Price Dislocations, Systematically Important Banks, and Spillovers*

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Abstract

We have developed a model to analyze the natural reflex of systemically important banks during the Great Recession. Large banks acquire nonperforming assets at dislocated prices under specific conditions. First, there is weak borrowing demand from the corporate sector due to inadequate market demand for products and services. Second, turmoils in mortgage markets have led to high-quality collateral being traded at heavily discounted prices. Third, only large banks buy nonperforming assets as small banks lack the same profit-generating capacity. These operations have led to large banks facing capital constraints, and spillover effects are on corporate borrowers in banking relationships.

JEL classification: E58; G21, G23, G24, G28, G51;
Keywords: bank asset problems, capital buffer, non-performing assets, systemic risk, spillovers

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1 Introduction

Shleifer and Vishny (2010a,b, 2011) propose a model on unstable banking and predict crowd-out bank operations during the Great Recession. The crowd-out occurs under two conditions. The first condition is price dislocation. In distressed MBS markets, fire sales force securities to be traded at discounts below their fair value. The second condition is bank capital losses. Because bank capital suffers losses due to price dislocation, banks must choose between purchasing securities at dislocated prices and making new loans to corporate borrowers. Because the expected returns from securities at dislocated prices are more attractive, bank speculations crowd out lending to the real economy.

In this study, we propose a new model to analyze why large banks purchased nonperforming assets during the Great Recession and what the consequences would be. In the second part of this study, we empirically analyze the spillover effects on corporate borrowers. The motivation for a new model is based on two inputs.

First, we identified new evidence that large banks had consistently added new risky assets. With an average asset of $537 billion, 22 large US banks had added 37 percentage points of new risky assets from 2006Q4 to 2009Q1. By adding more risky assets, banks must have more capital. In other words, the direct cause of the crowd-out effect does not hold.

Second, corporate debt demand was weak during the Great Recession. In Ivashina and Scharfstein (2010), different types of corporate borrowing were on a downward trend in 2007 and 2008. We collect evidence that corporate debt demand in 2009 remained at a low level as in 2008. Furthermore, Chu and Xiao (2024) has found that regular credit line borrowers only drew down 25% of their outstanding credit line in 2008 and 2009. The one-fourth drawdown is due to concerns from corporate borrowers that demand for their products and services was weak during the Great Recession.

We apply the fairness-of-exchange II model in Chu (2024) to analyze how large banks maintain their balance sheet assets during the Great Recession. Asset maintenance includes two operations: removing bad assets and adding new assets. In this study, two inputs

to the model are updated. Unlike the regular-sized banks in Chu (2024), the 22 banks are qualified as systemically important banks (SIB). In Chu (2024), discounts on fire sales vary depending on collateral heterogeneity. In this study, we allow discounts to vary in an additional dimension. For the same collateral, losses in fire sales can be normal or excessive.

Here are two unique characteristics of systemically important banks. First, the central bank will provide liquidity support if they are short of liquidity to meet household withdrawal requests in the deposit contract. The support for bank funding liquidity eliminates the necessary condition to develop panic runs in households. Second, systemically important banks have large good assets that generate more profits than a regular-sized bank. Therefore, large banks have more resources to remove bad assets and add more assets.

Our model predicts five large bank operations. Interestingly, two are identified as abnormal operations. Regular-sized banks cannot practice abnormal operations because they do not have the privilege of large banks. Abnormal operations practiced by large banks are misbehavior. In some cases, the operation could be criminal.

Operation 1: write off bad assets with bad collateral. Bad assets are loans in default, which can be bilateral or securitized. If borrowers stop making debt service payments before maturity, the bank can sell the loan collateral to recover part of the losses. However, bad collateral indicates that the collateral has been severely compromised. Furthermore, large banks will sell all bad assets whose collateral has not been undervalued because there is no expectation of value recovery in the future. Operation 1 is consistent with the maximization of the bank's long-term capital.

Operation 2: keep bad assets with good collateral suffering price dislocations on the balance sheet. This operation covers two types of bad assets. The first type of bad assets has been on the bank balance sheet. The second type refers to bad assets that the bank can purchase from the market.

Why should a large bank purchase bad assets whose collateral suffers price dislocations? This is because good assets generate profits and a large bank must acquire profit-generating

assets with the profits. Therefore, when the debt demand from corporate borrowers is weak, purchasing bad assets with good collateral suffering price dislocations becomes a rational decision to maximize the best interest of bank shareholders.

The large banks repeat operations 1 and 2 in each quarter. However, corporate debt demand has been continuously lower since the RMBS market collapsed in 2007Q2. Since shareholders demand that profits from good assets must acquire profit-generating assets, large banks start to accumulate bad assets with good collateral traded at price dislocations.

There are two side effects of operation 2. The first side effect is that large banks cannot sell bad assets without reporting losses if price dislocations persist. The second side effect is that large banks must pay holding costs for these bad assets because these assets are in default and do not generate any income. Therefore, income from remaining good loans must pay funding costs not only for themselves but also for bad assets.

The key element of bank asset problems in Chu (2024) refers to the relative size decreases of good loans to bad loans. The same element plays its role for large banks in the dynamic setting. As more bad assets sit on the balance sheet, profits from good assets become insufficient to cover the funding costs of bad assets. The capital buffer unique to large banks must pay for the funding costs of bad assets.

Therefore, the capital buffer has been stretched for two functions. Replenishing equity capital is the official role, but paying funding costs inevitably compromises the priority of the former. The large bank develops capital constrained once accumulative financing costs exhaust its capital buffer. Under capital constraints, liquidity support from regulators does not help much. The large bank must reduce its risky assets and issue new equity, which is operation 3.

Reducing the bank's balance sheet compromises financial stability because the small bank lacks the capital to fill the service vacuum. The banking system practices less risk transformation than before. Our model also predicts two abnormal operations when capital constraints have deteriorated. Abnormal operation 1: manipulate its borrowing interest

rates. To increase income, a bank must reduce its borrowing costs. Systematically important banks can use their market privilege to manipulate the interbank offer rate. The Libor scandal is consistent with abnormal operation 1. If interest rate manipulation is not enough to address the problem of capital constrained, reporting a higher total equity capital to the regulatory agency would be a natural choice. We refer to the bank capital misreporting as an abnormal operation 2.

In the second half of this study, we present empirical evidence in two strands. In the first strand, we present empirical evidence supporting operations 1 to 3 as well as abnormal operations 1 and 2. The consequences of operation 2 are that large banks become capital constrained, reduce risky assets, and recapitalize. The process takes three years. We refer large banks to 97 leading intermediaries that account for more than half of the finance sector's size and debt intermediary services.

The second strand of evidence is the "spillover" to corporate borrowers predicted by our model in the first part. Due to the weak demand for corporate borrowing, we choose the market beta of individual firms as the spillover indicator. Our identification strategy maintains a distance from the endogeneity concern because large banks have not reduced their balance sheet before 209Q2. The banking relationship refers to the 5-year borrower-bank relationship from 2002 to 2006.

We first identify the benefit of without relationship. We allocate all nonfinance and nonutility firms into three groups. Only firms that are historically dependent on leading intermediaries for debt financing reported a higher risk exposure. Firms keeping a distance from large banks, either accessing debt financing through smaller banks or without a history of debt financing, were insensitive to market risk or even reporting negative beta.

The second spillover highlights the revenue preference of the lending banks. There exists a revenue preference when a lending bank must make selective downsizing of its borrowing customers. Clients with a higher amount of debt in history were better off and reported a lower risk exposure.

The third spillover identifies collective bank operations. The revenue priority is about two firms with differential borrowing amounts. Now, we analyze two firms borrowing the same amount, but with differential banking relationships. A borrower that relies on two banks for debt financing brings lower revenues to each bank than the other borrower if the latter borrows exclusively from one bank. When both banks simultaneously downsize selective customers, each bank only prioritizes its high-revenue clients. Therefore, a borrower with an exclusive lender-borrower relationship reports a lower risk exposure than the other borrower with two bank relationships.

Here is the contribution of this study. We offer an alternative explanation to the theories of unstable banking in (Shleifer and Vishny, 2010a) and asset fire sales in Shleifer and Vishny (2010b). Three papers share a similar prediction. Banks prefer to buy nonperforming MBS at dislocated prices during the Great Recession.

Our model predicts a non-crowd-out effect, and our explanation is based on two new assumptions. First, our assumption is consistent with empirical evidence recently discovered that corporate borrowing demand has been in a downward trend since 2007Q2. Second, large banks must have a large portfolio of good assets, following Chu (2024). Profits of good assets will be the source of bank capital growth. Therefore, large banks will not be capital constrained in the initial periods when they acquire bad mortgage assets. Bank operations are natural and rational.

Therefore, our study offers a policy recommendation different from that in Shleifer and Vishny (2010a). Even if the Federal Reserve purchases bad mortgage assets and pushes their prices close to fair value, large banks will not make more new loans to the corporate sector than what has been documented in the literature. This is because corporations worry about insufficient demand when the economy is still in crisis. Therefore, our policy recommendation is to revitalize the economy.

Bank equity has long been recognized to affect lending behaviors (Holmstrom and Tirole, 1997). Recent contributions have linked bank capital shortages to banking crises and eco-

nomic slowdown. Among others, see (He and Krishnamurthy, 2012), (Acharya et al., 2017), (Rampini and Viswanathan, 2019), and (Baron, Verner, and Xiong, 2020).

Chu (2024) proposes to gauge the healthiness of a bank through three measurements in one formula: $P_{t,bwr_g} \geq FSL_{t,b} + |L_{t,bwr_b}|$. A bank loan portfolio may include bad loans in addition to good loans. The bank is healthy if the profits of good loans (P_{t,bwr_g}) are more than enough to cover the holding costs ($|L_{t,bwr_b}|$) and fire sale losses of bad loans ($|L_{t,bwr_b}|$). Otherwise, the bank has stepped into asset problems, and the worst case is bank failure.

This study is a sequel of Chu (2024) to elucidate two elements of bank size and excessive fire sales on bank capital. When a large bank is qualified for as a systematically important bank, the slow asset recovery and a disturbing offer that set a regular-sized bank as an acquisition target are no longer relevant. In other words, systematically important banks are unbreakable in theory. However, we document that these systematically important banks have collectively developed de facto capital constraints.

The spillover mechanism is also new to lending channel crises. The historical banking relationship with large banks is not necessarily a silo. When banks keep bad MBS on the balance sheet, performing corporate borrowers are affected. The outbreaks are exposure to market risk because borrowers have reduced borrowing demand before banks cut lending activities[1]. Spillovers to corporate borrowers caused by bank asset problems also feature revenue preference and collective operations.

2 Price Dislocations and Bank Asset Problems

Chu (2024) proposes a model to explain bank failures from the problems on the bank asset side. The main intuition of the model on bank asset problems includes two elements. The first element is bad loans. Bad loans are loans whose borrowers have made default announcements before maturities and stopped debt service payments. Bad loans are unavoidable. The second

[1](Chu and Xiao, 2024) provides a unifying explanation for liquidity management and analyzes the drawdown practice of active credit line borrowers during the years 2008 and 2009. Evidence has revealed an independent demand-side story, in addition to the supply-side story in the lending channel literature.

element is good loans. What matters is the relative size of good loans to bad loans.

A bank can actively replace bad loans if the profits from good loans are sufficient. By completely replacing bad loans, the bank can grow its loan business over time. When good loans decrease, a bank may not be able to completely replace bad loans. When profits from good loans are insufficient to cover fire sale discounts and holding costs of bad loans, the bank has developed bank asset problems.

The negative effects of bank asset problems are alarming. Slow asset recovery divides household beliefs. Households with concerns about slow asset recovery will withdraw their term deposits and become early bank lenders. With insufficient liquidity to pay household withdrawal requests, the bank must sell its good loans. The disturbing offer from an acquirer bank will cause households to panic. The result is that the loan business of a small bank will be acquired by a large bank.

Following the mechanism of bank asset problems, we are interested in a key change in the model. In this study, we model a large bank instead of a normal bank because the former does not completely depend on household deposits for funding liquidity. The central bank will replenish funding liquidity shortages if deposit withdrawals from some households cause liquidity shortages. The central bank liquidity guarantee will eliminate the cause that the large bank is forced to sell its good loans due to the shortages of funding liquidity. The large bank has a relatively larger size of good loans. Because good loans generate profits in each period, the accumulative profits can eventually replace bad loans. Therefore, large banks with central bank liquidity support should be resistant to bank failure. To verify this prediction, we draw attention to the large banks during the Great Recession.

2.1 Stylized facts of large banks in Great Recession

In Table I panel A, we collect balance sheet data entries from FR Y-9C and 10-Q for 22 large US banks. The 22 US banks are part of the 97 leading intermediaries in our

empirical analysis[2]. The 97 intermediaries account for more than 70% of the total assets of the finance sector (SICCD 6000-6999) with more than 1,800 financial institutions in 2006. Meanwhile, the 97 intermediaries account for more than 80% of the debt intermediary service on syndicate loans, credit lines, and corporate bonds from 2002 to 2006. Both rankings are from one year before 2007, the beginning of the Great Recession.

The 22 US banks share two unique characteristics compared to the rest 75 leading intermediaries. First, they are larger because they reported average assets (Compustat AT) of \$537 billion at the end of 2006[3], more than twice to qualify the bar of systemically important banks (SIBs) at \$250 billion. Second, the 22 banks share US domicile and report FR Y-9C to the Federal Reserves, in addition to 10-Q to the SEC that the other 75 leading intermediaries also report.

