Intra-Bank Capital Flows and Banking Crisis Contagion

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Abstract

This paper investigates whether internal capital movement between parent banks and their foreign affiliates contributes to the international transmission of banking crises. I first develop a game theoretic model of intra-bank capital flows during home-country crises. The model illustrates the competing mechanisms governing parent-affiliate capital movement, while predicting stylized conditions under which parents shift capital toward, or recall capital from, foreign affiliates during home crises. I then empirically test for the direction of intra-bank capital flows during home-country crises at both the macro-country and micro-bank levels. Across a broad range of crises and countries, I do not find a significant average effect of home-country crises on intra-bank capital flows in either case. This finding casts doubt on the widely held belief that parent banks systematically recall capital from foreign affiliates during home crises. However, I document a set of crisis conditions under which, and parent and affiliate bank characteristics for which, parents recall capital from their affiliates during home-country crises. These results suggest that targeted macroprudential policies—such as constraints on intra-group capital transfers—may, in certain circumstances, be effective in mitigating banking crisis transmission through the intra-bank capital flow channel.

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Contents

1 Introduction

This thesis asks whether internal capital movement within multinational banking networks contributes to the international transmission of banking crises. Peek and Rosengren (2000) establish a link between banking crises in a parent bank's home country and the transmission of domestic liquidity shocks to this parent's subsidiaries abroad. Intra-bank capital flows are one proposed channel through which parent banks export adverse home-country financial shocks to their foreign affiliates. Parent banks may respond to liquidity shocks at home by recalling capital from their banking network. This would strengthen the parent bank balance sheet while reducing capital available for lending by affiliates. In contrast, crisis-driven declines in home-market lending profitability may cause parent banks to shift capital toward foreign affiliates to increase foreign loan market exposure. This would weaken parent bank liquidity while attenuating the effect of intra-bank capital flow contagion.

The 2007-11 Global Financial Crisis (GFC, hereafter) reignited the debate surrounding financial globalization and the role of foreign banks as conduits for financial crisis transmission. As the global financial system has converged toward greater interconnectedness, multinational banks have grown increasingly integrated within foreign banking systems. Between 1999 and 2010, the average share of host-country banking system assets owned by foreign banks increased from 31% to 51%.[1] Evidence of the impact of foreign banks on host-financial systems is varied.

On one hand, foreign bank activity has been shown to increase the efficiency of, import institutional best practices to, and improve stability within host-country banking systems (Jeon et al., 2011; Mishkin, 2001; Demirguc-Kunt et al., 1998). On the other hand, existing literature establishes an association of home-country banking crises, the deterioration of parent bank capital positions, and the transmission of liquidity shocks to multinational bank subsidiaries (Jeon et al., 2013).

While there is an extensive literature connecting multinational banks and banking crisis contagion, most studies establish an association between parent bank balance sheet strength and foreign affiliates' loan supply. Previous studies attribute this association to intra-bank capital flows between parent banks and their affiliates, although direct evidence of the intra-bank capital flow transmission

[1] Foreign bank asset share calculated with data from the World Bank Regulation and Supervision surveys.

channel is limited. In contrast, I seek to add to the literature by examining the impact of home-country crises on direct measures of parent-affiliate capital flows.

Internal capital market transactions, through which parent banks reallocate capital across multinational banking networks, have important policy implications for bank subsidiary host countries. Bank capital outflows are of particular concern for developing-economy banking systems, which both rely more heavily on foreign capital funding and are more sensitive to exchange rate movements. There are multiple instances during the GFC in which parent banks precipitated host-country financial distress by recalling funds from foreign affiliates. In the third quarter of 2011, two Russian subsidiaries of French and Italian banks channeled $7B toward their respective parent banks, accounting for nearly 40% of net capital flight from Russia during the period (*Financial Times*, 2011). In the U.K., Spanish bank Santander SA recalled over £2B from its British subsidiary during the 2008-12 Spanish banking crisis, drawing regulatory concern over the capitalization and stability of the subsidiary (*Wall Street Journal*, 2011). This thesis looks for systematic evidence that parent banks retrench capital from foreign affiliates during home-country banking crises beyond such highly publicized instances.

In this paper, I first develop a game theoretic model of intra-bank capital flows. The model illustrates the competing mechanisms governing parent-affiliate capital movement during home-country banking crises, while providing intuition for the results presented in the empirical section of the paper. The model specifies two equilibria, which predict stylized conditions under which parents may respond to home crises by shifting capital toward, or recalling capital from, foreign affiliates. These equilibria yield two primary hypotheses. First, affiliates are more susceptible to capital retrenchment during severe home-country crises. Second, parent banks recall capital from smaller affiliates deemed non-core funding priorities by the parent.

I then empirically test these, and additional, theoretical predictions at both the macro-country and micro-bank levels to analyze the impact of home-country crises on intra-bank capital flows. At the country level, I analyze a sample of 22 mostly developed country banking systems for evidence of significant parent-affiliate capital flows during home crises. I then test for heterogeneous effects of home crises dependent on two conditions: whether the crisis constitutes a severe or relatively mild banking system disruption, and whether the crisis occurs in a highly integrated or relatively closed economy. The degree of crisis severity may impact intra-bank capital flows by affecting the magnitude of liquidity shocks to parent banks. The level of home-country economic integration may impact intra-bank capital flows by impacting either capital mobility or the extent of parent banks' cross-border lending relationships. In the micro-bank study, I analyze a sample of 52 parent banks and their 381 foreign subsidiaries for bank-level evidence of intra-bank capital flows during home crises. I then investigate which bank characteristics increase subsidiary susceptibility to, or insulate subsidiaries from, banking crisis contagion via intra-bank capital retrenchment.

At both the country and bank levels, I do not find a significant average effect of home-country crises on intra-bank capital flows. This finding casts doubt on the belief that, across banking crisis episodes, parent banks systematically recall capital from their foreign affiliates. Still, there are specific conditions under which parents transmit adverse financial shocks to their foreign affiliates through the intra-bank capital flow channel. At the country level, I find a bifurcation of crisis outcomes dependent on severity. Parent banks recall capital from affiliates during severe crises, in line with the intuitive notion that parents lean on their banking network to raise liquidity during periods of acute banking system distress. In contrast, parents shift capital toward affiliates during relatively mild crises, illustrating a competing mechanism whereby parent banks seek to optimize lending profitability across their banking network in the absence of significant liquidity pressures. Furthermore, at the bank level, I find evidence that parents recall capital from affiliates operating in developing countries, those that exhibit medium-to-high profitability, and those considered lesser funding priorities by the parent. These results suggest that under certain conditions, macroprudential policies imposed by host-country regulators such as ring-fencing—constraints on intra-group capital transfers—may be effective in mitigating banking crisis transmission through the intra-bank capital movement channel.

The remainder of the paper is organized as follows. Section 2 reviews the literature on multinational banks and banking crisis contagion. Section 3 presents the game theoretic model of intra-bank capital flows during home-country banking crises. Section 4 presents the country-level empirical analysis. Section 5 presents the bank-level empirical analysis. Section 6 concludes.

2 Literature Review

Traditional banking crisis theory literature can be broadly split into two segments. One strand of the literature considers bank liquidity crises as self-fulfilling panics and consequences of depositor withdrawal behavior under uncertainty of bank liquidity. Bryant (1980), Diamond and Dybvig (1983), and Waldo (1985) model banking crises as depositor coordination equilibria. If depositors share *ex-ante* expectations that other depositors will withdraw their deposits, thereby reducing bank liquidity, all depositors seek to salvage the value of their own deposit by withdrawing. A bank panic ensues, confirming liquidity fears *ex-post*.

A second strand of the literature studies the interaction of economic fundamentals and banking crisis incidence. Multiple studies highlight the role of macroeconomic policies and outcomes in precipitating banking crises, including: increases in short-term interest rates (Stiglitz and Weiss, 1981), stock market crashes (Mishkin, 1992), sudden stops in capital flows and currency depreciation (Reinhart and Kaminsky, 1999; Honig, 2006), and floating exchange rate regimes (Domaç and Peria, 2003). The model of Jacklin and Bhattacharya (1988) predicts that depositors respond to weak macroeconomic conditions by withdrawing deposits, precipitating bank liquidity shocks.

More recent international banking literature has evolved to study banking crisis contagion. Adverse bank liquidity shocks may be transmitted through *interbank* links (between banks) or *intra-bank* links (within a single corporate banking group). First, Allen and Gale (2000) study interbank networks under liquidity shock conditions. Banks buffer balance sheet shocks by receiving interbank deposits from peer banks. But interbank deposit connections act as transmission conduits: bank losses cascade throughout the network via interbank deposit defaults. Hale et al. (2016) empirically test the theoretical predictions of Allen and Gale (2000) by constructing an annual network of interbank loan exposures. The authors find that exposure to banking crises through interbank links reduces bank profit margins and loan growth. Accordingly, Hale et al. (2016) infer that interbank links transmit deteriorations of bank balance sheet strength across borders. Therefore, on one hand, functioning interbank loan markets act as crisis transmission conduits.

On the other hand, informational rigidities within interbank loan markets during periods of financial system disruption similarly produce banking crisis contagion. Studying the U.S. bank panic of 2007-08, Gorton and Metrick (2009) argue that the opacity of shadow banking system securitization restricted counterparty visibility over bank health. Financial institutions were unwilling to lend to peer institutions, and interbank markets froze as a source of liquidity. Bernanke (2010) contends that this sudden stop in interbank lending transmitted liquidity pressures to otherwise unexposed banks, propagating the subprime shock throughout the financial sector.

Second, the literature on the impact of foreign banks on domestic financial stability considers the role of intra-bank linkages in banking crisis contagion. Multinational banking groups operate internal capital markets through which parents form intra-bank loan and deposit connections with their foreign affiliates. Internal capital markets serve two purposes. First, Stein (1997) argues that internal capital markets allow corporate headquarters to bypass external financing frictions and allocate internal funds toward divisions with the highest return investment projects. In accordance with this explanation, De Haas and van Lelyveld (2010) hypothesize that parent banks may leverage internal capital markets to shift capital out of crisis-banking systems toward more stable markets with profitable investment (lending) opportunities. This would optimize lending profitability across the banking network, while exacerbating the adverse banking system shock in the crisis-country.

Second, Campello (2002) demonstrates that internal capital markets shield bank subsidiaries from monetary policy shocks. He argues that parent banks activate internal capital markets to relax subsidiary liquidity constraints, allowing subsidiaries to smooth credit growth during banking system downturns. In accordance with this purpose, De Haas and van Lelyveld (2010) hypothesize a competing mechanism by which parent banks shift capital toward financial systems experiencing banking crises. The authors suggest that parents may leverage internal capital markets as a liquidity support channel to reinforce affiliates' liquidity positions during crisis episodes. The direction of intra-bank capital flows during banking crises is therefore theoretically undetermined.

In this paper, I focus on intra-bank capital flows during banking crises in the home country of the parent banking entity. Existing models of bank capital flows during home-country crises focus on the role of foreign bank asset portfolio flows. The Garber and Grilli (1988) model predicts that foreign banks increase capital exposure to banking systems experiencing crises to buy fire-sale assets from capital-constrained domestic banks. Similarly, the model of Morgan et al. (2004) suggests that foreign banks shift capital toward countries experiencing banking crises to lend to domestic borrowers that insolvent domestic banks are unable to serve. In contrast, I develop a model of capital flows between a parent bank and its foreign affiliate during home-country crises. I then empirically test for the impact of home crises on intra-bank capital flows.

The underlying empirical challenge to testing for the role of intra-bank capital flows in banking crisis transmission is accurately identifying intra-bank capital flows. Intra-group transactions are often obscured by accounting consolidation at the bank holding company level and are generally directly observable only in confidential regulatory filings. Accordingly, the literature employs two identification methods to provide indirect evidence of the role of intra-bank capital flows in banking crisis contagion: the use of association studies to infer the existence of intra-bank capital flows, and the use of financial proxy variables.

The former approach is common in the international banking crisis contagion literature. Following the early method of Houston et al. (1997) and Houston and James (1998), multiple studies examine the association of parent bank home-country financial conditions and affiliate loan growth. De Haas and van Lelyveld (2010) study this association during home- and destination-country banking crises from 1991-2004. The authors demonstrate that foreign bank subsidiaries reduce loan supply in response to home crises but increase loan supply in response to destination crises. De Haas and van Lelyveld (2011) extend this result to the onset of the GFC, 2008-09, and confirm the positive association of parent home financial conditions and foreign subsidiary loan growth. Jeon et al. (2013) document that subsidiaries' loan growth is more sensitive to internal cash flows during periods of parent home-country financial system distress. In each case, the authors interpret the positive association between parent home-country financial conditions and subsidiary loan growth as evidence that parents recall capital from their banking networks during home crises to manage affiliate loan growth.

In terms of the financial proxy approach, Allen et al. (2014) proxy for the net intra-bank capital position with the more widely available net interbank capital position.[2] The authors study the impact of internal capital market activities on subsidiary loan growth during the GFC and find evidence that subsidiaries reliant on intra-bank funding were forced to reduce loan growth during the crisis. They then use this result to infer that parent banks reigned in capital support of subsidiaries during the crisis, forcing affiliates to reduce loan supply. Notably, however, this result still provides indirect evidence of parent bank capital retrenchment during periods of home-country financial distress.

In contrast to previous association studies, I seek to add to the literature by examining the impact of home-country banking crises on *direct* measures of intra-bank capital flows. This study most readily relates to three prior results. First, using confidential regulatory data on U.S. parent banks and their foreign affiliates, Cetorelli and Goldberg (2012) study determinants of the rate of parent-affiliate capital flows during the Great Recession; that is, bank characteristics impacting the second derivative of the net parent-affiliate capital position. The authors show that U.S. parents recalled funds at a faster rate from affiliates deemed non-funding priorities: those that funded a smaller proportion of their liabilities through intra-bank loans and deposits, and those operating in periphery markets comprising a smaller share of total banking group foreign lending. In contrast, I seek to add to the literature by documenting the impact of home crises on the direction of intra-bank capital flows; that is, the first-derivative effect of home crises.

