteristics, **Regression (3)**: Random effects estimator is adopted, **Regression (4)**: Include all observations (no outlier removal procedure), **Regression (5)**: Include *Foreign* and its interaction terms with MP, **Regression (6)**: A threshold to divide *Parents* is 5% (number of $Parents^{(1)}$ and $Parents^{(2)}$ are 12 and 11, respectively.), **Regression (7)**: A threshold to divide *Parents* is 10% (number of $Parents^{(1)}$ and $Parents^{(2)}$ are 9 and 14, respectively.)

Table 1.13: Robustness test (3): Corresponding Table 1.7

	Dependent: $\Delta lnLoan_{ijt}$				
	(1)	(2)	(3)	(4)	(5)
MP	-1.128***	-1.379*	-1.155***	-1.805***	-1.040***
	(0.000)	(0.066)	(0.000)	(0.000)	(0.004)
$MP \times Crisis$	2.464***	0.919	2.524***	4.045***	1.289
	(0.001)	(0.580)	(0.001)	(0.000)	(0.111)
$Parents^{(1)} \times MP$	1.725	2.029*	1.685*	2.038	1.629
	(0.104)	(0.058)	(0.097)	(0.183)	(0.134)
$Parents^{(1)} \times MP \times Crisis$	-3.128	-2.316	-3.004	-4.284*	-1.961
	(0.132)	(0.294)	(0.137)	(0.097)	(0.349)
$Parents^{(2)} \times MP$	0.063	0.084	0.080	0.704	-0.033
	(0.940)	(0.925)	(0.923)	(0.449)	(0.969)
$Parents^{(2)} \times MP \times Crisis$	1.368	1.906	1.354	-0.268	2.533*
	(0.289)	(0.209)	(0.281)	(0.855)	(0.057)
$Foreign \times MP$					-0.157
					(0.780)
$Foreign \times MP \times Crisis$					2.793*
					(0.064)
R^2	0.186	0.187		0.095	0.186
Observations	2613	2613	2613	2927	2613

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)**: baseline results in Table 1.4, **Regression (2)**: Include interaction terms between MP and bank characteristics, **Regression (3)**: Random effects estimator is adopted, **Regression (4)**: Include all observations (no outlier removal procedure), **Regression (5)**: Include *Foreign* and its interaction terms with MP and Crisis.

1.6 Conclusion

After the onset of the recent financial crisis, and alongside its development, the globalized bank network and its roles in shock propagation have received ample research interests. The main conclusion of the recent studies can be summarised as global banks reallocating their internal funds through their internal capital market to relieve the financial stress that the head offices face. This affects how the parent banks, or their subsidiaries, respond to the liquidity constraints they have.

In contrast to the previous studies that primarily focus on foreign banks in Asia region, we aim to examine the role of the Asian-headquartered global banks. Using this approach, we find evidence in support of the Cetorelli and Goldberg's hypothesis. This study contributes to the literature by building upon the Cetorelli and Goldberg (2012a) investigation, considering the Asian case, rather than the US case. It also contributes to the literature by building upon the Jeon and Wu (2014) study, considering *Parents*, which seems to be more important than the *Foreign banks* operating in the region.

Table 1.14: Robustness test (4): Corresponding Table 1.8

	Dependent: $\Delta Loan\ rate_{ijt}$				
	(1)	(2)	(3)	(4)	(5)
MP	0.426***	0.442***	0.418***	0.436***	0.447***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$MP \times Crisis$	-0.367***	-0.211*	-0.353***	-0.348***	-0.238***
	(0.000)	(0.093)	(0.000)	(0.000)	(0.005)
$Parents^{(1)} \times MP$	-0.174**	-0.082	-0.161**	-0.186**	-0.193**
	(0.024)	(0.312)	(0.025)	(0.036)	(0.014)
$Parents^{(1)} \times MP \times Crisis$	0.284***	0.296**	0.259***	0.267**	0.154
	(0.004)	(0.035)	(0.005)	(0.011)	(0.141)
$Parents^{(2)} \times MP$	0.125***	0.200***	0.134***	0.112***	0.105**
	(0.002)	(0.000)	(0.001)	(0.008)	(0.014)
$Parents^{(2)} \times MP \times Crisis$	-0.005	-0.018	-0.016	-0.037	-0.133
	(0.969)	(0.903)	(0.891)	(0.756)	(0.304)
$Foreign \times MP$					-0.036
					(0.532)
$Foreign \times MP \times Crisis$					-0.276*
					(0.053)
R^2	0.255	0.259		0.233	0.259
Observations	2613	2613	2613	2927	2613

Notes: 1) p-values are in parentheses. ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level, Standard errors are corrected for heteroscedasticity and clustered at bank level to control for the effects of residual autocorrelation.
2) **Regression (1)**: baseline results in Table 1.4, **Regression (2)**: Include interaction terms between MP and bank characteristics, **Regression (3)**: Random effects estimator is adopted, **Regression (4)**: Include all observations (no outlier removal procedure), **Regression (5)**: Include *Foreign* and its interaction terms with MP and Crisis.

From the annual panel data, consisting of data from 271 commercial banks in the eight selected Asian economies from 2000 to 2014, we find that 26 *Parents* (global banks headquartered in the region) are less responsive to domestic monetary policy. This hampers the monetary policy effectiveness in the conventional bank lending channel, as compared to other types of banks. Further aiming to reveal the role of the internal capital market with their *Juniors* abroad, we investigated the relevance of the size of the *Juniors* affiliated with the *Parents* to the hampering effect, and examined if the financial conditions of the *Parents* affected the *Juniors′* dependence on their internal funds in expanding their loan growth. We find that *Parents* with relatively larger *Juniors* have a greater hampering effect, and this difference becomes clearer for their loan price adjustment.

We also suggest the behaviours of *Parents* during the 2008-2009 crisis period to invigorate our interpretation. We find that *Parents* that have effectively large subsidiaries could shield their loan supply during the financial crisis while keeping their loan price relatively low. This complements Jeon et al (2014)'s finding: *Foreign banks*, some of which are the *Juniors* of the *Parents*, contracted their loan growth rate and raised their loan price significantly in spite of eased monetary policy and they postulated this might be due to the reallocation of global banks that have the foreign subsidiaries. These opposite responses of *Parents* and *Foreign banks*, in a symmetric way, strengthens our findings on the existence of the internal capital market. These results are robust to the various changes in the model specifications, especially when we control for the size of the banks and its interaction with the monetary policy effect ($Size \times MP$) on bank lending, which could address the possible endogeneity problem coming from selection bias.

Aiming to find more direct evidence for active role of internal capital market, we also find that the *Juniors′* dependency on their own internal funds weakens when their *Parents* are in good financial conditions. We believe that our findings support the relevance of the operational internal capital market in the hampering effect that *Parents* have. It is noteworthy, however, the evidences we suggest in this chapter is only suggestive in that we do not explicitly observe the internal transactions between the Asian-headquarterd global banks and its subsidiaries.

Our study suggests interesting areas for further research. First of all, we only suggested indirect evidences in search of the source of hampering effects that the global banks have. By investigating interbank transactions within the internal capital market, the degree of exposure to external funding, *Juniors′* various features other than its relative size, and the like, it would be possible to find more concrete evidence for the role of global banks in monetary policy transmssion. Secondly, in a broader context, it would be interesting to examine how an exposure to cross-border interbank transactions, not merely internal transaction between headquarter and subsidiaries, or dependency on wholesale funding affect the bank loan supply during normal periods and crisis periods. Considering that the size of foreign subsidiaries of Asian global banks are usually quite small and the transaction via internal capital market might be limited, study on cross-border interbank transactions would provide further insights on the process of liquidity shock propagation and monetary policy shock. Lastly, monetary policy indicators, indicative of monetary policy shocks, deserve more careful attention. The money market rates adopted in our study usually closely follow a change in monetary policy, but they are also affected by non-policy factors such as market expectation on future economic conditions, or other disturbances in the market.[36] It would be meaningful to examine how our main findings change if we adopt purely exogenous monetary policy shocks.

Policy implications The results of our study provide the following policy implications. Firstly, it is necessary to pay more attention to regional global banks and the consequences on the effectiveness of monetary policy and economic stabilization. Up until now, the relevant literature and policy-oriented studies have focused on the role of foreign banks (and foreign finance, in general) in host countries. Little attention has been paid to regional global banks. As is illustrated in this chapter, regional global banks significantly affect the effectiveness of monetary policy. Considering that they will build up a more globalized network that is in line with continuing economic growth, progress in financial liberalization and government policy promoting development in the financial sector, the role and impacts of Asia headquartered global banks on the economy will become increasingly important.

Secondly, the effect of monetary policy should be understood by considering an international perspective. As our finding and other relevant studies show, global banks could raise internal funds to better cope with the financial stress the head offices face. This would help countries with well-developed global banking sector better cope with the shortage of liquidity during the crisis periods. On the other hands, however, this implies that monetary policy shock in the home country can be transmitted to the host countries via the bank lending channel. The better protection that head offices enjoy in a monetary policy contraction does not come without a cost. The cost is that their foreign affiliates suffer from a lack of internal funds, so they might have to

[36] Realized market interest rates that are commonly used in the bank lending channel literature are endogenous to expected future macroeconomic conditions, which are likely to exert separate effects on both loan demand and loan supply, and this might cause a bias in the estimated response of bank lending to monetary policy shock. (Bluedorn, Bowdler and Koch 2013).

reduce their own loan supply, unintentionally importing contractionary monetary policy from the home to the host countries.

With this point of view in mind, it is also possible to interpret our findings in a way that the hampering effect the global banks have on domestic monetary policy does not actually lower the effectiveness of monetary policy, but instead, spreads out the domestic monetary effect across borders. The effect of these exports of monetary policy shocks on the economic stabilization of host countries might be different, depending on the possible combinations of the business cycle phases, both in the host and home countries, and the corresponding policy stances. This enlightens a channel of cross-border policy propagation via the banking network. Policymakers should bear this in mind in designing macroprudential policies to minimize shock propagation through internalized banking networks, and build up a channel for policy coordination across countries to better deal with cross-border spillovers of financial shock through global banking sector (Korinek 2016).[37]

[37] One recommended way to insulate a shock propagation in the banking system is to lower the maximum amount of interbank lending. The BIS stresses the importance of the control for exposures to a single borrower, or closely related counterparties, as a tool for limiting the maximum loss a bank could face in the event of a sudden counterparty failure or the withdrawal of lending to a level that does not endanger the banks solvency. The BIS recently recommended that its member countries fortify the relevant regulations (BIS 2013).

Chapter 2

US monetary policy and global banking flows

Abstract

This chapter investigates the influences of US monetary policy on US global bank leverage and cross-border banking flows using US monetary policy shocks identified based on narrative sources (Romer and Romer 2004). We measure the responses of the leverage of US global banks, banking flows, VIX, and the exchange rate of US dollar by incorporating the externally identified US monetary policy shocks into a reduced form VAR. Compared to Bruno and Shin (2015), we find that the leverage declines more quickly and to a much larger extent, while we do not find an apparent and significant rise of VIX. This suggests that there could be alternative channels through which US monetary policy affects US global banks other than the risk-taking channel. The decline in banking flows are essentially the same, and the magnitude of appreciation in the US dollar becomes larger. From county-level bilateral VARs for 36 countries, we find that emerging market economies suffer greater from banking outflows in response to US monetary policy tightening than advanced economies. This is in line with previous findings that the probability of occurrence and the magnitude of capital outflows are larger in EMEs during financial crisis (Calvo, Izquierdo and Talvi 2006 among many others).

2.1 Introduction

This chapter investigates the influences of US monetary policy shocks on US global bank leverage and cross-border banking flows.[1] A considerable literature has examined causes and consequences of international capital flows, and more recently, cross-border banking flows and US monetary policy shocks as a main driver for it have been studied (Bruno and Shin 2015, Rey 2015, Dedola, Stracca and Rivolta 2015). In line with this tradition, we examine the responses of global banking flows and the behaviour of US global banks which play an important role in intermediating the global banking flows to US monetary policy shocks.

First, we replicate Bruno and Shin (2015)′s a recursive VAR, one of the latest studies on the topic as a benchmark result. Bruno and Shin examine the operation of US global banks in the process in which US monetary policy shock affects global banking flows in a recursive VAR consisting of Federal Funds rate, leverage of US global banks, international banking flows, VIX and exchange rate of US dollar.[2] They find that market risk measures (proxied by VIX) rise in response to a US monetary policy tightening, which causes a decline in the leverage of US global banks. This in turn lowers the overall amount of international cross-border banking flows that US global banks intermediate, and brings about an appreciation of the US dollar. They argue that this evidence supports the transmission of US monetary policy operating via US global banks.

The main contribution of our study is that we measure the responses of US global bank leverage and banking flows to externally identified monetary policy shock that is incorporated into the VAR.[3] This is because we think that the monetary policy shock internally identified in the recursive VAR in Bruno and Shin might not represent true exogenous policy shock. The ordering scheme in the VAR in Bruno and Shin assumes that all movements in the Federal Funds rate (FFR) are exogenous, and this could be problematic if movements of

[1] In Chapter 2 and Chapter 3, banking flows represent the total foreign debt that the banking sector in a country as a whole owes to banks in foreign countries.

[2] Leverage of US global banks is the ratio of liabilities to equity in the Security and Broker dealer sector from the Flow of Funds (Federal Reserve). Banking flows are international bank-to-bank lending denominated in US dollars (BIS), and the exchange rate is real effective exchange rate of US dollar (IMF IFS). VIX is usually used as a measure of market volatility implied by S&P 500 stock option prices.

[3] In this sense, our focus is on the responses of endogenous variables to the exogenous monetary policy shock only, and we do not directly assess the existence of any channel of US monetary policy operating through global banks.

FFR are endogenously affected by FOMC (Federal Open Market Committee)′s internal economic forecasts. Suppose that as other economic agents, US global banks refer to the information on economic forecasts they have which might be based on the FOMC′s forecasts (or closely related at least). At the same time, it has shown that the FOMC considers its internal (Greenbook) forecasts for policy decision. If this is the case, the response of US global banks to the monetary policy shock (FFR shock) identified from a recursive VAR could be biased. For example, suppose US global banks recognize an increase in FFR as a pre-emptive action of Federal Reserve for economic boom which is consistent with expected output growth provided in the Greenbook forecasts. Then, the monetary policy tightening would not (or to a lesser degree) surprise US global banks, not leading to an adjustment in their behaviour, because the global banks could anticipate the policy change in advance. However, if the policy action is not implied by the economic outlook the Federal Reserve produces, it is more likely that global banks will interpret this as a surprise and adjust their leverage to a larger extent. For this reason, the response of US global banks to the FFR shock identified in a recursive VAR could be biased. This motivates us to reassess Bruno and Shin′s finding by using externally identified monetary policy shock purged of the endogenous movements.

We extract the intended and exogenous US monetary policy shock following Romer and Romer (2004)′s narrative approach. Romer and Romer separates an ″intended″ policy change from realized Federal Funds rate based on narrative sources. Then, they regress the intended policy change on the Federal Reserve′s in-house (Greenbook) forecasts for output and inflation to extract monetary policy changes that are not endogenously determined by the forecasts. They suggest this is a new measure of monetary policy shock that is ″intended and exogenous.″ We extend the US monetary policy shock based on Romer and Romer′s approach, following the procedure suggested by Bluedorn, Bowdler and Koch (forthcoming, BBK hereafter).[4] Then we incorporate this externally identified monetary policy shock into the same recursive form VAR used in Bruno and Shin, and examine the responses of endogenous variables to the monetary policy shock.

The main findings are as follows. First, the leverage of US global banks declines quickly and to a much larger extent in response to the externally

[4]Romer and Romer (2004) recovers the intended and exogenous monetary policy shock over a period $1969 - 1994$. Bluedorn, Bowdler and Koch extends the monetary policy shock to cover $1969 - 2007$ following the Romer and Romer′s approach. More explanation on this is described in Section 2.3.

identified monetary policy shock (UM shock) compared to a delayed response from the monetary policy shock identified in a recursive VAR (FFR shock). The maximum decline of leverage to UM shock is about three times larger in magnitude than that for the FFR shock. The difference in the responses of leverage implies a bias in the response of leverage to the FFR shock which does not consider the Federal Reserve′s internal forecasts. This result also implies that the role of US global banks in monetary policy transmission might be more significant than previously thought. That is, if US global banks intermediate global banking flows, US monetary policy shocks could be an important determinant of cross-border banking flows as a global push factor. Second, the response of banking flows to the two monetary policy measures are essentially the same during the first 20 quarters after the shock. This finding is seemingly contradictory to the difference in the responses of leverage to the monetary policy shocks. One possible reason might be that the specification of the VAR does not reflect possible heterogeneous responses across countries (aggregation bias). This motivates us to examine bilateral VARs in Section 2.5.3. Third, we do not find an apparent and significant hike in the VIX in response to the UM shock. This is interesting in that if a change in monetary policy is not anticipated by economic agents based on the economic outlook they have, this unexpected shock should cause a larger increase in market risk measure. Finally, the value of the US dollar measured as real effective exchange rate increases by about 5−7% for the first 20 quarters. This is consistent with previous findings (Bluedorn and Bowdler 2011).

Banking outflows across countries The influence of US monetary policy shocks on banking flows might be asymmetric across the recipient countries based on their economic conditions.[5] Considering this, we expand the baseline model to measure magnitudes in banking outflows across countries from the US monetary policy shocks. To be specific, we consider emerging market economies (EMEs) and advanced economies (AEs) in that it has been suggested that emerging economies suffer more from cross-border capital outflows (Mendoza 2011, Rey 2013, Dedola, Rivolta and Stracca 2015). We investigate this in two steps. First, we use two separate banking flows, instead of an aggregate: banking flows into advanced economies and into emerging market

[5]It has been argued that the probability of occurence and the magnitude of Sudden Stops, defined as a sudden reversal of capital inflows, are larger in EMEs (Calvo, Izquierdo and Talvi 2006, Frankel 2003, Bordo and James 2006 among many others). This is discussed in detail in Chapter 3.

economies, and compare the responses of the two banking flows to US monetary policy shocks. The two series are the sum of banking flows to 18 emerging market economies and that to 18 advanced economies, respectively.[6] Then, we move one step further. We consider country-level bilateral VAR models for 36 economies (18 EMEs and 18 AEs) including local interest rates, exchange rates, and country-level banking flows as well as US monetary policy, leverage of US global banks and the VIX. This is to reflect the local factors that might play a role as pulling factors, while maintaining the model as parsimonious as possible considering the relatively small sample size.

We find two implications from the results. First, EMEs suffer to a much larger extent from banking outflows due to a US monetary policy shock in all cases. This supports previous literature on sudden stop episodes. Second, in country-level bilateral VARs where aggregation bias in banking flows is minimized, the magnitude in banking outflows is much larger from the UM shock compared to the FFR shock. This is consistent with a larger, instantaneous and significant response of US global bank leverage to the UM shock which is not observed for the FFR shock.

The remainder of this chapter proceeds as follows. In Section 2.2, we introduce the relevant studies. Section 2.3 explains the methodology we use to extract the intended and exogenous US monetary policy shock following Romer and Romer (2004)′s approach. We describe the variables used in the analysis in Section 2.4. In Section 2.5, we describe the models and the empirical results. In Section 2.6, we perform robustness tests, and Section 2.7 concludes.

2.2 Relevant studies

This study is related to two strands of literature. The first one is studies that examine cross-border banking flows as a kind of capital flows, and the US monetary policy as a determinant for it. The second is an attempt to extract US monetary policy shocks that is intended and exogenous based on narrative sources.

[6]Banking flows denote the total foregin debt that the banking sector in a country as a whole owes to banks in foreign countries. In the baseline model, banking flows are the total sum of figures from all BIS reporting countries. Two subseries of banking flows are the sum of figures for 18 countries classified as advanced countries, and the sum of figures for 18 countries classified as emerging market countries, respectively. This categorization follows Dedola et al. (2015). The list of countries is provided in Footnote 25.

US monetary policy and banking flows On top of the literature that examines conventional capital flows,[7] recent literature has begun focusing on cross-border capital flows through the banking sector and global factors such as US monetary policy and market risk measures (VIX) as main determinants for it. Monetary policy in the centre country (the US) and a measure of market risk (proxied by VIX) have been investigated as a source of global financial cycle that affects global bank behaviour and cross-border capital flows (Arian and Shin 2014, Bruno and Shin 2015). One suggested mechanism for this as follows: Loosened US monetary policy lowers the risk measure (VIX) in financial markets and increases the leverage of US global banks, and this in turn raises overall cross-border bank lending around the world. To be specific, US monetary policy tightening could raise market risk measures (e.g. VIX, VaR), and banks which manage their balance sheet based on a Value-at-Risk rule would shrink their leverage to maintain the targeted VaR level in face of higher market risk following monetary tightening. This leads to an overall decline in lending of US global banks, and also a decline in global banking flows.[8] This is termed as the risk-taking channel of monetary policy (Gambarcota 2009, Borio and Zhu 2012, Bruno and Shin 2015).[9] If this is the case, when global banks apply more lenient conditions on local banks in the recipient countries that borrow from global banks, then the more lenient credit conditions are transmitted to the recipient economy. This way, more permissive liquidity conditions in the sense of greater availability of credit

[7] A considerable literature has examined the causes and consequences of cross-border capital flows. Global pushing factors as well as country-specific pulling factors have been studied as main determinants of global capital flows (See Calvo et al. (1996) among many others). The consequences of cross-border capital flows in the recipient countries has been investigated in different context (Calvo et al. 1996, Gertler, Gilchrist and Natalucci 2007, Reinhart and Reinhart 2008, Kose et al. 2009, Mendoza 2010, Lane and McQuade 2012, Brunnermeier et al. 2012, Schularick and Taylor 2012, Cesa-Bianchi et al. 2015, Dedola, Rivolta and Stracca 2015 among many others). One important conclusion of these studies is that cross-border capital flows play an important role in creating boom and bust cycles in recipient economies (especially emerging markets).

[8] This mechanism is grounded in three sequential steps: (1) The US monetary policy shock affects VIX, and (2) VIX affects the leverage of US global banks, and (3) US global bank leverage influences overall global banking flows. See Bruno and Shin (2015), Gambarcota (2009), Hahm, Shin and Shin (2013), Adrian and Shin (2014), Borio and Zhu (2012) for detail.

[9] This is closely related to Search-for-yield view, in that both explain how monetary policy may influence banks′ perception of or measure of market risk (Gambarcota 2009). Search-for-yield channel explains that lower interest rates may encourage banks to pursue higher risk and higher return investment opportunities especially under nominal return target. On the other hand, the risk-taking channel predicts that when monetary policy affects market measure of risk, this affects bank′s behaviour (leverage) especially when they manage their balance sheet based on VaR rule.

will be transmitted across borders through the interactions of global and local banks.