Here are five stylized facts of the 22 large US banks relevant to this study. (a) Large banks have been consistently adding risky assets throughout the sample period from 2007Q1 to 2009Q1; see column (1). (b) Retained earnings peaked in 2007Q3 and started to decrease until the end of the period; see column (4). (c) Large banks satisfy regulatory capital requirements in every quarter throughout the sample period; see column (7). (d) Common share outstanding has increased modestly at 17 percentage points by 2009Q1. (e) Large banks reduced risky assets by 6 percentage points and issued significant new common shares by 121 percentage points from 2009Q2 to 2009Q4; see columns (1) and (6).

[2]We merge 97 leading intermediaries into FR Y-9C through bank names on the Federal Financial Institutions Examination Council (FFIEC). We collect quarterly balance sheet data to analyze bank operations in compliance with Basel capital requirements. There are 27 initial matches, and we drop further 5 institutions after checking the consistency of the data. We compare the common equity–total in Compustat (CEQQ) and the total equity capital in FR Y-9C (BHCK3210). The 5 institutions dropped are Barclays Group U.S. Inc., HSBC North America Holdings Inc., Deutsche Bank USA Corporation/Taunus Corporation, and ABN AMRO North America Holding Company because the BHCK3210/CEQQ<33% from 2002 to 2006 as well as UnionBanCal Corp/MUFG Americas Holdings Corporation. The total assets of the 22 FR Y-9C large banks account for approximately 20% of the total assets of all institutions in the financial sector (SICCD 6000-6999).

[3]Data sources are FR Y-9C and Compustat. In column (1), we add BHCKA223 from 22 large banks and set the sum for 2006Q4 at 100. Therefore, the number 137 in 2009Q1 indicates that the 22 banks cumulatively added 37 percentage points of new risky assets to their balance sheets from 2006Q4 to 2009Q1. We repeat the exercise from column (1, BHCKA223) to column (6, BHCK3459). Column (5) is the calculated book equity (EC), a sum of 5 items: BHCK3283, 3230, 3240, B530, and A130 in FR Y-9C. Or it equals column (3) minus column (4). Columns (7) and (8) are equal-weighted ratios of the 22 large banks.

2.2 Twists in the highlighted stylized facts

There are three twists, or unexpected developments, in the above stylized facts. The first twist is that large banks keep nonperforming assets on the balance sheet. We identify the first twist by linking stylized facts (a) and (b) together. Some existing assets and new assets acquired by large banks did not generate profits, and the twist became prominent since 2007Q3. Retained earnings in column (4) dropped 18 percentage points from 108 in 2007Q3 to the period end in 2009Q4 at 90.

We emphasize that the newly acquired assets did not generate appropriate profits. If it is only because existing assets suffer losses, the dynamics of assets in column (2) should remain constant, while risk-weighted assets increase with time. However, this is different from what is in the data. Risk-weighted assets and assets increase over time; see columns (1) and (2).

The second twist is unclear sources of bank equity capital. Large banks have satisfied the Basel capital ratio in every quarter in column (7). Because risk-weighted assets in the denominator continue to increase, risk-based equity capital in the numerator must increase accordingly. This is what it is in column (3). Technically, risk-based capital is the sum of retained earnings and book equity capital. Both items are from the profits of good assets. Because retained earnings decreased from 2007Q3, book equity capital must increase significantly. True, it has increased by 154 percentage points from 2006Q4 to 2009Q1 as in column (5). The common share outstanding is the key contributor to the book equity capital. However, it only increased by a modestly 17 percentage points, as in column (6).

The capital buffer is not required until Basel III, which is not published until November 2010. We should not expect large banks to maintain capital buffers before official requirements because capital can originate profit-generating loans in the fairness-of-exchange model. Even if the capital buffer is required, it cannot explain the difference nine times from 17% in column (6) to 154% in column (5).

To the best of our knowledge, the reporting discrepancy is the only plausible explanation to consolidate the implausible difference. Large banks report differently to two regulatory

agencies. We arrive at our conclusion after due diligence checks and communication with regulators. Specifically, large banks *misreported higher* risk-based capital to the Federal Reserve (Fed) than to the SEC. We offer more details from the data work in association with ratios in column (8).

The same total equity capital is reported to two regulators as $BHCK3210$ in FR Y-9C and the common equity total ($CEQQ$) in Compustat (SEC, 10-Q). We calculate the ratio of total equity capital ($BHCK3210$ in FR Y-9C divided by $CEQQ$ in 10-Q). The ratio is calculated from each bank's quarter reporting and equally weighted across 22 large banks. Without a reporting discrepancy, the ratio ($BHCK3210/CEQQ$) should be equal to one. In our data collection, the ratio has been very stable at 98% from 2002 to 2007Q2. In other words, large banks have been more conservative in reporting equity capital to the Fed than to the SEC before 2007Q3.

We define the reporting discrepancy by the ratio $BHCK3210/CEQQ$ being higher than 100%. The discrepancy has three characteristics. (1) There has been no discrepancy before 2007Q3. The first discrepancy 101% occurred in 2007Q3, the quarter in which retained earnings peaked. (2) As retained earnings continued to decrease, the reporting discrepancy increased and peaked in 2008Q4 and 2009Q1. The equity capital reported to the Fed was more than 30 percentage points higher than that reported to the SEC. The discrepancy is significant because one (1) percentage point equals 7.2 billion dollars for the equity capital of the 22 large banks in 2006Q4. (3) The discrepancy decreased from 132% to 113% from 2009Q1 to Q4, and the reduction is significant.

Why do large banks report higher risk-based capital to the Fed and to the Fed only in a specific time window? Being the same accounting item reported to the Federal Reserve (Fed) and the SEC, only the item in FR Y-9C limits the bank's risk taking. Because only the Fed monitors the capital adequacy ratio, reporting a higher equity capital to the Fed could disguise that these large banks have been subject to capital constraints. Large banks did not practice misreporting to the SEC to greatly avoid litigation risk.

The third twist is that large banks were collectively constrained by regulatory capital requirements in 2009. Collectively, we refer to all 22 large banks. Two standard operations to free a bank up a bank from capital constraints are (a) issuing new common shares, (b) reducing existing risky assets, or both.

For operation (a), large banks reduced risky assets by 6 percentage points in column (1) from 2009Q1 to Q4. Meanwhile, the reduction in total assets is only one percentage point in column (2). The joint dynamics in columns (1) and (2) confirms that large banks reduce risky assets only. For operation (b), large banks have issued 121 percentage points of new common shares in the same period; see column (6).

The second and third twists confirm that large banks had been subject to capital constraints as early as 2008Q1. The measures to address capital constraints are different. In 2008, large banks disguised the constraints by misreporting. In other words, being capital constrained is the cause that large banks practice misreporting. In 2009, large banks adopted standard approaches to address capital constraints.

2.3 Large banks keep bad assets during Great Recession and why

The stylized facts and associated twists indicate that large banks maintain nonperforming assets on the balance sheet. The literature has studied why banks purchased securities at dislocated prices during the Great Recession. To keep terminology consistent with the literature, bank assets in this study include bank loans where borrowers are companies and securitized loans such as MBS. Nonperforming assets include corporate loans or MBS in default. For simplicity, we call nonperforming assets bad assets in the rest of this study. Bad assets do not generate debt service payments.

Here is the takeaway of theoretical models and the literature survey in Shleifer and Vishny (2010b,a, 2011) about banks buying bad assets in fire sales. Fire sales in RMBS markets have two effects. Fire sales have pushed security prices well below the fundamental value of these securities. Because banks hold these securities, their bank capital will suffer losses. Without

new bank capital, banks must choose between purchasing securities at dislocated prices and making loans for new projects. Since expected returns from securities at dislocated prices are higher than loan coupons on new projects, banks choose securities in dislocated markets. Therefore, bank operations that purchase bad loans at dislocated prices crowd out lending to corporate borrowers.

However, stylized facts collected in this study and new empirical evidence suggest a new explanation for the same question. Why do banks buy bad assets at dislocated prices during the Great Recession? Furthermore, the new evidence in our possession allows us to address follow-up questions. Why do only large banks purchase bad assets at dislocated prices? What could be the outcome of such large bank operations?

The new explanation is based on new information about the source and usage of bank capital. First, the most important element in bank operations is the source of bank capital. In Chu (2024), good assets generate profits to grow bank capital. With a large portfolio of good loans, a large bank will generate reserve capital in a significant amount.

Second, there are three usages of newly added bank capital, which we call reserve capital, from good assets. We present three usages with decreasing priority from a bank's perspective. The first two usages are analyzed in Chu (2024). In maximizing the bank's long-term capital, a bank only acquires good assets by originating new loans or buying new good assets that will generate future income. The second usage is to pay for the funding costs or the liquidation costs of bad assets.

Purchasing bad assets at dislocated prices is not analyzed in Chu (2024) because a distressed market is not assumed. In a distressed market, the transaction prices are significantly below the fundamental value. Therefore, purchasing bad assets at dislocated prices becomes a choice because their value will appreciate once the market has recovered.

Here is new evidence on weak corporate borrowing demand during the Great Recession. The demand for corporate debt, including credit lines, term loans and corporate bonds, was on a downward trend from 2007Q2 to 2008Q4 (Ivashina and Scharfstein, 2010, Fig. 1). In

Figure I Panel B, we identify that corporate debt demand in 2009 remained at a level similar to that of 2008. Chu and Xiao (2024) has findings on credit line drawdowns. Regular credit line borrowers only drew down 25% of their outstanding credit line in 2008 and 2009. Such low-level drawdowns are not due to bank restrictions because banks must convert off-balance sheet commitments to on-balance sheet assets when signing the credit line contract according to Basel II regulatory requirements.

We follow the fairness-of-exchange II model in Chu (2024). Therefore, good loans from a large bank generate profits even during the Great Recession. Large banks must purchase good assets to maximize their long-term capital. Dislocated prices indicate that large banks can expect price appreciation in the future once the market has returned to normal. Due to the weak demand for new corporate loans, acquiring bad assets at dislocated prices is a rational decision in the market condition since the collapse of the RMBS markets. There are no crowd-out effects in lending to corporate borrowers.

2.3.1 Diversified assets of a large bank during Great Recession

We model the group of large banks by B_L and define EC_L in Equation (1). $EC_{L,t,buf}$ is B_L's capital buffer. We assume that large banks maintain some capital buffer in cash even if it is not required before 2019.

Equation (2) indicates that B_L holds bad assets ($AT_{L,t,b}$) on the balance sheet. However, B_L is not subject to regulatory capital constraints because B_L's income from good assets ($NI_{L,t,g} = P_{t,bwr_g}$) is higher than the cost of holding bad assets ($|L_{t,bwr_b}| = |NI_{L,t,b}|$), as in Equation (3). In sum, B_L's overall loan portfolio is more than satisfied with the regulatory capital requirements while maintaining bad assets on its balance sheet; see Equation (4).

$$EC_L = EC_{L,t,g} + EC_{L,t,b} + EC_{L,t,buf}. \tag{1}$$

$$\frac{RE_{L,t,g} + EC_{L,t,g}}{AT_{L,t,g}} > BaselR > \frac{RE_{L,t,b} + EC_{L,t,b}}{AT_{L,t,b}}; \tag{2}$$

$$NI_{L,t,g} = P_{t,bwr_g} \gg |L_{t,bwr_b}| = |NI_{L,t,b}|. \tag{3}$$

$$BaselR < \frac{RE_{L,t,g} + EC_{L,t,g} + RE_{L,t,b} + EC_{L,t,b}}{AT_{L,t,g} + AT_{L,t,b}}. \tag{4}$$

2.3.2 Collateral heterogeneity in a distressed market

We model the market condition during the 2008 crisis. We can generally categorize the debt market into two sub-markets: MBS and corporate bond markets. There are collapsed MBSs at distressed prices for sale. On the other hand, corporate borrowers are cautious about borrowing due to concerns about insufficient market demand for their output.

With constant net income from good loans and limited demand from corporate borrowers, the challenge for large banks is how to find profitable opportunities from the collapsed MBS markets. We introduce collateral heterogeneity. Two borrowers have defaulted on their loan payments, but collateral differences decide how much a bank can recover its losses. By nature, collateral depreciates over time. However, care can make a difference. We define non-performing assets with good collateral ($AT_{L,b_{GC}}$) where the underlying collateral has been maintained well when the borrower makes a default announcement. Non-performing assets with bad collateral ($AT_{L,b_{BC}}$) indicate that the underlying collateral only carries residual value when the loan has been identified as non-performing.

Next, we combine orderly or forced transactions with collateral variations. Good collateral sales prices in orderly transactions ($AT_{L,b_{GC}} - FSL^N_{b_{GC}}$)[4] are higher than prices in distressed transactions ($AT_{L,b_{GC}} - FSL^E_{b_{GC}}$). However, the fetching price of bad collateral in an orderly transaction ($AT_{L,b_{BC}} - FSL^N_{b_{BC}}$) will be similar to that of a distressed transaction ($AT_{L,b_{BC}} - FSL^E_{b_{BC}}$). We define distressed collateral discounts (DCD) for good or bad collateral in Equations (5) and (6).

$$AT_{L,b_{GC}} : \ DCD_{b_{GC}} = FSL^E_{b_{GC}} - FSL^N_{b_{GC}} \gg 0; \tag{5}$$

[4]The supscripts are N (orderly transactions) and E (transactions reporting excessive fire sales losses). The subscripts gc (good collateral) and bc (bad collateral).

$$AT_{L,b_{BC}}: \ DCD_{b_{BC}} = FSL^{E}_{b_{BC}} - FSL^{N}_{b_{BC}} = 0. \tag{6}$$

There is no doubt that distressed markets will return to normal. However, the question is how long. Value appreciation will be equal to distressed collateral discounts ($DCD_{b_{GC}} = [\, AT_{L,b_{GC}} - FSL^{N}_{b_{GC}}] - [\, AT_{L,b_{GC}} - FSL^{E}_{b_{GC}}]$).