Next, Gupta (2021) shows that U.S. broker-dealers recalled capital from foreign affiliates during the height of the GFC.[3] Similarly, Allen et al. (2011) document a subset of parent-affiliate capital transactions in the E.U. during the GFC and demonstrate that certain parents recalled capital from affiliates during the crisis. In contrast to previous studies, however, I seek to add to the literature by documenting conditions under which parents shift capital toward, or recall capital from, foreign affiliates across a broad sample of countries and banking crises.

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[2] Where publicly available, the authors hand-aggregate the interbank and intra-bank, reported as a subset of interbank, capital positions of subsidiaries of Italian banking group UniCredit SpA. They show that intra-bank capital positions comprise a substantial portion of interbank capital positions.

[3] Gupta (2021) distinguishes between parent-branch capital flows, which have little regulatory oversight, and parent-subsidiary capital flows, which are subject to regulatory size caps. I argue that regulatory caps on intra-bank capital flows do not materially impact the results of this thesis, given that—as I will discuss—I do not find evidence of significant intra-bank capital flows during home-country crises, on average.

3 Model

In this section, I develop a simple model of intra-bank capital flows during home-country banking crises. The model serves two purposes. First, it demonstrates the competing liquidity support and lending profitability effects impacting parent-affiliate capital flows during home-country crises. Second, the model yields multiple equilibria that predict stylized conditions under which parent banks may shift capital toward, or recall capital from, affiliates during home crises.

3.1 Environment

I develop a four-period bank run model where $t \in \{0, 1, 2, 3\}$ indexes the time period. There are two countries: the home country, denoted by H, and the destination country, denoted by F. There is a multinational bank that operates a parent bank in the home country and a foreign affiliate bank in the destination country. There are D_H depositors in the home country.

In period $t = 0$, a set of exogenous transactions take place. First, each home-country depositor is endowed with one unit of currency and deposits this currency in the parent bank.[4] Next, as in Diamond and Dybvig (1983), the parent bank channels deposits into a cash-like liquid asset, C_H, and a loan-like illiquid asset, I_H. Therefore, we have that:

$$C_H + I_H = D_H \tag{1}$$

where $C_H, I_H \in [0, D_H]$. The liquid asset has gross return 1 at both time $t = 2$ and time $t = 3$. The illiquid asset has gross return $\delta_H < 1$ if liquidated at time $t = 2$ and gross return $R_H > 1$ if held to maturity at time $t = 3$.[5] I assume that the cost of liquidating the illiquid asset in the home country is greater than the net return to holding the illiquid asset to maturity. That is, $(1 - \delta_H) > (R_H - 1)$. This assumption eliminates equilibria in which the bank actively seeks to liquidate the illiquid asset, rather than sourcing liquidity across the banking network, to serve depositor withdrawals. I argue that these equilibria are extraneous in a real-world context given the extreme liquidity stress and increased insolvency risk associated with asset fire-sales (Shleifer and Vishny, 2010; Diamond and Rajan, 2009). Finally, in the destination country, the foreign affiliate bank is endowed with a liquid cash asset of

[4] As I will discuss, a depositor may withdraw her deposit at time $t = 2$ or time $t = 3$.

[5] The liquidation loss, $1 - \delta_H$, represents the haircut associated with selling the illiquid asset in an asset fire-sale (Diamond and Rajan, 2009). The return at maturity, R_H, represents the yield of the illiquid asset or the profits to lending realized at time $t = 3$.

value λ_F at time $t = 0$.[6]

Two features of the game take place in period $t = 1$. First, the home country banking system experiences a banking crisis. Adverse banking system shocks exacerbate adverse selection and moral hazard problems in lending markets, increasing the share of non-performing loans (NPLs) in the banking system (Mishkin, 2001; Ari et al., 2020). Hence, I represent the banking crisis as a decline in the gross return of the illiquid asset in the home country from R_H to $R_H^{'} \in (\delta_H, R_H)$, where $R_H^{'}$ is exogenously given and reflects the severity of the loan market disruption.[7] Second, the multinational bank reallocates the liquid assets held by the parent and affiliate across countries.[8] I denote the amount reallocated toward the home country by M_H. Since only the liquid cash asset may be reallocated across countries, we have that:

$$M_H \in [-C_H, \lambda_F] \tag{2}$$

The amount of capital reallocated to the destination country is $-M_H$. The values of the liquid asset in the home and destination country therefore become $C_H + M_H$ and $\lambda_F - M_H$, respectively.

Next, two features of the game take place at time $t = 2$. First, in the destination country, the liquid asset held by the foreign affiliate bank, $\lambda_F - M_H$, is invested into a loan-like illiquid asset, I_F. I impose two conditions on the illiquid asset in the destination country. First, the illiquid asset has gross return $R_F = R_H$ at time $t = 3$. This assumption is common in the international banking theory literature and implies that the non-crisis, steady-state return of holding assets, or the profits to lending, across countries is equal (Garber and Grilli, 1988).[9] Second, I assume that the illiquid asset cannot be liquidated or, equivalently, has liquidation value $\delta_F = 0$ at time $t = 2$.[10]

Second, in the home country, each depositor chooses whether to withdraw their deposit from

[6] λ_F can be interpreted either as the foreign affiliate bank's retained earnings from lending operations, or as the amount of capital lent by the parent bank to the foreign affiliate bank prior to the period captured in the model.

[7] If $R_H^{'} \leq \delta_H$, the return to holding the illiquid asset to maturity is at most the salvage value received after disposing of the asset in an asset fire-sale. I argue that this case is extraneous in a real-world context, given that asset fire-sales are typically associated with the buying and selling of assets at prices below face value (Diamond and Rajan, 2009).

[8] I assume that only the liquid asset in each country may be reallocated to mimic the purpose of internal capital markets as conduits for reallocating excess cash flows or liquidity across divisions of a conglomerate (Stein, 1997).

[9] Note, however, that in the home banking crisis circumstance considered in this model, $R_F > R_H^{'} \in (1, R_H)$. Furthermore, this assumption implies that $(R_F - 1) = (R_H - 1) < (1 - \delta_H)$.

[10] As I will discuss, this assumption becomes relevant only in the case of parent bank insolvency and reflects the difficulty of recovering extraterritorial assets to fulfill creditor claims in a bankruptcy scenario.

the parent bank at time $t = 2$ or wait to withdraw their deposit until time $t = 3$. Each home-country depositor perfectly observes the actions of other depositors. A depositor that withdraws her deposit at time $t = 2$ has a senior claim on bank assets and receives her one-unit deposit back, subject to bank asset availability. In contrast, each depositor that waits until period $t = 3$ to withdraw receives an equal share of remaining bank assets. I denote the number of depositors withdrawing their deposit at time $t = 2$ by K_H, where $0 \leq K_H \leq D_H$.

If the bank lacks sufficient liquid asset value to pay one unit to a depositor that withdraws at time $t = 2$, it must liquidate a portion of the home-country illiquid asset, I_H, to serve the withdrawal. In the case that the bank successfully meets all withdrawal obligations through illiquid asset liquidation, the bank remains solvent. If, after liquidation of the home illiquid asset, the bank lacks sufficient assets to pay one unit to each depositor that withdraws in period $t = 2$, then each withdrawing depositor receives an equal share of available bank assets. I denote this case of insolvency as bank failure. In the event of bank failure, the payoff to the bank is $\frac{C_H + M_H + \delta_H I_H}{K_H} - D_H < 0$, the withdrawals paid to withdrawing depositors at time $t = 2$ minus the total liabilities of the parent bank.[11]

Each home-country depositor seeks to maximize the value of her withdrawal, equivalent to the depositor payoff in the game. In the absence of bank failure, the bank receives a payoff equal to the gross return on the illiquid assets held in the home and destination countries at time $t = 3$. If bank failure occurs, the bank receives the negative payoff defined above.

3.2 Analysis

In this section, I analyze the game and describe the subgame perfect Nash equilibria of the model. Following the convention of Diamond and Dybvig (1983), I consider only pure-strategy subgame perfect equilibria. The payoff to a home-country depositor from withdrawing her deposit at time $t = 2$ is a function of the value of the liquid and illiquid asset in the home country, the bank's capital reallocation, M_H, and the number of depositors that withdraw their deposit at time $t = 2$. The payoff to a

[11]This payoff assumes that the illiquid asset in the destination country cannot be liquidated to serve home-country depositor withdrawals in the case of bank failure, or equivalently that the asset has liquidation value $\delta_F = 0$. I argue that this assumption is defensible, given the challenge of enforcing domestic law to attach extraterritorial assets to creditor claims in bankruptcy proceedings. For instance, in the U.S., while U.S.C. 15 §1505 permits domestic bankruptcy courts to engage in foreign asset recovery, the Supreme Court ruling in *Morrison v. National Australia Bank* (2010) affirmed that U.S. bankruptcy legislation generally applies only within the territorial jurisdiction of the United States.

depositor of withdrawing her deposit at time $t = 2$, when K_H depositors (including the depositor in question) withdraw their deposit at time $t = 2$, is as follows:

$$\pi_2(K_H) = \begin{cases} 1 & \text{if } K_H \leq C_H + M_H \\ 1 & \text{if } C_H + M_H < K_H \leq C_H + M_H + \delta_H I_H \\ \frac{C_H + M_H + \delta_H I_H}{K_H} & \text{if } C_H + M_H + \delta_H I_H < K_H \end{cases} \tag{3}$$

The payoff in the top case corresponds to the withdrawal received when the post-reallocation liquid asset value at the bank exceeds the number of depositors withdrawing at time $t = 2$. The payoff in the middle case corresponds to the withdrawal received when the number of withdrawing depositors at time $t = 2$ exceeds the post-reallocation liquid asset value, but the bank can liquidate a portion of the home-country illiquid asset to serve withdrawing depositors. The payoff in the bottom case corresponds to the withdrawal received in the case of bank failure, when, after full liquidation of the home illiquid asset, the number of withdrawing depositors at time $t = 2$ exceeds the total assets available at the parent bank.

Conversely, the payoff to a depositor of waiting to withdraw her deposit until time $t = 3$, when K_H other depositors withdraw their deposit at time $t = 2$, is as follows:

$$\pi_3(K_H) = \begin{cases} \frac{C_H + M_H - K_H + R'_H I_H}{D_H - K_H} & \text{if } K_H \leq C_H + M_H \\ \frac{R'_H \left(I_H - \frac{K_H - (C_H + M_H)}{\delta_H}\right)}{D_H - K_H} & \text{if } C_H + M_H < K_H \leq C_H + M_H + \delta_H I_H \\ 0 & \text{if } C_H + M_H + \delta_H I_H < K_H \end{cases} \tag{4}$$

In the ultimate stage of the game, home-country depositors play a subgame of perfect information with all other home-country depositors. There are two pure-strategy equilibria of this subgame, which I derive in the following proposition.

Proposition 1. *There are two pure strategy equilibria in the subgame played by home-country depositors: one in which all depositors withdraw their deposit at time $t = 2$ and a second in which zero depositors withdraw their deposit at time $t = 2$.*[12]

[12] For an intuitive explanation of Proposition 1, note that as fewer depositors withdraw at time $t = 2$, the bank faces lower liquidity pressures and preserves a higher share of the home illiquid asset for distribution to time $t = 3$ depositors.

Proof. Consider first the case in which zero home-country depositors withdraw their deposit at time $t = 2$. Note that by equation (2), $M_H \geq -C_H$. Therefore, $C_H + M_H \geq 0 = K_H$ and we are in the top case defined above. Here, $\pi_2(K_H) - \pi_3(K_H) = \pi_2(1) - \pi_3(0) = 1 - \frac{C_H + M_H + R'_H I_H}{D_H}$, which is positive only when $M_H < D_H - C_H - R'_H I_H$. Therefore, when zero depositors withdraw at time $t = 2$, the best response function for each depositor is as follows:

$$BR_H = \begin{cases} Wait & \text{if } M_H \geq D_H - C_H - R'_H I_H \\ Withdraw & \text{if } M_H < D_H - C_H - R'_H I_H \end{cases} \tag{5}$$

where $Wait$ corresponds to the strategy of waiting to withdraw until time $t = 3$ and $Withdraw$ corresponds to the strategy of withdrawing at time $t = 2$. A depositor can profitably deviate by withdrawing their deposit at time $t = 2$ in the case in which $K_H = 0$ only when $M_H < D_H - C_H - R'_H I_H$. Therefore, $K_H = 0$ is an equilibrium when $M_H \geq D_H - C_H - R'_H I_H$. Conversely, when $M_H < D_H - C_H - R'_H I_H$, each depositor deviates and we reach the case in which $K_H = D_H$.

Next, consider the case in which all depositors withdraw their deposit at time $t = 2$. When all $D_H - 1$ other depositors withdraw at time $t = 2$, the payoff to a depositor of withdrawing at time $t = 2$ minus the payoff to withdrawing at time $t = 3$ is:

$$\pi_2(K_H) - \pi_3(K_H) = \pi_2(D_H) - \pi_3(D_H - 1) =$$

$$\begin{cases} 1 - ((C_H + M_H) - (D_H - 1) + R'_H I_H) & \text{if } K_H \leq C_H + M_H \\ 1 - R'_H(I_H - \frac{(D_H - 1) - (C_H + M_H)}{\delta_H}) & \text{if } C_H + M_H < K_H \leq C_H + M_H + \delta_H I_H \\ \frac{C_H + M_H + \delta_H I_H}{D_H} & \text{if } C_H + M_H + \delta_H I_H < K_H \end{cases} \tag{6}$$

It can be shown that when all $D_H - 1$ other depositors withdraw at time $t = 2$, the best response function for each depositor is:

$$BR_H = \begin{cases} Wait & \text{if } M_H \geq D_H - C_H - \delta_H I_H \\ Withdraw & \text{if } M_H < D_H - C_H - \delta_H I_H \end{cases} \tag{7}$$

Therefore, the payoff to waiting to withdraw until period $t = 3$ increases in the number of depositors that withdraw at time $t = 3$. Hence, there is one equilibrium in which all depositors coordinate on waiting to withdraw until time $t = 3$. Conversely, if a sufficiently high number of depositors withdraw at time $t = 2$—depleting all bank liquidity—then each depositor seeks to salvage the value of their deposit by withdrawing at time $t = 2$, rather than receiving a withdrawal of 0 at time $t = 3$. Therefore, depositors may coordinate on an equilibrium in which all depositors withdraw at time $t = 2$.