Relevant supporting empirical evidence is provided. Bruno and Shin (2014) find empirical evidence from country-level panel data for 46 countries supporting that global banks′ leverage is a significant factor in determining cross-border bank inflows to the recipient countries. As described earlier, Bruno and Shin (2015) find that a loosening US monetary policy leads to a decrease in VIX which in turn leads to a rise in the leverage of global banks with a recursive VAR consisting of the FFR, leverage of US global banks, banking flows, VIX and effective exchange rate of US dollar. Rey (2015) finds that a strong comovement in capital flows exists, which is regarded as global financial cycle, and suggests that the VIX and US monetary policy shock could be the main drivers of such a movement in cross-border capital movements. Dedola, Rivolta and Stracca (2015) finds that a US monetary policy shock brings about a contraction in economic activity and an increase in unemployment in both advanced and emerging countries. But only the latter results in capital outflows, a domestic credit crunch and falling housing prices.

US monetary policy shock identification Monetary policy tightening would bring about a change in economic activities to a different degree based on whether it is expected by private agents or not. Assuming that private agents form their own economic outlook based on the Federal Reserve′s forecasts, a monetary policy that private agents could not infer from the Federal Reserve′s forecasts would affect economic activities to a larger degree. This motivates our study. Based on this intuition, Romer and Romer (2004) develops a measure of US monetary policy shocks for the period $1969 - 1996$ that is relatively free of endogenous and anticipatory movements. Quantitative and narrative records are used to infer the Federal Reserve′s intentions for the Federal Funds rate around FOMC meetings. They regress this series on the Federal Reserve′s internal forecasts to derive a monetary policy measure free of systematic responses to information about future developments. They find that estimates using the new measure indicate that policy has large, relatively rapid, and statistically significant effects on both output and inflation. The specific procedure of Romer and Romer, and its extension of BBK we adopt is decribed in detail in the following section.

2.3 Identification of monetary policy shocks

In this section, we describe the methodology used to identify intended and exogenous US monetary policy shocks following Romer and Romer (2004)′s approach. To extend the original work of Romer and Romer for the period 1969 − 1996, we follow Bluedorn, Bowdler and Koch (BBK) who extends the shocks for the period 1969 − 2007. The procedure involves three steps: (1) Appending Romer and Romer′s intended series from 1969 − 1996 with announced target rate for the period 1997 − 2007, (2) Removing the endogenous to the Federal Reserve′s forecasts from the intended movements in FFR by regressing the intended FFR change on Greenbook forecasts for economic activities, (3) Transforming the meeting-based shock into quarterly-based shock. In this section, we describe each of these procedures.

2.3.1 Intended change in Federal Funds rate

The effective (realized) Federal Funds rate might be affected by supply and demand shocks in the reserve market that are unrelated to the intension of monetary policy authority. To remove a change in Federal Funds rate irrelevant to Federal Reserve′s intention, Romer and Romer (2004) utilizes quantitative and narrative records around FOMC meetings for the period 1969 − 1996 to determine the size of the Federal Funds rate change targeted by the FOMC at their scheduled meetings. BBK notices that the Federal Reserve began announcing its targeted Federal Funds rate explicitly since February 1994, and by appending Romer and Romer′s intended series from 1969 − 1996 with announced target rate for the period 1997 − 2007, they generate intended change of Federal Funds rate for the period 1969 − 2007. During the overlapping period of 1994 − 1996, the two series have a correlation that is essentially 1, and this defends the pooling of the two series from different sources.[10]

2.3.2 Removal of endogeneity in the Federal Funds rate

The second step is to purge the intended movement in the Federal Funds rate of the part that is systematically related to the Federal Reserve′s economic forecasts. Romer and Romer regress the intended change in the Federal Funds rate on the Federal Reserve′s in-house (Greenbook) forecasts for output

[10]The correlation between target Federal Funds rate and Romer and Romer′s intended series is 0.975 for the period 1994 − 1996.

growth (real GDP), inflation, and unemployment over the horizons of up to two quarters ahead (Equation 2.1). They include both the forecasts for the contemporaneous meeting and the change in the forecast since the previous meeting because it is plausible that both the levels and the changes in the forecasts are important determinants of the Federal Reserve′s behaviour. The regression specification is as follows:

$$\begin{aligned}\Delta ff_m = \alpha + \beta ffb_m + \sum_{i=-1}^{2} \gamma_i \Delta\tilde{y}_{mi} + \sum_{i=-1}^{2} \lambda_i (\Delta\tilde{y}_{mi} - \Delta\tilde{y}_{m-1,i}) \\ + \sum_{i=-1}^{2} \phi_i \tilde{\pi}_{mi} + \sum_{i=-1}^{2} \theta_i (\tilde{\pi}_{mi} - \tilde{\pi}_{m-1,i}) + \rho_i \tilde{n}_{m0} + \varepsilon_m \qquad (2.1)\end{aligned}$$

Where, Δff_m is the change in the intended funds rate around FOMC meeting m. ffb_m is the level of the intended funds rate before any changes associated with meeting m. It is included to capture any tendency toward mean reversion in FOMC behavior. $\tilde{\pi}$, $\Delta\tilde{y}$ and $\tilde{n}$ refer to the forecasts of inflation, real output growth, and the unemployment rate. The i subscripts refer to the horizon of the forecast: -1 is the previous quarter; 0 is the current quarter; and 1 and 2 are one and two quarters ahead, respectively. ε_m is a mean-zero error term. A hat denotes the real-time forecast for a variable.

BBK extends Romer and Romer′s original regression (Equation 2.1) by including a larger set of unemployment forecasts and additionally includes real-time back-, now- and forecasts of manufacturing capacity utilization. The regression specification is as follows:

$$\begin{aligned}\Delta ff_m = \alpha + \beta ffb_m + \sum_{i=-1}^{2} \varphi_i^{y} \Delta\tilde{y}_{m,i} + \sum_{i=-1}^{2} \varphi_i^{\Delta y} (\Delta\tilde{y}_{m,i} - \Delta\tilde{y}_{m-1,i}) \\ + \sum_{i=-1}^{2} \varphi_i^{\pi} \tilde{\pi}_{m,i} + \sum_{i=-1}^{2} \varphi_i^{\pi} (\tilde{\pi}_{m,i} - \tilde{\pi}_{m-1,i}) \\ + \sum_{i=-1}^{2} \varphi_i^{n} \tilde{n}_{m,i} + \sum_{i=-1}^{2} \varphi_i^{n} (\tilde{n}_{m,i} - \tilde{n}_{m-1,i}) \\ + \sum_{i=-1}^{2} \varphi_i^{u} \tilde{u}_{m,i}^{mfg} + \sum_{i=-1}^{2} \varphi_i^{\Delta u} (\tilde{u}_{m,i}^{mfg} - \tilde{u}_{m-1,i}^{mfg}) + \varepsilon_m \qquad (2.2)\end{aligned}$$

where, $\tilde{u}^{mfg}$ is the manufacturing capacity utilization index measured in percentage points. They regard forecasts of manufacturing capacity utilization as proxies for latent policymaker perceptions concerning the cyclical position of the economy, which may contribute to policy decisions even after controlling for real output growth, inflation, and unemployment. As a rationale for inclusion of capacity utilization, BBK suggests the empirical relevance of capacity utilization as emphasized by Giordani (2004), who shows that controlling for such a proxy for actual output relative to potential is crucial for accurate policy identification. In this chapter, we follow BBK′s specification (Equation 2.2) considering this point.[11] The residual series from Equation (2.2) is the meeting-frequency based US monetary policy shock, which we will transform into quarterly basis in Section 2.3.3.

Results Table 2.1 presents the regression results from estimating Equation (2.2) for a sample of 354 FOMC meetings for the period 1969−2007. The regression results are the same to two decimals as in BBK. The sums of the coefficients on forecast levels are generally of the same signs as those reported by Romer and Romer (2004), indicating a tighter policy in response to stronger economic activity and higher prices. The inclusion of the capacity utilization and additional unemployment terms is also reflected in the regression R^2, which is higher than that for the original Romer and Romer specification (34.5% as compared to 28%).[12]

2.3.3 Frequency transformation

The residual in regression Equation (2.2) represents the US monetary policy shock that is the intended change of Federal Funds rate relatively free of systematic responses to information about future developments. This residual series is at a FOMC meeting frequency basis, while the data on banking flows and other macroeconomic variables that we investigate in our empirical work are reported on a quarterly basis.[13] In this sense, we need to transform the meeting-based monetary policy shock (residual of Equation (2.2)) into quarterly-based monetary policy shock series. Following Romer and Romer,

[11] In robustness test, we also consider a simpler specification of Romer and Romer′s original regression as Equation (2.1).

[12] The forecasts of each variable and their revisions are not statistically significant individually in some cases. However, the main purpose of this regression is not on judging the significance of individual forecasts, but on removing the movement of FFR that is systematically related to forecasts and its revision. With this perspective in mind, the statistical significance of individual series becomes less important.

[13] While daily and monthly data for effective Federal Funds rate and VIX are available, international banking flows (BIS) and leverage of US global banks (Federal Reserve) are reported as term-end amount of outstanding.

we transform the frequency by aggregating the shocks within the corresponding quarters. That is, a quarterly monetary policy shock is the accumulation of meeting-based monetary policy shocks of meetings that had occurred in the corresponding quarter (usually twice in that the committee meets 8 times a year).

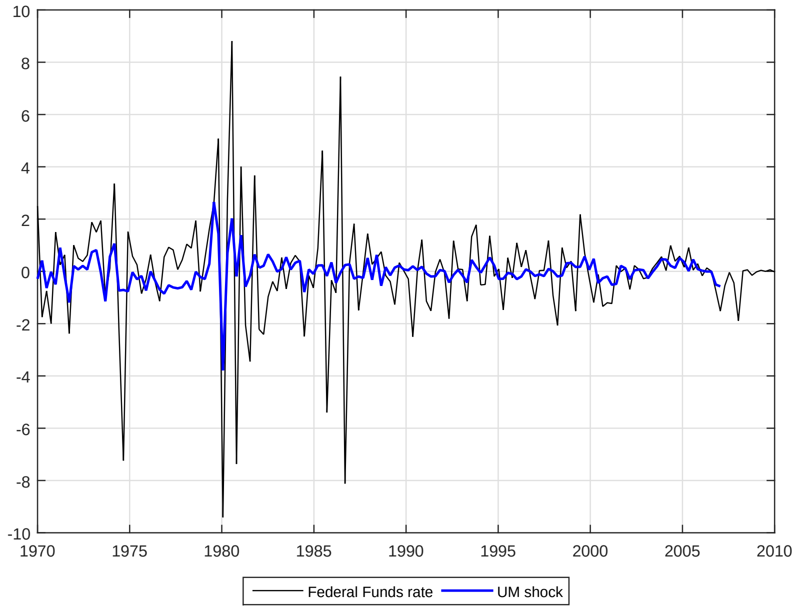
In Figure 2.1, we plot the shock identified based on Romer and Romer′s approach and then transformed into quarterly data (We refer to this as the UM shock from now on), and differenced quarterly Federal Funds rate (target and effective Federal Funds rates). In 1984Q4, the target FFR declined by more than 2.5%p, while the change in the intended FFR was only 0.5%p if we purge the target rate of the movement that is systematically correlated with the Federal Reserve′s internal forecasts. For the period $1970 - 2007$, the standard deviation of UM shock is 59 basis points and that of FFR is 213 basis points, suggesting that roughly three quarters of the variation in the Federal Funds rate is eliminated from UM as part of the identification procedure. The correlation of the two series is 0.543.

Table 2.1: Estimation results

		Coefficient	s.e.	t-statistics
Intercept		-0.967	0.759	-1.274
Target from the last meeting		-0.053	0.011	-4.997
forecast	-1	0.000	0.010	0.004
output	0	0.031	0.025	1.217
growth	1	-0.009	0.031	-0.283
	2	-0.016	0.032	-0.502
	Total Effect	0.006	0.028	0.230
output	-1	0.003	0.016	0.218
revision	0	0.071	0.030	2.324
	1	-0.019	0.036	-0.529
	2	0.029	0.038	0.751
	Total Effect	0.084	0.060	1.397
forecast	-1	0.023	0.022	1.059
inflation	0	-0.004	0.027	-0.146
	1	0.035	0.041	0.867
	2	0.022	0.044	0.493
	Total Effect	0.076	0.017	4.447
inflation	-1	0.010	0.028	0.367
revision	0	-0.072	0.035	-2.050
	1	0.002	0.051	0.032
	2	-0.016	0.059	-0.265
	Total Effect	-0.076	0.078	-0.975
forecast	-1	-0.081	0.147	-0.553
unemployment	0	0.261	0.336	0.779
	1	0.116	0.492	0.236
	2	-0.322	0.313	-1.029
	Total Effect	-0.025	0.027	-0.919
unemployment	-1	-0.180	0.177	-1.017
revision	0	-0.271	0.294	-0.921
	1	0.024	0.444	0.054
	2	-0.103	0.320	-0.322
	Total Effect	-0.529	0.163	-3.255
forecast	-1	0.068	0.047	1.441
capacity	0	-0.054	0.049	-1.110
utilization	1	0.000	0.000	0.221
	2	0.000	0.001	0.179
	Total Effect	0.015	0.008	1.843
capacity	-1	-0.068	0.047	-1.442
utilization	0	0.110	0.056	1.971
revision	1	0.000	0.000	-0.548
	2	0.000	0.001	-0.257
	Total Effect	0.041	0.028	1.444
		Obs.	R^2	D-W stat.
		354	0.345	1.870

Notes: 1) The sample is all scheduled FOMC meetings from the period March 1969 − December 2007. 2) The total effects refer to the sum of coefficients on sets of forecasts and forecast revisions for the previous (-1), current (0), and next two quarters (1, 2).

Figure 2.1: FFR and Exogenous MP shock



Notes: 1) Federal Funds rate is difference of quarterly effective Federal Funds rate (end of term value of daily series), and UM shock denotes exogenously identified US monetary policy shock as described in Section 2.3. 2) The correlation between UM shock and Federal Funds rate (1970Q1-2007Q4) is 0.543. 3) The UM shock ends at the end of 2007 considering that FFR does not have any effective variation under the zero lower bound after 2008.

2.4 Data description

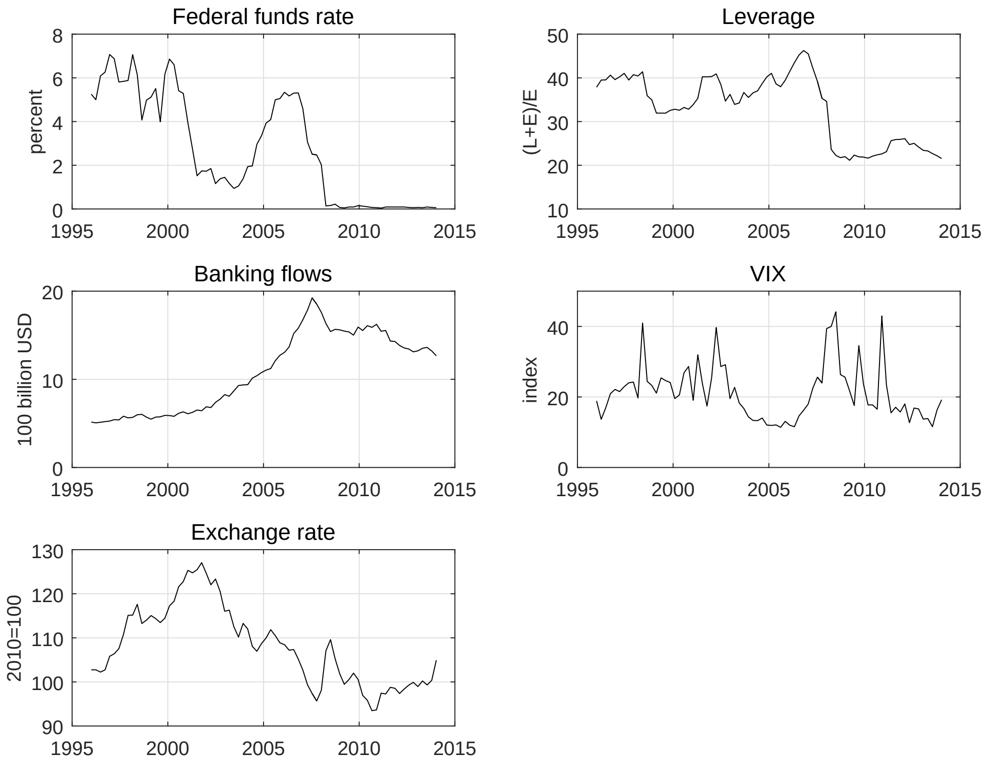
In this section, we describe the five variables used in the analysis. As an indicator of US monetary policy, an effective (realized) Federal Funds rate (FFR) is adopted. The leverage of the US security and dealer sector is used as a proxy for the leverage of US global banking sector (FRB, Flow of Funds statistics). Leverage is defined as $(L + E)/E$, where L denotes liabilities and E denotes equity. US global banks are assumed to play a key role in intermediating global banking flows and their activities expressed as leverage are affected by US monetary policy shock.[14] Global banking flows is measured as an international bank-to-bank lending statistics of BIS locational banking statistics. The key organizational criteria of the BIS locational statistics data are the country of residence of the reporting banks and their counterparties as well as the recording of all positions on a gross basis, including those vis-a-vis own affiliates. This makes the locational statistics appropriate for measuring the role of banks in the intermediation of international capital flows and lend-

[14] Changes in the leverage of US global banks has been mainly driven by the asset side, not by equity. See APPENDIX B.2 for detail.

ing flows (Bruno and Shin 2014). VIX (CBOE VIX index of implied volatility of S&P index options) represents volatility in US stock market perceived by market participants. This is usually used as a measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices, and adopted as the magnitude of riskiness that US global banks perceive. The value of US dollar (exchange rate) is included in that this affects the cost of dollar denominated funding. As an indicator for US dollar value, a real effective exchange rate of US dollar ($REER$), weighted by trade volume, is adopted (IMF IFS). Figure 2.2 plots these variables (See APPENDIX B.1 for detailed information).[15]

[15]Figure 2.2 indicates that there exists a break in the data used at the onset of $2007 - 2009$ financial crisis. This is one reason why we exclude the data after 2008 and include normal periods of $1996 - 2007$ only (The reason the analysis begins at 1996 is that banking flows statistics from BIS available from that point.), considering that the responses of banking flows to monetary policy during the crisis periods could be quite different from those in normal periods. In financial crisis periods, it is likely we observe a significant monetary policy easing accompanying a severe recession and financial turmoil. This is because the recession stemming from the crisis usually persists even though monetary authorities ease their monetary policy stances resolutely to minimize the harmful influences from the financial crisis (Remember 2008-2009 financial crisis). If this is the case, the observations during the crisis periods could distort the normal relationship between US global bank leverage (and banking flows) and monetary policy actions in non-crisis periods. This is why we do not include observations since 2008, and we distinguish the crisis periods from normal periods using dummy variables in chapter I.

Figure 2.2: Variables used



Notes: An increase in REER (real effective exchange rate of the US dollar) represents an appreciation of the US dollar. In the VAR model, banking flows and REER are log-differences, and leverage and VIX are log-levels.

2.5 Evidence from VARs

We measure the response of global bank leverage, banking flows, VIX and exchange rate to a US monetary policy tightening shock. First, we examine the responses of variables to the US monetary policy shock identified within a recursive VAR framework by replicating Bruno and Shin (2015) in Section 2.5.1. This is the benchmark case where the endogeneity problem between FFR and global bank leverage exists. Second, we incorporate the exogenously identified US monetary policy shock described in Section 2.3 into the VAR, and measure the responses of the endogenous variables to the externally identified shock. We then compare the response of banking outflows in EMEs and AEs to a US monetary policy shock.

2.5.1 Structural VAR: Replication of Bruno and Shin

For a baseline result, we replicate a recursive VAR scheme of Bruno and Shin (2015), one of the latest study on the issue. The VAR consists of five variables as follows.

$$y_t = [FFR, LEV, BF, VIX, REER]'.$$

FFR is the effective Federal Funds rate. LEV is the log leverage of US global banks. BF is the log-differenced banking flows denoted in US dollar. VIX is logged VIX index. $REER$ represents the log-differenced real effective exchange rate of US dollar. More detailed information on the variables is described in Section 2.4 and APPENDIX B.1. The ordering in a recursive VAR imposes a contemporaneous relationship among the variables.[16] This implies that FFR is not affected by the information on other variables instantaneously, but not vice versa. The Federal Funds rate reflects the periodic decision making process at the Federal Reserve and the slowly evolving implementation of monetary policy. This ordering scheme assumes that all movements in FFR are exogenous, and this could be problematic if movements of FFR are endogenously affected by Federal Reserve′s forecasts.

Our analysis includes samples for the period $1996 - 2007$. This is because the banking flows statistics from BIS begins from 1995Q4. We stop in 2007Q4 since the financial crisis is a structural break which might change the impact of US monetary policy shock in normal periods, and we do not have any meaningful variation the Federal Funds rate under the zero lower bound.[17]

The VAR model is specified with two lags following the Bruno and Shin′s original work. Lag selection procedures (the Hannan-Quinn information criterion and the Schwarz information criterion) suggest one lag. However, the Lagrange multiplier test for autocorrelation in the residuals of the VAR suggests that a null hypothesis that there is no serial correlation is rejected at 5% significance level in a model with one lag. In a model with two lags, all serial

[16] We follow the ordering suggested in Bruno and Shin (2015) in that it reports the main results are robust to alternative orderings of variables in the recursive VAR. We also confirmed that the results from different orderings do not change the main results in an essential way. In Section 2.5.2, where we measure the responses of endogenous variables to the exogenously identified monetary policy shock (UM shock), the ordering of variables does not affect the results by construction (Equation (2.3)).

[17] The zero lower bound after the crisis posits significant challenges to VAR estimation (Liu et al. 2011, Killian 2011).