With added information on distressed markets, the fairness-of-exchange model II makes the following predictions. Confident in the collateral, B_L will purchase bad assets with good collateral if necessary and sufficient conditions are satisfied; see Equation (7). The necessary condition (NC) is that the expected value appreciation is higher than the funding cost of holding bad assets. The sufficient condition (SC) is that the expected value appreciation is higher than the average returns of the market.

$$\text{NC: } DCD_{b_{GC}} > AT_{L,b_{GC}} \times BFL_{cbl,t}; \ \text{SC: } DCD_{b_{GC}} > AT_{L,b_{GC}} \times \overline{\mu}_{mkt}. \tag{7}$$

2.3.3 Large banks and standard operations

Operation 1: liquidate non-performing assets with bad collateral. Although lower than market interest rates, the central bank interest rate is yet higher than zero. From Equation (6), loans with bad collateral have no chance to recover. Therefore, writing off non-performing assets with bad collateral is rational.

This prediction is consistent with the MBS writedown during the 2008 financial crisis. The collapse of the subprime mortgage markets began in July 2007 (Longstaff, 2010). By September 2008, large banks reported 79.8% of cumulative MBS writedown losses from the finance sector[5].

Operation 2a: Hold the existing non-performing assets. B_L marks to market bad assets with good collateral against orderly transactions ($AT_{L,b_{GC}} - FSL^{N}_{b_{GC}}$) when the market transaction prices are distressed ($AT_{L,b_{GC}} - FSL^{E}_{b_{GC}}$). However, doing so, B_L cannot liquidate

[5]Source: Yalman Onaran and Dave Pierson, Banks' Subprime-Related Losses Surge to $591 Billion, Bloomberg, September 29 2008.

existing bad assets. Therefore, the large bank must pay funding costs until the loan is liquidated. Holding non-performing assets is rational only if the distressed collateral discounts meet necessary and sufficient conditions in Equations (7) and (**??**). B_L must reevaluate both equations in each period.

Operation 2b: Equation (7) predicts continuous risk taking, purchasing more bad assets at excessive discounts ($AT_{L,b_{GC}} - FSL^E_{b_{GC}}$) as long as the large bank is not subject to capital constraints. This is because the right hand side of the Equation (7) becomes expected profits higher than the holding costs. This is consistent with increasing risk-weighted assets after 2007Q3 for the 22 leading U.S. banks, column 1, panel A Table I.

2.4 When bad assets endamage financial stability

A natural counterpart of the normal bank failure is how the non-performing assets of the large bank could compromise financial stability. We demonstrate the process through which non-performing assets on the balance sheet of a large bank progress to constrain the capital of the banking system. $NI_{L,t,b} < 0$, the negative net income of B_L's loan portfolio, could increase for two reasons.

First, purchase non-performing assets at deep discounts at t. According to FSP FAS 157-4, banks can mark to market non-performing assets on the balance sheet against "orderly" fire sales discounts (FSL^N) if the market is "distressed" and fire sales losses are excessive (FSL^E)[6]. B_L can book asset appreciation in the next period $t+1$.

However, there are two side effects. Side effect (1), B_L cannot close the position without reporting losses if fire-sale discounts remain distressed. Side effect (2), B_L must pay the net founding cost as long as the non-performing assets stay on the balance sheet. Once side effect (2) outweighs the discount difference, the dislocated non-performing assets purchased as a bargain will hurt B_L balance sheet by reporting $NI_{L,t,b} < 0$. This is the first reason why

[6]FASB issues final staff positions to improve guidance and disclosures on fair value measurements and impairments, April 9, 2009. We assume that the large bank can practice similar exercises through their internal risk models before the practice has been supported by the FASB

$NI_{L,t,b} < 0$ will increase.

Second, as in Chu (2024), some households will become early bank lenders once they know that B_L has kept bad assets on the balance sheet. Short of term deposits, B_L has to borrow from the interbank market through Libor ($BFL_{Libor,t}$). During crisis periods, market Libor ($BFL_{Libor,t}$) could be more expensive than household deposits ($BFL_{Libor,t} > BFL_{td,t}$).

Profits from performing assets ($NI_{L,t,g}$) will increase both equity capital (EC) and retained earnings (RE) as in Equation (8). However, the lower retained earnings are due to the holding costs ($NI_{L,t,b} < 0$) of non-performing assets as in Equation (9). At the level of B_L's asset portfolio, $EC_{L,t} = EC_{L,t,g} + EC_{L,t,b}$, and $RE_{L,t} = RE_{L,t,g} + RE_{L,t,b}$.

$$\because NI_{L,t,g} > 0,\ EC_{L,t,g} + RE_{L,t,g} = \begin{cases} EC_{L,t,g} = EC_{L,t-1,g} + \gamma NI_{L,t,g}; \\ RE_{L,t,g} = RE_{L,t-1,g} + (1-\gamma) NI_{L,t,g}. \end{cases} \tag{8}$$

$$\because NI_{L,t,b} < 0,\ EC_{L,t,b} + RE_{L,t,b} = \begin{cases} EC_{L,t,b} = EC_{L,t-1,b}. \\ RE_{L,t,b} = RE_{L,t-1,b} - |NI_{L,t,b}|. \end{cases} \tag{9}$$

Here is our definition of RE warning. The costs of holding nonperforming assets are higher than the net income of performing assets allocated to retained earnings $(1-\gamma)NI_{L,t,g} < |NI_{L,t,b}|$. This is prominent when we compare RE variations in Equations (8) and (9). RE warning manifest itself with divergence of increasing EC but decreasing RE in period t compared to $t-1$; see Equation Equation (10).

$$\because (1-\gamma)NI_{L,t,g} < |NI_{L,t,b}|,\ EC_{L,t} > EC_{L,t-1} \text{ but } RE_{L,t} < RE_{L,t-1} \tag{10}$$

The RE decrease is what banks should be concerned about. After the RE warning in period t, the large bank should liquidate the non-performing assets if B_L maximizes its long-term capital. However, the large can continue to practice its maturity and risk transformations for k periods ($k \geq 1$) as long as net income from performing assets is

higher than the holding costs of non-performing assets ($\gamma NI_{L,t,g} + (1-\gamma)NI_{L,t,g} = NI_{L,t,g} > |NI_{L,t,b}|$).

The warning becomes the red flag in bank capital if the net income of the performing assets becomes insufficient to cover the funding costs of the bad assets, as in Equation (11). At $t+k$, $RE_{L,t+k} + EC_{L,t+k} < RE_{L,t+k-1} + EC_{L,t+k-1}$. The large bank must deploy capital buffer, or it is capital constrained. Assume that the capital buffer satisfy $EC_{L,t,buf} + NI_{L,t+k,g} - |NI_{L,t+k,b}| > 0$. B_L complies with the Basel capital ratio in period $t+k$, as in Equation (12). The large bank can purchase bad assets with good collateral at dislocated prices from the market ($AT_{t+k,b}$), justified by Equations (7) and (**??**). $AT_{t+k,b}$ refers to bad assets in the markets.

$$NI_{L,t+k,g} < |NI_{L,t+k,b}|. \tag{11}$$

$$\because \ BaselR < \frac{RE_{L,t+k} + EC_{L,t+k} + EC_{L,t,buf}}{AT_{L,t+k}}, \ AT_{L,t+k+1} = AT_{L,t+k} + AT_{t+k,b}. \tag{12}$$

However, here is the caveat. The funding costs of bad assets reduce the capital buffer by $|NI_{L,t,b}|$ in each period. If the markets remain distressed, B_L can not liquidate bad assets. The funding costs for the bad assets will exhaust the capital buffer from period $(t+k)$ to period K. Once the capital buffer drops to zero. The profits of the performing assets are less than the holding costs of the bad assets ($NI_{L,K,g} < |NI_{L,K,b}|$), and the large bank becomes capital constrained, as in Equation (13). Once B_L is subject to capital constraints, two standard operations are to issue new equity and downsize riksy assets.

$$EC_{L,t,buf} < \sum_{t+k}^{K} |NI_{L,t,b}|; \ BaselR > \frac{RE_{L,K} + EC_{L,K}}{AT_{L,K}}, \tag{13}$$

Operation 3 is to issue new equity capital. Issuing new equity and downsizing becomes essential if B_L is still below the Basel capital requirements after practicing the aforementioned normal and abnormal operations. In Table I Panel A, we observe two standard operations to unwind a bank from capital constraints. Large banks cumulatively issued 121 percentage

points of new equity from 2009Q1 to 2009Q4 and reduced risk-weighted assets by 6 percentage points. Downsizing could be a operation different from Operation 1 because the large bank may downsize good assets as we will show in Equation (15) later. In addition, because its dominant size in the economy, B_L can perform two abnormal operations.

2.4.1 B_L's privilege and abnormal operations

Abnormal operation 1: B_L manipulates costs its funding liquidity. Typically, Libor will be elevated when markets are in a crisis. Because some households are concerned about the bad assets on the balance sheet, they decide to withdraw their deposits. Therefore, B_L will substitute part of its funding liquidity with liquidity from the interbank Libor market.

Unlike all normal banks, B_L has the privilege and power to set the Libor. Therefore, B_L is incentivized to manipulate the market Libor so that manipulated interbank borrowing costs ($BFL_{LiborM,t}$) can increase B_L's revenue as in Equation (14). An example of abnormal operation 1 is the Libor scandal, a criminal offense in the UK.

$$NI_{L,t} = AT_{L,t} \times (BL - \beta BFL_{LiborM,t}) > AT_{L,t} \times (BL - \beta BFL_{Libor,t}). \tag{14}$$

Abnormal operation 2: Report an artificially higher equity capital (RE_L+EC_L). With higher capital, B_L complies with the Basel ratio without worrying about the regulatory penalty. To avoid litigation risk, B_L reports the noninflated equity capital to the SEC. Reporting higher capital to the Federal Reserve Board only is consistent with what we have observed in Table I column (8).

2.4.2 Cross-borrower spillovers

Let us continue to analyze that large banks reduced risk-weighted assets by 6 percentage points from 2009Q1 to 209Q4. Because normal banks (B_S) do not have capital capacity, the entire banking system has been constrained from maturity and risk transformation since

2009Q2 when B_L decides to downsize. Simply put, financial stability was compromised in 2009. The theoretical analysis in Equation (15) has confirmed stylized facts; The Great Recession is a systemic crisis.

$$BaselR > \frac{RE_{L,K,g} + EC_{L,K,g} + RE_{L,K,b} + EC_{L,K,b}}{AT_{L,K,g} + AT_{L,K,b}}, \text{ and } EC_{L,K,buf} = 0. \tag{15}$$

The mechanism of bank asset problems of a large bank in Equation (15) also indicates a unique spillover effect. Large banks will not liquidate non-performing assets ($AT_{L,K,b}$) due to distressed fire sales discounts. Therefore, they sell performing assets because fire-sale discounts are smaller. For bank borrowers, the spillover is unique. When banks must downsize due to non-performing borrowers, spillovers are actually on the performing borrowers. We term this unique spillover as the cross-borrower spillover and will explore the effects in the empirical analysis.

3 Empirical Design: Spillovers of Holding Bad Assets

We devote this section to spillovers to the corporate borrowers when large banks are capital constrained because bad assets on their balance sheets are too high. Our empirical work includes two parts. In Part 1, we introduce our empirical proxy of the large bank and report details of Operations 1 and 2 in Section 2[7]. In Part 2, we focus on spillovers to corporate borrowers.

3.1 Leading intermediaries as the large bank

In Section 2 analysis, the large bank is a duality of debt intermediary and ultimate lender. However, in practice, the two roles are separated. Syndicate debt offerings on loans and bonds have been practiced through the originate-to-distribute model since the 1990s; see Esty (2001) and Purnanandam (2011). A loan underwriter can trade syndicated shares

[7]We present the relevant data here and introduce the data collection process in the next section.

on the secondary loan market by novation, assignment, or sub-participation. The market has been active since 2004[8].

We focus on the "leading intermediaries" that share two characteristics: large and active. We project 97 leading intermediaries in a group as the "large bank" in Section 2 and use two terms interchangeably with the same meaning in the empirical analysis. The rest, smaller debt intermediaries are peripheral.

To analyze the capital ratio in the Basel standard, we map the 97 leading intermediaries to FR Y-9C and extract relevant balance sheet data for 22 banks. Data show that the Basel capital ratio has kept well above the safe level (Table I, panel A, column 7, BHCK7205). However, the details we will discuss reveal a different picture.

[Insert Table I here]

3.2 Operations 2a and 2b before 2009Q2

Households are the ultimate borrowers of MBS and ABS. The leading intermediaries hold non-trivial securitized household debt before the subprime crisis. On average, the ratio of MBS and ABS to shareholder equity (SEQ) was 2.36 times in five years from 2002 to 2006[9].

Large banks also added corporate and household debt after July 2007, as suggested in Operation 2. From 2006Q4 to 2009Q1, the leading intermediaries monotonically increased the risk-weighted assets (BHCKA223, column 1) by 37 percentage points, and the total assets (BHCK2170, column 2) confirmed a higher dollar amount. The ratio of MBS and ABS to SEQ increased to 2.78 times in 2007 and 2.94 times in the 2008 fiscal year.