In the case where $K_H = D_H$, each depositor can profitably deviate by waiting to withdraw until $t = 3$ only when $M_H \geq D_H - C_H - \delta_H I_H$. Therefore, $K_H = D_H$ is an equilibrium when $M_H < D_H - C_H - \delta_H I_H$. Conversely, when $M_H \geq D_H - C_H - \delta_H I_H$, each depositor deviates and we reach the case in which $K_H = 0$.

Finally, observe that from equation (5), when $K_H = 0$, all depositors withdraw their deposit at time $t = 2$ when $M_H < D_H - C_H - R'_H I_H < D_H - C_H - \delta_H I_H$, where the last inequality follows from the definition of $R'_H > \delta_H$. Therefore, the withdrawal threshold in equation (7) is satisfied by $M_H < D_H - C_H - R'_H I_H < D_H - C_H - \delta_H I_H$ and the unique Nash equilibrium when $M_H < D_H - C_H - R'_H I_H$ is $K_H = D_H$. In addition, from equation (7), when $K_H = D_H$, all depositors wait to withdraw until $t = 3$ if $M_H \geq D_H - C_H - \delta_H I_H > D_H - C_H - R'_H I_H$, where the last inequality follows from the definition of $R'_H > \delta_H$. Therefore, the waiting threshold in equation (5) is satisfied by $M_H \geq D_H - C_H - \delta_H I_H > D_H - C_H - R'_H I_H$ and the unique Nash equilibrium when $M_H \geq D_H - C_H - \delta_H I_H$ is $K_H = 0$. Note that if $M_H \in [D_H - C_H - R'_H I_H,\ D_H - C_H - \delta_H I_H)$, then either equilibrium can prevail. □

Proposition 1 guarantees two Nash equilibria of the subgame played by home-country depositors. In the non-bank run equilibrium, zero depositors withdraw their deposit at time $t = 2$, while all depositors withdraw at time $t = 2$ in the bank-run equilibrium. For simplicity, I refer to these cases by the number of depositors that withdraw their deposit at time $t = 2$. I write $K_H = 0$ to indicate the non-bank run equilibrium and $K_H = D_H$ to indicate the bank-run equilibrium.

The game played between depositors and the bank is a sequential game of perfect information. I backward induct from the depositor subgame to the overall depositor-bank game to obtain two subgame perfect Nash equilibria of the model. One equilibrium includes a bank run, while the second does not. Figure 1 on the following page summarizes these equilibria, which I now discuss in turn.

Suppose first that the prevailing equilibrium of the depositor subgame is $K_H = 0$. The bank maximizes its payoff by reallocating the minimal (maximal) amount of capital to the home (destination) country consistent with the $K_H = 0$ equilibrium. The proof of Proposition 1 implies that, to play a strategy consistent with $K_H = 0$, the bank must reallocate at minimum $M_H \geq D_H - C_H - R'_H I_H$

Figure 1: Subgame Perfect Nash Equilibria of Model

	Non Bank Run ($K_H = 0$)	Bank Run ($K_H = D_H$)
$\lambda_F \geq (D_H - C_H - \delta_H I_H)$	$(M_H = max\{-C_H,\ D_H - C_H - R'_H I_H\}; K_H = 0)$	No Subgame Perfect Equilibria
$\lambda_F < (D_H - C_H - \delta_H I_H)$		$(M_H = \lambda_F; K_H = D_H)$

Note: Matrix showing the subgame perfect Nash equilibria of the game for different values of λ_F. The non-bank run equilibrium (middle subtable) exists for every value of the capital endowment in the destination country, λ_F, while each bank run equilibrium (right subtable) exists only for certain values of the capital endowment.

to the home country. Furthermore, by equation (2), the minimal capital reallocation to the home country is $-C_H$. Together, these conditions imply that the bank minimizes M_H subject to the two constraints that $M_H \geq D_H - C_H - R'_H I_H$ and $M_H \geq -C_H$. The non-bank run equilibrium, which I specify with the two-tuple (Bank Strategy; Depositor Subgame Equilibrium) is therefore $(M_H = max\{-C_H,\ D_H - C_H - R'_H I_H\}; K_H = 0)$.[13] The payoff to each depositor in this equilibrium is $\pi_{Depositor} = \frac{C_H + max\{-C_H,\, D_H - C_H - R'_H I_H\} + R'_H I_H}{D_H}$, while the payoff to the bank is $\pi_{Bank} = R_F(\lambda_F - max\{-C_H,\ D_H - C_H - R'_H I_H\}) + R'_H I_H$.

Next, suppose that the prevailing equilibrium of the depositor subgame is $K_H = D_H$. The bank seeks to avert bank failure by reallocating capital from the foreign affiliate bank to the parent bank. There are two cases to consider. First, assume $\lambda_F < D_H - C_H - \delta_H I_H$. The bank lacks sufficient capital in the destination country to satisfy the liquidity shortfall at the parent bank and prevent bank failure. The bank minimizes its loss by reallocating all available capital from the foreign affiliate bank to the parent bank. The bank-run equilibrium, which includes bank failure in this case, is therefore $(M_H = \lambda_F; K_H = D_H)$. In this equilibrium, the payoff to each depositor is $\pi_{Depositor} = \frac{C_H + \lambda_F + \delta_H I_H}{D_H}$, while the payoff to the bank is $\pi_{Bank} = (C_H + \lambda_F + \delta_H I_H) - D_H < 0$.

Conversely, there is no subgame perfect Nash equilibrium with $K_H = D_H$ when $\lambda_F \geq D_H - C_H - \delta_H I_H$. To see the intuition of this result, suppose that $\lambda_F \geq D_H - C_H - \delta_H I_H$. The proof of Proposition 1 implies that $K_H = 0$ is the unique equilibrium of the depositor subgame if $M_H \geq D_H - C_H - \delta_H I_H$, while equation (2) implies that the bank may reallocate at most λ_F capital toward

[13] The home-country banking crisis, represented as a fall in R_H to R'_H, constrains the magnitude of the bank's capital reallocation. As compared to the counterfactual in which the gross return remains R_H, the bank can reallocate fewer funds to the foreign affiliate without inducing a home-country bank run during the banking crisis. This result suggests that home-country financial distress restricts intra-bank capital outflows, even in the absence of bank runs.

the home country. Consequently, because the bank moves first in the sequential bank-depositor game, the bank can preempt a prospective bank run in the home country by reallocating $M_H \geq D_H - C_H - \delta_H I_H$ toward the parent bank. By equation (7), this reallocation would prevent a bank run, and ensure that $K_H = 0$. This case would not be an equilibrium, however: if $K_H = 0$, the bank has an incentive to deviate from its strategy and we move to the non-bank run equilibrium, $(M_H = max\{-C_H,\ D_H - C_H - R'_H I_H\}; K_H = 0)$.

3.3 Discussion

For the purposes of this thesis, the important features of the model are the competing liquidity support and loan profitability optimization mechanisms that govern intra-bank capital movement decisions during home-country crises. The bank's capital reallocation serves two purposes: the parent bank can ease liquidity constraints at the parent bank by recalling capital from its foreign affiliate or optimize lending profitability by shifting capital toward the affiliate. Hence, the model illustrates the incentives underlying intra-bank capital flows but does not predict which effect dominates.

While the game yields two possible equilibria, I argue that this multiplicity supports the importance of studying the direction of intra-bank capital movement during home-country crises empirically. I contend that the conditions under which each equilibrium can exist in the model provide intuition for the real-world contexts studied in the empirical section of this paper.

In the non-bank run equilibrium—$(M_H = max\{-C_H,\ D_H - C_H - R'_H I_H\}; K_H = 0)$—the bank faces low liquidity pressures. The bank shifts capital out of the home-banking system experiencing the crisis, prioritizing lending profitability across its banking network. In contrast, in the bank-run equilibrium—$(M_H = \lambda_F; K_H = D_H)$—the bank faces a binding liquidity shortfall that constrains its ability to shift capital out of the home country. Rather, the parent bank recalls capital from its foreign affiliate to stabilize the liquidity position at home and avert bank failure. Together, these equilibria suggest that parent banks recall capital from their banking networks during home crises associated with severe liquidity shocks.[14] I summarize this insight in the following hypothesis.

[14] Most banking systems, including the majority of those studied in the empirical section of this paper, maintain deposit insurance in some form. This does not detract from the model, since the drying up of liquidity caused by depositor bank runs can be easily analogized to liquidity shocks caused by the freezing of short-term wholesale funding markets during

Hypothesis 1. *Parent banks recall capital from foreign affiliates during home-country crises associated with acute bank liquidity pressures.*

According to Afonso et al. (2011) and Laeven and Valencia (2018), severe banking crisis episodes are defined by the drying up of short-term liquidity markets and extreme liquidity pressures at exposed banks. I therefore test Hypothesis 1 at the country level by examining the impact of crisis severity on the direction of intra-bank capital movement (section 4.2.2.).

While the two equilibria presented in section 3.2. provide intuition for the conditions under which parents may shift capital to or recall capital from affiliates during home crises, the absence of a bank-run equilibrium when the destination-country capital endowment is large offers further insight. As described in section 3.2., there is no equilibrium including a bank run when $\lambda_F \geq D_H - C_H - \delta_H I_H$. This result implies that parents with access to capital from a large foreign affiliate face lower liquidity pressures during home-country crises: affiliate capital acts as an implicit guarantee on parent bank liquidity. In contrast, for small values of the destination-country capital endowment, there exists a bank-run equilibrium in which the bank prioritizes liquidity support and recalls capital to the parent bank. Together, these results suggest that parent banks are more likely to recall capital from smaller foreign affiliates with lower capital available for retrenchment during home-country crises. I summarize this insight in the following hypothesis.

Hypothesis 2. *Smaller foreign affiliate banks with lower capital available for recall are more susceptible to capital retrenchment from their parents during home-country banking crises.*

This hypothesis is consistent with evidence from Cetorelli and Goldberg (2012) that U.S. parent banks disproportionately recalled capital from subsidiaries deemed non-core funding priorities for the parent during the GFC. I test Hypothesis 2 at the bank level by examining the effect of home crises on intra-bank capital flows dependent on the ratio of each subsidiary's interbank borrowing to total parent bank interbank lending (section 5.2.2.). This ratio provides a proxy for the level of affiliate capital available for intra-bank retrenchment, in addition to the degree to which a subsidiary bank is a large funding priority for the parent.

banking crises (Gorton, 2008; Allen et al. 2009).

4 Country-Level Empirical Analysis

4.1 Data and Empirical Methodology

The country-level section of this thesis examines the impact of home-country banking crises on aggregate intra-bank capital flows. The sample comprises annual data for an unbalanced panel of 22 countries (20 developed, 2 emerging market) from 1983-2017. Data are aggregated at the home-country level. The list of countries in the sample is provided in the appendix.

4.1.1 Data and Baseline Empirical Specification

I regress the net intra-bank capital position of parent banks in the home country on a home banking crisis dummy, BC, and a vector of control variables. The baseline specification is as follows, where i denotes country and t denotes time:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot BC_{i,t} + \beta_2 \cdot Controls_{i,t} + \alpha_i + \delta_t + \epsilon_{i,t} \quad (8)$$
$$\text{for } Y_{i,t} = NetIntraPosition_{i,t}, NetIntraPos/Assets_{i,t}$$

α_i is the country-specific component of the error term and δ_t represents a time effect. There are two dependent variables used in the baseline specification: $NetIntraPosition$ ($ Billions), the net capital position of parent banks in the home country with their foreign affiliate offices, and $NetIntraPos/Assets$ (%), the net intra-bank capital position scaled by total home banking sector financial assets. I calculate the net intra-bank capital position as the total capital assets channeled by parent banks to foreign affiliates less the capital liabilities of parent banks owed to foreign affiliates.[15] A net capital outflow (inflow) from the home country indicates an increase (decrease) the net intra-bank capital position. Intra-bank capital assets and liabilities data, which are consolidated at the home-country level and reported in U.S. Dollars, are provided by the Bank for International Settlements (BIS) *Locational Banking Statistics* database.

The control variables in the baseline specification are: the annual GDP growth rate, $\%\Delta GDP$ (%); the ratio of trade to GDP, $Trade/GDP$ (%); an index of capital account openness, $KAOpen$; the real interest rate, $RealInt$ (%); the annual percent change in trade, $\%\Delta Trade$ (%); and the annual percent change in the net financial account, $\%\Delta FinAcc$ (%). In addition, I include the logarithm of

[15] Intra-bank asset claims and liabilities represent the sum of loans, deposits, reverse repurchase agreements, debt and equity securities, credit-loss allowances, and operational assets such as accounts receivable owed to the parent by affiliates and owed to affiliates by the parent, respectively.

banking sector assets, $ln(BankSectorAssets)$, in specifications with $NetIntraPosition$ ($ Bil) as the dependent variable. Data sources and full descriptions for the variables are provided in the appendix. In the baseline specification, I estimate the model using the fixed effects estimator with country and year fixed effects; robust standard errors are clustered by country.