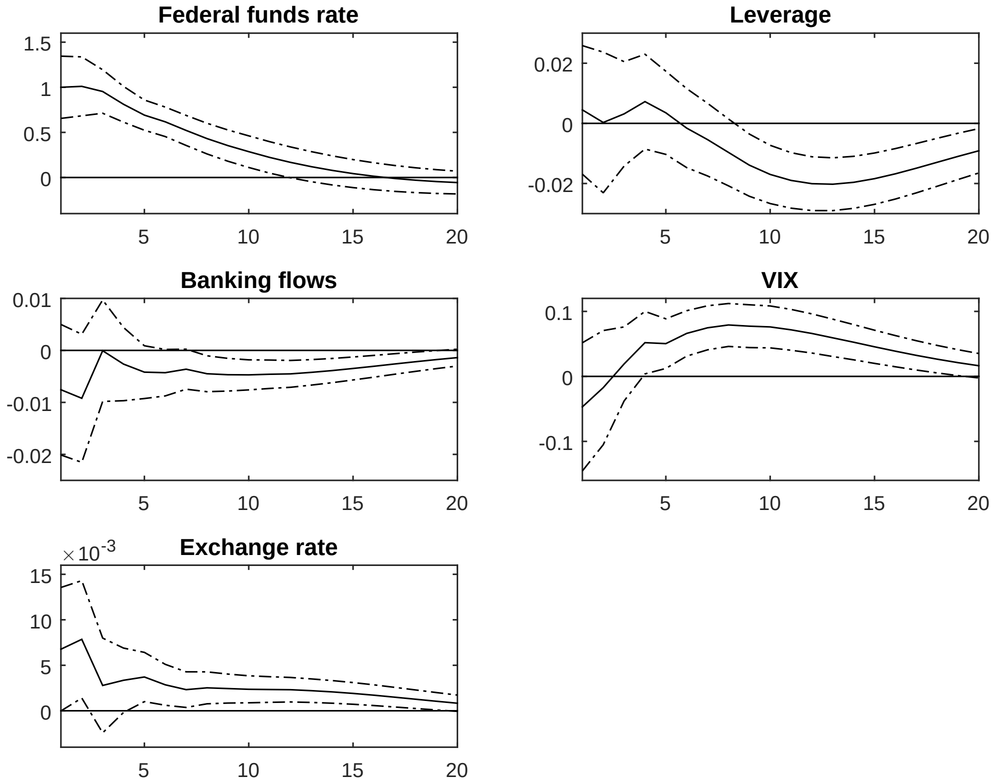
correlation in the residuals disappears, and all the eigenvalues lie inside the unit circle, satisfying the condition for the model to be stable.

Results The results are shown in Figure 2.3.[18] The figure shows responses of the five endogenous variables to Federal Funds rate shock of 100 basis point (We denote the monetary policy shock recovered from the recursive VAR as the FFR shock to distinguish this from the exogenously identified UM shock.) All impluse responses are normalized such that the response of the Federal Funds rate to a monetary policy shock is 100 basis points on impact. Dashed lines represent 95% bootstrapped confidence intervals generated from 1,000 replications. Overall, the results replicate the Bruno and Shin (2015)′s finding. Leverage (LEV) shows positive responses for the first five quarters and then begins declining. It reaches its minimum of negative 2% about 13 quarters after the shock. Banking flows (BF) continue to decrease after the shock, though the magnitude is small and responses become significant about 8 quarters after the shock. In total (accumulated sum), BF declines about 7.7% during the first 20 quarters after the shock. VIX shows an initial puzzle, decreasing for the first two quarters (though insignificant), then starts rising and reaches its maximum around 7.9% about 8 quarters after the shock. The positive response remains for 20 quarters and is significant during most of the time period. This shows that the perceived riskiness in the financial market in the US rises in the face of a US monetary tightening shock. The value of the US dollar ($REER$) increases promptly (appreciation of US dollar) and rises by about 5.4% in the first 20 quarters in total. This represents a delayed overshooting, not an instant jump as theory expects. Except for Federal Funds rate, the responses of all variables become siginificant after about 4−8 quarters after the shock.[19]

[18]The results compared with the responses to the exogenously identified monetary policy shock based on narrative approach is summarized in Table 2.2 and Figure 2.5.

[19]The results successfully replicate Bruno and Shin (2015). There are some differences in estimation from Bruno and Shin. First, we use nominal effective FFR as is common in the literature, not the real target FFR (intended target level of FFR − CPI inflation rate) in Bruno and Shin. Second, the leverage of US security and dealer sector might be different due to revision of the statistics. However, these do not cause signficant differences.

Figure 2.3: Responses to FFR shock



Notes: Estimated responses to one unit of FFR shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) in the recursive VAR model consisting of effective Federal Funds rate (FFR), logged US broker-dealer leverage (LEV), log-differenced cross-border banking flows (BF), logged VIX index (VIX), and log-differenced real effective exchange rate of US dollar ($REER$) with two lags, based on 1000 replications. BF in accumulation declines by 7.7%, and $REER$ in accumulation rises by 5.4% during the 20 quarters after the shock.

2.5.2 VAR with exogenously identified shock

In this section, we measure the responses of endogenous variables to a US monetary policy shock that is externally identified (UM shock) and incorporated into a reduced form VAR model. The externally identified monetary policy shock is extracted following Romer and Romer′s narrative approach as described in Section 2.3.

Methodology We incorporate the UM shock identified in Section 2.3 into the VAR framework used in Section 2.5.1 and measure the responses of endogenous variables to the exogenously identified UM shock. Except for the inclusion of the UM shock as an external term, all other aspects are the same as the previous estimation. The model we use is as follows:

$$y_t = A(L)y_t + B(L)UM_t + e_t \tag{2.3}$$

Where, y_t consists of the five endogenous variables as in the previous section (FFR, LEV, BF, VIX and $REER$), and UM represents the exogenous US monetary policy shock generated by Romer and Romer (2004)′s approach as explained in Section 2.3. The lag length of endogenous variables $A(L)$ is set to two, and that of exogenous UM shock $B(L)$ is set to four. With these lags, the LM test confirms that the VAR model does not have any autocorrelation in the residuals and all the eigenvalues lie inside the unit circle, satisfying the condition for the model to be stable.[20]

Results The responses to the UM shock are shown in Figure 2.4, and Table 2.2 and Figure 2.5 summarize the results in comparison with the responses to the FFR shock. All responses are normalized such that the contemporaneous response of the Federal Funds rate to the monetary policy shock is 100 basis points. At first, the leverage of US global banks (LEV) declines quickly and to a much larger extent in response to the UM shock compared to a delayed response in the face of the FFR shock. In the face of a one unit UM shock, leverage (LEV) declines 4% on impact and then declines further to reach its minimum of -6.1% after 3 quarters. This response is much larger, and faster compared to the response to the FFR shock. In case of FFR shock, the maximum decline of the leverage was about 2% and it occurs 13 quarters after the shock. In addition, the response of the leverage to UM shock is statistically significant for the first four quarters, while that to FFR shock becomes significant about eight quarters after the shock. The difference in the responses represents a bias in the response of leverage to the FFR shock which does not consider the Federal Reserve′s internal forecasts. That is, we regard this difference as stemming from the endogeneity problem arising between the FFR and bank leverage.

Second, the response of banking flows (BF) reveals alternating signs in the first two years, and after then it shows negative and marginally significant responses. In total (accumulated sum), BF declines by 7.9% in 20 quarters. The responses of banking flows (BF) to two monetary policy shocks are essentially the same during the first 20 quarters after the shock in total. This

[20]Different lags for the exogenous UM shock are examined in the robustness test.

finding seemingly contradicts the difference in the responses of leverages considering that US global banks play a role in intermediating the banking flows. One possible reason for this is that the specification of the VAR does not reflect possible heterogeneous responses across countries (aggregation bias). This motivates us to examine bilateral VARs in Section 2.5.3.[21]

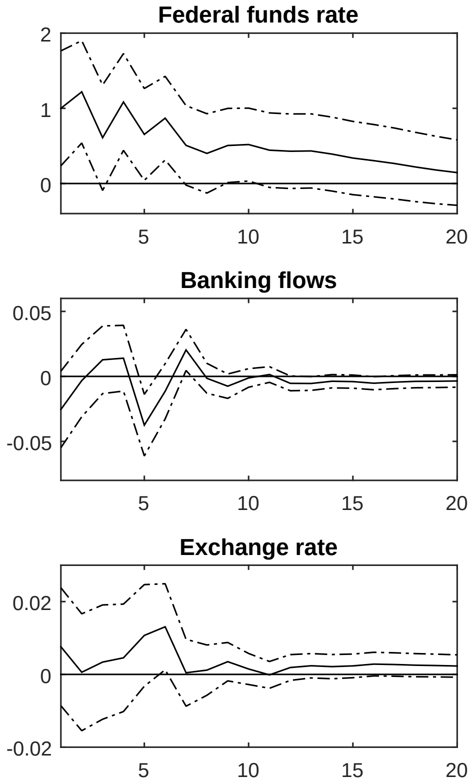
Third, exchange rate of dollar ($REER$) shows consistently positive (appreciation of US dollar) responses and increases by 6.8% in the first 20 quarters in total. This is a larger response compared for the FFR shock, and consistent with previous findings (Bluedorn and Bowdler 2011).

Finally, the response of the VIX shows volatile fluctuations for the first two years, and then begins rising, reaching its maximum positive 5.7% about 15 quarters after the shock. We do not find any apparent and significant hike in the VIX. This is interesting in that a change in monetary policy that was not anticipated by economic agents would raise market risk measures to a larger extent. This is not consistent with Bruno and Shin$'$ finding in which US monetary policy tightening affects global banking flows through the VIX. One possible interpretation is that there could be other channels in which US monetary policy shock affects US global banks, not through market risk measures.[22] In cases of banking flows, VIX and exchange rate, the responses to UM shock are not statistically significant in most cases for the first 3 years and only marginally significant since then.

[21]In the country-level bilateral VARs for 36 countries, we find that the UM shock leads to a larger decline in banking flows especially for emerging market economies.

[22]This might be also due to either relatively short sample period analyzed, or the fact that the true response of VIX might be contaminated by non-monetary policy events affecting VIX, as well. For example, the VIX rose significantly in the major events such as the starting of the Gulf War, 9/11, the climax of 2009 financial crisis, Russian crisis followed by the LTCM bankruptcy, the bursting of the dotcom bubble (Miranda-Agrippino and Rey 2012).

Figure 2.4: Responses to UM shock



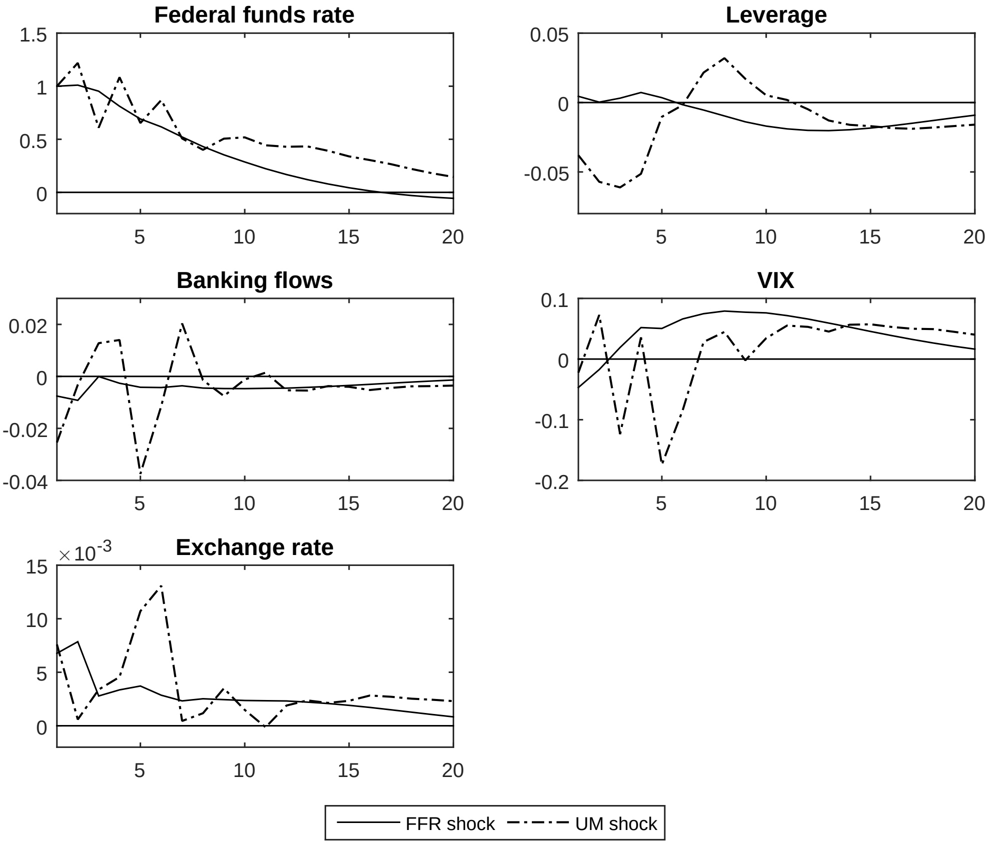
Notes: Estimated responses to one unit of UM shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) in the recursive VAR model consisting of effective Federal Funds rate (FFR), logged US broker-dealer leverage (LEV), log-differenced cross-border banking flows (BF), logged VIX index (VIX), and log-differenced real effective exchange rate of US dollar ($REER$) with two lags for endogenous variables and four lags for UM, based on 1000 replications. BF in accumulation declines by 7.9%, and $REER$ in accumulation rises by 6.8% during the 20 quarters after the shock.

Table 2.2: Maximum response

	FFR shock			UM shock		
	Max	S.E.	Quarter	Max	S.E.	Quarter
Leverage (LEV)	-2.00 %	0.344	13	-6.10 %	2.836	3
Banking flows (BF)	-7.70 %	1.862	20	-7.90 %	6.713	20
VIX (VIX)	7.90 %	1.352	8	5.70 %	3.857	15
Value of $US ($REER$)	5.40 %	0.973	20	6.80 %	4.406	20

Notes: 1) Figures are the maximum impulse response to two US monetary policy shocks within the 20 quarters and the corresponding quarter. In case of BF and $REER$ which were log-differenced in the VAR, the figures are the maximum values in accumulation. 2) FFR shock refers the US monetary policy shock identified within the recursive VAR, and UM shock refers the exogenously identified monetary policy shock based on narrative source.

Figure 2.5: Responses to two shocks



Notes: Estimated responses to one unit of FFR shock (solid lines) and to one unit of UM shock (dashed lines).

2.5.3 Banking outflows across countries

We measure the response of banking flows across countries in response to a US monetary policy shock considering that the magnitude of banking outflows might be different based on the economic conditions and characteristics of the recipient countries.[23] Following Dedola et al. (2015), we divide into advanced and emerging economies as a comprehensive categorization reflecting important aspects in the recipient countries. For this, we expand the baseline model to stress this point by disaggregating the total international banking flows into sub-series.[24] First, we consider two subgroups based on country′s

[23]The extent to which banking flows are affected by a US monetary policy shock may differ based on various aspects of countries (e.g. overall development of financial market and income level, the exchange rate regime it adopts, and the degree of financial openness, etc.).

[24]Banking flows denote the total foregin debt that the banking sector in a country as a whole owes to banks in foreign countries. This is country-specific data, and we use the global aggregate series for all BIS reporting countries in the baseline model. From now on, we use the series for specific country groups (AEs, EMEs) and country-specific figures.

features: Banking flows to 18 advanced economies (AEs) and those to 18 emerging market economies (EMEs). Secondly, we estimate the responses of country-specific banking flows for 36 countries in bilateral VAR models.[25]

2.5.3.1 Banking Flows: AEs and EMEs

We divide the aggregate banking flows into two subgroups: flows to advanced economies and flows to emerging market economies. Using these two banking flows, we extend the baseline five variable model into a six variable model as the following:

$$y_t = [FFR, LEV, BF^{AE}, BF^{EME}, VIX, REER]'$$

BF^{AE} and BF^{EME} denote the sum of banking flows to 18 countries belong to the advanced economies, and that to 18 countries classified as emerging market economies, respectively. Except that we use two separate banking flows, all other aspects are the same as in the previous section, and we measure the responses of endogenous variables to two monetary policy measures (FFR shock and UM shock).

Results Figure 2.6 presents the responses of the two banking flows series (BF^{AE}, BF^{EME}) to two different US monetary policy shocks. Table 2.3 summarizes the maximum accumulated responses of banking flows. As is in the previous section, we denote impluse responses to a US monetary policy shock identified within the recursive VAR as the FFR shock, and term those to an exogenously identified monetary policy shock based on narrative source as the UM shock.

The upper panels in Figure 2.6 presents impluse responses of two banking flows to the FFR shock. We observe that the response of BF^{AE} looks quite similar to that of aggregate banking flows in Figure 2.3. One possible explanation for this is that banking flows for the 18 advanced countries account for the majority of total banking flows (See Footnote 25). In the case of the EMEs, the decline of banking flows is much larger and significant. This result

[25] We follow the categorization of Dedola et al. (2015): Advanced economies includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Korea, Netherlands, Norway, Portugal, Spain, Sweden, and the UK. Emerging market economies inclues Brazil, Chile, China, Colombia, Czech Republic, Estonia, Hungary, India, Latvia, Lithuania, Malaysia, Mexico, Philippines, Poland, Russia, South Africa, Thailand, and Turkey. Banking flows to the 18 advanced economies and that to the 18 EMEs account for 59.2% and 3.0% of total banking flows, respectively, as in the end of 2007.

supports the previous literature that find emerging market economies suffer greater from capital outflows in the face of financial stress. The maximum response in accumulation of banking flows to AE and EME are -8.7% and -22.6%, respectively.

The bottom panels present the responses of banking flows to the UM shock. BF^{AE} shows quite similar development as in the baseline regression in Figure 2.4. The maximum response in accumulation is -7.8% which is comparable to the baseline result. The accumulative response of BF^{EME} is -14.9%, much larger than the accumulated of BF^{AE}, though is not significant for the first 20 quarters after the shock.

2.5.3.2 Country-specific bilateral VARs

We move one step further by examining the response of country-specific banking flows for 36 countries, controlling for local variables such as the interest rates and the exchange rates. First, we estimate a six variable VAR including three local variables. Then we also examine a smaller model consisting of four variables considering that data for country-specific interest rates and exchange rates are not available for several advanced economies belonging to EU.

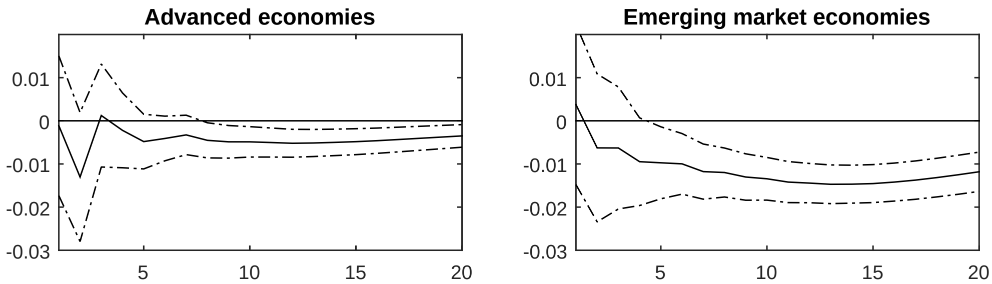
Model We expand the baseline model to include local factors such as the money market rates and the exchange rates, and country-specific banking flows.

$$y_t = [FFR, LEV, VIX, MP^*, BF^*, EXCH^*]'$$

Considering the relatively small sample size, we include three US variables, and three local variables: FFR, LEV and VIX as in the baseline model, and the country-specific money market rate (MP^*), banking flows (BF^*) which are banking flows in dollars that enter the banking sector in a particular country, and the bilateral exchange rate ($EXCH^*$, national currency per U.S. dollar). BF^* and $EXCH^*$ are log-differenced. US (global) variables such as (FFR, LEV, VIX) are defined the same as in the previous section. We estimate the model for 25 countries (18 emerging market economies, and 7 advanced economies) separately, and measure the responses to the two US monetary policy shocks. For the advanced economies, we only examine 7 out of 18 countries due to data availability.[26] The lag of the endogenous variables is set to two and lag of exogenous monetary policy shock is set to four as in the baseline model.

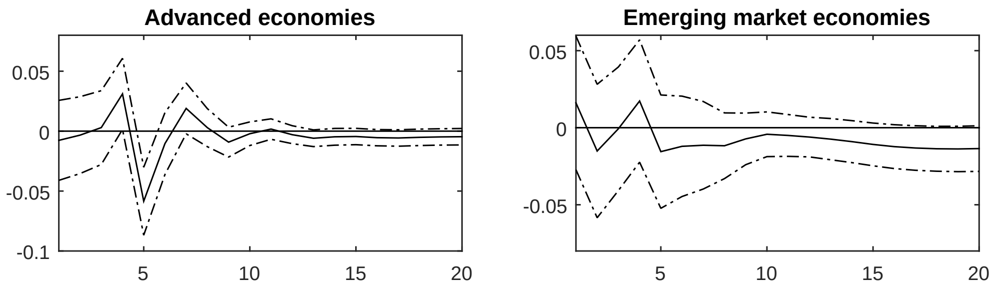
Figure 2.6: Responses of two banking flows

(a) FFR shock



Notes: Estimated responses to one unit of FFR shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) of the recursive VAR model consisting of effective Federal Funds rate (FFR), logged US broker-dealer leverage (LEV), log-differenced banking flows to AEs (BF^{AE}), log-differenced bank flows to 18 EMEs (BF^{EME}), logged VIX index (VIX), and log-differenced real effective exchange rate of US dollar ($REER$) with two lags, based on 1000 replications. BF^{AE} in accumulation declines by 8.7% and BF^{EME} in accumulation declines by 22.6% during the 20 quarters after the shock.

(b) UM shock



Notes: Estimated responses to one unit of UM shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) of the recursive VAR model consisting of effective Federal Funds rate (FFR), logged US broker-dealer leverage (LEV), log-differenced banking flows to AEs (BF^{AE}), log-differenced bank flows to 18 EMEs (BF^{EME}), logged VIX index (VIX), and log-differenced real effective exchange rate of US dollar ($REER$) with two lags, based on 1000 replications. BF^{AE} in accumulation declines by 7.8% and BF^{EME} in accumulation declines by 14.9% during the 20 quarters after the shock.

[26] We consider 36 countries (18 emerging market economies, and 18 advanced economies as in Dedola et al. (2015)). However, we could estimate this model for only 7 advanced economies since many of them belong to EU, and local money market rates and exchange rates are not available for the entire period of $1996 - 2007$ for those countries.

Table 2.3: Maximum response

	FFR shock			UM shock		
	Max	S.E.	Quarter	Max	S.E.	Quarter
Flows to AEs (BF^{AE})	-8.70 %	2.345	20	-7.80 %	7.513	20
Flows to EMEs (BF^{EME})	-22.6 %	3.155	20	-14.9 %	14.483	20

Notes: 1) Figures are the maximum impulse response of banking flows in accumulation to two US monetary policy shocks (FFR shock and UM shock) within the 20 quarters and the corresponding quarter. 2) FFR shock refers the US monetary policy shock identified within the recursive VAR, and UM shock refers the exogenously identified monetary policy shock based on narrative source.