A bank must report a higher total equity capital to satisfy the Basel capital requirement by adding risk-weighted assets. Indeed, total equity capital (BHCK3210, column 3)

[8]Source: (A) The ACT Borrower's Guide to LMA Loan Documentation for Investment Grade Borrowers, Slaughter and May, 2013; (B) Guide to Secondary Loan Market Transactions, Loan market association, 2018.

[9]The annual ratio of MBS and ABS to shareholder equity (SEQ) is 2.40 (yr 2002), 2.23 (yr 2003), 2.28 (yr 2004), 2.39 (yr 2005), and 2.48 (yr 2006).

increased by 44 percentage points from 2006Q4 to 2009Q1. Large banks were free of liquidity restrictions. Otherwise, they could not add risk-weighted assets. Fleming (2012) has confirmed that Federal Reserve funding liquidity programs supported at least 18 leading intermediaries.

3.3 Spillover Hypotheses

We propose spillover hypotheses on corporate borrowers before 2009Q2. Spillover effects occur when large banks continue risk taking while part of their balance sheet assets is nonperforming. Our empirical strategy includes two elements. First, our research window is *before* the end of 2009Q2. Second, we adopt market beta to capture the individual firm's exposure to the hard-to-diversify systematic risk. In our research window, the vertical gray dashed line (Figure I, panel A) indicates the meltdown of subprime MBS in July 2007, which separates the research window into pre- and during the subprime crisis stages.

[Insert Figure I]

Here is the intuition for the channel of risk-taking spillovers. When large banks added risk-weighted assets after July 2007, market investors predicted that firms reporting higher exposure to market risk from July 2007 to 2009Q1 were more likely to be removed from bank client lists since 2009Q2. The risk-taking channel is new to the lending channel because banks do not reduce their assets in our research laboratory. The leading intermediaries added risk-weighted assets (red line, Figure I, panel A) and the equity capital of the balance sheet (Table I column 3) from 2006Q4 to 2009Q1. We measure the difference by the higher risk exposures during the subprime period than in the presubprime period.

We propose three hypotheses associated with the capital constrained channel. The first hypothesis examines the active role of large banks for all sample firms. Depending on large banks, borrowers have difficulty accessing corporate bonds or bank loans if banks drop them off the client lists. This risk is difficult to avoid through diversification. On the other

hand, firms should be less sensitive to systemic event if they do not depend on leading intermediaries. This group of companies has access to debt financing through small banks or is independent of debt financing. Indeed, 30% of our sample firms do not have records of syndicated debt financing during the 5-year window before the crisis. We use firms to refer to nonfinancial and nonutility companies.

Hypothesis 1 *Firms without historical bank relationships are less exposed to elevated market risk during the Great Recession than borrowers who depend on leading intermediaries for debt financing.*

Hypothesis 1 highlights the isolation benefit. The second hypothesis focuses on the corporate borrowers of large banks. If a bank must drop some of its customers, it is less likely to start with its higher-value borrowers (measured by a higher historical borrowing amount). We term this as the revenue priority. Although the benefit is known as a stronger bank relationship in the spillovers of the lending channel, we analyze the risk of borrowers in the risk-taking channel as the lenders have not cut lending yet.

Hypothesis 2 *Borrowers with a stronger historical relationship with leading intermediaries are exposed to a lower market risk during the Great Recession.*

Finally, we test the collective operations of leading intermediaries. Consider two firms borrowing similar amounts (and generating similar revenues). Therefore, the revenue priority becomes inactive. However, a firm that borrows from two banks will generate lower revenues for each bank than the other borrower with an exclusive lender-borrower relationship. Therefore, a firm with two bank connections is unlikely to benefit from both bank relationships when banks collectively downsize. This is because each bank only takes care of its higher revenue borrowers. We also test two benefits in lending channel spillovers: alternative access to bond markets and multibank relationships (more than two banks).

Hypothesis 3 *When banks practice collective operations, borrowers with two bank connections are exposed to higher market risk than those with an exclusive bank relationship.*

4 Data Construction: Banks and Firms

In this section, we describe the data generation process. We start with the leading intermediaries. Next, we map the leading intermediaries to FR Y-9C for balance sheet data in compliance with the Basel Accords. We then separate firms in the real world into different categories according to their historical relationship with the leading intermediaries.

4.1 Leading intermediaries

At the end of 2006, more than 1,800 financial institutions at the GVKEY level in the finance sector (SICCD 6000-6999) reported positive total assets in Compustat. We rank them by their total assets and choose the top 150 institutions because their total assets account for 93% of the sector's total assets. The top 150 financial institutions satisfy our first criterion for leading intermediaries: being sufficiently large[10].

To identify active debt intermediaries, we searched all borrowing records in Dealscan over 5 years from the beginning of 2002 to the end of 2006, as in (Bharath et al., 2011). We collect lead lender(s), dollar amounts, and borrower information from individual borrowing contracts for syndicated loans and credit line facilities. 1,774 lead lenders and their syndicate groups serve 24,000 borrowers with more than 15 trillion dollars in loans and lines of credit[11]. Following conventions, we assign the dollar amount of each facility equally to the lead lender(s)[12]. The dollar amount of all loans and lines of credit in the 5 years accumulates to each lead lender as part of its 'pseudo' private debt offering service.

Many of the lead lenders on Dealscan share the same parent institution[13]. Subsidiaries

[10]International banks are included as long as their total assets are reported in Compustat.

[11]The single lender in Dealscan accounts for less than 2% of the dollar amount from 2002 to 2006. We omit single lenders to keep this consistent with practice in the literature. The ranking of the leading intermediaries would not change if we were to retain them

[12]Other syndicate members, if any, are ignored. This method is common in the literature, arguing that the lead banks are more important than other syndicate members, perhaps because they may play a monitoring role. See Diamond (1984) and Holmstrom and Tirole (1997), for theoretical studies, and Sufi (2007), for an empirical study.

[13]Take JP Morgan Chase for example. The names of 21 lead lenders include JP Morgan. We standardize the 21 lead lenders to JP Morgan Chase. Since 2004, lead lenders of Bank One are also standardized to JP

implement strategies from headquarters to take risks or downsize. We standardize the lead lenders to the top 150 financial institutions. 586 of the 1,774 lead lenders are standardized to 87 financial institutions, representing 81% of the loan initiation covered by Dealscan.

Similarly, we search for syndicated corporate bond offerings in the FISD. During the same period of 2002-2006, 740 (lead) underwriters syndicated over $14 trillion of corporate bond issuance for more than 4,500 borrowers. After a similar exercise of name-driven standardization, 332 underwriters are standardized to 75 financial institutions, facilitating more than 89% of bond issuance in FISD.

After merging the 87 financial institutions active in syndicated loans and the 75 financial institutions active in syndicated bonds, we obtain 97 unique financial institutions and name them *leading intermediaries*[14]. From an aggregate perspective, we summarize economic-wide borrowing activities on loans, lines of credit, and corporate bonds. The leading intermediaries serve multiple borrower groups, as shown in Table I panel B.

The 97 leading intermediaries are large and active. They represent 74.8% of the total assets of all institutions in the financial sector. They account for 81% to 96% debt intermediary business in Dealscan or FISD in dollar amount or the number of borrowers. Among the leading intermediaries, the syndicated debt offering is also concentrated. The top 20 banks account for 89% of the amount offered by the 97 leading intermediaries. The appendix lists the top 20 leading intermediaries ranked by syndicated debt offerings. We term the remaining 77 debt intermediaries "peripheral".

4.2 Balance sheet operations of leading intermediaries

We collect quarterly balance sheet data to analyze bank operations in compliance with Basel Accords. We merge 97 leading intermediaries into FR Y-9C through bank names in the Federal Financial Institutions Examination Council (FFIEC). There are 27 initial matches,

Morgan Chase because of M&A activity.

[14]For robustness, we search the remaining lead lenders and (lead) underwriters to ensure that no other financial institutions offers higher 'pseudo' amounts than any of the 97 leading intermediaries in the period of 2002-2006.

and we drop further 5 institutions after checking the consistency of the data[15]. The total assets of the 22 FR Y-9C large banks account for approximately 20% of the total assets of all institutions in the financial sector (SICCD 6000-6999).

We collect annual MBS and ABS holdings for the leading intermediaries. In FR Y-9C, the total asset is a sum of 11 items. 3 of the 11 items may include MBS and ABS assets, which are Securities, Loan and lease financing receivables, and Trading assets. For U.S. bank holding companies, MBS and ABS assets are collected from FR Y-9C. We follow the definition for U.S. non-bank holding financial institutions and collect the data from 10-K. For non-U.S. financial institutions, we collect the data from 20-F. Of the 97 leading intermediaries, 77 have reported MBS and ABS assets from 2002-2008, and the number of banks dropped to 67 in 2008 fiscal years[16].

In addition, we collect cumulative writedown losses related to subprime MBS. We map the 97 leading intermediaries to the list updated by Onaran and Pierson on September 29, 2008. 35 leading intermediaries are matched with $471.7 billion, or 79.8%, writedown losses of the total $590.8 billion writedown losses to subprime MBS.

4.3 Corporate firms and borrowers

Not every firm borrows. If companies borrow, corporate debt is heterogeneous (Rauh and Sufi, 2010). The four main borrowing vehicles are bank loans, lines of credit, corporate bonds, and commercial paper (Colla, Ippolito, and Li, 2013).

We merge borrowers in DealScan and FISD with nonfinancial, nonutility firms in Compustat and CRSP in the period from 2005 to 2009 and identify 3,518 CRSP firms in the nonfinance and nonutility industries[17]. 2,378 firms have a history of access to debt financing

[15]We compare the common equity–total in Compustat (CEQQ) and the total equity capital in FR Y-9C (BHCK3210). The 5 institutions dropped are Barclays Group U.S. Inc., HSBC North America Holdings Inc., Deutsche Bank USA Corporation/Taunus Corporation, and ABN AMRO North America Holding Company because the BHCK3210/CEQQ<33% from 2002 to 2006 as well as UnionBanCal Corp/MUFG Americas Holdings Corporation.

[16]76 and 75 large banks report MBS and ABS in 2006 and 2007 fiscal years.

[17]There are 5,748 firms with no less than 54 weekly returns from September 1, 2005 to June 30, 2007,

from 2002 to 2006, but not the remaining 1,140 firms (Table I, panel C). Firms with a history of debt financing are divided into three subgroups. 1,138 firms have accessed private debt financing[18], and at least once through the 97 leading intermediaries. 447 firms have only accessed private debt and only through peripheral intermediaries. 773 firms have a history of access to corporate bonds (or public debt) through leading intermediaries.

5 Empirical Results

We report the test results for three hypotheses. The main dependent variable is *Market Beta*. Each firm has two exposures in two 96-week subperiods: (1) the pre-subprime crisis period from September 1, 2005, to June 30, 2007, and (2) the in-subprime crisis period from August 1, 2007, to May 31, 2009. The main independent variable is a dummy *In Crisis*, equal to one during the subprime crisis period and zero before. We incorporate firm characteristics, including book-to-market (logBM), capitalization (LogME), leverage, and illiquidity, to control for possible sources of firm-level beta variation unrelated to risk exposure to a systemic event. We also control industry fixed effects on Fama French 12-industry classification. Standard errors are clustered at the PERMNO level. Key variables are defined in the paper when it is first applied, and all definitions are summarized in the online appendix. The summary statistics are reported in Table II.

[Insert Table II about here]

5.1 Distance to large banks and isolation benefit

We begin with all 3,518 sample firms to test Hypothesis 1, whether keeping a distance from the leading intermediary group offers isolation benefits. Table III reports the results of

and 4,997 firms with no less than 54 weekly returns from August 1, 2007 to May 31, 2009. Combined, we have 4,555 unique nonutility firms, of which 3,518 are nonfinance and nonutility firms.

[18]We use the terminology of private debt to include bank loans and lines of credit.

the regression (16) for different subsample firms.

$$Market\ Beta_{it} = \alpha + \beta_1 \cdot In\ Crisis_t + \delta \cdot firm\ controls_{it} + \gamma \cdot industry\ effect + \varepsilon_{it}. \quad (16)$$

Although firms with measured historical debt financing report significantly higher market beta during the subprime crisis period (Table III, column 1), the average in-crisis beta is lower for firms without a history of debt financing (Table III, column 2). The comparison base is the market beta before the subprime crisis. At least 1,000 firms with no history of debt financing between 2002 and 2006 enjoyed the crisis isolation benefit (a lower exposure) during the subprime mortgage crisis.

[Insert Table III about here]

Next, we focus on 2,378 firms with a history of debt financing. Among firms with access to private debt, market beta increased significantly during the subprime crisis period for 1,138 firms with a history of lender-borrower relationships through leading intermediaries (Table III, column 4), but not for 447 firms only through peripheral intermediaries (Table III, column 3). For the 773 firms with access to corporate bonds through leading intermediaries, regardless of whether they have a history of private debt financing, their beta during the subprime crisis increased significantly (Table III, column 5).

The outbreak differentials confirm the lender-borrower relationship in Hypothesis 1. Borrowers without a direct relationship with the leading intermediaries are less sensitive to the subprime crisis period. We also note the significant coefficients of the control variables *size* and *leverage*, to which we return later.

5.2 Risk exposure and revenue priority

Next, we zoom in on all firms with a history of debt financing. Assume that a bank has decided to unload a certain amount of corporate debt and that two borrowers are alternatives.

Both firms (A and B) have borrowed bank loans, but firm A has additional access to corporate bonds. Will the bank keep firm A and drop firm B?