As a robustness test, I include the one-year lag of the dependent variable, $NetIntraPosition$ (-1) or $NetIntraPos/Assets$ (-1), as an explanatory variable. The rationale for including the lag of the dependent variable is two-fold. First, the debt and equity instruments comprising intra-bank capital assets and liabilities may carry maturity dates beyond one year. As a result, the contemporaneous net intra-bank capital position is likely correlated with past realizations of the variable. Second, the introduction of an autoregressive framework reduces serial correlation of the error term in dynamic panel settings (Keele and Kelly, 2006). To address dynamic panel bias arising from the inclusion of the lag of the dependent variable (Nickell, 1981), I estimate the model using the System Generalized Method of Moments (GMM) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998).[16] The small sample size of the country-level dataset restricts the use of the two-step GMM estimator. I therefore estimate the model with the one-step System GMM estimator with the Windmeijer (2005) small sample correction.[17] I include country and year fixed effects; robust standard errors are clustered by country.

The banking crisis dummy BC signifies a contemporaneous banking crisis in the home country. $BC = 1$ for each year that the home country is in a banking crisis and $BC = 0$ otherwise. Banking crisis incidence data are provided by Laeven and Valencia (2018). If parent banks respond to home-country banking crises by moving capital from (to) foreign affiliates to (from) the parent bank, then we would expect the coefficient of BC to be negative (positive) as the net stock of capital intermediated between parents and their affiliates decreases (increases).

[16] In STATA, I use the xtabond2 command coded by Roodman (2009). Given the small sample size, I use the "collapse" option to prevent the instrument set from being quadratic in T and the "orthogonal" option to use orthogonal deviations rather than first differences.

[17] While the use of the two-step System GMM estimator improves asymptotic estimation efficiency in large samples, the loss of degrees of freedom associated with estimating the optimal weighting matrix in the two-step procedure restricts this efficiency gain in finite samples (Hwang and Sun, 2018). Given the small sample size of the country-level dataset, the two-step system GMM model is overidentified in the country-level section of this paper. Therefore, I use the one-step procedure with the Windmeijer (2005) small sample correction for inference in this section.

To isolate the causal effect of home banking crises on intra-bank capital flows, I include two variables that capture channels for international financial shock transmission separate from parent-affiliate capital movement, in addition to standard macroeconomic control variables from the multinational banking literature. Financial shocks may be transmitted across countries via real trade or financial linkages (Gerlach and Smets, 1995; Van Rijckeghem and Weder, 1999). While bilateral intra-bank capital data are not publicly available, it is likely that home-country banks operate affiliate offices in countries with real and financial linkages to the home country. Crisis transmission to destination countries could impact intra-bank capital flows for two reasons. First, foreign affiliates may require greater capital support during destination-country crisis periods (Jeon et al., 2013). Second, parents may reduce capital exposure to destination countries in crisis, as lending profitability in these markets falls (Aisen and Franken, 2010). I capture the trade linkage transmission channel by including the annual percent change in trade, $\%\Delta Trade$ (%), with data from the World Bank World Development Indicators (WDI) database. In addition, I capture the financial linkage transmission channel by including the annual percent change in the net financial account, $\%\Delta FinAcc$ (%), for which data come from the International Monetary Fund International Financial Statistics (IFS) database.

The GDP growth rate, $\%\Delta GDP$ (%), for which data are provided by the WDI database, measures the attractiveness of expanding credit in the home country. The expected sign of $\%\Delta GDP$ is negative, as faster home-country economic growth would induce parent banks to move capital into the home country to increase loan growth (Jeon et al., 2013; Allen et al., 2014). The real interest rate, $RealInt$ (%), for which data are provided by the OECD and WDI, provides a benchmark real return on yield-generating assets in the home country and measures the attractiveness of increasing capital exposure to the home country.

In specifications with $NetIntraPosition$ ($ Bil) as the dependent variable, I include the logarithm of banking sector assets, $ln(BankSectorAssets)$, for which data are provided by the BIS *Consolidated Banking Statistics* database. The inclusion of this regressor controls for home-country banking sector size, as the net intra-bank capital position of all parent banks in the home country is likely to be greater in magnitude for economies with larger banking systems. The inclusion of country fixed effects also controls for banking sector size, in addition to time-invariant factors that may affect intra-bank capital positions such as home-country banks' established market position in foreign banking sectors, geography, and legal origin.

I include two variables that indicate the level of economic openness of the home country, $KAOpen$ and $Trade/GDP$ (%). I capture the degree of capital mobility in the home country with $KAOpen$, which is measured by the Chinn-Ito index and ranges from 0-1 with higher values indicating greater capital account openness (Chinn and Ito, 2008). Greater capital account openness should be correlated with larger capital flows, but greater capital mobility may increase both capital inflows and capital outflows. Accordingly, the expected sign of $KAOpen$ is ambiguous. The ratio of trade to GDP, $Trade/GDP$, measures the level of home-country trade integration with the world. Since greater trade openness may indicate greater foreign business presence in the home country, and because banks open foreign affiliate offices to follow borrowers and maintain lending relationships abroad, the expected sign of $Trade/GDP$ is positive (Cull and Martinez-Peria, 2007).

4.1.2 Banking Crisis Severity and Economic Openness Interactions

As I will discuss in section 4.2.1., I do not find evidence of significant intra-bank capital flows in response to home-country banking crises. This result suggests that either the competing liquidity support and loan profit optimization effects offset, on average, or that neither effect has a substantial impact on intra-bank capital flows during home-country crises. To investigate conditions under which the liquidity support or lending profitability effect could dominate the other, I replace the banking crisis dummy, BC, in equation (8) with one of two measures of banking crisis severity. These two severity measures are: the cumulative loss of output during the crisis relative to trend GDP, $GDPLoss$ (% of GDP); and the fiscal bailout cost as a percentage of GDP, $BailoutCost$ (% of GDP). Larger output losses and higher fiscal bailout costs indicate more severe banking crises. The severity specification, which is limited to crisis observations, is as follows:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot Severity_{i,t} + \beta_2 \cdot Controls_{i,t} + \alpha_i + \delta_t + \epsilon_{i,t} \tag{9}$$

for $Y_{i,t} = NetIntraPosition_{i,t}, NetIntraPos/Assets_{i,t}; Severity_{i,t} = GDPLoss_{i,t}, BailoutCost_{i,t}$ where i denotes country and t indexes time. The control variables are identical to those in equation

(8). I estimate equation (9) using the fixed effects estimator with country and year fixed effects; robust standard errors are clustered by country.

If more severe banking crises produce greater liquidity shocks to parent bank balance sheets, then the liquidity support effect should dominate the lending profitability effect during severe crisis episodes. Parent banks should then recall capital from affiliates during severe crises. Conversely, the lending profitability effect should dominate the liquidity support effect during less severe crises, as parent banks face lower liquidity pressures. Therefore, the expected signs of $GDPLoss$ and $BailoutCost$ are each negative.

Another possible explanation for the lack of significance of BC in the estimation of equation (8) is heterogeneity in economic openness across sample countries. Parent banks in more open economies may shift capital to foreign affiliates during home crises, whereas capital may remain trapped in relatively closed economies. These effects may offset, producing an insignificant coefficient of BC in the estimation of equation (8). To allow for differing impacts of crises dependent on the economic openness of the home country, I interact each measure of economic openness, $KAOpen$ and $Trade/GDP$ (%), with the banking crisis dummy.

The interaction term $BC * KAOpen$ measures whether intra-bank capital flows respond differently to banking crises dependent on the level of home-country capital mobility. While de jure capital controls should restrict both capital inflows and outflows, empirical evidence suggests that de facto capital controls are more effective in restricting capital inflows (Ariyoshi et al., 2000). Therefore, capital controls should be associated with lower intra-bank capital inflows during home-country crises, and the expected sign of $BC * KAOpen$ is negative.

The interaction term $BC * Trade/GDP$ (%) measures whether intra-bank capital flows respond differently to home-country banking crises depending on how integrated the home economy is with the world. As discussed in section 4.1.1., multinational banks headquartered in highly integrated economies may have more robust lending relationships in foreign markets. To retain these relationships, parent banks in highly integrated economies should be less likely to recall capital from foreign affiliates during home crises. Accordingly, the expected sign of $BC * Trade/GDP$ is positive.

4.1.3 Summary Statistics

TABLE 1
Summary Statistics

	$BC = 0$						
VARIABLES	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**IQR**
$NetIntraPosition$ (\$Bil)	336	18.18	8.13	42.67	-75.02	139.90	27.00
$NetIntraPos/Assets$ (%)	331	5.15	2.89	12.19	-24.14	89.10	8.91
$\%\Delta GDP$ (%)	336	2.41	2.44	1.74	-4.67	8.26	2.08
$KAOpen$	336	0.92	1	0.18	0.16	1	0.00
$Trade/GDP$ (%)	336	67.11	59.99	31.61	16.60	188.60	39.61
$\%\Delta Trade(\%)$	336	6.87	5.78	9.81	-19.03	28.46	14.22
$RealInt$ (%)	336	1.78	1.41	2.41	-2.27	8.74	3.26
$\%\Delta FinAcc$ (%)	336	-10.98	-3.14	140.10	-588.90	341.00	89.28
$\ln(BankSectorAssets)$ (\$Bil)	336	5.63	5.85	2.00	1.14	8.88	2.91
	$BC = 1$						
VARIABLES	**Obs.**	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**	**IQR**
$NetIntraPosition$ (\$Bil)	49	24.90	11.07	54.00	-75.02	139.90	68.47
$NetIntraPos/Assets$ (%)	49	3.81	2.31	13.65	-24.14	48.26	5.22
$\%\Delta GDP$ (%)	49	-1.07	-0.81	2.83	-4.67	4.18	5.23
$KAOpen$	49	0.98	1	0.06	0.76	1	0.00
$Trade/GDP$ (%)	49	69.92	59.33	34.53	19.07	191.50	30.32
$\%\Delta Trade(\%)$	49	-0.76	1.75	13.93	-19.03	24.28	29.71
$RealInt$ (%)	49	0.87	0.72	2.61	-2.27	8.94	3.01
$\%\Delta FinAcc$ (%)	49	-14.84	6.15	108.90	-588.90	98.52	59.64
$ln(BankSectorAssets)$ (\$Bil)	49	6.06	6.52	2.02	1.17	8.30	2.40
$GDPLoss$ (% of GDP)	49	37.37	32.20	23.15	0.00	107.70	13.50
$BailoutCost$ (% of GDP)	49	10.10	5.40	9.58	0.20	37.60	8.30

Note: Values for all variables, excluding BC, $GDPLoss$, and $BailoutCost$, are winsorized at the second and ninety-eighth percentiles.

Table 1 above provides summary statistics for all observations with banking crises ($BC = 1$) and without banking crises ($BC = 0$). The sample comprises annual data for an unbalanced panel of 22 (20 developed, 2 emerging market) countries between 1983 and 2017. The starting point of the sample coincides with the earliest year for which BIS publishes cross-border banking claims data. The ending year is restricted by the availability of banking crisis data from Laeven and Valencia (2018). To remove outlier values while retaining the maximal sample size, I winsorize all variables, excluding BC, $GDPLoss$, and $BailoutCost$, at the second and ninety-eighth percentiles.

Home countries experienced banking crises in about 13% of observations (49 crisis observations with 385 total observations). Across crisis and non-crisis observations, the mean of $NetIntraPosition$ (\$ Bil) is higher than its median. This reflects the inclusion of large banking centers, such as the United

States and United Kingdom, in the sample. For both crisis and non-crisis observations, the median of $KAOpen$ is 1, showing that countries in the sample have few capital controls, on average. The median of $\%\Delta Trade$ (%) in non-crisis years of 5.78% and in crisis years of 1.75% shows that countries experience faster trade growth in non-crisis periods, on average. The higher median of $RealInt$ (%) in non-crisis years of 1.41% than in crisis years of 0.72% reflects central banks' use of accommodative monetary policy during banking crises to stimulate aggregate demand.

4.2 Results

4.2.1 Testing for Direction of Intra-Bank Capital Flows During Home-Country Crises

Table 2 on the following page presents the results from the baseline estimation of equation (8) for each dependent variable, $NetIntraPosition$ ($ Bil) and $NetIntraPos/Assets$ (%). If parent banks respond to home-country crises by moving capital from (to) foreign affiliates to (from) the parent, then we would expect the coefficient of BC to be negative (positive) as the net stock of capital channeled by parents to their affiliates decreases (increases).

Columns (1) through (3) of Table 2 present the results with $NetIntraPosition$ ($ Bil) as the dependent variable. Across specifications (1) through (3), the coefficient of BC is positive yet insignificant, suggesting that neither the liquidity support effect nor lending profitability effect dominates the other during home-country crises. The coefficient of BC in column (3), although insignificant, indicates that after controlling for macro covariates and shock transmission channels, home-country banking crises are associated with an $11.64 billion dollar increase in the net capital position of parent banks with their foreign affiliates.

The annual percent change in trade, $\%\Delta Trade$ (%), and the annual percent change in the net financial account, $\%\Delta FinAcc$ (%), capture channels through which home-country crises may be transmitted to destination countries independent of intra-bank capital flows.[18] Specification (3) of Table 2 includes both variables to close off the trade and financial linkage transmission channels, while specification (2) excludes each variable. The inclusion of the transmission channel variables does not sub-

[18] As discussed in section 4.1.1., crisis transmission to destination countries may effect intra-bank capital flows either by increasing affiliates' demand for capital, or by reducing lending profitability in the destination market.

stantially impact the coefficient of BC: the coefficient remains similar in magnitude and significance across columns (2) and (3). In addition, in omitted regressions, I include $\%\Delta Trade$ and $\%\Delta FinAcc$ in estimation individually. In each case, the results are similar to those presented in column (3).