Results Figure 2.7 presents the histograms of the maximum decline in BF^* within 20 quarters for the two country groups (Advanced and Emerging market countries) in response to the two monetary policy shocks (FFR shock and UM shock). The upper panels show the responses of banking flows of 7 advanced countries (left) and 18 emerging market economies (right) to the FFR shock. The mean of the responses for the 7 advanced countries is -6.1%, while it is -9.1% in emerging market economies. The bottom panels shows the responses to the UM shock. In case of the advanced economies, the mean decline is -8.2%, while the mean decline is -18.2% in case of emerging market economies. The results tell us that the impact on banking flows of US monetary policy shock is larger in EMEs compared to that in AEs. By comparing the monetary policy shocks, the magnitude of decline becomes larger for the UM shock compared to the FFR shock. In comparison with Section 2.5.3.1, where the two aggregate banking flows (EME, AE) are examined, it still holds that EMEs suffer to a larger extent from banking outflows in the face of US monetary policy tightening. However, in the country-level bilateral VAR, we find that the magnitude of the responses is larger for the UM shock, and the difference between AEs and EMEs becomes larger.

Four variable model Now we consider a smaller model excluding local money market rates and exchange rates, where none of the 36 countries are omitted. The model is as follows.

$$y_t = [FFR, LEV, VIX, BF^*]'$$

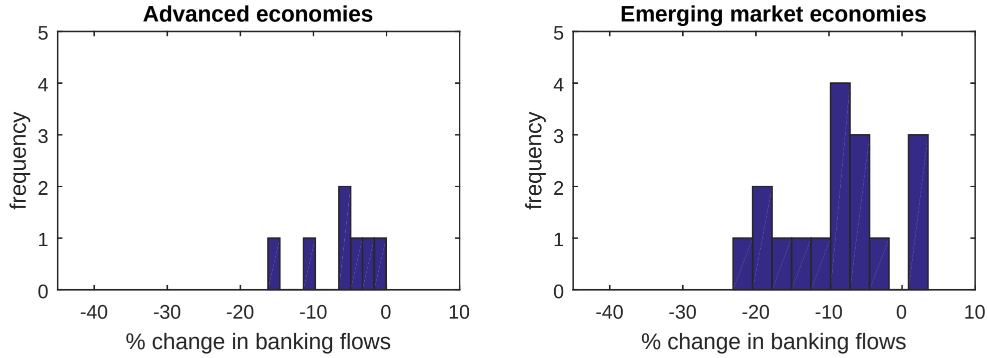
The estimation results are shown in Figure 2.8. The implication of the results is essentially the same as in the six variable model. The mean of the responses of BF^* of 18 advanced countries to the FFR shock is -9.0%, while it is -13.4% for emerging market economies. In case of the UM shock, the average response of advanced economies is -12.9%, while that of the emerging market economies is -19.0%. We find that the EMEs suffer more from a decline in banking flows from a US monetary policy shock compared to the AEs for both of the monetary policy shock measures. For both AEs and EMEs, the magnitude of banking outflows tend to be much more severe for the UM shock compared to the FFR shock.

Summary of results Table 2.4 summarizes the influences of US monetary policy shocks on banking flows across the country groups. We find two implications from the results. First, EMEs suffer to a much larger extent from banking outflows in the face of US monetary policy shocks in all cases. A well-known rationale for this is that EMEs, which are more likely to adopt fixed exchange rate due to Fear of Floating (Calvo and Reinhart 2002), cannot use their exchange rates to absorb the shock on the onset of financial crisis (US monetary tightening). In addition, they need to raise local interest rates to maintain their currency values, and this reinforces the recession further. In case of AEs, which have flexible exchange rates in combination with inflation targeting as their monetary policy regime, can allow their local currency to devaluate and this helps absorb the shock (Gertler, Gilchrist and Natalucci 2007 among many others).[27] Second, in country-level bilateral VARs where aggregation bias in banking flows is minimized, the magnitude in banking outflows is much larger in the face of the UM shock compared to the FFR shock. This is consistent with a larger, instantaneous and significant response of US global bank leverage in the face of the UM shock which is not observed in the face of the FFR shock.

[27] In chapter 3, we will examine how this procedure works in an economy under fixed exchange rate regime or flexible exchange rate regime using an open economy model with banking sector and cross-border banking flows.

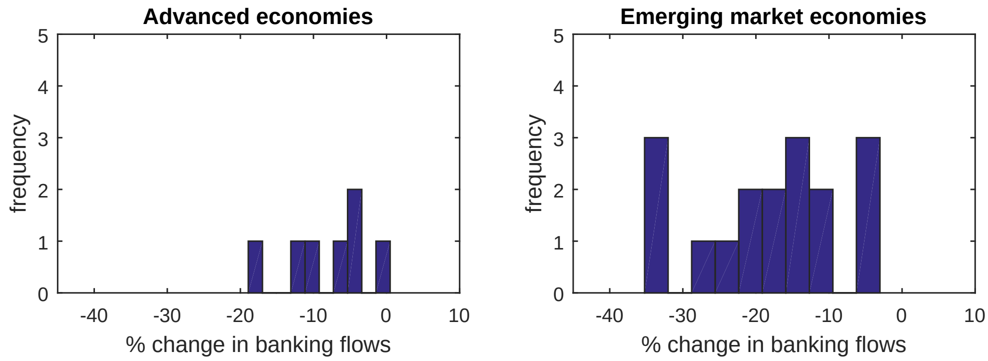
Figure 2.7: Histograms: Responses of banking flows (6 variable model)

(a) FFR shock



Notes: 1) The histograms present distribution of the maximum responses of BF^* of 7 advanced economies (left) and 18 emerging market economies (right) to FFR shock in the six variable VAR model. 2) FFR shock refers the US monetary policy shock identified within the recursive VAR. 3) The maximum response is measured in accumulation within the first 20 quarters after the shock. The mean values of the distributions are -6.1% (left) and -9.1% (right), respectively.

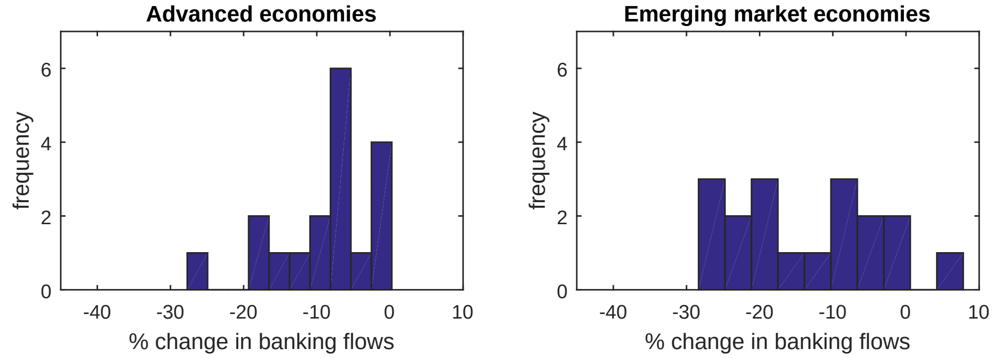
(b) UM shock



Notes: 1) The histograms present distribution of the maximum responses of BF^* of 7 advanced economies (left) and 18 emerging market economies (right) to UM shock in the six variable VAR model. 2) UM shock refers the exogenously identified monetary policy shock based on narrative source. 3) The maximum response is measured in accumulation within the first 20 quarters after the shock. The mean values of the distributions are -8.2% (left) and -18.2% (right), respectively.

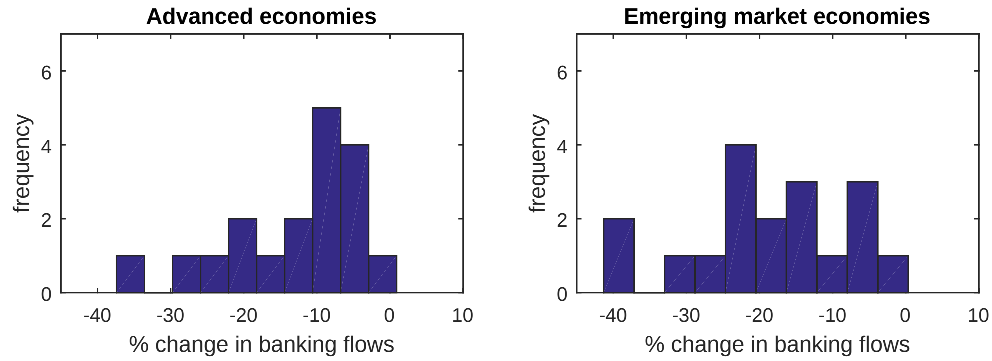
Figure 2.8: Histograms: Responses of banking flows (4 variable model)

(a) FFR shock



Notes: 1) The histograms present distribution of the maximum response of BF^* of 18 advanced economies (left) and 18 emerging market economies (right) to FFR shock in the four variable VAR model. 2) FFR shock refers the US monetary policy shock identified within the recursive VAR. 3) The maximum response is measured in accumulation within the first 20 quarters after the shock. The mean values of the distributions are -9.0% (left) and -13.4% (right), respectively.

(b) UM shock



Notes: 1) The histograms present distribution of the maximum response of BF^* of 18 emerging market economies (left) and 18 emerging market economies (right) to UM shock in the four variable VAR model. 2) UM shock refers the exogenously identified monetary policy shock based on narrative source. 3) The maximum response is measured in accumulation within the first 20 quarters after the shock. The mean values of the distributions are -12.9% (left) and -19.0% (right), respectively.

2.6 Robustness tests

We examine whether the results in the Section 2.5 are subject to different methodologies in identifying the exogenous US monetary policy shock based on narrative approach, and to the specification of the exogenous shock in the model.

First, we use a simpler regression specification in extracting the exogenous UM shock from the intended change in FFR. In the baseline model (Equa-

Table 2.4: Banking flows: Maximum response

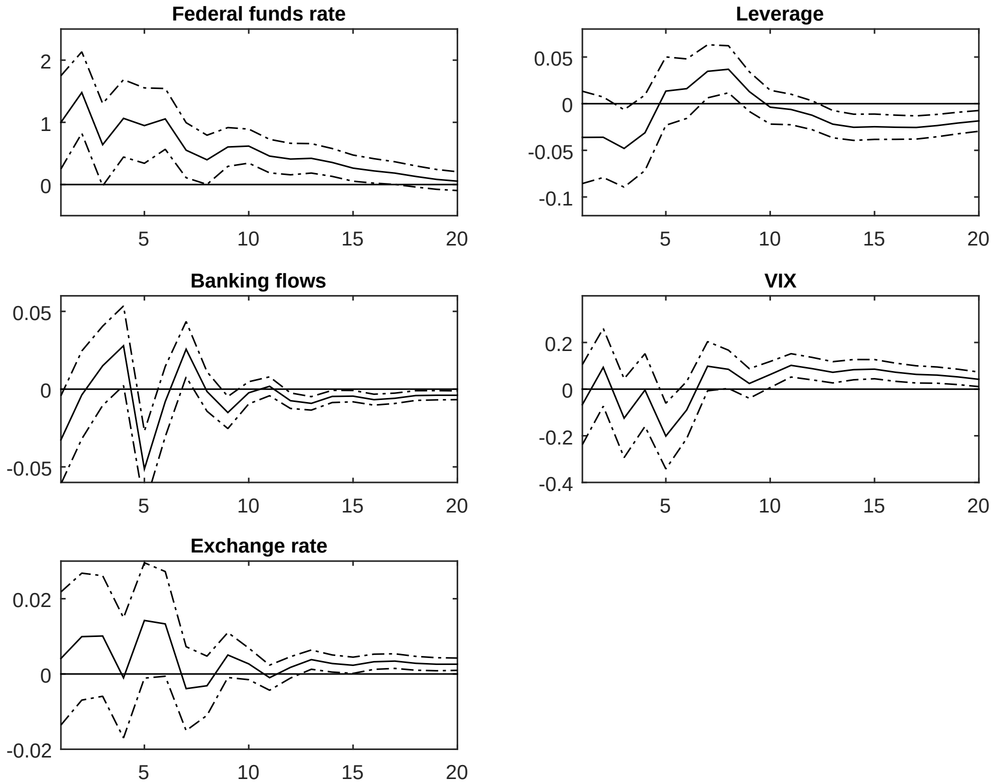
	FFR shock	UM shock
(1) Main model (Table 2.2)	-7.7%	-7.9%
(2) Two Banking flows (Table 2.3)		
Banking flows to AEs	-8.7%	-7.8%
Banking flows to EMEs	-22.6%	-14.9%
(3) Bilateral VAR (6 variable model)		
7 advanced economies (mean)	-6.1%	-8.2%
18 emerging countries (mean)	-9.1%	-18.2%
(4) Bilateral VAR (4 variable model)		
18 advanced economies (mean)	-9.0%	-12.9%
18 emerging countries (mean)	-13.4%	-19.0%

Notes: 1) Figures are the maximum responses of banking flows in accumulation within the 20 quarters. 2) FFR shock refers the US monetary policy shock identified within the recursive VAR, and UM shock refers the exogenously identified monetary policy shock based on narrative source.

tion 2.2), we adopt an expanded version that includes manufacturing capacity utilization index and more information on unemployment as well as forecasts and corresponding revisions of real GDP and inflation, and contemporaneous forecast for unemployment rate as used in BBK. To examine if our baseline results are affected by specification of the regression model, we use a simpler regression as suggested in Romer and Romer (2004). The result is in Figure 2.9. Though LEV still shows a decline early in the period from the monetary policy shock, the impact on the LEV becomes weak both in magnitude and in statistical significance. This implies that there might exist endogenous movements in the FFR linked to extra Greenbook forecasts information (capital utilization index) that causes bias.

Second, we adopt different lags for the exogenous UM shocks. In the baseline, we have four lags. With the lag of endogenous variables fixed at two, we adopt lags of two and three for the exogenous monetary policy shock. In both cases, the VAR model is stable and the residual series do not have serial autocorrelation in the Lagrange Multiplier test. The results are suggested in Figure 2.10 and Figure 2.11, respectively, and they are essentially the same as in the baseline results.

Figure 2.9: Robustness test1: Simpler RR regression

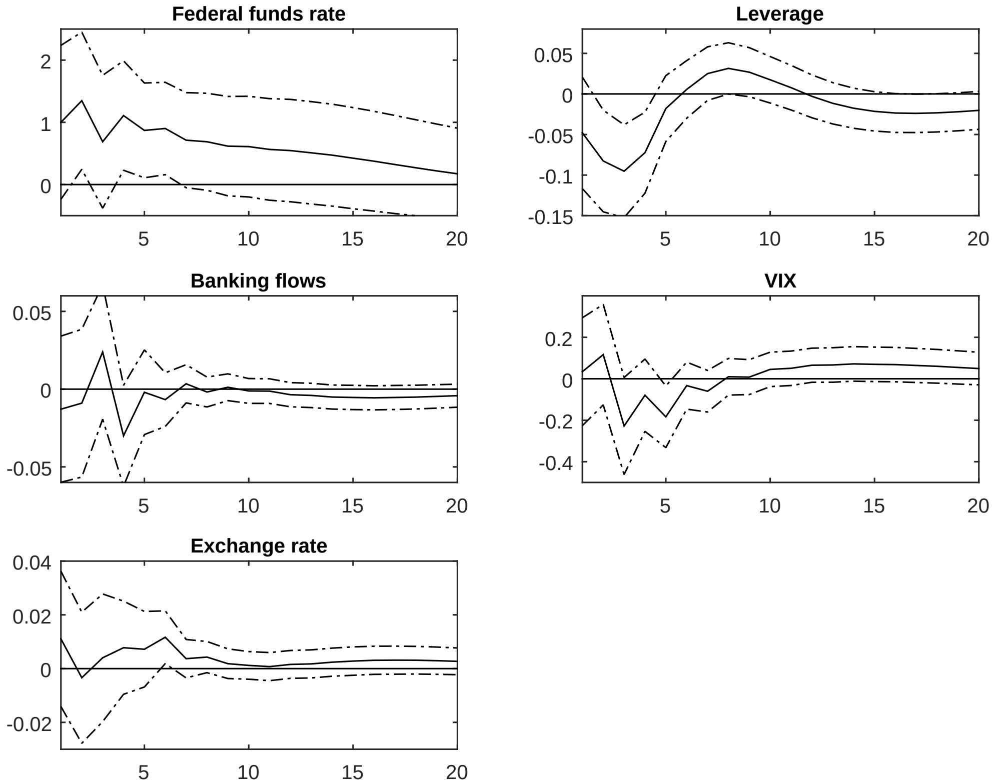


Notes: Estimated responses to one unit of UM shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) of the baseline recursive VAR model. The UM shock is generated from the residual in regression Equation (2.1).

2.7 Conclusion

In this chapter, we investigate the response of global banking flows and the behaviour of US global banks to a US monetary policy shock which we believe could be an important determinant of global capital flows. Considering possible endogeneity problems between monetary policy shock internally identified within a recursive VAR approach (Bruno and Shin 2015) and the behaviour of US global banks (leverage), we identify the US monetary policy shock externally outside a VAR based on Romer and Romer $(2004)'$s narrative approach and its extension in Bluedorn, Bowdler and Koch (forthcoming).

Figure 2.10: Robustness test2: Lag of UM shock: 2



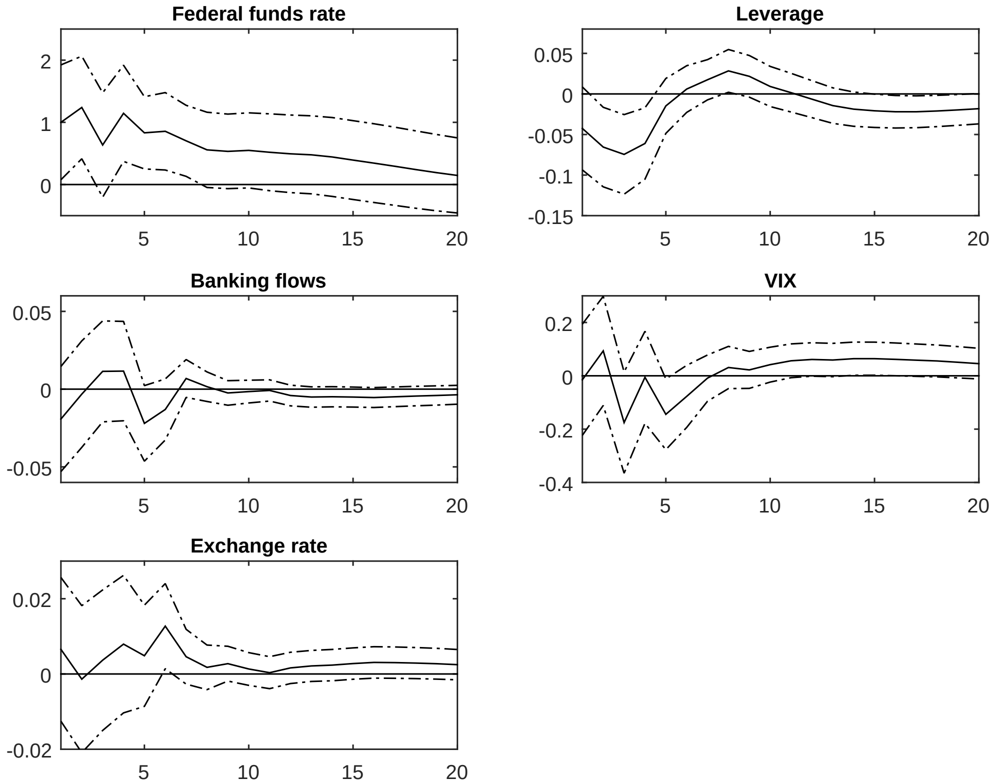
Notes: Estimated responses to one unit of UM shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) of the baseline recursive VAR model. The lag of UM shock in Equation (2.6) is set to two.

The main finding can be summarized as follows. First, the externally identified US monetary policy shock (UM shock) results in a more prompt and stronger impact on the US global bank leverage than the shock internally identified in a recursive VAR (FFR shock). This suggests that the endogeneity issue that motivates the adoption of an externally identified monetary policy shock does actually matter. Identifying the monetary policy shock within a recursive VAR does not remove the movements that is anticipated by economic agents from the Federal Funds rate. If an expected monetary policy tightening would not surprise US global banks (or to a lesser degree), not leading to an adjustment in their behaviour, the shock from a recursive VAR could cause a bias in measuring the true response of the US global banks. The apparent difference in the responses of US global bank leverage to two monetary policy measures reveal that this could be an important issue in measuring the role of US global banks in intermediating global banking flows. This finding provides a more concrete evidence for the operation of US monetary policy transmission through US global banks than previously suggested (Bruno and Shin 2015). Second, we do not find an apparent and significant hike in the VIX in response to the UM shock. This is interesting in that if a change in monetary policy is not anticipated by economic agents based on the economic outlook they have, this unexpected shock should cause a larger increase in market risk measures. A less convincing response of VIX in combination with a large decline in US global bank leverage implies that there might be alternative channels through which US monetary policy affects US global banks other than the risk-taking channel (Borio and Zhu 2012, Adrian and Shin 2014). Third, the value of the US dollar measured as real effective exchange rate increases by about 5−7% for the first 20 quarters. This is consistent with previous findings. Fourth, in country-level bilateral VARs for 36 countries where aggregation bias in banking flows is minimized, we find that that emerging market economies suffer much more from sudden banking outflows triggered by US monetary policy shocks. This is in line with previous findings that the probability of occurrence and the magnitude of capital outflows are larger in EMEs during financial crisis (Calvo, Izquierdo and Talvi 2006 among many others). In addition, the magnitude in banking outflows is much larger from the UM shock compared to the FFR shock. This is consistent with a larger, instantaneous and significant response of US global bank leverage in the face of the UM shock which is not observed for the FFR shock.

There exists a lot of room for further research. First of all, alternative methodologies to extract exogenous US monetary policy shock could be investigated. For example, the identification of unanticipated change in Federal Funds rate using Federal Funds Futures could be an appropriate alternative in that it extracts unexpected movement in FFR in a similar context of Romer and Romer′s approach (Kuttner 2001 among others).[28] Secondly, it would be possible to understand better how a US monetary policy shock affects

[28]While the monetary policy shocks of Romer and Romer (2004) are constructed outside of a VAR and thus do not require that the included endogenous variables are sufficient to describe the economy′s dynamics, this approach involves some subjective judgement and might fail to consider all information concerning current and future economic developments that was available to FOMC members. Considering this point, we can consider alternative methods to extract unexpected US monetary policy shocks. For example, the monetary policy shock identification based on Federal Funds Futures (Kuttner 2001, Bernanke and Kuttner 2005, Georgiadis 2015) would be a meaningful alternative in that it extracts unanticipated monetary policy action from the difference between last periods federal funds futures rate and the current period′s average federal funds rate target, purged from the effects of economic news.