To test the bond priority channel (the alternative access to bond markets in the lending channel), we narrow the sample firms to 2,378 firms with a debt financing history and separate them into two subgroups. Firms that only borrow private debt are the 'control' versus firms that are 'treated' because each has at least one instance of access to public bonds. We run a difference-in-difference (DID) regression in (17).

$$\begin{aligned} \textit{Market Beta}_{it} = \alpha &+ \beta_1 \cdot \textit{In Crisis}_t + \beta_2 \cdot \textit{Public bond access}_i \\ &+ \beta_3 \cdot \textit{In Crisis}_t \times \textit{Public bond access}_i \\ &+ \delta \cdot \textit{firm controls}_{it} + \gamma \cdot \textit{industry effect} + \varepsilon_{it}. \end{aligned} \tag{17}$$

The *public bond access* is measured by *Bond history*, which takes a value of one (1) for the 773 firms that have access records to the corporate bond market from 2002 to 2006, or *Bond rating*, which takes a value of one (1) if the firms have a bond rating at the end of 2006 (but did not necessarily issue bonds). We consider the rating of bonds as an alternative measure of a firm's ability to access the public bond market (Faulkender and Petersen, 2006). The remaining firms without an actual bond history or a bond rating are coded as zero (0) for both indicator variables. The test results are reported in Table IV, panel A.

The coefficients of interaction terms are important, as in all finance literature. However, we are interested in whether a borrower reports a higher risk exposure during the subprime crisis due to its prior connections with large banks because the latter practiced unsustainable risk-taking. Therefore, we focus on the combined coefficients of *public bond access* and its interaction with the *In Crisis* dummy. The coefficients of *Bond history* or *Bond rating* are positive but insignificant. Therefore, we cannot reject the null that access to public bond markets does not affect the pre-subprime period. The coefficient on the interaction term *In Crisis* × *Bond rating* is positive and statistically significant (Table IV, panel A, column

2). Together, borrowers with bond market ratings were more sensitive to market risk than those without such ratings during the subprime crisis when the dominant lender group held nonperforming assets.

[Insert Table IV about here]

Next, we turn to the revenue priority channel. Intuitively, banks prefer higher revenue borrowers, so the latter is less likely to be on the shelf when a bank has to drop some customers. We generate four relationship measures following the lending channel literature.

Following Ivashina et al. (2009), we generate two quantity measures. First, the dollar amount of loans/lines of credit of a borrower, denoted by *Relationship intensity (Exposure, bn$)*. Second, the number of loans/lines of credit of a borrower, denoted by *Relationship intensity (N)*. Each measure is between a borrower i and its leading intermediary m in the 5 years from 2002 to 2006. If a borrower has established connections to multiple leading intermediaries, we choose the intermediary with the strongest connection on each measure in the five-year period[19]. We also generate two ratio measures following Bharath et al. (2011). Third, the dollar amount of loans with a lender is divided by this borrower's total amount of loans during the same 5-year period, denoted by *REL (Amount)*. Fourth, the number of loans/lines of credit divided by the total number of loans by borrower, denoted by *REL(Number)*.

In our laboratory, two quantity measures reveal additional information from a lender's perspective. *Relationship intensity (Exposure, bn$)* distinguishes the higher amount of dollar borrowing across borrowers, and *Relationship intensity (N)* indicates a higher number of borrowing facilities. Scaled by the total borrowing dollar or the total number of facilities, the ratio measures have significantly reduced the borrowing variations across borrowers.

[19] As shown in Table II, the median value for REL(Number), REL(Amount), Relation Intensity (Exposure, bn$), and Relationship Intensity (N) is 1, 0.63, $0.3 billion, and 2, respectively.

Table IV panel B reports the results of the DID regression (18).

$$\begin{aligned} \textit{Market Beta}_{it} = \alpha &+ \beta_1 \cdot \textit{In Crisis}_t + \beta_2 \cdot \textit{Relationship intensity}_i \\ &+ \beta_3 \cdot \textit{In Crisis}_t \times \textit{Relationship intensity}_i \\ &+ \delta \cdot \textit{firm controls}_{it} + \gamma \cdot \textit{industry effect} + \varepsilon_{it}. \end{aligned} \tag{18}$$

Let us start with two sets of quantity measures. In column (1), the coefficient for borrowing dollar amount (*Relationship intensity (Exposure, bn$)*) is negative and significant. However, the coefficient for the interaction term with the *In Crisis* dummy is insignificant. Companies that borrowed more in dollar amounts were exposed to lower market risk during the subprime period. In other words, these borrowers are better off.

In column (2), the coefficient for the debt facility number (*Relationship intensity (N)*) is negative and significant. However, the coefficient for the interaction term with the *In Crisis* dummy is positive and significant. Together, the combined coefficients are marginally positive (0.001). Companies that borrowed a larger number of debt facilities are exposed to increased market risk during the subprime period. In short, these borrowers are worse off.

We consolidate the difference between two quantity measures. The revenue priority suggests that borrowers with a higher historically borrowing dollar amount are safer during the subprime period. A larger number of facilities may bring higher total revenue to banks, but initiating a debt facility has a fixed cost that banks must pay. Banks can accommodate more borrowing requests during normal times if the focus is on overall dollar revenues. However, banks are sensitive to high fixed-cost customers during a crisis. Therefore, market investors predict that customers with higher loan numbers could be exposed to higher risk exposure, although the effect is marginal.

Two ratios did not pick up the benefits or costs from historically borrowing activities, as in Table IV, panel B, columns 3 and 4. Neither of the coefficients (*REL (Amount)* and *REL (Number)*) is significant, nor are the interaction terms with the dummy *In Crisis*. Since we

analyze the same borrowers, it is reasonable that it is because the ratio measures greatly reduce the revenue difference among borrowers.

We consolidate the results of instrument priority (panel A) and revenue priority (panel B). The lending channel crises documented the borrower's options to access alternative debt financing. Although the test is not on borrowing practice, the active revenue priority but the silent instrument priority suggests that alternative financing is not as efficient as in the lending channel, and market investors can predict such a risk. We move on to search for a potential explanation.

5.3 Risk exposure and collective risk-taking

In this section, we test the hypothesis of collective operations (Hypothesis 3). We generate two variables to conduct tests at three levels among 97 leading intermediaries. The first variable measures the number of *distinct* connections to the leading intermediaries. *# Conn to leading intermediaries* is defined as ln(1+# of distinct connections to the leading intermediaries). Because the test focuses on borrowers in connection with the 97 leading intermediaries only (through either private or public debt markets), our sample firms narrow down further to 1,911 borrowers.

$$\begin{aligned} \textit{Market Beta}_{it} = \alpha &+ \beta_1 \cdot \textit{In Crisis}_t + \beta_2 \cdot \textit{Bond history}_i + \beta_3 \cdot \textit{In Crisis}_t \times \textit{Bond history}_i \\ &+ \beta_4 \cdot \textit{\# Conn to leading intermediaries}_i \\ &+ \beta_5 \cdot \textit{In Crisis}_t \times \textit{\# Conn to leading intermediaries}_i \\ &+ \delta \cdot \textit{firm controls}_{it} + \gamma \cdot \textit{industry effect} + \varepsilon_{it} \end{aligned} \tag{19}$$

In the difference-in-difference specifications (19), the main coefficients of interest are those in *# Conn to leading intermediaries* and the interaction of *In Crisis* × *# Conn to leading intermediaries*. To control for the potential difference of public vs. private debt access discussed above, we retain our 0/1 indicator associated with firms that have a history of

access to the corporate bond market, *Bond history*, as well as the interaction of that variable with the *In Crisis* indicator. Table V, panel A reports the results of the regression (19).

The coefficient of the number of connections to the leading intermediaries, *# Conn to leading intermediaries*, is both negative and significant in column 2 and column 3, panel A, Table V. During normal times, multiple connections to the leading intermediaries indeed reduce the market risk exposure of these borrowers. The coefficients for interaction with *In Crisis* are positive and statistically significant in columns (2) and (3), with additional control for the history of the bond market. The combined coefficients are negative (-0.025), suggesting the benefits of having multibank relationships when the leading intermediaries practiced risk-taking.

[Insert Table V about here]

However, the results raise follow-up questions. The core test of Hypothesis 3 is about the collective operations of two bank connections versus one connection. Furthermore, we are interested in the role of larger banks. To answer the two questions, we test the spillover effects of collective operations of the top 20 leading intermediaries and restrict borrowers to these intermediaries only. The selected borrowers and leading intermediaries are more homogeneous than the sample in Table V, panel A. However, the side effect is that the borrower sample is smaller.

We have adjusted the test design as in regression (20). The control sample is selected if a borrower has one and only one connection with the top 20 banks. We consider two possible treatment samples: borrowers in treatment group A (treatment B) have established exactly two (more than two) distinct connections with the top 20 banks. The key independent variable of interest is *More core connections*, which is equal to one if a borrower has more than one connection to the top 20 banks and zero otherwise. If treatment groups A and B deliver different results, we can further differentiate the effects from collective operations (of

two banks) versus more than two banks. The results are reported in Table V, panel B.

$$\begin{aligned} \textit{Market Beta}_{it} = \alpha &+ \beta_1 \cdot \textit{In Crisis}_t + \beta_2 \cdot \textit{Bond history}_i + \beta_3 \cdot \textit{In Crisis}_t \times \textit{Bond history}_i \\ &+ \beta_4 \cdot \#\ \textit{More core connections}_i \\ &+ \beta_5 \cdot \textit{In Crisis}_t \times \#\ \textit{More core connections}_i \\ &+ \delta \cdot \textit{firm controls}_{it} + \gamma \cdot \textit{industry effect} + \varepsilon_{it} \end{aligned} \tag{20}$$

The interaction terms *In Crisis* × *More core connections* are positive and significant in all four specifications. The combined coefficients are positive, indicating that borrowers are exposed to higher market risk due to more than one connection to the top 20 leading intermediaries when the latter practiced risk-taking during the subprime crisis period.

Finally, we conduct a further focused analysis where the lender group includes only the top 4 U.S. banks specialized in the syndicated loan/lines of credit markets. The top 4 (by the end of 2006) are Citigroup, J.P. Morgan, Bank of America, and Wachovia. All borrowers are filtered with connections to the top 4 banks only. The control sample has only one relationship, but the treatment sample has precisely two distinct connections or more than two connections. The test results are reported in panel C, Table V.

The results of having two connections to the top 4 U.S. banks are similar to what we documented for the top 20 core banks in Table V, panel C, columns (1) and (2). Borrowers are worse off due to collective operations. However, diversification benefits dominate when a borrower has established connections with most of the top four banks, at 10% significant level, Table V, panel C, columns (3) and (4).

We summarize and consolidate the explanations for the collective spillover. When a large bank is forced to downsize under capital constraints, its customers are subject to ex-ante dropout risk. Before the release of the dropout list, market investors predict that all lenders prioritize exclusive borrowers over customers with more than one connection for revenue reasons. A borrower with two connections has a higher exposure to elevated market risk than

another borrower with two connections. This is the collective operation channel. However, when a company is well connected (with more than two bank relationships), the spillovers from collective operations could be offset by the benefits of multibank relationships.

5.4 Robustness tests

We have conducted several robustness tests and report three results here. The first is on a borrower-matched sample test. In addition to the relationship between risk exposure and connections to the leading intermediaries, the test results show that higher exposures are naturally associated with two firm characteristics, market capitalization, and leverage. To appreciate the difference, we report the size and leverage of the four subsample firms in Table VI, panel A. All numbers are from the pre-subprime crisis period.

The observed variation in firm size is pronounced. In particular, nonfinancial firms with connections to the private debt market through peripheral intermediaries are generally the smallest. In contrast, firms with connections to the public debt market (through the leading intermediaries) are generally the largest. Non-financial firms without any record of debt financing pre-subprime crisis report close to zero leverage, especially at the median. The pattern is similar to that of (Strebulaev and Yang, 2013). The leverage ratios of the other three subsamples are larger than zero and quite different from each other.

We conduct a matched sample analysis to remove the potential effects on market beta from the measured size and leverage. Treatment firms (those with access to debt financing pre-subprime crisis) and control firms (those without) are matched by firm characteristics. Three groups of treatment firms are selected from 1,138 firms with access to private debt through leading intermediaries, 447 firms with access to private debt through peripheral intermediaries, and 773 firms with access to public debt through leading intermediaries. The control firms for each treatment group are matched from 1,140 firms without measured debt financing activity pre-subprime crisis. For each pair, we match the treatment and control firm by size, leverage, book-to-market ratio, and market beta, all of which are matched based

on the pre-subprime crisis and adjusted by the individual firm's relevant industry median.

We conduct *t-test* on the equality of firm characteristics and market beta before and during the subprime crisis between treatment and control firms. Results are reported separately for each of the three matched groups in VI, panels B, C, and D.

[Insert Table VI about here]

In all three panels, the firm characteristics between treatment firms (those with a debt history) and the control firms (those without) are not significantly different after matching, either before or during the subprime crisis. However, the difference is significant in column (7), panels B and C, Table VI. Specifically, industry median adjusted market betas are statistically higher during the subprime crisis for firms with historical connections to the leading intermediaries. This is consistent with the earlier regression results. However, the difference between market beta changes is insignificant when borrowers are connected to peripheral intermediaries, column (7), panel D.

The second robustness considers an alternative exposure measure, namely a bank beta. Test results indicate that spillover can be captured by a firm's exposure to market risk. Alternatively, we can run a "large bank" factor regression, where $(Ret_{bank,t} - Ret_{rf,t})$ is the excess return on a bank factor.

$$(Ret_{i,t} - Ret_{rf,t}) = Bank\beta \times (Ret_{bank,t} - Ret_{rf,t}).$$

The bank beta is estimated by the value-weighted stock return minus the risk-free interest rate of a group of the top 97, the top 20, and the 22 large banks in FR Y-9C. We expect that firms' exposures to bank risk share similarities but reveal the difference from their exposures to market risk. The similarity is the intrinsic relationship between collective operations in risk-taking and systematic risk. The difference exists because the exposure to banks includes components other than market risk.