TABLE 2
OLS Estimation: Net Intra-Bank Position with Banking Crisis Indicator

Dependent Variable:	$NetIntraPosition$ ($ Billions)			$NetIntraPos/Assets$ (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
BC	3.15	11.74	11.64	-2.46	-2.09	-2.72
	(12.55)	(12.61)	(12.46)	(4.80)	(4.45)	(4.80)
$\%\Delta GDP$ (%)		3.38*	3.43*		-0.10	0.24
		(1.82)	(1.84)		(0.79)	(0.68)
$KAOpen$		-4.80	-5.11		10.66	10.20
		(20.20)	(20.69)		(9.15)	(9.32)
$Trade/GDP$ (%)		-0.24	-0.25		0.10	0.10
		(0.48)	(0.48)		(0.17)	(0.16)
$RealInt$ (%)		-4.36**	-4.41**		-0.80	-0.69
		(2.01)	(1.86)		(0.80)	(0.75)
$ln(BankSectorAssets)$	10.16	10.50	10.42			
	(11.14)	(10.91)	(10.95)			
$\%\Delta Trade$ (%)			0.01			-0.22
			(0.69)			(0.27)
$\%\Delta FinAcc$ (%)			0.01			0.00
			(0.01)			(0.00)
Observations	385	385	385	380	380	380
R-squared	0.291	0.313	0.314	0.174	0.197	0.205
Number of Countries	22	22	22	22	22	22
Country and Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: Robust Standard errors clustered by country in parentheses. Values for each variable, excluding BC, are winsorized at the second and ninety-eighth percentiles. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

The coefficient of $RealInt$ (%) is negative and significant at the 5% level across specifications (2) and (3), providing evidence that a higher benchmark financial return in the home country is associated with intra-bank capital retrenchment. The coefficient of $\%\Delta GDP$ (%) is significant at the 10% level for specifications (2) and (3), although it has the opposite sign as predicted in section 4.1.1. This result, however, can be attributed to the problem that the real interest rate and the GDP growth rate each capture the attractiveness of expanding capital exposure to the home country. Faster home-country GDP growth, then, may independently cause parents to shift capital out of the home country, as they face lower liquidity and solvency pressures during booms.

Columns (4) through (6) of Table 2 present results from the estimation of equation (8) with $NetIntraPos/Assets$ (%) as the dependent variable. Similar to the results with $NetIntraPosition$ ($ Bil) as the dependent variable, the coefficient of BC is insignificant across columns (4) through (6). This result suggests that neither the liquidity support nor the lending profitability effect dominates the other during home crises. In contrast to the results presented for $NetIntraPosition$ ($ Bil), however, the coefficient of BC is negative with $NetIntraPos/Assets$ (%) as the dependent variable. For the full model specification (column (6)), the coefficient of BC, although insignificant, indicates that home-country crises are associated with a 2.72% decrease in the net intra-bank capital position as a percentage of banking sector assets. One possible explanation for the negative sign of BC is that the net intra-bank capital position may increase during home-country crises, but at a slower rate than the growth of total banking sector assets (the denominator of $NetIntraPos/Assets$). The positive coefficient of BC in columns (1) through (3), with the net intra-bank capital position measured in dollars as the dependent variable, provides support for this interpretation.

The negative sign and insignificance of BC is robust to the inclusion of $\%\Delta Trade$ (%) and $\%\Delta FinAcc$ (%) in column (6). There is no evidence of a differential impact of home-country crises with the closing-off of the trade and financial linkage crisis transmission channels. In addition, in omitted regressions, I include $\%\Delta Trade$ and $\%\Delta FinAcc$ individually in estimation. The results are nearly identical to those presented in specification (6).

To summarize the results of estimating equation (8), there is little evidence of a significant average effect of home-country banking crises on intra-bank capital flows. The contradictory signs of the coefficient of BC in estimations with $NetIntraPosition$ ($ Bil) and $NetIntraPos/Assets$ (%) as the dependent variable, and the insignificance in each case, make it difficult to discern the direction of intra-bank capital flows during home-country crises. Given the insignificant result found in the estimation of equation (8), I now turn to the estimation of models that allow for differing effects of banking crises dependent on crisis severity and the economic openness of the crisis-country.

4.2.2 Effect of Banking Crisis Severity on Intra-Bank Capital Flows

One possible explanation for the insignificant coefficient of BC in section 4.2.1. is a differential impact of home-country crises dependent on crisis severity. As the first key prediction, the model developed in section 3 suggests that parent banks respond to severe liquidity shortfalls by recalling capital from foreign affiliates (Hypothesis 1). Severe banking crisis episodes are associated with acute bank liquidity pressures (Cetorelli and Goldberg, 2011; Afonso et al., 2011). Therefore, more severe crises may be associated with parent bank capital retrenchment, whereas parents may shift capital toward affiliates during less severe crisis episodes.

To examine the differential effect of home-country banking crises on intra-bank capital flows dependent on crisis severity, I estimate equation (9) from section 4.1.2. Table 3 on the following page presents the results of estimation with $NetIntraPosition$ ($ Billions) as the dependent variable. For brevity, I omit the coefficients of the control variables. In both specifications with $GDPLoss$ (% of GDP) and $BailoutCost$ (% of GDP) as the severity metric, the coefficient of interest carries the expected negative sign, suggesting that severe banking crises are associated with intra-bank capital retrenchment. Both coefficients, however, fall just short of significance at the 10% level.

The results of the estimation of equation (9) with $NetIntraPos/Assets$ (%) as the dependent variable, presented in Table 4 on the following page, provide stronger evidence of the capital retrenchment effect. The coefficients of both severity metrics are negative and significant at the 1% level. The coefficient of $GDPLoss$ ($BailoutCost$) indicates that a one percent increase in the output loss (fiscal bailout cost) is associated with a 11.83% (25.75%) decrease in the net intra-bank capital position as a percentage of banking sector assets.[19] These results suggest a bifurcation of crisis outcomes, whereby parent banks recall capital from foreign affiliates during severe crises but shift capital toward affiliates during less severe crises. This bifurcation is consistent with the intuitive notion that parent banks prioritize capital use profitability during non-severe crises but are forced to recall capital from affiliates to strengthen the parent balance sheet when confronted with extreme liquidity shortfalls.

[19] In addition, to include non-crisis years in estimation, I replace $GDPLoss$ with the interaction term $BC*\%\Delta GDP$ in an omitted regression. The results are similar in sign and significance to those presented in Table 4.

TABLE 3 **OLS Estimation: Net Intra-Bank Position and Crisis Severity**		
Dependent Variable: $NetIntraPosition$ ($ Billions)	(1)	(2)
$GDPLoss$ (% of GDP)	-75.24 (47.22)	
$BailoutCost$ (% of GDP)		-163.75 (102.79)
Observations	49	49
R-squared	0.661	0.661
No. of Countries	16	16
Country and Year FE	Yes	Yes

TABLE 4 **OLS Estimation: Net Intra-Bank Position and Crisis Severity**		
Dependent Variable: $NetIntraPos/Assets$ (%)	(1)	(2)
$GDPLoss$ (% of GDP)	-11.83*** (3.45)	
$BailoutCost$ (% of GDP)		-25.75*** (7.51)
Observations	49	49
R-squared	0.816	0.816
No. of Countries	16	16
Country and Year FE	Yes	Yes

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by country in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.2.3 Economic Openness Interactions

A second possible explanation for the weakly positive coefficient of BC found in section 4.2.1. is heterogeneity in economic openness among sample countries. Parent banks operating in relatively open economies may shift capital toward foreign affiliates during home-country crises, while capital may remain trapped in relatively closed economies. To examine this hypothesis, I interact the banking crisis indicator, BC, with each measure of economic openness, $KAOpen$ and $Trade/GDP$ (%), and estimate equation (8).

Table 5 on the following page presents the results with $NetIntraPosition$ ($ Bil) as the dependent variable, while Table 6 presents the results with $NetIntraPos/Assets$ (%) as the dependent variable. The coefficient of the interaction term $BC * KAOpen$ is insignificant in estimation with either dependent variable. The coefficient of $BC * Trade/GDP$ (%), while not significant with either dependent variable, has a p-value just above the 10% threshold when $NetIntraPosition$ ($ Bil) is used as the dependent variable. Contradicting the expected sign discussed in section 4.1.2., the coefficient of $BC * Trade/GDP$ is negative in this case. This result indicates that intra-bank capital outflows during crises are larger for less integrated economies. One possible explanation for this surprising result is that domestic borrowers in closed economies may have greater business exposure to the home country, indicating a greater risk of balance sheet deterioration during home

TABLE 5
OLS Estimation: Economic Openness Interactions

Dependent Variable: $NetIntraPosition$ ($ Billions)	(1)	(2)
BC	8.93	36.46*
	(101.83)	(19.85)
$BC * KAOpen$	2.80	
	(105.39)	
$BC * Trade/GDP$ (%)		-0.37
		(0.22)
$ln(BankSectorAssets)$	10.42	10.40
	(10.91)	(11.15)
Observations	385	385
R-Squared	0.314	0.322
No. of Countries	22	22
Country and Year FE	Yes	Yes

TABLE 6
OLS Estimation: Economic Openness Interactions

Dependent Variable: $NetIntraPos/Assets$ (%)	(1)	(2)
BC	71.09	1.75
	(79.80)	(6.18)
$BC * KAOpen$	-76.31	
	(81.13)	
$BC * Trade/GDP$ (%)		-0.07
		(0.05)
Observations	380	380
R-Squared	0.222	0.21
No. of Countries	22	22
Country and Year FE	Yes	Yes

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by country in parentheses. Values for each variable, excluding BC, are winsorized at the second and ninety-eighth percentiles. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

crises. Parent banks in closed economies may then reduce capital exposure to the home country during home crises, shifting capital to foreign affiliate countries to pursue more profitable lending opportunities abroad. For the second specification in Table 5, the overall effect of home-country crises, $\beta_{BC} + Trade/GDP \cdot \beta_{BC*Trade/GDP}$, is positive and significant at the 10% level under the F-test for values of $Trade/GDP$ (%) $\leq 24.8\%$.

4.2.4 Robustness Tests

As an initial robustness test, I include the one-year lag of the dependent variable as a regressor and estimate equation (8) with the one-step System GMM estimator.[20] Table 7 on the following page presents the results. For brevity, I omit the coefficients of the control variables. The results of the GMM estimation of equation (8) for each dependent variable are similar to those presented in Table 2 for OLS estimation. For columns (1) through (4), with $NetIntraPosition$ ($ Bil) as the dependent variable, the coefficient of BC remains positive and insignificant across specifications. For columns (5) through (8), with $NetIntraPos/Assets$ (%) as the dependent variable, the coefficient of BC remains

[20]As discussed in section 4.1.1., the inclusion of the lag of the dependent variable serves an economic purpose, as the net stock of intra-bank capital is likely to correlated within each country across time, and an econometric purpose, as it reduces serial correlation in the estimation of equation (8).

negative and insignificant across specifications. For both dependent variables, however, the inclusion of the lagged dependent variable as a regressor reduces the magnitude of the coefficient of BC as compared to the baseline specification.

The contemporaneous value of each dependent variable is highly correlated with the one-year lag of the dependent variable. The coefficients of $NetIntraPosition$ (-1) and $NetIntraPos/Assets$ (-1) are positive and significant at the 1% level across columns (1) through (4) and columns (5) through (8), respectively.[21] Furthermore, the decrease in the magnitude of BC in the GMM estimation framework can be attributed to this robust correlation, as the inclusion of the lagged dependent variable in an autoregressive framework may capture most of variation in the contemporaneous realization of the dependent variable.

TABLE 7
One-Step GMM Estimation: Net Intra-Bank Position with Banking Crisis Indicator

Dependent Variable:	$NetIntraPosition$ ($ Billions)				$NetIntraPos/Assets$ (%)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$NetIntraPosition$ (-1)	0.78***	0.78***	0.76***	0.76***				
	(0.08)	(0.08)	(0.10)	(0.10)				
$NetIntraPos/Assets$ (-1)					0.73***	0.72***	0.71***	0.70***
					(0.09)	(0.10)	(0.08)	(0.09)
BC	3.88	2.75	3.42	2.26	-1.67	-2.09	-1.88	-2.28
	(7.38)	(7.45)	(7.67)	(7.76)	(2.75)	(3.02)	(2.80)	(3.06)
$ln(BankSectorAssets)$	1.18	1.31*	1.02	1.13				
	(0.74)	(0.65)	(0.81)	(0.71)				
Observations	379	379	379	379	371	371	371	371
Number of Countries	22	22	22	22	22	22	22	22
Country and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) Test p-value	0.321	0.322	0.269	0.284	0.180	0.203	0.160	0.154
Hansen J-Test p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Number of Instruments	73	74	74	75	72	73	73	74

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by country in parentheses. Values for each variable, excluding BC, are winsorized at the second and ninety-eighth percentiles. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

In addition, for each dependent variable, I estimate equation (8) via OLS with country and year fixed effects and include the one-year lagged value of the dependent variable. The results are nearly identical to those presented in Table 7; accordingly, I omit the regressions. The similarity of the results

[21] These results are unsurprising, given that NetIntraPosition ($ Bil) and $NetIntraPos/Assets$ (%) are stock variables and the average annual percent change in each is just 3.2% and 7.5% of the prior year's value, respectively.

is unsurprising: while the use of a lagged dependent variable in OLS estimation introduces dynamic panel bias into estimation, the large sample time frame (T = 35 years) attenuates this bias.

For the second robustness check, I test for a delayed effect of home-country crises on intra-bank capital flows. Home crises may have a delayed impact on parent-affiliate capital flows, as parent bank balance sheet shocks may be delayed from the onset of the crisis, or the bank may need time to unwind home-country illiquid capital commitments before shifting funds out of the country. Therefore, I replace BC with the first-, second-, and third-year lags of the banking crisis indicator and estimate equation (8) via OLS. The results are similar to those presented in section 4.2.1. with the contemporaneous banking crisis indicator. Accordingly, I omit the regressions.