Figure 2.11: Robustness test2: Lag of UM shock: 3



Notes: Estimated responses to one unit of UM shock (solid lines) and 95% bootstrapped confidence intervals (dashed lines) of the baseline recursive VAR model. The lag of UM shock in Equation (2.6) is set to three.

country-specific banking flows while controlling other local variables such as bank lending, housing prices and output that might interact with borrowing from the international banking market. Monetary and exchange rate policy regimes in recipient countries and its impact on the magnitude in banking outflows could also be examined. The influences of US domestic economic conditions on the behaviour of US global banks and thus global banking flows would be an interesting research agenda. At last, our results do not provide evidence on the specific channels through which US monetary policy shocks affect US global bank leverage. This could be further investigated empirically and theoretically. We leave this for future research.

Chapter 3

Exchange rate regimes and sudden banking outflows

Abstract

This chapter investigates a sudden reversal in cross-border banking flows triggered by US monetary policy tightening and its influences on EMEs. First, we suggest empirical evidence on the responses of banking flows, bank lending, housing prices and exchange rates for 18 EMEs to a US monetary policy shock. The US monetary policy shock is identified conditional on that it causes typical responses in US domestic variables and a rise in credit costs (Dedola et al. 2015, Gertler and Karadi 2015). In an open economy model estimated using the empirical finding, we examine the interaction between monetary policy regimes (exchange rate regimes) and the influences of sudden banking outflows in the recipient countries. The results provide evidences supporting conventional wisdom in Sudden Stops literature: countries in the position of having to defend an exchange rate peg are more likely to suffer severe financial distress (Gertler, Gilchrist and Natalucci 2007).

3.1 Introduction

This chapter investigates a sudden reversal in the cross-border banking flows[1] and its influences on the recipient EMEs. Sudden stop episodes that feature a reversal of international capital flows and accompanying declines in investment and output, and corrections in asset prices have attracted a lot of research, especially for EMEs. This is because EMEs are more vulnerable to financial crises and debt default, in large part due to their extensive debt obligations denominated in foreign currencies (Calvo, Izquierdo and Talvi 2006, Frankel 2003, Bordo and James 2006, among many others). In the spirit of the Sudden Stop literature, we focus on cross-border banking flows as a kind of capital inflows, and US monetary policy shocks as a trigger for sudden banking outflows. Banking flows into EMEs have grown rapidly, and thus could be a potential source of a financial crisis.[2] US monetary policy is considered to determine the borrowing costs for banking flows and as a shock that triggers sudden banking outflows. The spread between interest rates in the core (proxied by US Federal Funds rate) and the peripheral countries generates the existence of cross-border banking flows into EMEs (Search-for-yield). At the same time, however, a hike in the US policy rate could cause a sudden rise in borrowing costs resulting in sudden withdrawal of banking flows.[3] Considering these, we examine sudden stops episodes focusing on the influences of a US monetary policy shock on banking outflows, and the following adjustment in recipient EMEs both empirically and theoretically. In this analysis, we pay attention to the interaction between the monetary policy regimes (exchange rate regimes) and sudden banking outflows, considering that exchange rate policy is closely related to the fundamental cause and the influences of sudden stops as well as the rebalancing process after the shock in EMEs.[4]

[1] In this chapter, the banking flows represent the total foreign debt that the banking sector in a country as a whole owes to banks in foreign countries. This is the same definition and statistics used in Chapter 2.

[2] APPENDIX C.1 describes trends in banking flows into EMEs as well as total banking flows, and interest rates in the Federal Funds rate, a proxy for world interest rates charged on cross-border banking flows and domestic interest rates in EMEs.

[3] As an exogenous shock triggering Sudden Stops, a hike in country specific risk-premium and world financial liquidity shock also could be considered. For example, Gertler, Gilchrist and Natalucci (2007) investigate a rise in risk-premium as a driver of Sudden Stops episode in the Korean financial crisis during the 1998-1999 Asian financial crisis, and Rey (2015) explains risk measures (VIX) in global financial market play an important role in determining capital inflows into EMEs.

[4] EMEs that are less financially mature and must borrow abroad in dollars are especially vulnerable to financial crises, because of external debt obligation denominated in dollar. For this reason, EMEs that are afraid of Sudden Stop and debt default might be more inclined to peg their currencies (Calvo et al. 1996, Kaminsky and Reinhart 1999, among many others).

Empirical evidence We first measure empirically how banking flows, bank lending, housing prices and the exchange rate in emerging market economies respond to US monetary policy shocks. This provides a benchmark result that we aim to explain in the model. US monetary policy shocks are extracted from a VAR with sign-restrictions (Dedola, Rivolta and Stracca 2015, Gertler and Karadi 2015). To be specific, the US monetary policy shock is identified by imposing that it generates textbook responses of US economic activities and financial variables. This implies that the US monetary policy shock satisfies conventional expectations on its impact on US domestic economy. Then, we measure the responses of local variables in EMEs to the US monetary policy shock in an autoregressive distributed lag model for the selected 18 EMEs. We find that global banking flows decline, credit to the private sector reduces, and housing prices fall, which are in line with empirical regularities of sudden stops episodes.

Open economy model with banking flows We build up an open economy model equipped with a banking sector and cross-border banking flows as one of the funding sources for local banks. In the baseline model, it is assumed that policy rates are determined to maintain the value of the local currency unchanged at a predetermined level. This is to reflect that EMEs are more prone to pegging, and the strong inertia in the first two years in the response of the exchange rate which we find in the empirical analysis. The banking sector intermediates funding from deposits from households to firms. Additionally we allow banks to raise funding from cross-border banking flows, which is the foreign debt they owe to the foreign (global) banking sector. In this setup, a rise in world interest rates (Federal Funds rate) charged on the banking flows causes an immediate rise in borrowing costs and leads to a reversal in banking flows. A collateral constraint tied to real asset prices that restricts the amount of lending that firms can borrow plays a role in amplifying the initial shock on the course of propagation (Kiyotaki and Moore 1997). Features of an open economy model broadly follow Gertler, Gilchrist and Natalucci (2007, GGN hereafter), and the banking sector and relevant frictions are close to Iacoviello

At the same time, the probability of the occurrence of sudden stop episodes is higher in countries under fixed exchange rate regimes. The choice of monetary policy also affects how EMEs absorb the shock and rebalance. Floaters who allow the exchange rate to absorb the shock can recover from the shock faster than peggers who use interest rates to adjust so as to keep the currency fixed (Fornaro 2015, Ghosh et al. 2008). This is because defending an exchange rate peg generally requires the monetary authority to adjust interest rates in a direction that reinforces the crisis (Gertler, Gilchrist and Natalucci 2007).

(2015). Some of the structural parameters in the model are estimated by minimizing the distance between the empirical responses we find and those implied by the model (Christiano, Eichenbaum and Evans 2005). The baseline model predicts a decline in banking flows, lending, housing prices, consumption and output in response to a US monetary policy tightening shock, which is consistent with the empirical regularities in sudden stop episodes.[5] This is also consistent with empirical findings we suggest.

A counterfactual exercise suggests that the choice of monetary policy (exchange rate) regimes affects the magnitude of banking outflows triggered by US monetary policy tightening and its influences on local economies. The results show that countries in the position of having to defend an exchange rate peg are more likely to suffer severe financial distress. The likely reason is straightforward: defending an exchange rate peg generally requires the central bank to adjust interest rates in a direction that reinforces the crisis (Calvo, Izquierdo and Talvi 2006, Gertler, Gilchrist and Natalucci 2007, among many others). We also suggest a hybrid monetary policy regime that considers the exchange rate as well as inflation and output. The hybrid regime that nests both a pure pegging and floating regimes as extreme cases could provide a realistic description on the operation of monetary / exchange rate policy in EMEs. An economy that claims to conduct its monetary policy under inflation targeting in conjunction with a flexible exchange rate regime in normal periods might also adjust its policy rate to partially absorb the impact on the exchange rate during a financial crisis due to a fear of floating. With a proper weight on the exchange rate term, the model could explain an economy that adjusts both exchange rate and policy rate during a financial crisis (e.g. Korea during the $1998 - 1999$ Asian financial crisis).

The remainder of this paper proceeds as follows. Section 3.2 describes the US monetary policy shock identification and responses of key local variables in 18 EMEs to the shock. We present the model in Section 3.3. Section 3.4 first presents a baseline simulation which describes how local economies under a fixed exchange rate regime respond to US monetary policy tightening. We also implement counterfactual policy experiments to illustrate the interaction between the financial crisis and exchange rate regimes. Section 3.5 concludes.

[5] The empirical regularities that define Sudden Stops are: (i) reversals of international capital flows, reflected as sudden increases in net exports and the current account, (ii) declines in production and absorption, and (iii) corrections in asset prices (Mendoza 2010).

3.2 Empirical evidence

We provide an empirical evidence on how a US monetary policy tightening shock affects banking flows, exchange rates, credits (loans to the private sector) and housing prices in emerging market economies, following Dedola, Rivolta and Stracca (2015) and Gertler and Karadi (2015). First, we identify US monetary policy shocks from a VAR with sign restrictions. Second, we examine how the US monetary policy shock affects local variables using an autoregressive distributed lag model.[6]

3.2.1 Identification of US the monetary policy shock

The US monetary policy shock is identified by imposing that it generates stereotypical responses of domestic economic activities and credit costs. We use a VAR augmented with sign-restrictions to extract US monetary policy shock.[7] The VAR consists of 13 variables including FFR (Federal Funds rate), industrial production, CPI (Consumer Price Index), credit costs and global variables (Table 3.1). The restrictions are imposed on the responses of economic activities, credit costs and global variables to a change in the FFR, and we regard the innovation satisfying those restrictions as the true monetary policy shock. This implies that we measure the influence of the US monetary policy shock on local variables in EMEs, conditional on the US monetary policy shock identified bringing about conventionally expected impacts on the US economy.

Table 3.1 shows the variables used in the VAR and relevant sign restrictions. The restrictions imposed present the characteristics of US monetary policy shock we aim to identify: The movement in Federal Funds rate (i) that brings about typical responses in US economic activities, and (ii) that raises credit costs, and (iii) that is US-specific. The first three restrictions (1)−(3) assure that the shock leads to conventional responses of the US economic activities. That is, the US monetary policy shock brings about a rise in Federal Funds rate and a slowdown in economic activities (a fall in output and prices). The next three restrictions (4)−(6) impose the movements of credit costs in response to US monetary policy shock reflecting that a US monetary policy shock might lead to large movement in credit costs (Gertler

[6]Dedola et al., the classification of EMEs is from the IMF World Economic Outlook. The list of countries is in APPENDIX C.3.

[7]See APPENDIX C.2 for the shock identification methodology in detail.

and Karadi 2015).[8] To be specific, the US monetary policy shock is required to cause a rise in 1 year US government bond yield and raise the spreads on mortgage and commercial papers over 10 year US government bond yield. The seventh restriction imposes a fall of US stock market prices on impact. The restrictions (8)−(9) requires the US monetary policy shock identified is US-specific. To be specific, the eighth requires an appreciation of US dollar against currencies of major trading partners. The ninth restriction represents the difference between interest rates in other major currencies and the US rate falls on impact. This requires interest rates in major currencies to increase by less than US interest rates and thus to be more accommodative if other things equal. This can then result in an attenuation of US monetary policy on the rest of the world. The eighth and ninth restrictions help in ensuring the identification of a US-specific monetary policy shock. The last four variables (10)−(13) are left unrestricted. Considering the possibility that these global variables might affect other financial variables with lags, these are included in the VAR though they are unconstrained. The shock identified by imposing these sign restrictions is then used to measure the response of local variables to the US monetary policy shock.

3.2.2 Responses of local variables to US monetary policy shock

Next we measure how local variables in 18 EMEs respond to the US monetary policy shock identified in the previous section. We use the following autoregressive distributed regression model (Romer and Romer 2004, Canova 2005). Quarterly data from 1996:Q1 to 2012:Q2 are used.

$$y_{i,j,t} = \alpha_{i,j,t} + \phi(L)y_{i,j,t} + \beta(L)MP_t^{US} + trend + seasonal + u_{i,j,t} \tag{3.1}$$

In Equation (3.1), $y_{i,j,t}$ denotes variable i of country j at time t. To be specific, $y_{i,j,t}$ is one of the four selected local variables (banking flows, credit to private sector, exchange rate, and housing prices). Variables are log-levels. MP_t^{US} is the US monetary policy shock identified in the previous section. $Trend$ and $seasonal$ denote time-trend and seasonal dummies, respectively.

[8]Gertler and Karadi (2015) empirically investigates how US monetary policy shock (identified based on high frequency financial data around policy announcements) affects movements in credit costs. The methodology they use is to incorporate the exogenously identified US monetary policy shock into an otherwise standard VAR and measure the responses of endogenous variables to the shock as we do in Chapter II.

Table 3.1: Variables in the VAR and sign restrictions

	Variable		Restrictions
1	Federal Funds rate	$+$	for $t = 1, ..., 6$
2	Industrial production	$-$	for $t = 2, ..., 6$
3	Consumer price index	$-$	for $t = 1, ..., 4$
4	1 year gov't bond yield	$+$	for $t = 1, ..., 4$
5	Mortgage spread[1)]	$+$	for $t = 2$
6	Commercial paper spread[1)]	$+$	for $t = 1, 2, 3$
7	S&P 500	$-$	for $t = 1$
8	Nominal effective exchange rate	$+$	for $t = 1$
9	World interest rates spread[2)]	$-$	for $t = 1$
10	Corporate bond spread (Moody's Baa)[1)]	..	
11	Commodity price (CRB)	..	
12	World industrial production (OECD)	..	
13	World stock price (MSCI)	..	

Note: 1) Rates over 10 year US government bond yield, 2) World interest rates − US rates (world rate is an average in the rates of Canada, EU area, Japan and the United Kingdom.), 3) The first 6 restrictions are broadly in line with Gertler and Karadi (2015), 4) All variables are log-levels except interest rates variables in level.

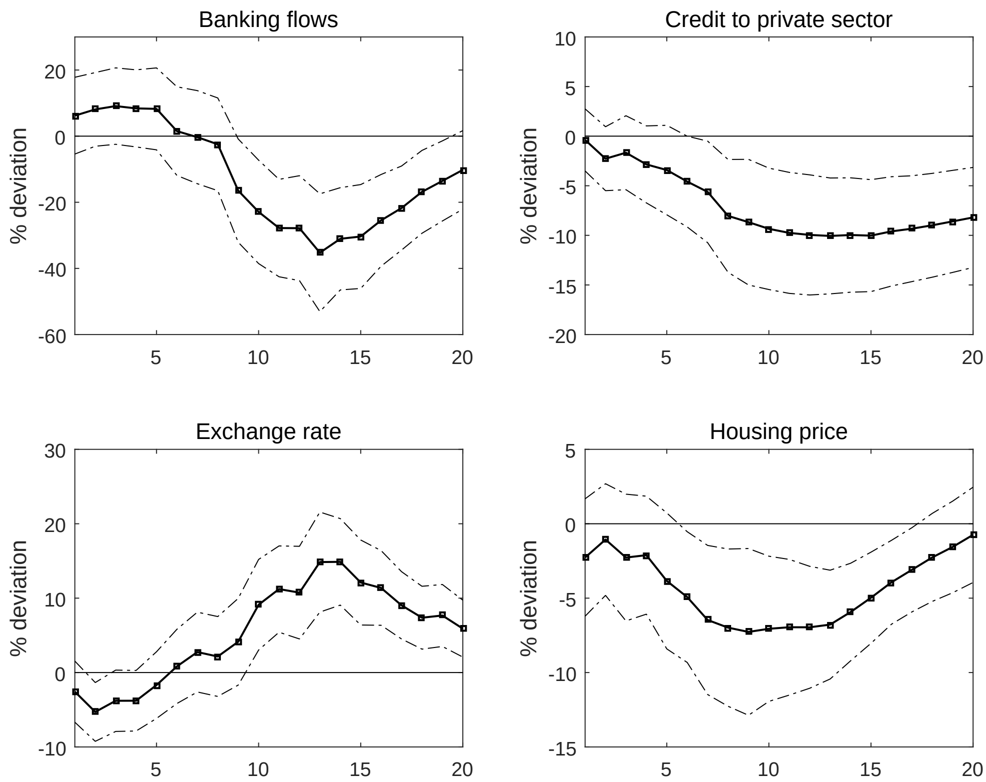
$\phi(L)$ and $\beta(L)$ are lag operators for the dependent variable and the US monetary policy shock, respectively, which are set to 12. Equation (3.1) is estimated for each of the four variables for 18 countries and we can retrieve the responses of each variables to the monetary policy shock at time horizon at h by measuring $IRF_{i,j,h} = \frac{\partial y_{i,j,t+h}}{\partial MP_t^{US}}$ via iterative substitutions of estimated Equation (3.1).

The responses of the local variables to US monetary policy shock are plotted in Figure 3.1. Each response of the variables is averaged for 18 countries to the US monetary policy tightening shock of 100 basis point. The responses are in line with empirical regularities of sudden stop episodes (Mendoza 2010). To be specific, banking flows decline (reversal of banking flows) by 37% on average.[9] Credit to the private sector reduces by 10% about 3 years after the shock (credit crunch), and housing prices fall by 7% about 2 years after the

[9] From this result, we can deduce that the balance sheet of banking sector in the recipient EMEs decreases by 4.8% assuming that other components in the balance sheet are left unchanged (4.8% = 37% × 13.1%, considering that banking flows accounts for 13.1% in the local balance sheet of banking sector in 18 EMEs. See APPENDIX C.3 for this figure.). A decline of 4.8% in bank balance sheet might not be that large as it looks at a first glance: (i) at first, it is very unlikely that we observe a rise of 100bp in FFR at a time (Remember that FFR hasn't been changed yet after FOMC raised the rate by 25bp last December). According to our results, a 25bp rise in FFR would cause 1.2% decline in the bank balance sheet. (ii) In addition, in our analysis, the US monetary policy measure used is ″shock″ identified with several conditions imposed, and is different from a pure change of FFR. For this reason, only a fraction of a realized change in FFR would represent a monetary policy shock, and thus the real impact on banking flows and bank balance sheet of a change of FFR could be smaller than what our empirical finding suggests.

shock (correction in asset prices). In case of the exchange rate, the responses show strong inaction for the first two years after the shock, and then reveal a rise by15% about 3 years after the shock. One possible interpretation is that a fixed exchange rate regime they adopt as a monetary policy regime prevents its currency value from falling on impact of the shock, while the monetary authorities slowly adjust the value of local currency.

Figure 3.1: Responses of local variables to US monetary policy shock



Notes: 1) All variables are log-levels in the estimation regression Equation (3.1), 2) Error bands are generated from residual bootstrapping of 1,000 replications, and represent 68% confidence interval, 3) A rise in exchange rate represents a depreciation of local currency against the US dollar, 4) Scale of IRFs is adjusted such that the response of FFR (Federal Funds rate) on impact to the identified US monetary policy shock becomes one unit. 5) Credit to private sector and housing prices are real variable deflated by consumer price index.

3.3 Model

In this section, we build up an open macroeconomic model equipped with a banking sector and cross-border banking flows as one of the funding sources for local banks. A rise in world interest rate charged on the banking flows causes an immediate rise in the borrowing costs and leads to a reversal of banking flows. A collateral constraint tied to real asset prices that impose the amount of lending that firms can borrow play a role in amplifying the initial shock on the course of propagation.[10]

3.3.1 Households

The representative household chooses consumption $c_{H,t}$, housing $h_{H,t}$ and time spent working n_t. They make a deposit d_t that provides them predetermined interest income which in turn flows into firms through the banking sector. Households solve the following intertemporal problem:

$$\max_{\{c_{H,t},h_{H,t},d_t,n_t\}} U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_H^t \frac{\left(c_{H,t}h_{H,t}^j - n_t^\omega z_t\right)^{1-\sigma} - 1}{1-\sigma} \tag{3.2}$$

$$where, z_t = (c_{H,t}h_{H,t}^j)^\zeta z_{t-1}^{1-\zeta} \tag{3.3}$$

subject to the following flow-of-funds constraint:

$$c_{H,t} + d_t + q_t h_{H,t} = w_t n_t + \frac{r_{d,t-1}d_{t-1}}{\pi_t} + q_t h_{H,t-1} \tag{3.4}$$

where, $c_{H,t}$ is real composite consumption, $h_{H,t}$ is housing demand, and n_t is working hours. $c_{H,t}$ consists of domestically produced goods $c_{H,t}^H$ and imported goods $c_{H,t}^F$, and the allocation between these goods are described in Section 3.3.4. β_H represents household′s quarterly discount factor. π_t is the gross inflation rate p_t/p_{t-1}, where p_t is consumer price index. d_t are bank deposits earning a gross return $r_{d,t}$, and w_t is real wage rate and q_t is real

[10]The model we present is closest to Gertler, Gilchrist and Natalucci (2007, GGN) which provides similar intuitions on the interaction between monetary / exchange rate policy scheme and the influences of financial crisis. GGN provides a calibrated open economy model to describe the development of Korean economy during the 1998-1999 Asian financial crisis, while we suggest an estimated model that matches empirical finding on banking outflows after US monetary policy shock in 18 EMEs. The notable differences in models are as follows: (i) GGN does not introduce banking sector, and the households play a role in borrowing foreign funding. In contrast, we introduce banking sector explicitly, which plays a role in intermediating foreign banking flows to local firms. (ii) In GGN, they consider 300 basis point increase in country risk-premium as an external shock to Korea economy. In contrast, we examine the influences of 100 basis point rise in the Federal Funds rate which determines the borrowing costs for cross-border banking flows. (iii) GGN does not provide quantitative response of the foreign borrowing in face of the shock, while we provide the response of banking flows which matches well the empirical finding we suggest. In spite of these differences, GGN and this chapter provides the same intuition: Countries in the position of having to defend an exchange rate peg are more likely to suffer severe financial distress. It is noteworthy that both GGN and this chapter suggest open economy macro models that describe sudden stop episodes, but they are not a typical sudden stop model with occassionally binding constraints (e.g. Mendoza 2011 among many others).

price of housing. We set $\sigma = 1$, which corresponds to the case of logarithmic utility. Without z_t The period utility function takes the form introduced by Greenwood et al. (1998), often referred to as GHH preferences. This type of utility is widely used in the small open economy literature in that GHH preference eliminates the wealth effect on labour supply (Mendoza 1991, Correia et al. 1995, Fornaro 2015 among others). The presence of z_t introduces habits, and makes the adjustment of household demand for consumption and housing sluggish (Jaimovich and Rebelo 2007).[11] The optimality conditions yield standard first-order conditions for consumption, deposits, housing demand, and labour supply.

$$U_{c,t} = \lambda_t + \lambda'_t \zeta \frac{z_t}{c_{H,t}} \tag{3.5}$$

$$\frac{\lambda_t}{\lambda_{t+1}} = \beta_H \frac{r_{d,t}}{\pi_{t+1}} \tag{3.6}$$

$$q_t \lambda_t = U_{h,t} - \lambda'_t j \zeta \frac{z_t}{h_{H,t}} + \beta_H q_{t+1} \lambda_{t+1} \tag{3.7}$$

$$w_t \lambda_t = U_{n,t} \tag{3.8}$$

$$\lambda'_t = U_{z,t} + \lambda'_{t+1} \beta_H (1-\zeta) \frac{z_{t+1}}{z_t} \tag{3.9}$$

where, λ_t and λ'_t represent the lagrange multipliers for the budget constraint and the habit term, respectively. U_c, U_h, U_n and U_z denote marginal utility for the corresponding variables in the subscript.