We first replicate the tests in Table III with three bank betas. In Table VII, panel A,

we report the coefficients of *In Crisis* for simplicity. The consistent result is that all the coefficients of *In Crisis* are negative and significant. All firms have *lower* exposure to large banks during the subprime MBS crisis period than before the crisis. The difference from the market beta coefficients in Table III is not surprising because the stock depreciation of large banks is more severe than the market index during the subprime crisis period[20].

We revisit firms with at least one connection to the top 20 leading intermediaries. Specifically, we practice the difference-in-difference regression in (20) but replace the market beta with the bank beta of 22 large banks in FR Y-9C[21]. Results are reported in Table VII, panel B. The coefficients of the bank beta ($Bank\beta$) in columns (3) and (4) show spillover effects of risk-taking similar to those of the market beta in Table V, panel B.

We consolidate the results in panels A and B of VII. Panel A adds additional information to the spillover mechanism. The risk-taking operations of large banks do not spill over directly to their borrowers. Instead, their collective risk-taking operations (holding nonperforming household debt during the subprime mortgage crisis) contribute to overall market risk. The exposure difference is evident through the historical bank-borrower relationships. The coefficients could be positive, insignificant, or negative (without debt financing history) in Table III, but the sign becomes all negative in Table VII, panel A. Next, we look at the similarity. Although market beta and bank beta do not capture the same risk, the overlapping component is their collective risk-taking during the subprime crisis. It is supported by similar results in columns (3) and (4), panels B of Table V and Table VII.

[Insert Table VII about here]

The third robustness test focuses on parallel trends. Up to now, all analyses are cross-sectional; each firm has one risk exposure before and one during the subprime crisis. In this

[20]From December 2006 to March 2009, the 97 leading intermediaries lost about 80% of market equity, as shown by the black solid line in Figure I, panel A. Meanwhile, the S&P 500 index lost about 46% of total market capitalization.

[21]Bank beta is estimated from the top 22 large banks in FR Y-9C because the available data confirm the complete cycle of developing and addressing the capital constraints. The lender-borrower relationship is with the top 20 leading intermediaries.

robustness check, we estimate the market beta for individual firms in a time-series context. The treatment and control firms are the same as in Table VI, panels B, C, and D. The firm beta is estimated from weekly returns in each calendar year from 2002 to 2010, so each firm has nine betas. The raw beta estimation is then adjusted by the industry median each year. The equal-weighted average of industry-adjusted betas are plotted in Table VIII, panel A, panel B, and panel C. Two time series for treatment firms with connections to the leading intermediaries in panel A and panel B (solid line) are significantly higher in 2008 and 2009 than the control firms matched by firm characteristics yet without a record of debt financing (dashed line). However, such a difference is not visible in panel C, where the treatment firms have records of debt financing only through peripheral intermediaries. Taken together, the time-series evidence echoes the cross-sectional evidence.

[Insert Table VIII about here]

Unreported, we have also examined three additional robustness tests (1) an asset beta (as opposed to an equity beta), (2) a time-based placebo test, and (3) an examination of return volatility. All are consistent with existing results and are available upon request.

6 Conclusion

When default events are local and idiosyncratic, bank lenders and lending banks remove nonperforming assets from the balance sheet of the intermediary sector. The conventional wisdom expects that the capital buffer in Basel III could enhance financial stability when markets are distressed, with two existing safety nets of liquidity support from regulators and fair value accounting practice. With the support of three safety nets, we can expect a resilient financial system when bank borrowers default on their debt.

Our study identifies a challenge: a wave of household default events. We show that the resilience of the banking system could be compromised with all three safety nets. In front of a wave of household defaults, regulators' liquidity supports are justified for financial

stability and a more fundamental concern. Household consumption is important for long-term economic growth. With liquidity support, keeping nonperforming debt with good collateral on the balance sheet is a rational decision when market transaction prices are dislocated. With the additional safety net of capital buffer, the decision is also rational that lending banks add more nonperforming assets with good collateral but at large discounts. Both are what happened in the 2008 crisis.

Here is a gap in the dynamic setting. Holding nonperforming assets requires funding costs, which the capital buffer has to pay. If the capital buffer is exhausted before the recovery of an orderly market, lending banks are under capital constraints. During the 2008 crisis, large banks were affected. The intermediary sector was compromised because small banks did not have the capacity to fill the service vacuum. The spillovers of risk-taking were on corporate borrowers with established bank relationships.

Households, on average, borrow more over time (Mian and Sufi, 2011), and a significant proportion of household populations are financially constrained[22]. The wave of household defaults may occur in the future. In addition, the crisis development mechanism applies to corporate borrowers. After sequential interest rate hikes, we should not be surprised by a wave of corporate defaults. How can we maintain a resilient banking system while minimizing negative impacts on all participants? Both the scope and the scale of the challenge deserve further research.

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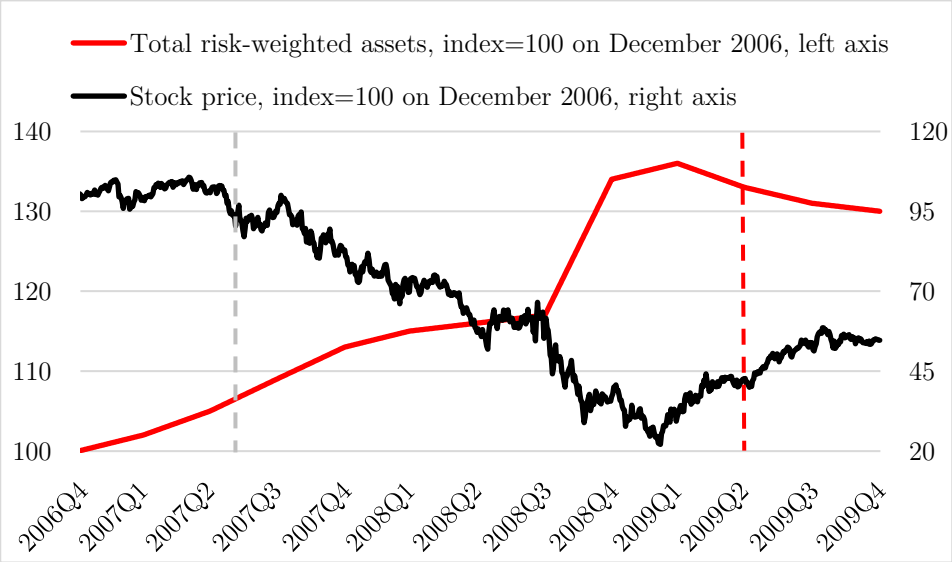
Figure I
Bank Risk-Weighted Assets, Stock Price, and Corporate Borrowing

Panel A

Panel A presents the equal-weighted index of total risk-weighted assets and stock price. The risk-weighted assets (BHCKA223) are reported in FR Y-9C for 22 large banks. The market stock price is for all 97 leading intermediaries.



Panel B

Panel B presents the number of syndicated debt offerings ($ billion) through syndicated loans, lines of credit, and corporate bonds for all CRSP-listed companies. The borrowing records are aggregated from Dealscan and FISD.

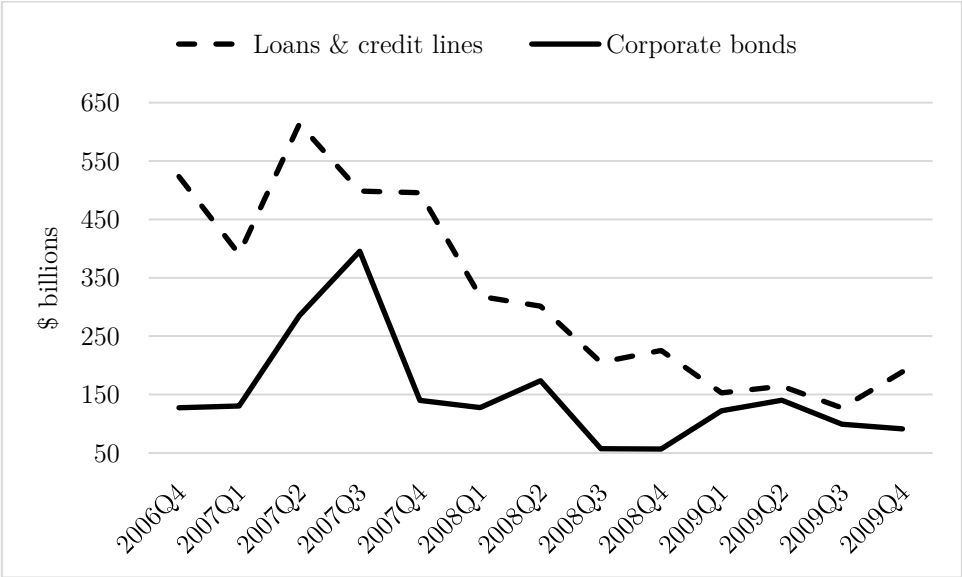


Table I
Large Banks' Basel Capital and Aggregate Borrowing

Panel A: Large banks' risk transformation, equity capital, and source of capital

This panel reports balance sheet items reported in FR Y-9C by 22 large banks overlapping with 97 leading intermediaries. Columns (1) to (4) and (6) to (8) are equal-weighted ratios or indexes. For an FR Y-9C index item (code starting with BHCK), the value of each individual bank is set equal to 100 in 2006Q4. The formula ratio is given in columns (4) and (8). The ratio of column (5) is calculated as (BHCK3210-BHCK3247)/BHCK3210.

Time	BHCKA223 total risk-weighted assets	BHCK2170 total assets	BHCK3210 total equity capital	BHCK3247 retained earnings	Calculated book equity sum of 5 items	BHCK3459 common shares outstanding	BHCK7205 total risk-based capital ratio	Calculated Ratio of total equity capital FR Y-9C/10-Q
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
2006Q4	100	100	100	100	100	100	13%	98%
2007Q1	102	104	101	103	99	100	12%	98%
2007Q2	107	109	102	106	94	100	12%	98%
2007Q3	111	113	104	108	96	99	12%	101%
2007Q4	113	114	103	104	101	98	12%	101%
2008Q1	115	116	107	103	117	100	12%	102%
2008Q2	117	116	112	102	132	102	13%	104%
2008Q3	121	126	111	100	132	103	12%	105%
2008Q4	131	134	132	90	219	110	15%	131%
2009Q1	137	136	144	91	254	117	15%	132%
2009Q2	133	135	148	92	265	136	15%	120%
2009Q3	131	136	151	92	275	212	15%	115%
2009Q4	131	135	148	90	269	238	15%	113%

Table I
Large Banks' Basel Capital and Aggregate Borrowing (continued)

Panel B: Aggregate debt borrowing and leading intermediary market share

This panel reports borrowing activity from 2002 to 2006 in two datasets: Dealscan and FISD. The Dealscan data include borrowing records through syndicate loans and lines of credit. FISD data include borrowing records through corporate bonds. We report the dollar amount of borrowing activity for all borrowers, borrowers from North America, six U.S. agencies (FHLMC, FNMA, FHLB, FFCB, IBRD, and IDB[23]), and CRSP listed companies.

	Dealscan for loans and revolvers			FISD for corporate bonds		
	Company number	Trillion dollars	Market share	Company number	Trillion dollars	Market share
Distinct leading intermediaries	87			75		
Borrowers						
All	24,729	\$15.99		4,553	\$14.19	
Through leading intermediaries	20,097	\$12.99	81.20%	4,370	\$12.74	89.81%
North American	11,919	\$7.66		3,334	\$9.46	
Through leading intermediaries	10,503	\$7.30	95.35%	3,222	\$8.41	88.87%
US agency (FHLMC, FNMA, FHLB)	2	\$0.00		3	\$3.98	
US agency (FFCB, IBRD, IDB)				3	\$0.26	
North American listed in CRSP	3,924	\$5.00		1,253	\$2.03	
Through leading intermediaries	3,432	\$4.82	96.36%	1,215	\$1.82	89.68%

Panel C: CRSP non-financial, non-utility firms and their histories of debt financing

This panel reports the history of syndicated debt financing across non-financial, non-utility firms. Syndicated debt financing includes loans, lines of credit (both as private debt), and corporate bonds (public debt). The sample includes 3,518 non-financial, non-utility CRSP listed firms from 2002 to 2006.

2,378 firms with a history of access to syndicate debt financing
1,138 firms access private debt at least once through 97 leading intermediaries
447 firms access private debt only through peripheral intermediaries
773 firms access public debt at least once through 97 leading intermediaries
20 firms access public debt only through peripheral intermediaries
1,140 firms without a record of syndicate debt financing

[23]Federal Home Loan Mortgage Corporation(FHLMC), Federal National Mortgage Association (FNMA), Federal Home Loan Banks (FHLB), Federal Farm Credit Banks Funding Corporation(FFCB), International Bank for Reconstruction and Development (IBRD), and Inter-American Development Bank (IDB).

Table II
Summary Statistics

This panel reports summary statistics for the variables used in this study. Variable definitions are summarized in the online Appendix.