TABLE 8
OLS Estimation: Net Intra-Bank Position with Initial Banking Crisis Year Indicator

Dependent Variable:	$NetIntraPosition$ ($ Billions)			$NetIntraPos/Assets$ (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
BC	-3.07	6.17	6.45	-1.67	-0.88	-2.29
	(15.80)	(17.41)	(15.73)	(8.41)	(8.65)	(9.76)
$\%\Delta Trade$ (%)			0.04			-0.23
			(0.63)			(0.32)
$\%\Delta FinAcc$ (%)			0.00			0.00
			(0.01)			(0.00)
$ln(BankSectorAssets)$	11.64	11.53	11.54			
	(11.48)	(11.05)	(11.09)			
Observations	348	348	348	348	343	343
R-squared	0.319	0.319	0.319	0.319	0.241	0.248
Macro Covariates	No	Yes	Yes	No	Yes	Yes
Number of Countries	22	22	22	22	22	22
Country and Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by country in parentheses. Values for each variable, excluding BC, are winsorized at the second and ninety-eighth percentiles. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

As the key robustness test of the country-level section of this paper, I examine a potential source of simultaneity bias in the estimation of equation (8). Reinhart and Kaminsky (1999) find that capital outflows during banking crises deepen banking system distress and prolong the crisis. Therefore, intra-bank capital outflows may increase the probability of banking crisis incidence, indicating positive contemporaneous feedback between the dependent variable and BC. This positive reverse causality would bias the coefficient of BC upward. Therefore, I estimate equation (8) including only the initial year of a banking crisis episode and exclude all subsequent crisis-years.

Table 8 on the previous page presents the results from the estimation of equation (8) via OLS with the initial banking crisis year indicator. For brevity, I present only the coefficients of the variables of interest. Columns (1) through (3) report the results with $NetIntraPosition$ ($ Bil) as the dependent variable. The results are similar to those presented for the baseline specification in Table 2. Across columns (1) through (3), the coefficient of BC remains insignificant. There is some evidence of positive simultaneity bias in the baseline estimation of equation (8), however, as the coefficient of BC in column (3) is smaller in magnitude than the coefficient presented for the full baseline model in Table 2. Columns (5) through (8) display the results with $NetIntraPos/Assets$ (%) as the dependent variable. The results are similar to those presented for the baseline model specification in Table 2.

For the final robustness test, I split the sample into the pre-GFC period (1983-2006) and concurrent and post-GFC period (2007-2017) and estimate equation (8) using OLS. Multiple results in the literature demonstrate that developed-country parent banks reduced capital exposure to foreign affiliates during the GFC (Aisen and Franken, 2010; Cetorelli and Goldberg, 2012). *A priori*, this result may contribute to the insignificant coefficient of BC presented for each dependent variable in Table 2: parent banks may have recalled capital from foreign affiliates during the GFC, whereas parents may have shifted capital toward affiliates during crises not associated with the GFC.

The results from the split sample estimation of equation (8) are similar to those presented for the overall sample in Table 2. Accordingly, I omit the regressions. The coefficient of BC does not register significance in any case of the split sample estimation and there is no discernable difference in intra-bank capital movement across crises during the pre- and post-GFC periods.

5 Bank-Level Empirical Analysis

5.1 Empirical Methodology and Data

The bank-level section of this thesis examines the impact of home-country banking crises on intra-bank capital flows at the individual banking-group level, while investigating the bank-specific characteristics that effect parent-subsidiary capital movement during home crises. The bank-level sample comprises an unbalanced panel of 381 subsidiary banks in 83 destination countries, corresponding to 52 parent banks in 19 developed countries, between 1990 and 2011. The lists of home countries and parent banks are provided in the appendix.

5.1.1 Data and Empirical Specification

I regress the net interbank borrowing of each subsidiary bank on a dummy for a banking crisis in the home country of the subsidiary's parent bank, in addition to vectors of parent-bank, subsidiary-bank, and home- and destination-country macroeconomic controls. The baseline specification is as follows, where P and H denote parent bank and home country, respectively, S and D denote subsidiary bank and destination country, respectively, and t indexes time:

$$\begin{aligned} Y_{S,t} = \beta_0 + \beta_1 \cdot BC_{H,t} + \beta_2 \cdot ParControls_{P,t} + \beta_3 \cdot HomeMacroControls_{H,t} \\ + \beta_4 \cdot SubsControls_{S,t} + \beta_5 \cdot DestMacroControls_{D,t} + \alpha_s + \delta_t + \epsilon_{H,P,D,S,t} \\ \text{for } Y_{S,t} = NetIntBorr_{S,t}, NetIntBorr/Assets_{S,t} \end{aligned} \tag{10}$$

α_S is the subsidiary-specific component of the error term and δ_t represents a time effect. The parent bank control variables are: the equity to assets, or capital ratio, EQ/A_P; and the ratio of liquid assets to liabilities, or quick ratio, $Quick_P$. The subsidiary bank control variables are: the capital ratio, EQ/A_S; return on equity, ROE_S (%); the loan growth rate, $\Delta Loan_S$ (%); and the log of assets, $ln(Assets_S)$. In addition, I include the lag of the ratio of interbank borrowing of the subsidiary to interbank lending of the parent bank, $IntRatio_{S,P}$ (-1), as a regressor. The macroeconomic regressors for both the home and destination countries are: a banking crisis dummy, BC; the GDP growth rate, $\%\Delta GDP$ (%); and an index of capital account openness, $KAOpen$.

Data sources and full descriptions for the variables are provided in the appendix. As the dependent variables, I use the net interbank borrowing position of the subsidiary bank, $NetIntBorr_S$ ($ Bil), and the net interbank borrowing position divided by subsidiary assets, $NetIntBorr/Assets_S$ (%), with data provided by Bureau van Dijk's BankScope database. I calculate the net interbank borrowing position of the subsidiary as interbank borrowing less interbank lending. As discussed in section 2, Allen et al. (2014) find that intra-bank capital positions constitute a substantial portion of parent and subsidiary interbank capital positions.[22] Therefore, I follow the authors' convention in adopt-

[22]Under the U.S. Generally Accepted Accounting Principles and the International Financial Reporting Standards, parent-affiliate common control transactions are eliminated on the consolidated company balance sheet (*Deloitte*, 2016; *PwC*, 2019). As a result, the net stock of capital channeled by parent banks to their foreign affiliates is sparsely reported in bank financial reports and intra-bank capital position data are scarce in the BankScope database.

ing the net interbank borrowing position of a subsidiary bank as a proxy for the net stock of capital channeled by the parent bank to the subsidiary. As a robustness test, I include the one-year lag of the dependent variable as a regressor in the estimation of equation (10). The debt instruments comprising subsidiary net interbank borrowing may carry maturities beyond one year; therefore, the one-year lag and contemporaneous realization of each dependent variable are likely correlated.

The inclusion of bank-specific regressors introduces endogeneity into the estimation of equation (10). The parent- and subsidiary-specific control variables may be correlated with contemporaneous or past realizations of the error term, and therefore may be predetermined but not exogenous or endogenous (Jeon et al., 2013; Allen et al., 2014). I address the endogeneity issue in two ways. First, I instrument for the parent and subsidiary bank controls with the lagged first difference and lagged level of each variable. Second, I estimate the model with the two-step System GMM estimator from Arellano and Bover (1995) and Blundell and Bond (1998). The large sample size in the bank-level dataset permits the use of the two-step GMM estimator, which improves asymptotic estimation efficiency in large samples as compared to the one-step estimator (Hwang and Sun, 2018). The use of the GMM estimator relaxes the strict exogeneity condition for the parent and subsidiary bank-specific regressors (Roodman, 2009). I estimate the baseline specification with subsidiary and year fixed effects; standard errors are clustered by subsidiary.

As in section 4, the home-country banking crisis dummy, BC_H, is 1 for each year that the home country is in a banking crisis and 0 otherwise. If parent banks respond to home-country banking crises by shifting capital from (to) the subsidiary to (from) the parent bank, then we would expect the coefficient of BC_H to be negative (positive) as the stock of capital channeled by the parent to their subsidiary decreases (increases). To eliminate omitted variable bias arising from correlated banking crises across countries, I include a destination-country banking crisis dummy, BC_D, in the baseline specification. Home and destination country banking crisis incidence data are provided by Laeven and Valencia (2018).

By including the parent's capital ratio, EQ/A_P, and quick ratio, $Quick_P$, I look at the reaction of intra-bank capital flows to two variables that should be central to the parent's ability to channel capital to its foreign subsidiaries. Data for both variables are retrieved from BankScope. Better capitalized parent banks and parent banks with higher liquidity are at lower risk of facing solvency or liquidity shocks that may necessitate capital retrenchment from their banking network. Consequently, the expected signs of EQ/A_P and $Quick_P$ are both positive.

I include the subsidiary's capital ratio, EQ/A_S, and return on equity, ROE_S (%), given the aforementioned liquidity support and lending profitability effects hypothesized by De Haas and van Lelyveld (2010). Data for both variables come from BankScope. Under the liquidity support effect, parents reallocate capital across their banking network to support undercapitalized subsidiaries; accordingly, the expected sign of EQ/A_S is negative. Under the lending profitability effect, parents reallocate capital to optimize profitability across the banking network; accordingly the expected sign of ROE_S is positive. By including the loan growth rate, $\Delta Loan_S$ (%), I seek to measure the sensitivity of intra-bank capital flows to subsidiaries' demand for capital. Subsidiaries with faster loan growth require greater capital support to maintain risk-based capital and liquidity requirements (Jeon et al., 2013).

I include the logarithm of subsidiary assets, $ln(Assets_S)$, in specifications with $NetIntBorr_S$ ($ Bil) as the dependent variable to control for subsidiary bank size. The net interbank borrowing position is likely to be greater in magnitude for larger subsidiaries with greater assets. The inclusion of subsidiary fixed effects also controls for subsidiary size, in addition to time-invariant factors that may impact intra-bank capital flows such as the subsidiary's ability to source stable local deposit liabilities, destination-country banking system regulations, and geography.

I include the lag of subsidiary interbank borrowing over parent interbank lending, $IntRatio_{S,P}$ (-1), for which data are provided by BankScope, based on the result from Cetorelli and Goldberg (2012) that U.S. parent banks disproportionately recalled capital from affiliates in non-core markets during the GFC. $IntRatio_{S,P}$ (-1) captures the degree to which the subsidiary is a funding priority for the parent bank. The expected sign of $IntRatio_{S,P}$ (-1) is positive, as parents should provide greater funding support to affiliates deemed funding priorities.

For both the home and destination country, I include the macroeconomic control variables,

$\%\Delta GDP_H$ and $KAOpen_H$ and $\%\Delta GDP_D$ and $KAOpen_D$ respectively, for the same reasons described for the country-level analysis in section 4.1.1.

5.1.2 Bank Characteristic Interactions

To further investigate the underlying mechanism through which home-country banking crises impact intra-bank capital flows, I include a set of interaction terms that allow for differing effects of home-country crises. First, I interact the home banking crisis dummy with the two parent-specific controls, EQ/A_P and $Quick_P$. These interaction terms examine how capital and liquidity constraints at the parent bank impact intra-bank capital movement during home crises. Undercapitalized parent banks should be more likely to recall capital from subsidiaries during crises to reduce insolvency risk. Parent banks facing liquidity shortfalls may activate internal capital markets as a substitute for external finance to meet working capital requirements (Campello, 2002). Accordingly, the expected sign of both $BC_H * EQ/A_P$ and $BC_H * Quick_P$ is positive.

Next, I interact BC_H with the subsidiary-specific controls. The interaction terms $BC_H * EQ/A_S$ and $BC_H * ROE_S$ (%) measure the differential effects of home-country banking crises dependent on the capitalization and profitability of the subsidiary bank. In addition, I include the interaction of the home crisis dummy with subsidiary loan growth, $BC_H * \Delta Loan_S$ (%), to capture the impact of subsidiary capital demand on intra-bank capital flows during home crises.

Finally, I include the interaction $BC_H * IntRatio_{S,P}$ (-1) to examine whether parent-subsidiary capital flows during crises depend on the degree to which the subsidiary is a funding priority for the parent. The coefficient of $BC_H * IntRatio_{S,P}$ can be interpreted in two ways. First, as whether parent-subsidiary capital movement during home-country crises depends on if the subsidiary is a funding priority; and second, as whether parent capital support to subsidiaries deemed core and non-core funding priorities depends on if there is a banking crisis in the home country.

5.1.3 Summary Statistics

Table 9 on the following page provides summary statistics for all observations over the sample period, 1990 to 2011. The starting and ending years of the sample are restricted by the availability of bank-specific data from BankScope. The mean and median of ROE_S (%) of 11.16% and 10.76%, respectively, show that, despite the global decline in bank return-on-equity from 2007-09 captured in the sample period, subsidiary banks in the sample are, on average, very profitable (King, 2009). The mean of EQ/A_P is substantially higher than its median, reflecting the inclusion of mature parent banks with significant retained earnings balances in the sample. Likewise, the mean of $IntRatio_{S,P}$ (-1) is higher than its median, reflecting the inclusion of subsidiaries that fund a majority of their operations through interbank borrowing and parent banks that rarely lend in interbank markets in the sample. The mean of BC_H and BC_D show that home and destination countries experienced banking crises in roughly 20% and 12% of observations, respectively.

TABLE 9
Summary Statistics

VARIABLES	Obs.	Mean	Median	Std. Dev.	Min	Max	IQR
Subsidiary Variables							
$NetIntBorr_S$ ($Bil)	2,024	0.74	0.00	8.10	-71.72	117.10	0.35
$NetIntBorr/Assets_S$ (%)	1,963	1.77	0.58	28.75	-99.88	99.72	27.77
EQ/A_S	2,024	0.13	0.10	0.13	0.00	0.99	0.10
$ROE_S(\%)$	2,024	10.98	11.05	25.82	-406.70	268.80	14.41
$\%\Delta Loan_S$ (%)	2,024	448.20	8.29	11,070.00	-100.00	48,2581.00	64.09
ln($Assets_S$) ($Bil)	2,024	0.30	0.29	2.23	-11.73	6.70	2.83
Parent Variables							
EQ/A_P	2,024	0.14	0.07	0.22	0.00	0.85	0.07
$Quick_P$	2,024	0.22	0.15	0.19	0.00	1.50	0.21
$IntRatio_{S,P}$ (%)	2,008	0.54	0.01	5.19	0.00	132.40	0.04
Home Macro Variables							
BC_H	2,024	0.20	0	0.40	0	1	0.00
$\%\Delta GDP_H$ (%)	2,024	2.03	2.36	2.27	-5.69	11.47	2.48
$KAOpen_H$	2,024	0.97	1	0.11	0.16	1	0.00
Destination Macro Variables							
BC_D	2,024	0.12	0	0.32	0	1	0.00
$\%\Delta GDP_D$ (%)	2,024	3.62	3.85	3.83	-14.76	38.00	3.85
$KAOpen_D$	2,024	0.72	0.88	0.32	0	1	0.58

5.2 Results

5.2.1 Testing for Direction of Intra-Bank Capital Flows During Home-Country Crises

Table 10 presents the results from estimating equation (10) from section 5.1.1. Columns (1) through (4) present the results with $NetIntBorr_S$ ($ Billions) as the dependent variable, while columns (5) through (8) present the results with $NetIntBorr/Assets_S$ (%) as the dependent variable. If parent banks respond to home-country crises by moving capital from (to) subsidiaries to (from) the parent, then we would expect the coefficient of BC_H to be negative (positive) as the net stock of capital channeled by parents to their subsidiaries decreases (increases).