3.3.2 Firms

The representative firms produce goods by using standard Cobb-Douglas constant-to-scale technology that uses real estate, labour and capital as inputs. For this, they hire household's labour and pay a wage, and they borrow from banks. The amount they borrow is constrained by the value of collateral they provide. To be specific, the firms problem is as follows:

$$\max_{\{c_{E,t}, h_{E,t}, l_t, n_t, k_t\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_E^t log c_{E,t} \tag{3.10}$$

[11] Jaimovich and Rebelo (2007) introduces z_t term in GHH preference to allow short-run wealth effects on the labour supply.

subject to

$$c_{E,t} + q_t h_{E,t} + \frac{r_{l,t-1} l_{t-1}}{\pi_t} + I_t + w_t n_t + \psi_t^E = \frac{p_t^H}{p_t} y_t^H + l_t + q_t h_{E,t-1} \tag{3.11}$$

$$f(k_{t-1}, h_{E,t-1}, n_t) = y_t^H = A k_{t-1}^{\alpha} h_{E,t-1}^{(1-\alpha)\nu} n_t^{(1-\alpha)(1-\nu)} \tag{3.12}$$

$$l_t \leq m_H \, \mathbb{E}_t \, \pi_{t+1} \left(\frac{q_{t+1} h_{E,t}}{r_{l,t+1}} \right) + m_K k_t - m_N w_t n_t \tag{3.13}$$

Equations (3.11), (3.12) and (3.13) denote the budget constraint, the production function and the borrowing constraint, respectively. In the budget constraint (Equation 3.11), firms consume composite goods $c_{E,t}$ and housing $h_{E,t}$ (commercial real estate) and produce final good y_t^H and sell them at the home price p_t^H. They also hire labour n_t and pay wages w_t to households. I_t denotes investment, $k_t - (1-\delta)k_{t-1}$. The term l_t denotes the loans that banks extend to firms. ψ_t^E is a quadratic loan portfolio adjustment cost, with the specific form of $\frac{\phi_{EE}}{2} \frac{(l_t - l_{t-1})^2}{l}$ (where l denotes the steady-state value of l_t). This cost penalizes firms for changing their loan balances too quickly between one period and the next, and captures the idea that the volume of lending changes slowly over time.

Equation (3.12) describes the production function: firms use variable capital k_t, commercial real estate in $h_{E,t}$ and labour n_t to produce output y_t^H.

Equation (3.13) represents the borrowing constraint, and implies that lenders (banks) can repossess the borrower′s assets by paying a proportional transaction costs (Kiyotaki and Moore 1997). This implies that the maximum amount that a creditor can borrow is bound by a fraction of the collateral value (m_H, m_K). It is also assumed that the wage bill must be paid in advance (Neumeyer and Perri 2005). A collateral constraint tied to real asset prices that impose the amount of lending that firms can borrow play a role in amplifying the initial shock on the course of propagation of the shock. For example, as the collateral value tied to housing prices falls, lending capacity to firms reduces amplifying the influences of the initial shock (Fisherian debt-deflation). This could further dampen investment and output and change an initial shock into a full-fledged recession. The optimality conditions yield standard first-order conditions for consumption, loan, housing demand, labour demand, and investment.

$$\mu_t = 1/c_{E,t} \tag{3.14}$$

$$1 - \frac{\mu'_t}{\mu_t} - \frac{\partial \psi_t^E}{\partial l_t} = \beta_E \frac{\mu_{t+1}}{\mu_t} \frac{r_{l,t}}{\pi_{t+1}} \tag{3.15}$$

$$q_t - m_H \pi_{t+1} \frac{q_{t+1}}{r_{l,t+1}} \frac{\mu'_t}{\mu_t} = \beta_E \frac{\mu_{t+1}}{\mu_t} \left(q_{t+1} + \frac{p_{t+1}^H}{p_{t+1}} f_{h,t+1} \right) \tag{3.16}$$

$$\frac{p_t^H}{p_t} f_{n,t} = w_t \left(1 + m_N \frac{\mu'_t}{\mu_t} \right) \tag{3.17}$$

$$1 - \frac{m_k}{r_{l,t}} \frac{\mu'_t}{\mu_t} = \beta_E \frac{\mu_{t+1}}{\mu_t} \left(1 - \delta + \frac{p_{t+1}^H}{p_{t+1}} f_{k,t+1} \right) \tag{3.18}$$

where, μ_t and μ'_t represent the lagrange multipliers for the budget constraint and the collateral constraint, respectively. f_n, f_h and f_k denote the marginal products for the corresponding production factors. The optimality conditions show that the existence of the borrowing constraint as measured by the multiplier μ'_t introduces a wedge between the cost of factors (prices) and their marginal products.

3.3.3 Banks

Banks intermediate funds from patient households to impatient firms. In the model, banks also can raise funds from cross-border banking flows. The representative banker solves the following problem:

$$\max_{\{c_{B,t}, l_t, d_t, bf_t^*\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta_B^t log c_{B,t} \tag{3.19}$$

subject to

$$c_{B,t} + l_t + \frac{r_{d,t-1} d_{t-1}}{\pi_t} + \frac{s_t r_{t-1}^* bf_{t-1}^* \phi_{t-1}}{\pi_t} = d_t + s_t bf_t^* + \frac{r_{l,t-1} l_{t-1}}{\pi_t} \tag{3.20}$$

$$d_t + s_t bf_t^* \leq \gamma_E l_t \tag{3.21}$$

Equation (3.20) and Equation (3.21) denote banks$'$ budget constraint and capital requirement constraint, respectively. d_t denotes household deposits, and bf_t^* is dollar-denoted cross-border bank-to-bank borrowing. s_t is the exchange rate expressed as a local curreny per a unit of US dollar (an increase in s_t represents depreciation of local currency). l_t are loans to firms, and $c_{B,t}$ is the bank′s private consumption. $c_{B,t}$ is interpretated as the residual profit (dividends) of the bank after deposits have been repaid and loans have been issued. $r_t^* = \overline{r}\exp(\varepsilon_t)$ is interest rate charged on cross-border borrowing, where ε_t is an interest rate shock around a mean value $\overline{r}$. In simulations, the shock process for ε_t is assumed to follow a first order autoregressive process with coefficient of 0.9 to illustrate a 100 basis point tightening shock of the Federal Funds rate. $\overline{r}$ is 1.005 which implies that the borrowing cost for the banking flows is 2% in annum. The budget constraint implies that banks have two different sources of funding for liabilities: deposits from households d_t and cross-border bank-to-bank borrowing bf_t^*. ϕ_t is the country borrowing premium, and depends on cross-border borrowing and world interest rates. We assume that the risk premium increases (i) as Federal Funds rate rises,[12] and (ii) the amount of banking flows rises by heightening demand pressure for global interbank funding marginally.

$$\phi_t = \exp[\psi(r_t^* - r^*)]\left\{\exp\left(\frac{bf_t^* - bf^*}{y_t}\right) - 1\right\} + 1 \tag{3.22}$$

Banking flows are assumed to account for 15% in the balance sheet of local banks in the steady state based on observations for 18 EMEs.[13]

Equation (3.21) imposes an equity condition. Banks are required to maintain a certain level of equity compared to total bank lending (size of the balance sheet). For example, if γ_E is set to 0.9, this implies that banks have to maintain at least 10% of its liabilities as a form of equity, and the corresponding leverage ratio would be 10 ($= \frac{1}{1-\gamma_E}$). The optimality conditions yield standard first-order conditions for consumption, loan, deposit and banking flows.

[12] The risk-taking channel of US monetary policy explains that a US monetary policy tightening heightens market risk measures (e.g. VIX) and uncertainty, and this in turn affects the leverage of US global banks that manage their balance sheet based on VaR rule (See Adrian and Shin 2014, Borio and Zhu 2012, Bruno and Shin 2015, Gambarcota 2009, Rey 2015). If this is the case, global financial intermediaries would require higher risk-premium after US monetary policy shock to compensate the higher level of riskiness and uncertainty they face in lending their funding to banks in the receiving countries.

[13] This figure is 13.1% for 18 EMEs as of end of 2015. See APPENDIX C.3 for detail.

$$\vartheta_t = 1/c_{B,t} \tag{3.23}$$

$$1 - \gamma_E \frac{\vartheta'_t}{\vartheta_t} = \beta_B \frac{\vartheta_{t+1}}{\vartheta_t} \frac{r_{l,t}}{\pi_{t+1}} \tag{3.24}$$

$$1 - \frac{\vartheta'_t}{\vartheta_t} = \beta_B \frac{\vartheta_{t+1}}{\vartheta_t} \frac{r_{d,t}}{\pi_{t+1}} \tag{3.25}$$

$$1 - \frac{\vartheta'_t}{\vartheta_t} = \beta_B \frac{\vartheta_{t+1}}{\vartheta_t} \frac{s_{t+1}}{s_t} \frac{r^*_t}{\pi_{t+1}} \left(\phi_t + bf^*_t \phi'_t\right) \tag{3.26}$$

where, ϑ_t and ϑ'_t represent the lagrange multipliers for the budget constraint and the capital requirement constraint, respectively, and ϕ'_t denotes a partial derivative of the risk premium with respect to banking flows ($\equiv \frac{\partial \phi_t}{\partial bf^*_t}$).

By combining Equations (3.24) and (3.25), we have Equation (3.27) which explains the relationship between the interest rates for lending $r_{l,t}$ and for deposits $r_{d,t}$.

$$1 - \gamma_E = \beta_B \frac{\vartheta_{t+1}}{\vartheta_t} \left(\frac{r_{l,t}}{\pi_{t+1}} - \gamma_E \frac{r_{d,t}}{\pi_{t+1}} \right) \tag{3.27}$$

The optimality condition for the choice of banking flows (Equation 3.26) in conjunction with that for deposits (Equation 3.25) yields the following uncovered interest rate parity condition (UIP):

$$r_{d,t} = \frac{s_{t+1}}{s_t} r^*_t \left(\phi_t + bf^*_t \phi'_t\right) \tag{3.28}$$

In Equation (3.28), the existence of risk-premium term ($\phi_t + bf^*_t \phi'_t$) produces a wedge in the interest rates charged on deposits and banking flows in the steady state.

The non-stochastic steady state model of the optimality conditions implies the relationship between the discount factors and the interest rates. The deposit rate is the inverse of the household discount factor (Equation 3.29). Since $r_d = \frac{1}{\beta_H}$, this equation implies that the lending rate is higher than the deposit rate ($r_l > r_d$) as long as banks are less patient than households ($\beta_H > \beta_B$) which is the case in our analysis (Equation 3.30). Equation (3.31) indicates the model requires that the discount factor for firms, β_E, be higher than a weighted average of the discount rates of households and bankers.

$$r_d = \frac{1}{\beta_H} \tag{3.29}$$

$$r_l = \gamma_E \frac{1}{\beta_H} + (1-\gamma_E)\frac{1}{\beta_B} > r_d \tag{3.30}$$

$$\frac{1}{\beta_E} > \gamma_E \frac{1}{\beta_H} + (1-\gamma_E)\frac{1}{\beta_B} \tag{3.31}$$

3.3.4 Features of a small open economy

The open economy features of the model involves the export of domestic goods and import of foreign goods, and a change in the value of the local currency against the US dollar.

Imports are determined by the consumer demand (households, banks and firms) for foreign goods. Consumption c_t is a composite of tradable consumption goods produced at home and those imported from the foreign country. We assume CES preference for consumption, and this results in the consumption for domestic goods and imported goods as a fraction of total consumption which is determined by the share of domestic goods in consumption γ and the relative price between two consumption bundles.[14]

$$c_t^H = \gamma \left[\frac{p_t^H}{p_t}\right]^{-\rho} c_t \tag{3.35}$$

[14] The allocation of total consumption between home goods and imported goods arise from the following CES preferences over home consumption, c_t^H, and foreign consumption, c_t^F:

$$c_t = \left[\gamma^{\frac{1}{\rho}} (c_t^H)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}} (c_t^F)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}} \tag{3.32}$$

The corresponding consumer price index (CPI), p_t, is given by

$$p_t = \left[\gamma (p_t^H)^{1-\rho} + (1-\gamma)(p_t^F)^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{3.33}$$

The optimality conditions for the consumption allocation are conventional:

$$\frac{c_t^H}{c_t^F} = \frac{\gamma}{1-\gamma}\left[\frac{p_t^H}{p_t^F}\right]^{-\rho} \tag{3.34}$$

By combining Equations (3.32), (3.33) and (3.34), we can derive Equations (3.35) and (3.36).

$$c_t^F = (1-\gamma)\left[\frac{p_t^F}{p_t}\right]^{-\rho} c_t \tag{3.36}$$

This implies that consumption c_t is allocated between home goods and foreign goods following Equations (3.35) and (3.36). This allocation rule applies to the consumption of banks and firms as well as households. The aggregate consumption for foreign goods constitutes imports.

$$im_t = c_{H,t}^F + c_{E,t}^F + c_{B,t}^F \tag{3.37}$$

Exports ex_t are equivalent to foreign demand for dometically produced goods $c_t^{H^*}$, and determined by the relative price of exporting goods $p_t^{H^*}$ denoted in US dollars, to the international price p_t^*, and the economic size of the rest the world y_t^*. We assume that foreign demand for the home tradable good, c_t^{H*}, is given by

$$c_t^{H^*} = \left[\left(\frac{p_t^{H^*}}{p_t^*}\right)^{-\chi} y_t^*\right]^{\eta} \left(c_{t-1}^{H^*}\right)^{1-\eta} \tag{3.38}$$

where y_t^* is real foreign output, which we take as given (The size of this is set such that trade is in balance in the steady state). The term $\left(c_{t-1}^{H^*}\right)^{1-\eta}$ introduces inertia in foreign demand for domestic products.

The price of imported goods p_t^F is determined by the exchange rate, assuming world price p_t^* is normalized and fixed at 1.

$$p_t^F = s_t p_t^* \tag{3.39}$$

3.3.5 Monetary policy regime and equilibrium

We assume that EMEs manage their policy rates such that the value of local currency is maintained at predetermined level. Under a fixed exchange rate regime, the monetary authority keeps the nominal exchange rate pegged at the steady state level as follows.

$$s_t = \overline{s}, \quad \forall t \tag{3.40}$$

The aggregate resource constraint in the economy is described as follows (Gertler, Gilchrist and Natalucci 2007).

$$y_t^H = c_t^H + c_t^{H^*} + I_t \tag{3.41}$$

where y_t^H is final domestic output, c_t^H is aggregate consumption for domestically produced goods of households, banks and firms ($c_t^H = c_{H,t}^H + c_{E,t}^H + c_{B,t}^H$), c_t^{H*} is exports, I_t is firm investment $k_t - (1-\delta)k_{t-1}$. The stock of housing that households and firms hold is assumed to be fixed and normalized as follows.

$$h_t^H + h_t^E = 1 \tag{3.42}$$

3.3.6 Parameters

Calibration Table 3.2 shows the values of the calibrated parameters. In the steady state model, the interest rate on deposits is equivalent to the inverse of the household discount factor. The quarterly discount factor β_H is set to 0.9877 such that the deposit rate r_d becomes annualized at 5 percent. β_B is determined by the spread between r_l and r_d, and γ_E. These are consistent with the lending rate and the deposit rate in the steady state being annualized at 9% and 5%, respectively. The model requires that the discount factor for firms, β_E, be higher than a weighted average of the discount rates of households and bankers. Considering this, β_E is set to 0.94. The Federal Funds rate, a proxy for world interest rate, determining borrowing costs for banking flows, is set to 2% in annum. The leverage parameter for bank γ_E is set to 0.9, when requires banks to hold at least 10% of its total liabilities for equity. This figure is consistent with historical data on bank balance sheets that show capital-asset ratios for banks close to 0.1 (Van Den Heuvel 2008). m_N is set to 1 so that all labour costs must be paid in advance, and m_K is set to 0.9. Housing preference shares for household j is set to 0.075. This household′s preference share for housing in conjunction with the share of housing in the production implies the share of housing for household of 0.65, and that for the firm of 0.35, respectively. We set $\sigma = 1$, which corresponds to the case of logarithmic utility. The share of domestic goods γ is set to 0.5. Elasticity of export demand χ is 1, and inertia in export demand $1 - \eta$ is 0.75 (Gertler, Gilchrist and Natalucci 2007). Capital share in production α and depreciation rate on capital δ are set to 0.2 and 0.035, respectively. ϕ_{EE}, which determines the loan adjustment cost for firms, is set to 0.25 (Iacoviello 2015).

Estimation The rest of parameters are estimated by minimizing a measure of the distance between the empirical responses (Section 3.2) and the model responses (Christiano, Eichenbaum and Evans 2005). To be specific, a set of parameters $\boldsymbol{\xi}$ is estimated by solving $\mathbf{min}_{\boldsymbol{\xi}} \left(\boldsymbol{\Psi}(\boldsymbol{\xi}) - \widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}\right)' \boldsymbol{\Phi} \left(\boldsymbol{\Psi}(\boldsymbol{\xi}) - \widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}\right)$, where $\boldsymbol{\Psi}(\boldsymbol{\xi})$ and $\widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}$ represent the responses from the data and those from the model, respectively.[15] The estimation results are shown in Table 3.3. Loan-to-Value (LTV) on housing for firm m_H is estimated to be 0.9, and ζ determining the magnitude of habit on demand for consumption good and housing for household is estimated to 0.15. The estimated values for the share of housing in production, ν, and the parameter representing elasticity of labour supply, ω, are 0.08 and 2.4, respectively. These values are overall consistent with the values suggested in the relevant literature while minimizing the difference between empirical evidence and model responses.

Table 3.2: Calibrated parameters

Description	Parameter	Value
HH′s discount factor	β_H	0.9877
Firm′s discount factor	β_E	0.94
Bank′s discount factor	β_B	0.8989
Housing preference share	j	0.075
Intertemporal elasticity of substitution	σ	1
Firm′s Loan adjustment cost	ϕ_{EE}	0.25
Loan-to-Value ratio on capital	m_K	0.9
Wage bill paid in advance	m_N	1
Liability to asset ratio for bank	γ_E	0.9
Production function: share of capital	α	0.2
Depreciation rate of capital	δ	0.035
Share of domestic goods in consumption	γ	0.5
Consumption intra-temporal elasticity of substitution	ρ	1
Elasticity of export demand	χ	1
Weight of inertia in export demand	$1-\eta$	0.75

[15] See APPENDIX C.2 for the estimation procedure in detail. A criticism on this estimation method is that it selects parameter values that make the model responses closest to the empirical responses by construction. If this is the case, it would be less convincing to argue that our result is appealing because it can mimic the empirical findings well.

Table 3.3: Estimated parameters

Description	Parameter	Value	s.e.
Loan-to-Value ratio on housing	m_H	0.90	0.048
Households habit	ζ	0.15	0.386
Production function: share of housing	ν	0.08	0.016
Elastisity of labour supply	ω	2.40	1.724

Notes: 1) See APPENDIX C.5 for the estimation methodology in detail.

3.4 Exchange rate regimes and banking outflows

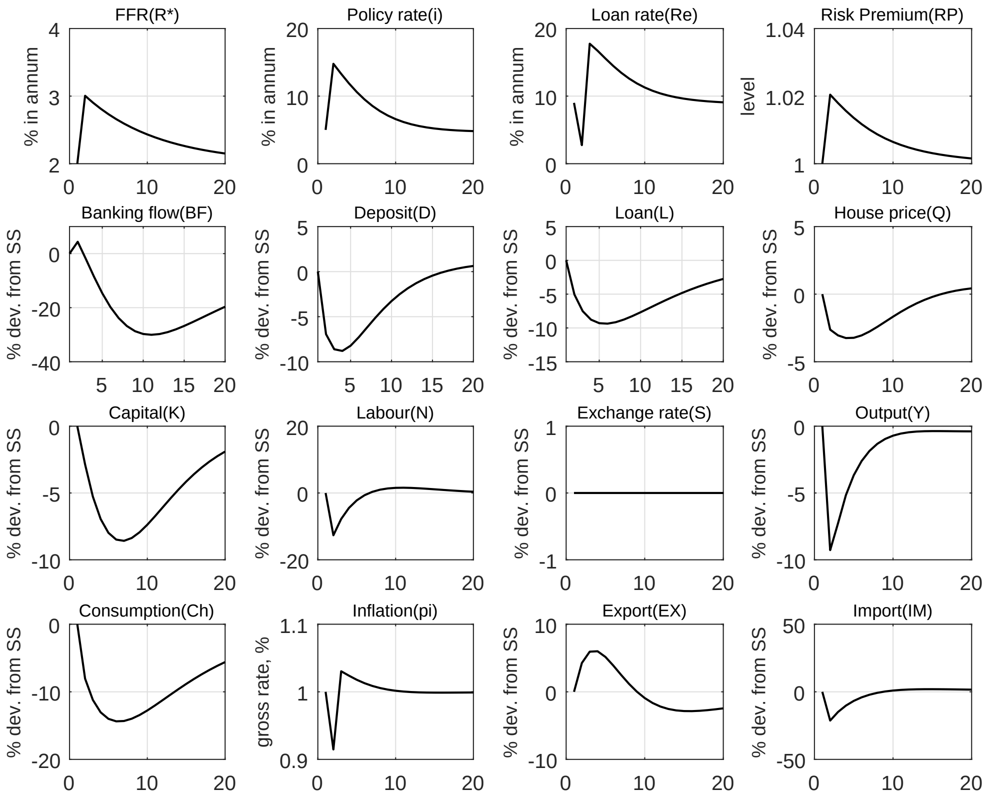
We examine the influences of sudden banking outflows triggered by a US monetary policy tightening based on the estimated model. The baseline model in which a fixed exchange rate regime is assumed as the monetary and exchange rate policy regime produces the responses of local variables consistent with empirical regularities at the onset of a financial crisis. Two alternative monetary policy regimes are examined in counterfactual analysis.

3.4.1 Baseline simulation

We analyze an unanticipated increase in the world interest rate (FFR) which is the interest rate charged on cross-border banking flows. In particular, we consider a 100 basis point increase in the FFR (r^*). We assume that the shock persists as a first-order autoregressive process with a 0.9 coefficient.[16] Figure 3.2 describes the responses of 16 key variables under a fixed exchange rate regime as the monetary policy regime. Because the economy has a fixed exchange rate, in the wake of the shock, the domestic nominal interest rate rises sharply following the increase in the Federal Funds rate. There is also a significant increase in the real interest rate which, in turn, induces a contraction in output. The rise in the real interest rate causes a contraction in asset prices, which causes a further decline in bank lending: As the collateral value tied to housing prices falls, lending capacity to firms reduces amplifying the influences of the initial shock (Fisherian debt-deflation). This further dampens investment and output. Households reduce their labour supply as real wages declines, and their consumption and saving decrease. Exports increase as the price of home-produced goods become competitive (cheaper), while imports decline as demand for total consumption reduces.