Variable	N	Mean	25th	Median	75th	SD
All companies						
Market beta before subprime crisis	4,555	1.0245	0.5787	1.0317	1.4425	0.6304
financial firms	1,037	0.7345	0.2460	0.7754	1.0971	0.5517
non-financial, non-utility firms	3,518	1.1099	0.6835	1.1131	1.5317	0.6268
Market beta in subprime crisis	4,555	1.1270	0.7285	1.0666	1.4584	0.5861
financial firms	1,037	1.1193	0.6149	1.0444	1.5171	0.6782
non-financial, non-utility firms	3,518	1.1293	0.7491	1.0706	1.4469	0.5561
Distinct connections to leading intermediaries	2,309	3.8146	1	2	5	4.0022
for financial	398	4.6784	1	3	6	4.6099
for non-financial	1,911	3.1198	1	2	4	2.9284
Relation Intensity (Exposure, bn$)	2,028	0.9249	0.05	0.2988	0.85	2.0517
Relation Intensity (N)	2,029	3.3056	1	2	5	3.1201
REL(Amount)	2,028	0.6384	0.4633	0.6353	1	0.3314
REL(Number)	2,029	0.7671	0.6	1	1	0.3338
Leverage	4,516	0.1931	0.0140	0.1400	0.2979	0.2007
Book to Market	4,110	-0.7121	-1.2162	-0.7161	-0.2926	1.0465
Size	4,126	6.2216	4.8695	6.0875	7.4286	1.9061
Illiquidity	4,549	0.9929	0.0011	0.0085	0.1228	5.7785

Table III
Risk Exposure Before and During Subprime Crisis, All firms

This table reports the regression results for different subsample firms. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime mortgage crisis. The key independent variables are *In Crisis*. Columns (1) and (2) include firms with and without a history of debt financing; Columns (3) and (4) include firms with access to private debt through peripheral intermediaries and through leading intermediaries; Column (5) includes firms with access to public debt through leading intermediaries. Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors, clustered at the PERMNO level, and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta					
	History of debt financing	Without history of debt financing	Private debt thru peripheral intermediaries	Private debt thru leading intermediaries	Public debt thru leading intermediaries
	(1)	(2)	(3)	(4)	(5)
In Crisis	0.064***	-0.081***	0.054	0.061***	0.070***
	(4.63)	(-3.57)	(1.47)	(3.02)	(3.32)
Leverage	0.327***	0.165*	0.091	0.252***	0.445***
	(6.13)	(1.74)	(0.69)	(3.27)	(4.39)
Book to Market	-0.012	-0.004	-0.041	-0.004	-0.004
	(-1.24)	(-0.33)	(-1.35)	(-0.38)	(-0.19)
Size	0.039***	0.098***	0.139***	0.067***	-0.053***
	(6.92)	(11.90)	(7.44)	(7.16)	(-4.92)
Illiquidity	-0.001***	0.000	-0.000	-0.002***	-0.005***
	(-3.16)	(1.29)	(-0.23)	(-3.06)	(-4.99)
Industry F.E.	Y	Y	Y	Y	Y
Adjusted R^2	0.1125	0.1103	0.1605	0.1229	0.1869
# of firms	2,378	1,140	447	1,138	773

Table IV
Instrument Priority, Revenue Priority and Risk Exposure

Panel A: Public debt priority and risk exposure

This table reports the results of difference-in-difference regression. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime crisis. The key independent variables are *In Crisis*, *Bond Rating*, and *Bond history*. Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta		
	Access to private or public debt	
	(1)	(2)
In Crisis	0.039	0.033*
	(1.49)	(1.91)
Bond Rating		0.025
		(0.93)
In Crisis × Bond Rating		0.108***
		(3.72)
Bond history	-0.019	
	(-0.68)	
In Crisis × Bond history	0.036	
	(1.17)	
Leverage	0.328***	0.272***
	(6.10)	(4.96)
Book to Market	-0.012	-0.018*
	(-1.23)	(-1.84)
Size	0.039***	0.031***
	(6.88)	(5.10)
Illiquidity	-0.001***	-0.001***
	(-3.15)	(-3.17)
Industry F.E.	Y	Y
Adjusted R^2	0.1128	0.1173
Company number	2,378	2,378

Panel B: Revenue priority and risk exposure

This table reports difference-in-difference regressions. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime crisis. The key independent variables are *In Crisis, Relation Intensity (Exposure, bn$), Relation Intensity (N), REL (Amount),* and *REL (Number).* Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta				
	Private debt history through 97 leading intermediaries			
	(1)	(2)	(3)	(4)
In Crisis	0.061***	0.008	0.117**	0.171**
	(2.82)	(0.25)	(2.08)	(2.06)
Relation Intensity (Exposure, bn$)	-0.035***			
	(-3.19)			
In Crisis × Relation Intensity (Exposure, bn$)	-0.002			
	(-0.27)			
Relation Intensity (N)		-0.016***		
		(-2.72)		
In Crisis × Relation Intensity (N)		0.017**		
		(2.40)		
REL(Amount)			0.005	
			(0.07)	
In Crisis × REL(Amount)			-0.074	
			(-1.05)	
REL(Number)				0.011
				(0.13)
In Crisis × REL(Number)				-0.128
				(-1.38)
Leverage	0.288***	0.280***	0.236***	0.240***
	(3.74)	(3.54)	(2.96)	(3.07)
Book to Market	0.004	-0.003	-0.007	-0.005
	(0.35)	(-0.24)	(-0.59)	(-0.47)
Size	0.078***	0.069***	0.064***	0.066***
	(7.68)	(7.20)	(6.44)	(7.05)
Illiquidity	-0.002***	-0.002***	-0.002***	-0.002***
	(-3.00)	(-3.04)	(-3.00)	(-3.00)
Industry F.E.	Y	Y	Y	Y
Adjusted R^2	0.1266	0.1236	0.1215	0.1220
# of firms	1,138	1,138	1,138	1,138

Table V
Collective Operations and Risk Exposure

Panel A: Exclusive relationship vs. multi-connections, 97 leading intermediaries
This table reports difference-in-difference regressions. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime crisis. The key independent variables are *In Crisis* and *# Conn to leading intermediaries*. Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at the PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta			
	Access to private or public debt through 97 leading intermediaries		
	(1)	(2)	(3)
In Crisis	0.040	-0.019	-0.025
	(1.46)	(-0.51)	(-0.63)
Bond history	0.004		0.022
	(0.14)		(0.71)
In Crisis × Bond history	0.033		0.013
	(1.01)		(0.39)
# Conn to leading intermediaries		-0.084***	-0.087***
		(-3.20)	(-3.26)
In Crisis × # Conn to leading intermediaries		0.065***	0.062**
		(2.61)	(2.45)
Leverage	0.386***	0.437***	0.425***
	(6.47)	(7.11)	(6.86)
Book to Market	-0.006	0.002	0.004
	(-0.57)	(0.16)	(0.36)
Size	0.019***	0.030***	0.029***
	(2.80)	(3.70)	(3.58)
Illiquidity	-0.002***	-0.002***	-0.002***
	(-3.47)	(-3.40)	(-3.46)
Industry F.E.	Y	Y	Y
Adjusted R^2	0.1185	0.1206	0.1211
Company number	1,911	1,911	1,911

Panel B: Exclusive relationship vs. multi-connections, top 20 leading intermediaries

This table reports difference-in-difference regressions. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime crisis. The key independent variables are *In Crisis* and *More core connections*. Control and treatment borrowers have one or more than one connection to the top 20 leading intermediaries (accounting for 89% of debt financing undertaken by all 97 leading intermediaries). There are two groups of treatment borrowers. Treatment borrowers in columns (1) and (2) have exactly two distinct connections, but more than two connections in columns (3) and (4). Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at the PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta				
	Access to private debt or public debt through the top 20 leading intermediaries			
	Only one connection vs. exact two distinct connections		Only one connection vs. more than two distinct connections	
	(1)	(2)	(3)	(4)
In Crisis	-0.080**	-0.028	-0.083**	-0.077
	(-2.43)	(-0.59)	(-2.54)	(-1.63)
Bond history		0.048		0.035
		(0.99)		(0.69)
In Crisis × Bond history		-0.086		-0.011
		(-1.52)		(-0.18)
More core connections	-0.030	-0.029	-0.132***	-0.138***
	(-0.55)	(-0.52)	(-2.59)	(-2.62)
In Crisis × More core connections	0.201***	0.200***	0.222***	0.225***
	(3.18)	(3.18)	(4.11)	(4.05)
Leverage	0.391***	0.383***	0.290***	0.275**
	(3.44)	(3.33)	(2.76)	(2.55)
Book to Market	-0.015	-0.016	0.010	0.011
	(-0.73)	(-0.75)	(0.51)	(0.54)
Size	0.058***	0.058***	0.038***	0.037**
	(3.93)	(3.89)	(2.64)	(2.56)
Illiquidity	-0.003***	-0.003***	-0.003***	-0.003***
	(-7.78)	(-7.91)	(-8.46)	(-8.38)
Industry F.E.	Y	Y	Y	Y
Adjusted R^2	0.1354	0.1370	0.1225	0.1232
Firm number	524	524	545	545

Panel C: Exclusive relationship vs. multi-connections, top 4 U.S. banks

This table reports difference-in-difference regressions. The dependent variable is firm-level market beta, estimated in two periods before and during the subprime crisis. The key independent variables are *In Crisis* and *More core connections*. All borrowers have connections only to the top 4 U.S. financial institutions by the end of 2006, specializing in syndicate loans and credit lines, which are Citigroup, J.P. Morgan, Bank of America, and Wachovia. The key independent variables include *In Crisis* and *More core connections*. There are two groups of treatment borrowers. Treatment borrowers in columns (1) and (2) have exactly two distinct connections, but more than two distinct connections in columns (3) and (4). Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Dependent variable: Market Beta				
	Access to private debt or public debt through the top 4 U.S. bank			
	Only one connection vs. exact two distinct connections		Only one connection vs. more than two distinct connections	
	(1)	(2)	(3)	(4)
In Crisis	-0.038	-0.008	-0.035	-0.020
	(-1.03)	(-0.16)	(-0.96)	(-0.38)
Bond history		0.028		-0.020
		(0.48)		(-0.33)
In Crisis × Bond history		-0.054		-0.027
		(-0.80)		(-0.39)
More core connections	-0.122*	-0.123*	-0.181*	-0.181*
	(-1.71)	(-1.74)	(-1.69)	(-1.69)
In Crisis × More core connections	0.269***	0.273***	0.110	0.116
	(3.08)	(3.13)	(0.88)	(0.93)
Leverage	0.071	0.069	-0.052	-0.036
	(0.47)	(0.44)	(-0.33)	(-0.23)
Book to Market	0.020	0.019	0.057	0.056
	(0.62)	(0.61)	(1.53)	(1.48)
Size	0.070***	0.070***	0.093***	0.094***
	(3.80)	(3.76)	(4.34)	(4.35)
Illiquidity	-0.003***	-0.003***	-0.002***	-0.002***
	(-7.99)	(-8.07)	(-6.39)	(-6.37)
Industry F.E.	Y	Y	Y	Y
Adjusted R^2	0.1438	0.1445	0.1642	0.1654
Firm number	349	349	286	286

Table VI
Matching by Firm Characteristics and Risk Exposure

The panel A reports the size and leverage of four subsample firms. Panels B, C, and D report treatment and control matching sample tests. The treatment firms in Panel B (Panel C) are selected from 773 (1,138) firms with access to public (private) debt through the leading intermediaries. The treatment firms in Panel D are selected from 447 firms with access to private debt through peripheral intermediaries. The control firms for Panels B, C, and D are selected from 1,140 firms without a history of debt financing from 2002-2006. The treatment and control firms are matched by precrisis market beta, size, leverage, and book-to-market ratios, adjusted by industry median. Variable definitions are summarized in the online Appendix. The industry classification follows the Fama-French 12-sectoral definition.

Panel A: Firm size and leverage

	private debt leading inst.	private debt peripheral inst.	public debt leading inst.	without history of debt financing
	(1)	(2)	(3)	(4)
Size, $mn, mean	2,414	516	10,696	1,049
Size, $mn, median	602	168	2,832	182
Leverage, mean	0.2026	0.1461	0.3149	0.0884
Leverage, median	0.1731	0.0793	0.2851	0.0015
Firm number	1,138	447	773	1,140

Panel B: Treatment: access to public debt through leading intermediaries

	firm number	unique firms	Beta before crisis	Size	Leverage	B/M	Beta in crisis	Size	Leverage	B/M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	158	140	0.1342	1.212	0.0977	0.0134	0.2418	1.2599	0.0839	0.0408
Control	158	146	0.1331	1.0276	0.0886	0.0441	0.0971	1.0749	0.0598	-0.044
t-statistic			0.02	0.94	0.46	-0.25	2.66***	0.84	1.1	0.69

Panel C: Treatment: access to private debt through leading intermediaries

	firm number	unique firms	Beta before crisis	Size	Leverage	B/M	Beta in crisis	Size	Leverage	B/M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	510	452	-0.0272	-0.1679	0.0010	0.0868	0.0750	-0.1690	0.0062	0.1111
Control	510	440	-0.0288	-0.2298	0.0037	0.0432	-0.0282	-0.3491	-0.0008	0.0296
t-statistic			0.04	0.63	-0.26	0.65	3.28***	1.54	0.55	1.21

Panel D: Treatment: access to private debt through peripheral intermediaries

	firm number	unique firms	Beta before crisis	Size	Leverage	B/M	Beta in crisis	Size	Leverage	B/M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treatment	295	282	-0.2110	-1.1325	-0.0058	-0.0271	-0.0361	-1.0780	-0.0163	-0.0344
Control	295	249	-0.2067	-1.1404	-0.0098	0.0117	-0.0444	-1.2640	-0.0351	-0.0354
t-statistic			-0.08	0.07	0.30	-0.52	0.19	1.38	1.22	0.01