Across specifications (1) through (4), with $NetIntBorr_S$ ($ Bil) as the dependent variable, the coefficient of BC_H is insignificant, suggesting that neither the liquidity support nor lending profitability effect dominates the other during home-country crises. For the full model specification presented in column (4), the point estimate of BC_H is negative yet insignificant. The lack of significance of this coefficient at the bank level supports country-level evidence that home-country crises do not have a significant effect on intra-bank capital flows (section 4.2.1.). Yet the contradictory signs of the coefficient of the home-crisis indicator in Table 2 of section 4.2.1. and Table 10 on the following page provide an ambiguous point estimate of the impact of home banking crises on parent-affiliate capital movement. I investigate this point further in section 5.2.3.

In terms of the bank-specific determinants of parent-affiliate capital flows, the coefficient of $IntRatio_{S,P}$ (-1) is negative and significant across specifications (3) and (4), whereas a positive sign would be predicted if parent banks provide greater capital to subsidiaries deemed funding priorities (Cetorelli and Goldberg, 2012). One possible explanation for this surprising result is that subsidiaries deemed funding priorities may operate in foreign markets important for parent bank wholesale deposit funding, and these subsidiaries may channel funds toward the parent as a result. All other control variables are insignificant in the full model specification (column (4)).

For columns (5) through (8), with $NetIntBorr/Assets_S$ (%) as the dependent variable, the coefficient of BC_H is negative and significant. However, the inclusion of macroeconomic, subsidiary- and parent-specific controls in columns (6) through (8) attenuate the significance of the coefficient. In the full model specification (column (8)), the coefficient of BC_H is significant at the 10% level and indicates that home-country crises decrease the net interbank borrowing position of a subsidiary by 6.00% as a share of total bank assets. Taken together with the negative but insignificant coefficient of BC_H in columns (1) through (4), which regress $NetIntBorr_S$ ($ Bil) on BC_H, this result suggests that parent banks may recall capital from subsidiaries during home-country crises, but at a slower rate than the growth of subsidiary assets.

TABLE 10
GMM Estimation: Subsidiary Net Interbank Borrowing with Banking Crisis Indicator

Dependent Variable:	$NetIntBorr_S$ ($ Billions)				$NetIntBorr/Assets_S$ (%)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Macroeconomic Variables:								
BC_H	-0.486	0.185	-0.373	-0.660	-6.175**	-5.426*	-5.823*	-6.000*
	(0.688)	(0.495)	(0.611)	(0.773)	(2.63)	(2.955)	(3.059)	(3.436)
$\%\Delta GDP_H$ (%)		0.215**	0.091	0.093		0.014	-0.056	-0.149
		(0.104)	(0.160)	(0.135)		(0.548)	(0.782)	(0.677)
$KAOpen_H$		8.239	0.923	-1.473		20.931*	5.567	29.182
		(6.025)	(6.889)	(5.986)		(12.608)	(55.926)	(39.697)
BC_D		0.541	0.537	0.471		3.605	5.379*	4.279*
		(0.345)	(0.572)	(1.169)		(2.281)	(2.940)	(2.536)
$\%\Delta GDP_D$ (%)		-0.065*	-0.076	-0.054		-0.479**	-0.373	-0.368
		(0.039)	(0.059)	(0.041)		(0.208)	(0.271)	(0.243)
$KAOpen_D$		1.571*	0.282	0.107		10.822***	11.383*	14.875***
		(0.814)	(0.922)	(0.726)		(3.458)	(6.465)	(5.267)
Subsidiary Bank Variables:								
EQ/A_S			4.807	2.882			-40.022	-71.030***
			(4.999)	(5.562)			(27.062)	(21.835)
ROE_S (%)			0.014	0.002			0.114	0.038
			(0.050)	(0.040)			(0.135)	(0.111)
$\Delta Loan_S$ (%)			0.000	0.000			0.000	0.000
			(0.00)	(0.00)			(0.000)	(0.000)
ln($Assets_S$)	0.271	0.059	1.072	0.989				
	(0.454)	(0.330)	(0.810)	(0.618)				
$IntRatio_{S,P}$ (-1)			-0.003**	-0.003**			0.001	0.001
			(0.001)	(0.001)			(0.001)	(0.020)
Parent Bank Variables:								
EQ/A_P				2.295				26.015
				(7.164)				(23.213)
$Quick_P$				2.622				20.510**
				(2.571)				(10.074)
Observations	2,024	2,024	2,024	2,024	1,963	1,963	1,963	1,963
No. of Subs. Banks	381	381	381	381	379	379	379	379
Subs. and Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(2) Test p-value[1]	.	.	0.163	0.262	0.584	0.577	0.497	0.858
Hansen J-Test p-value[2]	0.608	0.893	0.282	0.027	.	.	0.935	0.706
No. of Instruments	42	47	119	153	22	27	101	136

Note: Robust standard errors clustered by subsidiary bank in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

[1] The results of the Arellano and Bond test of second-order correlation in the first differences of the GMM-style instruments are omitted for specifications (1) and (2), since the use of a single instrument in the collapsed GMM instrument set reduces statistical power available for computation.

[2] Specifications (5) and (6) have zero GMM-style instruments. Therefore, the Hansen J-Test of overidentifying restrictions for the GMM-style instrument set is invalid for these models.

For specifications with $NetIntBorr/Assets_S$ (%) as the dependent variable, the coefficients of the subsidiary- and parent-specific control variables are similar in magnitude and significance to those presented for estimation with $NetIntBorr_S$ ($ Bil) as the dependent variable. In columns (7) and (8), however, the coefficient of $IntRatio_{S,P}$ (-1) becomes insignificant, while the coefficient of EQ/A_S becomes negative and significant, indicating that parent banks provide greater capital support to poorly capitalized subsidiaries (De Haas and van Lelyveld, 2010).

To summarize the bank-level evidence of the direction of intra-bank capital flows during home crises, I find some limited evidence of parent bank capital retrenchment. But when $NetIntBorr_S$ ($ Bil), which provides the most direct measure of intra-bank capital flows unaffected by subsidiary asset growth, is used as the dependent variable, there is no significant impact of home-country crises on parent-affiliate capital movement. Given this insignificant result, I now examine a set of banking crisis interaction terms to investigate the bank characteristics for which parents may shift capital toward, or recall capital from, their subsidiaries.

5.2.2 Bank Characteristic Interactions

Table 11 on the following page presents the results from estimating equation (10) with $NetIntBorr_S$ ($ Bil) as the dependent variable, including the bank-specific characteristic interaction terms. For brevity, I omit the coefficients of the control variables. Two interaction terms register significance. First, in specification (1), the coefficient of the interaction $BC_H * EQ/A_P$ is negative and significant at the 1% level, whereas a positive coefficient would be consistent with the liquidity support effect. One possible explanation for this surprising result is that parents with higher capital ratios are more conservative. These parents may recall capital to reinforce the parent bank capital position under uncertainty of the scope or duration of the home-country crisis (De Haas and van Lelyveld, 2011).[23] The overall effect of home banking crises, $\beta_{BC_H} + EQ/A_P * \beta_{BC_H * EQ/A_P}$ is negative and significant at the 5% level under the F-test for values of $EQ/A_P \geq 0.3$.

[23] A second possible explanation is omitted variable bias. Home-country bank regulators may impose higher capital requirements during crises to curb excessive risk taking by banks (Corbae and D'Erasmo, 2021), limit implicit too-big-to-fail policies (Koch et al., 2020), or to distinguish between strong and distressed banks. This would force parent banks to improve their equity-to-assets ratio, and parents may recall capital from their banking network to meet the capital requirement threshold (Morrison and White, 2005). Unfortunately, detailed capital requirement data is not widely available

TABLE 11
GMM Estimation: Subsidiary Net Interbank Borrowing with Banking Crisis Interactions

Dependent Variable: $NetIntBorr_S$ = Subsidiary Net Interbank Borrowing ($ Billions)						
	(1)	(2)	(3)	(4)	(5)	(6)
BC_H	0.49	1.97	-1.02	-1.07	-0.52	-1.07
	(0.67)	(1.65)	(1.68)	(0.66)	(0.65)	(0.67)
	Parent Interactions		*Subsidiary Interactions*			
Interaction Variable:	EQ/A_P	$Quick_P$	EQ/A_S	ROE_S	$\Delta Loan_S$	$IntRatio_{S,P}$
BC_H * *Interaction Var.*	-5.34***	-7.34	3.05	0.06	0.00	2.67***
	(1.80)	(5.78)	(9.69)	(0.05)	(0.00)	(1.01)
Observations	2,024	2,024	2,024	2,024	2,024	2,008
No. of Subsidiary Banks	381	381	381	381	381	380
Subsidiary and Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by subsidiary bank in parentheses. **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Second, I test the second key prediction of the model in section 3 with the inclusion of the interaction term $BC_H * IntRatio_{S,P}$ (-1). The model developed in section 3 suggests that parents are more likely to recall capital from smaller foreign affiliate banks with less capital available for retrenchment (Hypothesis 2). The positive and significant coefficient of $BC_H * IntRatio_{S,P}$ (-1) confirms this hypothesis: parent banks recall capital from subsidiaries whose interbank borrowing comprises a lower share of parent bank interbank lending. These subsidiaries are smaller funding priorities for the parent bank, whereas subsidiaries that are larger funding priorities receive capital support from parents during home-country crises. This result extends the analysis of Cetorelli and Goldberg (2012), who find that U.S. parents recalled capital at a faster rate from affiliates deemed non-core funding priorities during the GFC, to a first-derivative capital flow effect setting. The overall effect of home banking crises, $\beta_{BC_H} + IntRatio_{S,P} * \beta_{BC_H * IntRatio_{S,P}}$ is positive and significant at the 5% level under the F-test for values of $IntRatio_{S,P}$ (-1) $\geq 1.3\%$.

Table 12 on the following page presents the results from the estimation of equation (10) with $NetIntBorr/Assets_S$ (%) as the dependent variable, with the inclusion of the bank-specific interaction terms. For brevity, I omit the coefficients of the control variables. The results are similar to those presented in Table 11, although the coefficient of $BC_H * ROE_S$ (%) registers significance at

for the sample and I am unable to test this hypothesis.

TABLE 12
GMM Estimation: Subsidiary Net Interbank Borrowing with Banking Crisis Interactions

Dependent Variable: $NetIntBorr/Assets_S$ = Subsidiary Net Interbank Borrowing (% of Assets)	(1)	(2)	(3)	(4)	(5)	(6)
BC_H	3.43	6.12	-5.16	-2.45	-6.35*	-6.67*
	(3.48)	(8.66)	(5.95)	(3.41)	(3.36)	(3.72)
	Parent Interactions		*Subsidiary Interactions*			
Interaction Variable:	EQ/A_P	$Quick_P$	EQ/A_S	ROE_S	$\Delta Loan_S$	$IntRatio_{S,P}$
BC_H * *Interaction Var.*	-52.43***	-33.03	1.83	-0.57***	0.00	1.63
	(10.83)	(21.83)	(33.37)	(0.21)	(0.00)	(1.08)
Observations	1,963	1,963	1,963	1,963	1,963	1,963
No. of Subs. Banks	379	379	379	379	379	379
Subs. and Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: For brevity, I present only the coefficients of the variables of interest. Robust standard errors clustered by subsidiary bank in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

the 1% level, while the coefficient of $BC_H * IntRatio_{S,P}$ (-1) falls short of significance. In column (3), the negative sign of $BC_H * ROE_S$ implies that parent banks recall capital from more profitable subsidiaries, which generate larger internal cash flows. This result supports multiple arguments in the literature suggesting that internal capital markets allow conglomerates to bypass external financing frictions by moving internally generated capital through the business network (Stein, 1997; Campello, 2002). The overall effect of home banking crises, $\beta_{BC_H} + ROE_S * \beta_{BC_H * ROE_S}$, is negative and significant at the 5% level under the F-test for values of $ROE_S \geq 6.0\%$.

5.2.3 Robustness Tests

For an initial robustness test, I estimate equation (10) using the two-step System GMM estimator and include the one-year lag of the dependent variable as a regressor.[24] For each dependent variable, the results are similar to those presented for the baseline specification in Table 10. Accordingly, I omit the regressions. There remains little evidence of a significant average effect of home crises on parent-affiliate capital flows with the inclusion of the one-year lag of the dependent variable as a regressor.

In addition, I estimate equation (10) for each dependent variable via OLS both with and without the one-year lag of the dependent variable as a regressor. The results for the regression including the lagged dependent variable are similar to those with the GMM estimation framework, although

[24] As discussed in section 5.1.1., given that interbank loans may carry durations beyond one year, a subsidiary's net interbank borrowing position is likely impacted by the previous value of the variable.

the magnitude of the coefficient of BC_H differs slightly from the GMM results. The difference in coefficient size using OLS is unsurprising, given the large dynamic panel bias in large N, small T samples (Roodman, 2009). The results for the regression excluding the lagged dependent variable are nearly identical to those presented in Table 10. For brevity, I omit both sets of results.