[16] The first order autogressive model with 0.9 coefficient describes the response of Federal Funds rate to a US monetary policy shock well, and this is quite robust to shock identification methodologies.

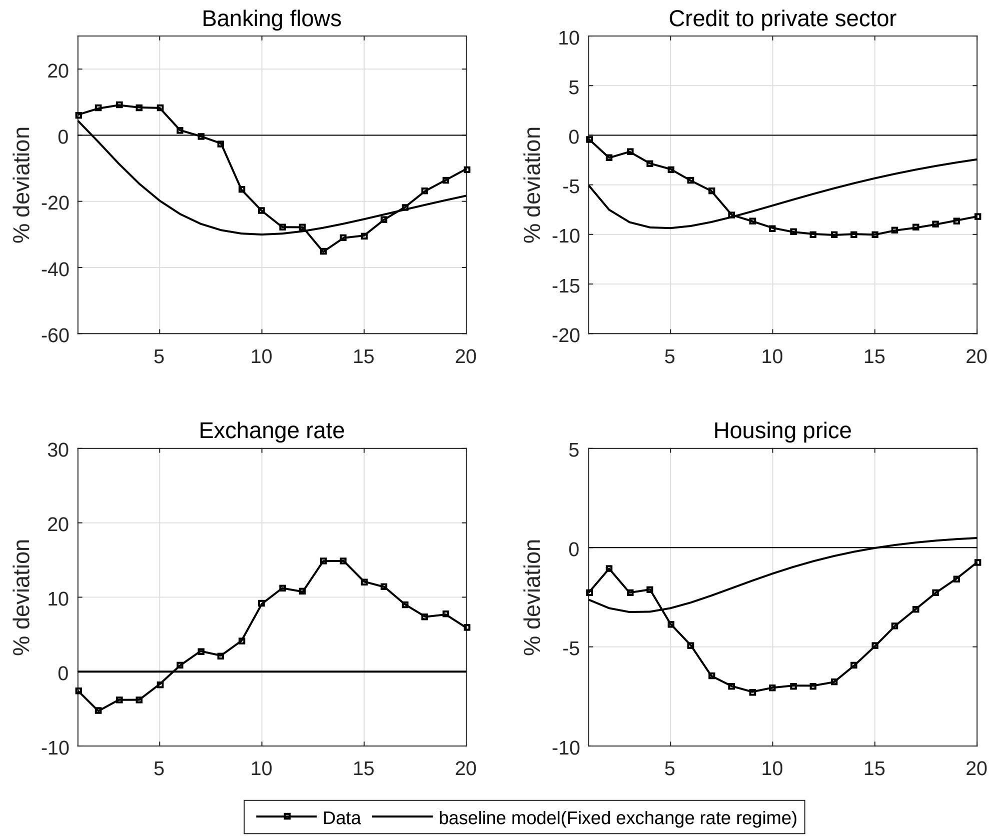
Figure 3.2: Baseline: Fixed exchange rate regime



Notes: 1) These represent the responses to 100 basis point shock in the Federal Funds rate in the baseline model (fixed exchange rate regime).

Figure 3.3 plots the empirical responses extracted from the data (Figure 3.1) and the responses from the baseline model (Figure 3.2). Banking flows, in the face of a US monetary policy tightening shock of 100 basis points, decline by about $30 - 35\%$, though the empirical responses reveals more sluggishness, reaching the trough (maximum decline) 18 quarters after the shock. Bank lending to local firms (private sector) also reveals similar magnitudes in the decline (around -10%), but the response from the data seems to have a stronger persistence. In case of housing prices, the model predicts about a 3% decline within 4 quarters after the shock, while the data response shows relatively slow, but larger adjustment. For the exchange rate, the responses show strong inaction for the first two years after the shock, and then reveal a rise by about 15% three years after the shock. One possible interpretation is that the fixed exchange rate regime they adopt as monetary policy scheme prevents their currency rate from rising in the face of the shock, while the monetary authorities adjust the value of local currency slowly.

Figure 3.3: Data and Model (baseline)



Notes: 1) Dotted lines represent empirical responses to 100 basis point shock of the US moentary policy shock (Figure 3.1). Solid lines represent responses from baseline model (Figure 3.2).

3.4.2 Counterfactual: Alternative exchange rate policy

Two alternative monetary policy regimes are investigated to illustrate the interaction between the exchange rate regimes (monetary policy regimes) and the influence of the financial crisis: (i) one where the economy adopts a pure flexible exchange rate / inflation targeting regime; (ii) the other where the economy follows a typical flexible exchange rate regime but adjusts its policy interest rate to partially defend the value of local currency (hybrid regime).[17] These two alternatives are compared to the baseline case in which the economy begins and remains under a purely fixed exchange rate regime.

[17] This economy also can be descirbed as a former pegger that is being forced to abandon its peg in the financial crisis. They abandon the peg, but still adjust interest rates aiming to avoid a sharp depreciation of the currency.

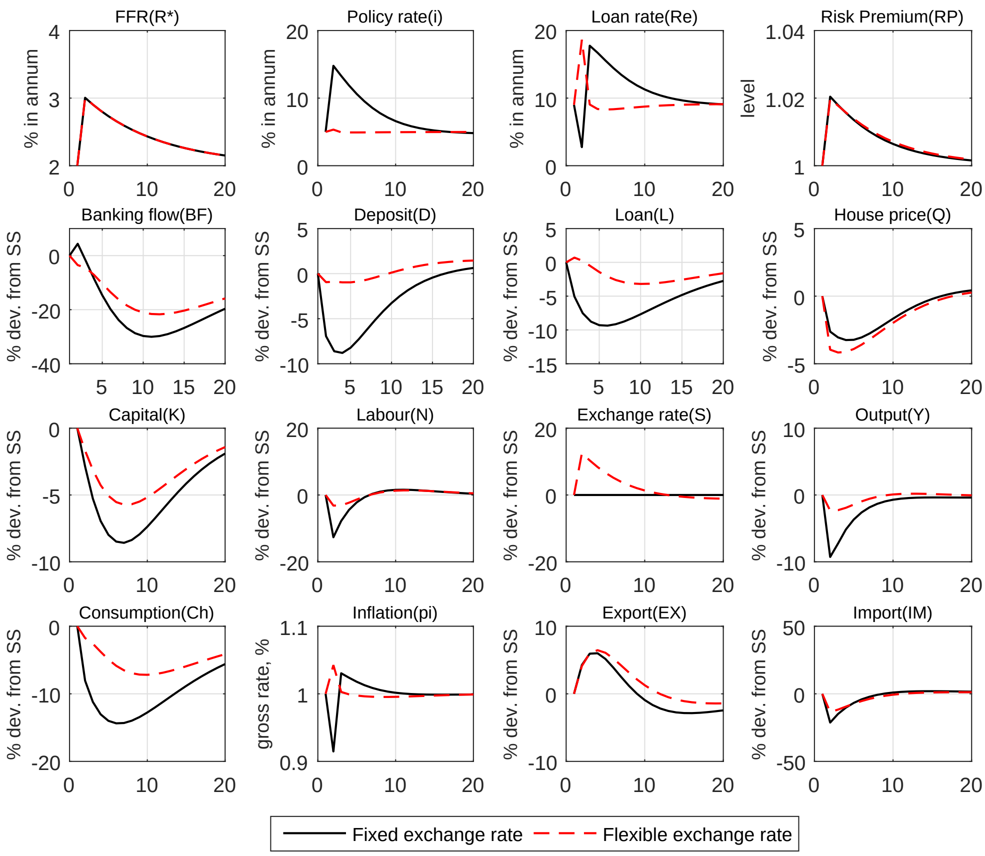
Inflation rate targeting with a flexible exchange rate regime The monetary policy regime that follows a flexible exchange rate / inflation targeting regime can be described as following a Taylor rule as Equation (3.43).

$$i_t = \bar{i} \left(\frac{p_t}{p_{t-1}} \right)^{\gamma_\pi} \left(\frac{y_t}{y} \right)^{\gamma_y} + 1 \tag{3.43}$$

where the Taylor rule coefficient on inflation γ_π, and on output γ_y are set to 2 and 0.75, respectively (Gertler, Gilchrist and Natalucci 2007). $\bar{i}$ is set to 0.0125 such that the policy rate in annum would be 5% in the steady state. The target gross inflation rate is assumed to be unity for simplicity. This rule is a form of flexible inflation targeting, in the sense of Bernanke, Gertler and Gilchrist (1999). The central bank adjusts the interest rate to ensure that the economy meets its inflation target over time, but with flexibility in the short term so as to meet stabilization objectives. It is assumed that the central bank is able to credibly commit to the Taylor rule.

Figure 3.4 compares the responses to a US monetary policy shock under a fixed exchange rate regime (baseline) and a flexible exchange rate regime under inflation targeting (counterfactual). First of all, we find that the crisis would have been less severe had the economy adopted a credible floating exchange rate regime. Under a flexible exchange rate regime, the local nominal policy rate is no longer tied to the foreign interest rate (Uncovered Interest rate Parity), and is instead determined by the feedback rule (Taylor rule in Equation 3.43). In this case, a rise in the world interest rate leads to an immediate depreciation of the local currency (a rise in exchange rate), which in turn prompts an increase in exports and a rise in CPI inflation. The monetary authority raises the nominal interest rate to fight inflation according to the Taylor rule. As Figure 3.4 shows, this monetary policy implies only a modest increase in the real interest rate and thus a relatively moderate drop in investment. Since the rise in inflation stems from the depreciation, it is short-lived. The responses of output, consumption and other variables are moderate compared to those under the fixed exchange rate regime. Overall, output is significantly more stable under the flexible exchange rate regime than under the fixed exchange rate regime.

Figure 3.4: Counterfactual: Fixed vs. Flexible exchange rate policy



Notes: 1) Solid lines represent the responses to 100 basis point tightening shock in the US monetary policy under fixed exchange rate (baseline). Dotted lines represent the responses under flexible exchange rate regime (counterfactual).

A hybrid regime: A modified Taylor rule A more realistic description of the monetary policy regime in EMEs might be that local monetary authorities adjust the policy rate to minimize the sharp decline in the currency value at the onset of the financial crisis. This might be the case regardless of the monetary policy regime they have on impact of the shock: (i) if they were peggers and were forced to abandon the fixed exchange rate, they could not only allow the exchange rate to float, but also could raise their policy rates to use both tools to absorb the shock. (ii) Suppose they were floaters with inflation targeting that follows a typical Taylor rule like in Equation (3.43), but they were afraid that a sudden and significant depreciation of the local currency might bring about a full-fledged financial crisis. Then they might try to absorb the shock by raising interest rates, deviating from the inflation target temporarily. In either case, this could provide a more realistic description of the conduct of monetary policy at the onset of financial crisis triggered by US monetary policy tightening. This type of policy regime could be described as a policy feedback rule otherwise a typical Taylor rule except that it adjusts the policy instrument (nominal interest rate) reflecting exchange rate deviations from the steady state level. Equation (3.44) describes this.

$$i_t = \bar{i}\left(\frac{p_t}{p_{t-1}}\right)^{\gamma_\pi}\left(\frac{y_t}{y}\right)^{\gamma_y}\left(\frac{s_t}{s}\right)^{\gamma_s} + 1 \tag{3.44}$$

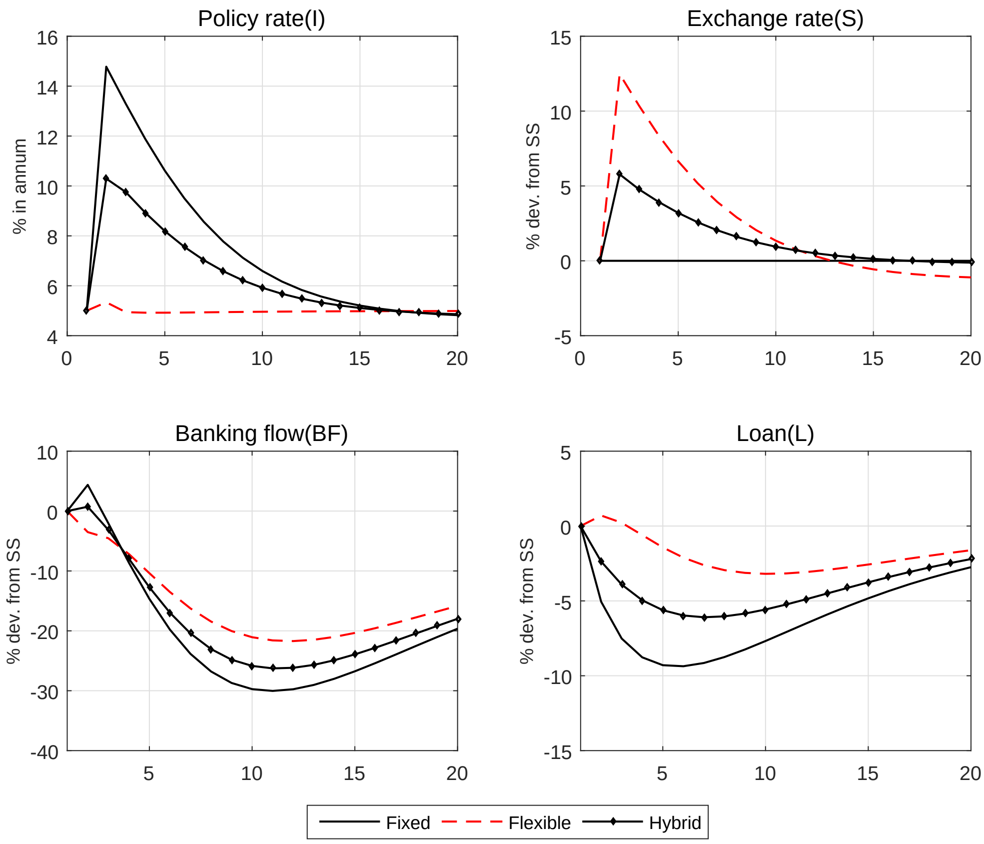
where Taylor rule coefficient on exchange rate γ_s reflects the weight on exchange rate term. If γ_s is set to zero, the Equation (3.44) represents a typical Taylor rule as in Equation (3.43). With an infinte value of γ_s, this equation approximates a fixed exchange rate regime. Therefore, with a proper weight on γ_s, this policy rule could be regarded as a hybrid nesting both a pure floating regime and a pure fixed regime, and γ_s represents the relative importance of the currency value that monetary authority recognizes in conducting monetary policy. In normal periods when the exchange rate remains stable, monetary policy would be a typical inflation targeting / flexible exchange rate regime with γ_s equal to 0. As the financial crisis unfolds, however, monetary authorities in EMEs with Fear of Floating might put an high weight for exchange rate term to protect the currency value. This can explain the experiences of EMEs in which both a sharp decreciation of the local curreny and a hike in real interest rates are observed.[18]

Figure 3.5 describes the adjustment of key variables in response to 100 basis point FFR shock under three different monetary policy regimes. Under the hybrid regime, it is shown that both the policy interest rate and exchange rate adjust to absorb the shock, unlike that one of them mainly changes either in a pure fixed or a pure flexible exchange rate regimes. As discussed above, the responses of an economy under a modified Taylor rule that augments exchange rate term places somewhere between those under a pure floating and pegging exchange rate policy with properly chosen coefficient γ_s. Table 3.4 summarizes the magnitude in the responses of key variables under the three monetary policy regimes.[19]

[18] Gertler, Gilchrist and Natalucci (2007) describes Korean monetary policy regime during 1998 − 1999 Asian financial crisis as switching regime: abandoning its fixed exchange rate regime and allowing its exchange rate to float under a predetermined probability as crisis unfolds. The hybrid monetary policy regime we suggest could be interpreted in a similar context.

[19] We can also consider the welfare loss occurred under baseline and alternative policy scenarios compared to the steady-state level without financial crisis. The welfare level could be calculated by adding up the realized utility values for households, firms and banks (Equations

Figure 3.5: Counterfactual: Hybrid Taylor rule



Notes: 1) Solid lines represent the responses to a 100 basis point shock in the US monetary policy under a fixed exchange rate regime (baseline). Two dotted lines represent the responses under the two alternative monetary policy regimes, the flexible exchange rate regime and a hybrid policy regime ($\gamma_s = 20$), respectively.

3.5 Conclusion

In this chapter, we develop a small open macroeconomic model to explore a sudden reversal in banking flows in EMEs triggered by a US monetary policy shock, and its influences on local economies. The notable difference from one of the closest study on the issue (Gertler, Gilchrist and Natalucci 2007) is that we explicitly introduce a banking sector that raises cross-border banking flows as a funding source other than conventional local deposits. The results implied by the model are supported by empirical evidence we suggest based on US monetary policy shock identification from sign-restrictions (Dedola et al. 2015, Gertler and Karadi 2015).

(3.2), (3.10) and (3.19)) for the first 20 quarters after the shock. Compared to steady-state level without financial turmoil, the welfare losses occurred are about 8.5% and 5.1% for baseline scenario (fixed exchange rate regime) and counterfactual scenario (flexible exchange rate regime), respectively. The loss under a hybrid regime is about 6.8%.

Table 3.4: Influences of sudden stops across monetary policy regimes

	Fixed Exchange	Flexible exchange	Hybrid regime
Banking flows	−21.2	−16.2	−19.0
Lending	−6.2	−2.0	−4.2
Consumption	−5.8	−4.8	−5.3
Housing price	−3.0	−3.8	−3.4
Output	−5.0	−1.6	−3.4
Exchange rate	..	7.8	3.7

Notes: 1) Average of percent deviation from the steady state level for the first 6 quarters after the 100 basis point shock in the Federal Funds rate. In case of Banking flows and Lending, the figures are average for the first 20 quarters considering the persistence of the responses.

In the analysis, we pay attention to the interaction between exchange rate regimes and financial crisis in that the choice of exchange rate regimes is closely related to the probability of occurence and the magnitude of financial crisis, and the adjustment of the shock in EMEs. We find the model is able to explain the empirical regularities in sudden stop episodes: sudden reversal of banking flows, a fall in credit and housing prices, and a contraction of investment and output in response to a US monetary policy tightening. A counterfactual exercise suggests that a choice of monetary policy regimes (exchange rate regimes) is closely related to the magnitude of the crisis, and thus welfare losses following a financial crisis triggered by a US monetary policy tightening. Our result provides evidences supporting the well-known wisdom in the literature on Sudden Stops: countries in the position of having to defend an exchange rate peg are more likely to suffer severe financial distress. This is because defending an exchange rate peg generally requires the central bank to adjust interest rates in a direction that reinforces the crisis (Calvo, Izquierdo, Talvi 2006, Gertler, Gilchrist, Natalucci 2007 among many others). As a realistic description on the conduct of monetary and exchange rate policy in EMEs especially at the onset of financial turmoil, we also provide a hybrid Taylor rule in which the currency value as well as inflation and output are considered in determining policy rates.

This study could be extended in several ways. First of all, the influence of sudden banking outflows could be conditional on economic situations in the recipient EMEs. Examining the role of the banking sector and the related financial frictions in different domestic business cycle phases on the impact of an external shock would provide meaningful implications on monetary and macroprudential policies. In addition, we do not model the global financial intermediaries that play a role in intermediating the banking flows to local banks in EMEs. By introducing global banks, we can examine specific mechanisms through which an initial shock on global banks is transmitted to banking sector in EMEs (Cesa-Bianchi, Ferrero and Rebucci 2016). In methodological aspects, it could be also useful to consider the nonlinear dynamics at work in times of financial turbulence. Distinguishing peggers and floaters among EMEs in a sophisticated way could provide more concrete empirical evidence (Calvo and Reinhart 2002). The role of active fiscal policies in response to sudden banking outflow and its interaction with monetary policy would also provide useful insights for policy mix especially for EMEs where implementation of monetary policy is restricted due to exchange rate peg. We leave these for future research.

Appendix A

APPENDIX: Chapter 1

A.1 Data description

Table A.1: Data description

Variables	Description	Source
Bank-level variables		
Dependent variables		
• Real loan growth rate (%) ($\Delta lnLoan$)	$= \Delta ln(nominal\ loan_{ijt}/CPI_{jt}) \times 100$	*BankScope* *IMF IFS*
• Real loan interest rate (%p) ($\Delta Loan\ rate$)	$= \Delta(interest\ income_{ijt}$ $/total\ earning\ asset_{ijt}) \times 100$	*BankScope*
Bank characteristics		
• Liquidity (%)	$= liquid\ asset_{ijt}/asset_{ijt} \times 100$	*BankScope*
• Capitalization (%)	$= equity_{ijt}/asset_{ijt} \times 100$	
• Size	$= ln(asset_{ijt})$	
• Riskiness (%)	$= loan\ loss\ provision_{ijt}/loan_{ijt} \times 100$	
• Profitability (ROAA, %)	$= net\ income_{ijt}/asset_{ijt} \times 100$	
Internal funds		
• Internal funds (%)	$= net\ income_{ijt}/loan_{ijt-1} \times 100$	*BankScope*
Country-level variables		
• Monetary policy measure[6] (%p)	$= \Delta money\ market\ rate_{jt}$	*IMF IFS*
• Real GDP growth rate (%)	$= \Delta ln(real\ GDP)_{jt}$	*IMF IFS*
• Financial depth (%)	$= (bank\ credit\ to\ private\ sector_{jt}/$ $nominal\ GDP_{jt}) \times 100$	*World Bank*
• Herfindahl-Hirschman index	$= \sum_{i=1}^{N} s_{ijt}^2$, where $s_{ijt} = \frac{asset_{ijt}}{\sum_{i=1}^{N} asset_{ijt}}$	*BankScope*

Note: 1) Subscript i denotes individual bank, j denotes the country where the bank operates in, and t denotes year.
2) Assets are classified as Earning asset, Non-earning asset and Fixed assets. **Earning assets** consists of loans (less reserves for impaired loans), loans and advances to banks, derivatives, other securities, while **Non-earning assets** includes cash and due from banks, foreclosed real estate, other intangibles and the like.
3) **Net income** is sum of net interest revenue, other operating income (net gains on trading and derivatives, net gains on assets, net fees and commissions, etc.), net of overhead, loan loss provisions and tax.
4) **Liquid asset** includes trading securities, loan and advances to banks, reverse repos and cash collateral, cash and due from banks, less mandatory reserves included above.
5) **Money market rate** is average of daily rates of overnight interbank lending rates. Since interbank lending rates fluctuates during the day by contracts affected by market conditions, the representative lending rates are calculated as a weighted average of lending rates of single contract based on the amount of contracts.
6) In case of Singapore, we use money market rate in foreign currency, reflecting high dependence on money market transactions in US dollar in Singapore.