Table VII
Alternative Risk Exposure and Collective Risk-Taking

This table reports the alternative risk exposure measured by the bank beta. In Panel A, the dependent variable is the individual firm's bank beta measured through three bank groups: 97 leading intermediaries, the top 20 leading intermediaries, and the top 22 U.S. banks in FR Y-9C. In Panel B, the bank beta is measured by the top 22 U.S. banks in FR Y-9C. The key independent variables are *In Crisis* and *More core connections*. Variable definitions are summarized in the online Appendix. Industry fixed effects are included at the FF 12 sectoral level. Heteroskedasticity-consistent standard errors clustered at PERMNO level and t-statistics are reported in brackets. The symbols *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: All firms and three bank beta

Key independent variable: In Crisis					
	History	Without	Private debt thru		Public debt
Dependent variable:	of debt financing	history of debt financing	peripheral intermediaries	leading intermediaries	thru leading intermediaries
Bank Beta of	(1)	(2)	(3)	(4)	(5)
Top 20 banks	-0.269***	-0.297***	-0.229***	-0.282***	-0.276***
	(-32.17)	(-19.00)	(-9.87)	(-23.02)	(-22.64)
Top 97 banks	-0.277***	-0.302***	-0.223***	-0.290***	-0.292***
	(-28.77)	(-16.84)	(-8.34)	(-20.64)	(-20.69)
FR Y-9C 22 banks	-0.204***	-0.216***	-0.146***	-0.221***	-0.216***
	(-23.60)	(-12.93)	(-6.07)	(-17.62)	(-16.88)
Industry F.E.	Y	Y	Y	Y	Y
# of firms	2,378	1,140	447	1,138	773

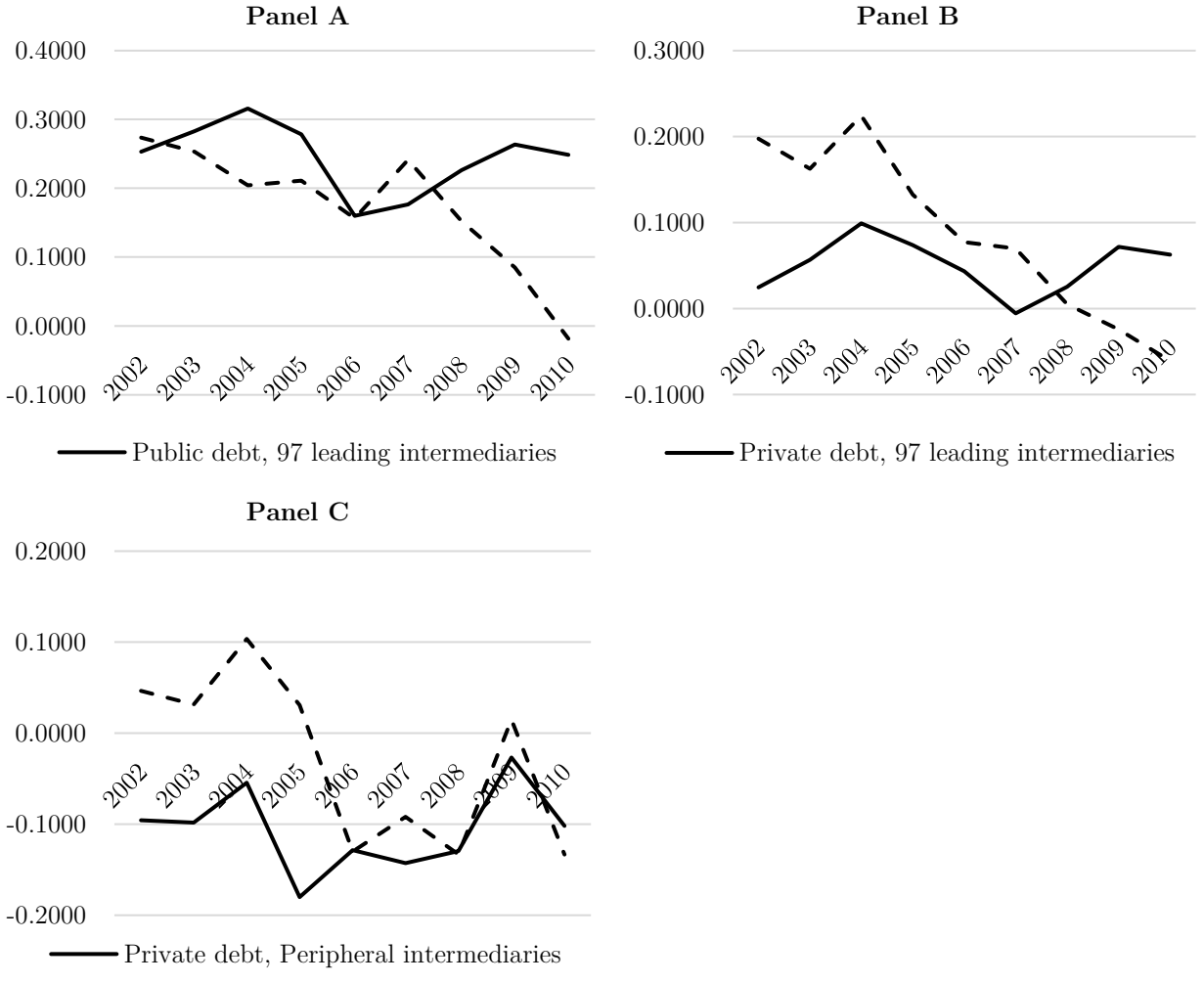
Panel B: Bank beta and collective risk-taking

There are two groups of treatment borrowers. Treatment borrowers in columns (1) and (2) have exactly two distinct connections to the top 20 leading intermediaries, but more than two distinct connections in columns (3) and (4).

Dependent variable: Bank Beta (FR Y-9C 22 large banks)				
	Access to private debt or public debt through the top 20 leading intermediaries			
	Only one connection vs. exact two distinct connections		Only one connection vs. more than two distinct connections	
	(1)	(2)	(3)	(4)
In Crisis	-0.276***	-0.261***	-0.276***	-0.274***
	(-13.91)	(-9.32)	(-13.92)	(-9.49)
Bond history		0.008		0.011
		(0.25)		(0.34)
In Crisis × Bond history		-0.024		-0.005
		(-0.72)		(-0.13)
More core connections	-0.011	-0.011	-0.066**	-0.068**
	(-0.34)	(-0.34)	(-2.05)	(-2.04)
In Crisis × More core connections	0.053	0.052	0.072**	0.073**
	(1.48)	(1.47)	(2.22)	(2.17)
Leverage	0.212***	0.213***	0.139***	0.135**
	(3.84)	(3.78)	(2.72)	(2.55)
Book to Market	-0.000	-0.000	0.007	0.008
	(-0.02)	(-0.04)	(0.65)	(0.66)
Size	0.033***	0.033***	0.024***	0.024***
	(4.48)	(4.42)	(3.42)	(3.31)
Illiquidity	-0.001***	-0.001***	-0.001***	-0.001***
	(-5.41)	(-5.51)	(-5.68)	(-5.71)
Industry F.E.	Y	Y	Y	Y
Adjusted R^2	0.2656	0.2660	0.2500	0.2502
# of firms	524	524	545	545

Table VIII
Risk Exposure Variations in Parallel Trends

This table reports industry-adjusted market beta in time series. We use 52 weekly stock returns to estimate the market beta for each firm in each calendar year from 2002 to 2010. Each market beta is then adjusted annually by its industry median. The equal-weighted average of industry-adjusted betas is plotted for the matching sample in the three panels. In the Panel A, the treatment includes 773 firms with access to public debt through leading intermediaries. In Panel B, the treatment includes 1,138 firms with access to private debt through leading intermediaries. In Panel C, the treatment includes 447 firms with access to private debt through peripheral intermediaries. All controls are selected from 1,140 firms without a history of debt financing in Dealscan or FISD. For each pair, we match the treatment and control firm by size, leverage, book-to-market ratio, and market beta, all of which are matched based on pre-subprime crisis measurements and adjusted by the individual firm's relevant industry median. The dash lines in the three panels are the market beta of matched firms without a history of debt financing.



Appendix: Top 20 of 97 leading intermediaries

This appendix reports the names of the top 20 of the 97 leading intermediaries ranked by syndicate debt offering (SYN debt offering) in dollar amount in Dealscan and FISD from 2002 to 2006. We also report on their total assets in the fourth quarter of 2006 (AT 2006Q4). Units are in millions of dollars.

Ranking	Compustat Company Name	AT 2006Q4	SYN debt offering
1	Citigroup Inc	1,884,318	3,598,292
2	JP Morgan Chase & Co	1,351,520	3,115,960
3	Bank Of America Corp	1,459,737	1,527,199
4	Deutsche Bank AG	1,486,286	1,228,639
5	Merrill Lynch & Co Inc	841,299	941,075
6	UBS AG	1,965,159	891,239
7	Credit Suisse Group	1,030,512	839,054
8	Morgan Stanley	1,120,645	836,459
9	ABN-Amro Holdings NV	1,302,628	797,832
10	Goldman Sachs Group Inc	838,201	768,252
11	Lehman Brothers Holdings Inc	503,545	727,189
12	Barclays Plc	1,952,307	638,482
13	HSBC Holdings Plc	1,860,758	559,042
14	BNP Paribas	1,900,821	462,846
15	Wachovia Corp	707,121	458,616
16	Nomura Holdings Inc	310,251	413,344
17	MIZUHO Financial Group Inc	1,275,865	379,841
18	Royal Bank Of Scotland Group	1,706,787	350,421
19	Bear Stearns Companies Inc	350,433	317,392
20	Mitsubishi UFJ Financial Grp	1,607,759	292,871

Online Appendix: variable definition

Variable	Definition
In Crisis	It is the short name for a period during the subprime mortgage crisis. It is a dummy variable equal to one in the period from August 1, 2007 to May 31, 2009 (in-subprime crisis) or zero for the period from September 1, 2005 to June 30, 2007 (pre-subprime crisis).
Leading intermediaries	Leading intermediaries share two criteria: large and active. By large, the leading intermediaries account for 74.8% of total assets in the finance industry (SICCD 6000-69999) by the end of 2006. By active, the leading intermediaries take dominant market shares in syndicate debt offerings as the lead agent or bank for bank loans, credit lines, and corporate bonds from 2002 to 2006. 80% is the cutoff for the dominant market share. Please refer to Section 4.1 for details.
# Conn to leading intermediaries	Ln (distinct connection(s) to the 97 leading intermediaries +1).
More core connections	A dummy variable equal to one if a firm has two or more distinct connections to the top 20 leading intermediaries (top 4 U.S. lead banks) or zero otherwise.
Bond history	Non-financial firms with debt financing records in FISD from 2002 to 2006 through leading intermediaries, regardless of a history of access to credit lines or loans.
Bond rating	Non-financial firms with bond ratings (but did not necessarily issue bonds) by the end of 2006, or zero otherwise.
Relationship intensity (Exposure) (bn$)	The amount of loans/revolvers (bn$) by leading intermediary m to borrower i in 5 years from 2002 to 2006. We pick up the intermediary with the highest value for a borrower with access to multiple leading intermediaries. This measure is similar to the measure of Loan intensity (exposure) in Ivashina, Nair, Saunders, Massoud, and Stover (2008).
Relationship intensity (N)	Number of loans/revolvers by leading intermediary m to borrower i in 5 years from 2002 to 2006. We pick up the intermediary with the highest quantity for a borrower with access to multiple leading intermediaries. This measure is similar to the measure of Loan intensity (N) in Ivashina, Nair, Saunders, Massoud, and Stover (2008).
REL(Amount)	Amount of loans ($) by leading intermediary m to borrower i in 5 years from 2002 to 2006 divided by the total amount of loans by borrower i in the same period. We pick up the intermediary with the highest value for a borrower with access to multiple leading intermediaries. This measure is similar to that in Bharath, Dahiya, Saunders, and Srinivasan (2009).

REL(Number)	Number of loans/revolvers by liquidity provision institution m to borrower i in 5 years from 2002 to 2006 divided by the total number of loans by borrower i in the same period. For a borrower with access to multiple intermediaries, we pick up the intermediary with the highest quantity. This measure is similar to that in Bharath, Dahiya, Saunders, and Srinivasan (2009).
Size	LogME =log(MKVALT) in 2006 and 2008.
Book to market (B/M)	LogBM =log(sum(CEQ,TXDB)/MKVALT) in 2006 and 2008.
Illiquidity	Illiquid measure follows Amihud (2002). $$ILLIQ_{iy} = 1/D_{iy} \sum_{t=1}^{D_{iy}} \left|R_{iyd}\right| / VOLD_{ivyd}$$ Before crisis Amihud is measured by trading days in the period from January 1, 2006 to December 31, 2006. In crisis Amihud is measured by trading days from January 1, 2008 to December 31, 2008.
Leverage	Leverage=sum(DLC,DLTT)/AT in 2006 and 2008. The measure follows Ivashina and Scharfstein (2010).
Market Beta	The Market Beta is estimated by CAPM for individual firms in two subperiods before 2009Q2. Each beta is estimated by weekly stock returns in 96 weeks. The pre-subprime crisis period covers the first 96-week from September 1, 2005 to June 30, 2007. The in-subprime period covers the second 96-week from August 1, 2007 to May 31, 2009. The two subperiods are separated by July 2007.
Bank Beta	Bank beta is estimated through CAPM by replacing the market risk premium with the value-weighted stock return of large banks minus the risk-free interest rate. There are three groups of large banks: 97 leading intermediairies, top 20 banks, and top 22 FR Y-9C banks.