TABLE 13
GMM Estimation: Subsidiary Net Interbank Borrowing with Banking Crisis Indicator by Destination Country Development Classification

Dependent Variable: $NetIntBorr_S$ = Subsidiary Net Interbank Borrowing ($ Billions)	*Developed*	*Developing*
BC_H	0.84	-0.58**
	(1.91)	(0.24)
$ln(Assets_S)$	-0.06	0.10
	(1.45)	(0.09)
Observations	748	1,276
Number of Subsidiary Banks	133	248
Subsidiary and Year Fixed Effects	Yes	Yes
Dependent Variable: $NetIntBorr/Assets_S$ = Subsidiary Net Interbank Borrowing (% of Assets)	*Developed*	*Developing*
BC_H	-1.81	-12.17***
	(5.74)	(4.11)
Observations	724	1,239
Number of Subsidiary Banks	132	247
Subsidiary and Year Fixed Effects	Yes	Yes

Note: For brevity, I omit the coefficients of the control variables. Destination country development classification based on the 2003 country classification from Arnone et al. (2007). Robust standard errors clustered by subsidiary bank in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

For the second robustness test, I split the sample by destination country development classification and estimate equation (10) using the GMM estimator. Multiple results in the international finance literature show that developing countries are more susceptible to sudden stops in capital inflows (Reinhart and Calvo, 1999; López-Mejía, 1999) and are at greater risk of net capital flow reversals during financial crises in connected economies (Bosworth et al., 1999). Therefore, the negative coefficient of BC_H found in section 5.2.1. may be attributable to intra-bank capital retrenchment from affiliates operating in developing countries, whereas parent banks may retain or increase capital exposure to developed destination countries during home crises.

Table 13 above presents the results of the split sample estimation of equation (10). Given the reduced sample size for each subsample, and the subsequent loss in statistical computing power, I estimate each specification with the one-step system GMM estimator. For brevity, I omit the coefficients of the control variables. When restricting the sample to developed destination countries, the coefficient of BC_H is insignificant with each dependent variable. In contrast, when the sample is restricted to developing destination countries, the coefficient of BC_H is negative and significant for both dependent variables. This result indicates that parent banks recall capital from foreign subsidiaries operating in developing countries during home-country crises. This finding contributes to the extant literature on developing-country capital flows by documenting an additional channel through which developing countries are exposed to destabilizing capital outflows.

For the final robustness test, I seek to reconcile the results from the country-level and bank-level sections of the paper. Recall that when using the dollar amount of the net intra-bank capital position as the dependent variable, home-country crises are associated with a positive but insignificant capital outflow from parent banks at the country level (section 4.2.1.) and a negative but insignificant capital inflow to parents at the bank level (section 5.2.1.). *A priori*, these differing results may reflect heterogeneity in parent bank responses by size. A small share of parent banks with greater stocks of capital channeled to foreign affiliates may shift funds toward affiliates during home crises, while a larger percentage of parents with less capital may recall funds from their banking network. This would produce a positive effect of home crises on aggregate intra-bank capital flows but a negative effect on individual bank capital flows, on average.

Therefore, I split the sample into three terciles based on parent interbank loan stock size and estimate equation (10) for each tercile.[25] Tables 14 and 15 on the following page present the results for the dependent variables of $NetIntBorr_S$ ($ Bil) and $NetIntBorr/Assets_S$ (%), respectively. Given the reduction in sample size for each restricted subsample, I estimate equation (10) using the one-step system GMM estimator. For brevity, I omit the coefficients of the control variables. I find limited suggestive evidence supporting the above hypothesis. In Table 14, the coefficient of BC_H is negative yet insignificant for the lowest and middle terciles of parent interbank lending. When restricting the

[25]The terciles are determined by calculating the rolling annual average of trailing two-year parent interbank lending values, then separating the subsidiary-year observations into three groups based on the 33.3% and 66.6% percentile values for each year. Note that because the percentiles are based on parent bank size, and larger parents may have a greater number of subsidiaries, the terciles have an unequal number of observations.

TABLE 14 **GMM Estimation: Subsidiary Net Interbank Borrowing by Parent Interbank Lending Tercile**	
Dependent Variable: $NetIntBorr_S$ ($ Billions)	
Lowest Parent Bank Interbank Lending	
BC_H	-1.15
	(1.94)
Observations	591
Number of Subsidiary Banks	136
Medium Parent Bank Interbank Lending	
BC_H	-2.08
	(1.35)
Observations	571
Number of Subsidiary Banks	181
Highest Parent Bank Interbank Lending	
BC_H	0.53
	(1.23)
Observations	862
Number of Subsidiary Banks	324

TABLE 15 **GMM Estimation: Subsidiary Net Interbank Borrowing by Parent Interbank Lending Tercile**	
Dependent Variable: $NetIntBorr/Assets_S$ (%)	
Lowest Parent Bank Interbank Lending	
BC_H	-22.02**
	(11.45)
Observations	580
Number of Subsidiary Banks	135
Medium Parent Bank Interbank Lending	
BC_H	-14.46*
	(7.45)
Observations	555
Number of Subsidiary Banks	181
Highest Parent Bank Interbank Lending	
BC_H	-2.55
	(3.66)
Observations	828
Number of Subsidiary Banks	320

Note: For brevity, I present only the coefficients of the variables of interest. Parent interbank lending terciles calculated by separating subsidiary-year observations into three groups based on 33.3% and 66.6% percentile values of rolling annual average of trailing 2-year parent interbank lending values. Robust standard errors clustered by subsidiary bank in parentheses. *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.

sample to the highest parent interbank lending tercile, however, the point estimate of the coefficient of BC_H is positive yet insignificant. In Table 15, the coefficient of BC_H is negative and significant for estimation on the lowest and medium parent interbank lending size terciles. The coefficient for the highest tercile is negative and insignificant, however, whereas a positive coefficient would be expected if parents with greater interbank loan stocks shift funds toward subsidiaries during home-country banking crises.

6 Conclusion

The goal of this thesis is to examine the impact of home-country banking crises on intra-bank capital flows. I first develop a game theoretic model of parent-affiliate capital flows that predicts stylized conditions under which parents shift capital toward, or recall capital from, foreign affiliates during home-country crises. I then provide empirical evidence of the effect of home crises on intra-bank capital flows at both the country and bank levels.

The principal contribution of this thesis relative to the existing literature is twofold. First, this paper examines the direction of parent-affiliate capital flows during home crises using *direct* measures of net intra-bank capital flows, whereas much of the literature provides *indirect* evidence of internal capital movement by focusing on the association of home-country crises and affiliate loan growth. Second, I document a set of crisis conditions and bank characteristics for which parents shift capital toward, or recall capital from, foreign affiliates during home-country crises.

Previous studies of multinational banks and banking crisis contagion leverage the association of home crises and the reduction of foreign affiliates' loan growth to infer that parent banks recall capital from affiliates during home-country crises. In contrast, using direct measures of parent-affiliate capital movement, I do not find a significant average effect of home crises on intra-bank capital flows. This finding suggests that, across crises and countries, either the competing liquidity support and lending profitability effects offset or that neither effect is significant, on average. Given that the direct measures of parent-affiliate capital flows utilized in this paper provide stronger identification of the impact of home crises on intra-bank capital flows than prior indirect measures employed by the literature, the results of this thesis suggest that previous studies are not accurately capturing the causal mechanism for crisis transmission within multinational banking groups. In particular, the insignificant average crisis effect presented in this paper casts doubt on the widely held belief that parent banks systematically recall capital from foreign affiliates during home-country banking crises.[26]

Still, the parent-affiliate capital flow channel should not be dismissed as a conduit for international banking crisis transmission in all circumstances. While I do not find a significant average effect of home-country crises, I document a set of crisis conditions and bank financial characteristics for which parent banks recall capital from foreign affiliates during home crises. Specifically, parents recall capital from affiliates during severe crisis episodes. Furthermore, affiliates operating in developing countries, more profitable affiliates, and those deemed non-core funding priorities by the parent are

[26]A possible avenue for further inquiry is whether the results of this thesis also apply to parent-affiliate equity capital flows, individually. Equity capital contributes directly to the maintenance of affiliate capital buffers. Consequently, a study of the impact of home crises on intra-bank equity capital movement may shed further light on the transmission of solvency and liquidity shocks across multinational banking networks.

particularly susceptible to capital retrenchment during home crises. These conditions for capital retrenchment highlight circumstances under which host-country banking systems may face a tradeoff between enjoying the benefits of foreign bank funding while facing the risk of intra-bank capital flow contagion. Furthermore, the results of this thesis suggest a set of conditions under which targeted constraints on parent-affiliate capital flows may be effective in insulating foreign affiliate banks from banking crisis contagion.

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Appendix

TABLE A1
Country-Level Study Home Countries

Developed Countries				Developing Countries
Australia	Finland	Italy	Spain	India
Austria	France	Japan	Sweden	Mexico
Belgium	Germany	Netherlands	Switzerland	
Canada	Greece	Portugal	United Kingdom	
Denmark	Ireland	South Korea	United States	

Table A2
Country-Level Analysis Variables and Data Sources

Variable	Description and Data Source
$NetIntraPositon$ *($Bil)*	Aggregate parent bank asset claims on foreign affiliates less liabilities owed to affiliates. *Source*: Bank for International Settlements (BIS).
$NetIntraPos/Assets$ (%)	Aggregate parent bank net intra-bank capital position divided by banking sector assets. *Source*: BIS.
BC	1 for a banking crisis, 0 otherwise. *Source*: Laeven and Valencia (2018).
$\%\Delta GDP$ (%)	Annual GDP growth (%). *Source*: World Bank *World Development Indicators* (WDI).
$KAOpen$	Capital account openness index (0 to 1); higher values indicate more openness. *Source*: Chinn and Ito (2008).
$Trade/GDP$ *(%)*	Total Exports plus Imports divided by GDP (%). *Source*: WDI.
$\%\Delta Trade$ (%)	Annual growth rate of Imports plus Exports (%). *Source*: WDI.
$RealInt$ *(%)*	Short-term Treasury Bill Rate minus Annual Inflation Rate (CPI). *Source*: WDI and OECD.
$\%\Delta FinAcc(\%)$	Annual change in Net Financial Account (%). *Source*: International Monetary Fund International Financial Statistics (IFS).
$ln(BankSectorAssets)$ ($ Bil)	Logarithm of nominal banking sector capital assets claims. *Source*: BIS.
$GDPLoss$ *(% of GDP)*	Cumulative loss in output during banking crisis relative to trend GDP. *Source*: Laeven and Valencia (2018).
$BailoutCost$ *(% of GDP)*	Cost of fiscal bailout of financial sector during banking crisis (% of Nominal GDP). *Source*: Laeven and Valencia (2018).

TABLE A3
Bank-Level Study Home Countries, Parent Banks, Number of Corresponding Subsidiaries

Country	Parent Banks	No. of Subs.
Australia	Australia and New Zealand Group, Commonwealth Bank, Westpac Bank	11
Austria	Erste Group, Raiffeisen Bank	20
Belgium	Belfius Bank, Dexia Bank, Fortis Group, Fortis-BNP Paribas, KBC Bank	24
Denmark	Danske Bank	3
France	BNP Paribas, Credit Agricole, Societe Generale	33
Germany	Bayerische, CommerzBank, DZ, Deutsche, Dresdner, LandesBank, W. LandesBank	61
Greece	Alpha Bank, EFG EuroBank	6
Ireland	Allied Irish Banks	1
Italy	Banca Monte dei Paschi di Siena, Intesa Sanpaolo, UniCredit	29
Japan	Kabushiki Kaisha Mitsubishi, Mitsubishi UFJ Group, Mizuho, Sumitomo Mitsui	18
Netherlands	ING Bank, RaboBank	11
Norway	DnB Bank	6
Portugal	Millenium Bank	5
South Korea	Kookmin Bank, Shinhan Bank, Woori Bank	7
Spain	Santander Bank, BBVA Bank	23
Sweden	Nordea Bank, Skandinaviska Enskilda Bank, Svenska HandelsBank, SwedBank	21
Switzerland	UBS	11
United Kingdom	HSBC Holdings, Royal Bank of Scotland	36
United States	Bank of America, Citigroup, J.P. Morgan Chase	51

Table A4
Bank-Level Study Variables and Data Sources

Variable	Description and Data Source
Subsidiary Variables	
$NetIntBorr_S$ ($Bil)	Subsidiary net interbank borrowing position ($ Billions). *Source*: Bureau van Dijk (BvD) Bankscope
$NetIntBorr/Assets_S(\%)$	Subsidiary net interbank borrowing position divided by subsidiary assets (%). *Source*: BvD Bankscope
EQ/A_S	Subsidiary bank equity divided by assets. *Source*: BvD Bankscope.
$ROE_S(\%)$	Subsidiary bank net income divided by average shareholders' equity. *Source*: BvD Bankscope.
$\Delta Loan_S(\%)$	Subsidiary bank annual loan growth (%). *Source*: BvD Bankscope.
ln($Assets_S$) ($Bil)	Logarithm of Subsidiary bank assets ($ Billions). *Source*: BvD Bankscope.
$IntRatio_{S,P}(\%)$ (-1)	Subsidiary bank interbank borrowing divided by Parent bank interbank lending. *Source*: BvD Bankscope.
Parent Variables	
EQ/A_P	Parent bank equity divided by assets. *Source*: BvD Bankscope.
$Quick_P$	Parent bank liquid assets divided by total liabilities. *Source*: BvD Bankscope.
Macro Variables (Home and Dest.)	
BC	1 for a banking crisis, 0 otherwise. *Source*: Laeven and Valencia (2018).
$\%\Delta GDP(\%)$	Annual GDP growth (%). *Source*: World Bank World Development Indicators.
KAOpen	Capital account openness index (0 to 1); higher values indicate more openness. *Source*: Chinn and Ito (2008).