A.2 Structure of the banking industry

Table A.2: Structure of the banking industry

	type[2)]	2000		2005		2010		2014	
Hong Kong	*Parents*	2	[5.5]	2	[5.6]	2	[6.2]	2	[6.4]
	Domestic	8	[3.8]	6	[2.6]	5	[0.9]	4	[0.8]
	Foreign	33	[90.8]	22	[91.8]	24	[92.9]	17	[92.8]
Indonesia	*Parents*	1	[34.6]	1	[21.0]	1	[15.8]	1	[15.8]
	Domestic	35	[57.4]	28	[52.9]	24	[56.0]	24	[54.7]
	Foreign	20	[6.2]	23	[26.1]	26	[28.3]	27	[29.5]
Korea	*Parents*	3	[35.6]	3	[43.9]	6	[80.9]	6	[82.6]
	Domestic	13	[59.9]	10	[39.6]	7	[10.0]	6	[10.1]
	Foreign	1	[4.5]	4	[16.4]	2	[9.1]	2	[7.3]
Malaysia	*Parents*	3	[44.4]	3	[42.6]	5	[61.8]	5	[70.3]
	Domestic	9	[32.9]	9	[35.2]	6	[15.9]	3	[9.5]
	Foreign	12	[22.6]	13	[22.2]	13	[22.3]	12	[20.3]
Philippines	*Parents*	1	[29.4]	2	[23.0]	3	[33.6]	3	[36.0]
	Domestic	16	[65.6]	21	[75.4]	17	[64.8]	13	[62.2]
	Foreign	6	[5.0]	4	[1.6]	4	[1.6]	4	[1.8]
Singapore	*Parents*	3	[70.4]	3	[94.6]	3	[94.8]	3	[94.3]
	Domestic	5	[24.9]	2	[0.3]	2	[0.3]	0	[0.0]
	Foreign	8	[4.7]	6	[5.1]	5	[4.8]	4	[5.7]
Taiwan	*Parents*	3	[13.4]	4	[22.4]	4	[22.7]	4	[24.2]
	Domestic	35	[85.0]	35	[76.0]	30	[71.1]	29	[69.0]
	Foreign	1	[1.6]	1	[1.7]	3	[6.2]	4	[6.8]
Thailand	*Parents*	2	[32.7]	2	[28.9]	2	[31.0]	2	[35.1]
	Domestic	12	[61.1]	15	[66.2]	14	[62.7]	10	[58.7]
	Foreign	4	[6.2]	3	[4.8]	4	[6.3]	4	[6.2]
Total	*Parents*	18	[25.0]	20	[31.7]	26	[41.2]	26	[41.8]
	Domestic	133	[46.9]	126	[39.0]	105	[26.8]	89	[24.5]
	Foreign	85	[28.0]	76	[29.3]	81	[31.9]	74	[33.7]

Note:1) Number of banks by type of ownership, 2) **Parents**: Global banks headquartered in the eight Asia countries, **Domestic**: Domestically-owned banks in the eight Asia countries that do not have foreign subsidiaries, **Foreign**: Foreign-owned banks operating in the eight Asia countries,
3) Figures in brackets are asset share (%) in domestic banking sector.

A.3 Descriptive statistics

Table A.3: Descriptive statistics

	Descriptive statistics			*Pairwise cross correlation coefficients*						
	Mean	Std. Dev	Median	$\Delta ln(loan)$	$\Delta loan\ rate$	*Liquidity*	*Capital*	*Size*	*Risk*	*Profit*
Parents										
$\Delta ln(loans)$	8.557	12.070	7.143	1						
$\Delta loan\ rate$	-0.285	0.797	-0.179	-0.023	1					
Liquidity	17.889	8.948	17.056	0.119**	-0.010	1				
Capital	8.474	2.148	8.288	0.064	0.046	0.418***	1			
Size	10.673	0.954	10.722	-0.104*	0.083	-0.445***	-0.261***	1		
Risk	1.085	1.462	0.646	0.088	-0.109*	-0.107*	-0.286***	-0.198***	1	
Profitability	0.942	0.749	0.992	0.123**	0.054	0.159***	0.449***	-0.021	-0.607***	1
Domestic banks										
$\Delta ln(loan)$	8.055	16.205	6.593	1						
$\Delta loan\ rate$	-0.271	1.313	-0.159	-0.081***	1					
Liquidity	19.319	14.126	15.664	0.176***	-0.043	1				
Capital	10.002	7.772	8.035	0.037	-0.053**	0.043	1			
Size	8.396	1.647	8.642	-0.130***	0.050*	-0.351***	-0.325***	1		
Risk	1.135	1.794	0.763	-0.061**	-0.095***	-0.015	-0.039	0.063**	1	
Profitability	0.739	1.494	0.723	0.147***	0.013	0.135***	0.348***	-0.127***	-0.392***	1
Foreign banks										
$\Delta ln(loan)$	8.346	21.206	6.943	1						
$\Delta loan\ rate$	-0.390	2.044	-0.196	-0.101***	1					
Liquidity	27.608	16.634	24.070	0.047	-0.067**	1				
Capital	14.118	8.746	11.666	-0.031	-0.150***	0.170***	1			
Size	7.896	1.999	8.055	-0.005	0.117***	-0.212***	-0.648***	1		
Risk	0.907	2.075	0.459	-0.080**	-0.213***	-0.014	0.022	-0.163***	1	
Profitability	1.359	1.555	1.229	0.048	-0.083**	0.075**	0.316***	-0.163***	-0.339***	1

Note: 1) **Parents**: Global banks headquartered in the eight Asia countries, **Domestic banks**: Domestically-owned banks in the eight Asia countries that do not have foreign subsidiaries, **Foreign banks**: Foreign-owned banks operating in the eight Asia countries. 2) Variables are constructed as defined in Appendix 1, 3) ***: significant at 1% level, **: significant at 5% level, *: significant at 10% level

A.4 List of *Parents* and the relevant information

Table A.4: List of *Parents* and the relevant information

Home country / *Parents*	Asset size[1)] (US$ bill.)	Size of *domestic*[2)] (avg. US$ bill.)	Asset size of *Juniors*[3)] (% of *Parents*)	Location of *Juniors*[4)] (host countries)
Hong Kong				
Bank of East Asia Ltd	68.7	2.5 (9.6)	79.8%	CN, VG, ID, MY, CA, US
Dah Sing Bank Ltd	16.8		8.8%	MO
Indonesia				
Bank Mandiri (PERSERO) Tbk	45.4	6.7 (44.3)	0.3%	GB
Korea				
KB Kookmin Bank	225.4	17.0 (30.7)	4.1%	HK, GB, KZ
Woori Bank	197.8		0.2%	RU, CN, ID
Shinhan Bank	182.3		1.1%	CN, DE, JP, VN, HK, KZ, CA
Industrial Bank of Korea	146.8		0.7%	CN
Hana Bank	123.5		19.6%	CN(2), ID
Korea Exchange Bank	84.8		0.9%	BR, CN, DE, AU, ID, CA
Malaysia				
Malayan Banking Berhad Maybank	80.6	11.0 (26.2)	1.1%	PG, ID, PH, TH, KH
Public Bank Berhad	60.5		2.3%	KH, VN
CIMB Bank Berhad	55.4		19.8%	KH, TH, CN
RHB Bank Berhad	34.1		0.2%	KH
Hong Leong Bank Berhad	25.2		89.3%	VN, CN

Table A.4: List of *Parents* and the relevant information (continued)

Home country / *Parents*	Asset size[1] (US$ bill.)	Size of *domestic*[2] (avg. US$ bill.)	Asset size of *Juniors*[3] (% of *Parents*)	Location of *Juniors*[4] (host countries)
Philippines				
Metropolitan Bank & Trust Company	15.8	4.4 (21.9)	0.1%	BS, CN
Bank of the Philippine Islands	16.1		1.9%	GB
Philippine National Bank	6.7		3.2%	GB(2), HK, CN
Singapore				
DBS Bank Ltd	185.2	0.7 (0.8)	27.6%	CN, TW, HK, ID, PH
Overseas-Chinese Banking Corporation	107.7		80.5%	CN(2), MY(3), ID
United Overseas Bank Limited UOB	138.0		53.2%	CN(2), PH, MY, ID, TH(2)
Taiwan				
Mega International Commercial Bank	75.4	25.1 (134.4)	0.7%	TH, CA
CTBC Bank Co Ltd	59.3		43.7%	HK, PH, ID, JP, CA
Cathay United Bank Co Ltd	54.1		0.0%	KH, VN
Taipei Fubon Commerical Bank Co Ltd	50.9		8.3%	CN
Thailand				
Bankkok Bank Public Company Ltd	63.5	16.2 (58.2)	1.3%	CN, MY
Siam Commercial Bank Public Company	48.6		0.6%	VN

Note: 1) The asset of the *Parents* (not include assets of their *Juniors*), 2) Average of assets of all *Domestic banks* in the country (Figures in parenthesis are asset size of the largest *Domestic bank* in the country), 3) A ratio of total asset of all *Juniors* to *Parents′* asset, 4) AU=Australia, CA =Canada, CN =China, DE=Germany, GB=U.K., HK=Hong Kong SAR, ID=Indonesia, ID=Indonesia JP=Japan, KH= Cambodia, KZ= Kazakhstan, MO=Macao, MY=Malaysia, PG=Papua New Guinea, PH=Philippines, RU=Russian Federation, TH=Thailand, TW=Taiwan, US =U.S.A., VG=Virgin Islands (British), VN=Vietnam, 5) Figures are as of 2010, 6) Some *Parents* launched their first foreign subsidiaries only after 2000: Industrial Bank of Korea (2009), Hana Bank (2007), RHB Bank Berhad (2008), Hong Leong Bank Berhad (2009), Bank of the Philippine Islands (2007), Taipei Fubon Commercial Bank Co Ltd (2003)

Appendix B

APPENDIX: Chapter 2

B.1 Data description

Banking flows is the locational banking statistics (LBS) at BIS.[1]

Leverage is the leverage of US global banking sector, and calculated by using ″Security Brokers and dealers sector″ in Federal Reserve Flow of Funds statistics.[2]. Leverage is defined as 2/(2 - 1), where, (1) total liabilities (FL664190005.Q) and (2) total liabilities and equity (FL664194005.Q).

Exchange rate of US dollar is real effective exchange rate (IMF IFS).

VIX is CBOE implied volatility on the S&P index (The Federal Reserve Bank of St. Louis, https://research.stlouisfed.org/fred2/series/VIXCLS).

Effective Federal Funds rate is from the Federal Reserve Bank of St. Louis (https://research.stlouisfed.org/fred2/series/DFF).

Money market rate is from IMF IFS, and **Nominal exchange rate** is national currency per US dollar, period-average (IMF IFS).

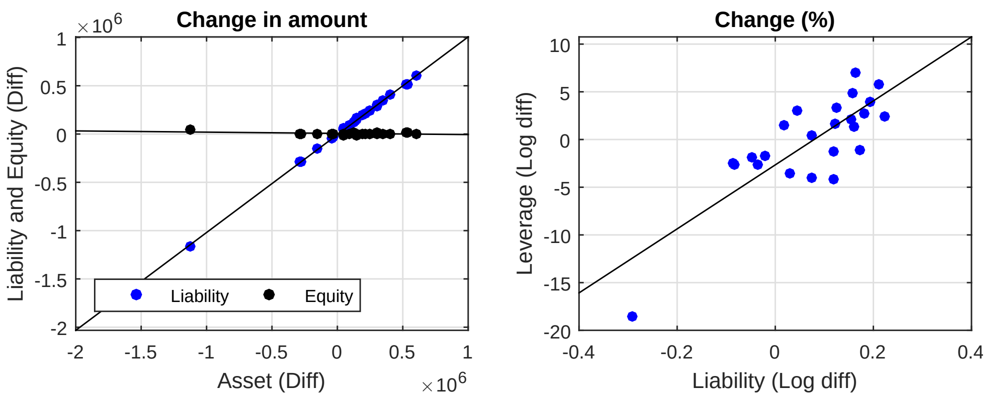
[1]″The LBS ... capture (s) outstanding claims and liabilities of internationally active banks located in reporting countries against counterparties residing in more than 200 countries. Banks record their positions on an unconsolidated basis, including intragroup positions between offices of the same banking group. The data are compiled following principles that are consistent with balance of payments statistics. Currently banking offices located in 44 countries, including many offshore financial centres, report the LBS. The LBS capture around 95% of all cross-border interbank business.″ (Introduction to BIS statistics, 2015) http://www.bis.org/statistics/index.htm

[2]According to the FRBs manual (Federal Reserve, 2016): ″... Security brokers and dealers are firms that buy and sell securities for a fee, hold an inventory of securities for resale, or do both. ... Brokers and dealers are an important link in the transmission of funds from savers to investors because they are a means of distributing both new security issues and those being resold on the secondary market.″

B.2 Leverage of US global banks

Figure B.1 shows the change in the leverage of the US global banks has been mainly due to a change in debt and the following changes in asset.[3] The first panel plots $\{(\Delta\text{Asset}, \Delta\text{Debt})\}$ and $\{(\Delta\text{Asset}, \Delta\text{Equity})\}$ of US global banks 1991 − 2015 (difference in one year ago). The fitted line through the points $\{(\Delta\text{Asset}, \Delta\text{Debt})\}$ is close to 1, while that through the points $\{(\Delta\text{Asset}, \Delta\text{Equity})\}$ is close to zero. The second panel plots $\{(\Delta\text{lnDebt}, \Delta\text{lnLeverage})\}$, and shows that growth rates in the debt and the leverage have the same signs in most cases only exception of 5 out of 24 cases. These imply that a change in debt, rather than that in equity has driven a change in the US global bank leverage.

Figure B.1: Changes in Bank leverage, Asset, and Equity of US global banks



Notes: 1) The left panel plots the annual difference of asset, debt and equity of US global banking sector in amounts of US dollar. 2) The right panle plots the annual rate of change in debt and leverage of US global banking sector (Federal Reserve Flow of Funds statistics).

[3]Bank leverage can vary in two ways over the financial business cycle (Hahm, Shin and Shin 2013): (1) The relative proportion between equity and debt changes with total asset fixed, and/or (2) Asset varies in line with the movement of debt with equity fixed. If US global banks play an important role in intermediating global banking flows and thus a change in the leverage of US global banks is regarded as an important determinant of global banking flows, it must be the case that bank leverage moves in line with asset size over the business cycles. We find that a change in the US global bank leverage has been mainly driven by a change in debt and asset, and thus leverage could be useful in measuring their activity of intermediating banking flows.

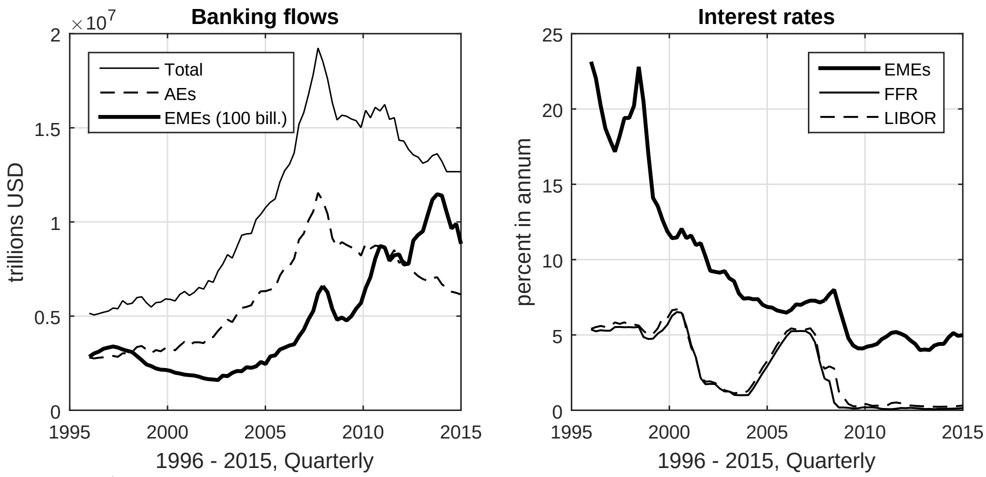
Appendix C

APPENDIX: Chapter 3

C.1 Banking flows and interest rates

Figure C.1 describes banking flows (global aggregate, AEs and EMEs) and interest rates (Federal Funds rate, LIBOR, and averaged money market rates for 18 EMEs).

Figure C.1: Cross-border banking flows and interest rates

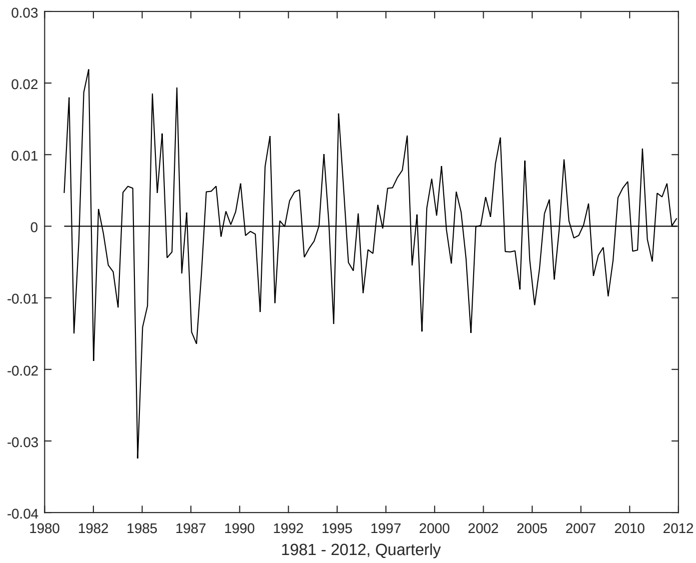


Notes: 1) Left panel plots global banking flows. As of end of 2015, total cross-border banking flows outstanding is 12.7 trillion USD, and that to advanced economies (18 countries) accounts for 48.5%. In case of emerging market economies (18 countries), that is 7.0%. The list of 18 EMEs and 18 AEs are in Footnote 25 in Chapter 2 and APPENDIX C.3. The EMEs analyzed in Chapter 3 are the same as those in Chapter 2. 2) Right panel plots interest rates. Federal Funds rate and Libour (3-month) are end-of-term basis. Money market rates of EMEs are an average of money market rates of 18 emerging market economies. From 1996 to 2015, FFR is on average around 2%, and money market rates of 18 EMEs are on average around 7%. The spread is 5%p, and can be regarded as risk-premium and costs related to international transactions.

C.2 Monetary policy shock identification

A specific number (e.g. 100) of A_0 matrices (e.g. from 10,000 draws) that satisfy the sign restrictions (Table 3.1) is generated via Bayesian estimation ($A(L)y_t = \varepsilon_t$). The residual u_t in a reduced-form VAR is estimated using Ordinary Least Squares. The specific number (e.g. 100) of a monetary policy shock is then retrieved from $\varepsilon_t = A_0 u_t$. The VAR consists of 13 variables with monthly data from 1981:1 to 2012:6. Median value of structural shock series at each point is used as the monetary policy shock. Quarterly US monetary policy shock is generated by aggregating the figures of the corresponding months.

Figure C.2: MP shock identified from sign-restriction VAR



Notes: 1) This plots quarterly US monetary policy shock identified from sign-restriction augmented VAR.

C.3 Banking flows by country

The ratio of banking flows to total balance sheet in each country is reported in Table C.1. Total balance sheet is the sum of assets of all commercial banks in the country reported in BankScope. The average of the ratio for 18 EMEs is 13.1% as the end of 2015.

Table C.1: Size of cross-border banking flows in EMEs

Country	Ratio	Country	Ratio
Brazil	16.78%	Chile	6.77%
Colombia	7.18%	Czech	16.07%
Estonia	21.11%	Hungary	17.05%
India	5.33%	Korea	9.35%
Lithuania	19.64%	Latvia	25.91%
Maxico	12.19%	Malaysia	9.14%
Phippines	8.68%	Poland	17.7%
Russia	7.07%	Thailand	10.43%
Turkey	16.43%	South Africa	8.23%

Notes: 1) The criterion for classification is from Dedola, Rivolta and Stracca (2015) and IMF Economic Outlook. 2) The figures are as of end of 2015.

C.4 Data description

Monthly data used in sign-restrion VAR: All financial data are from Federal Reserve Bank of St. Louis, Economic database, except nominal effective exchange rate of US dollar (IMF IFS), Commodity price (Thompson Reuters Core Commodity Equal Weighted Index), S&P 500 (Global Financial Database), industrial production index for OECD countries (OECD database), World Stock price (MSCI, Datastream).

C.5 Estimation methodology

Parameters are estimated by minimizing a measure of the distance between the empirical responses and the model responses (Christiano, Eichenbaum and Evans 2005). Let $\boldsymbol{\xi}$ a vector of parameters to be estimated, and then the $\widehat{\boldsymbol{\xi}}$ is generated by solving;

$$\min_{\xi}\left(\boldsymbol{\Psi}(\boldsymbol{\xi})-\widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}\right)'\boldsymbol{\Phi}\left(\boldsymbol{\Psi}(\boldsymbol{\xi})-\widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}\right) \tag{C.1}$$

where, $\boldsymbol{\Psi}(\boldsymbol{\xi})$ is the $n\times 1$ vector collecting the model impulse responses and $\widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}$ is the $n\times 1$ vector of empirical responses (n is the number of empirical responses used in the estimation). $\boldsymbol{\Phi}$ is a weighting matrix, $\boldsymbol{\Phi}=\boldsymbol{\Omega}\boldsymbol{\Upsilon}^{-1}$, where $\boldsymbol{\Omega}$ is a $n\times n$ diagonal matrix of weights that gives reletive importance among responses used, and $\boldsymbol{\Upsilon}$ is the matrix with the sample variances of the emprical responses on the main diagonal.

The covariance matrix for the estimator $\widehat{\boldsymbol{\xi}}$ that minimize the criterion function is

$V=(G'\boldsymbol{\Phi}G)^{-1}G'\boldsymbol{\Phi}\boldsymbol{\Upsilon}\boldsymbol{\Phi}G(G'\boldsymbol{\Phi}G)^{-1}$ and this could be simplified as

$V=(D'D)^{-1}(D'\boldsymbol{\Phi}D)(D'D)^{-1}$,

where G is a gradient of the m(ξ) $\equiv\boldsymbol{\Psi}(\boldsymbol{\xi})-\widehat{\boldsymbol{\Psi}(\boldsymbol{\xi})}$, and $D\equiv\boldsymbol{\Phi}^{1/2}G=\boldsymbol{\Phi}^{1/2}\frac{\partial m(\xi)}{\partial\xi}$. The standard errors of the estimated parameters are the square roots of diagonal elements of V matrix.

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