3

Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007 to 2009

Tobias Adrian, *Federal Reserve Bank of New York*
Paolo Colla, *Bocconi University*
Hyun Song Shin, *Princeton University and NBER*

I. Introduction

The financial crisis of 2007 to 2009 has given renewed impetus to the study of financial frictions and their impact on macroeconomic activity. Economists have refined existing models of financial frictions to construct narratives of the recent crisis. Although the recent innovations to the modeling of financial frictions share many common elements, they also differ along some key dimensions. These differences may not matter so much for story-telling exercises that focus on constructing logically consistent narratives that highlight particular aspects of the crisis. However, the differences begin to take on more significance when economists turn their attention to empirical or policy-related questions that bear on the costs of financial crises. Since policy questions must make judgments on the relative weight given to specific features of the models, the underpinnings of the models matter for the debates.

A long-running debate in macroeconomics is whether financial frictions manifest themselves mainly through shocks to the demand for credit or to its supply. Frictions operating through shocks to demand may be the result of the deterioration of the creditworthiness of borrowers, perhaps through tightening collateral constraints or to declines in the net present value of the borrowers' projects. Shocks to supply arise from tighter lending criteria applied by the lender, especially by the banking sector. The outcome of this debate has consequences not only for the way that economists approach the theory but also for the conduct of financial regulation and macro stabilization policy.

Our paper has two main objectives. The first is to revisit the debate on the demand and supply of credit to firms in the light of the evidence

978-0-226-05277-9/2013/2012-0301$10.00

from the recent crisis. We argue that the evidence points overwhelmingly to a shock in the supply of intermediated credit by banks and other financial intermediaries. Firms that had access to direct credit through the bond market took advantage of their access and tapped the bond market in large quantities. For such firms, the decline in bank lending was largely made up through increased borrowing in the bond market. However, the cost of credit rose steeply, whether for direct or intermediated credit, suggesting that the demand curve for bond financing shifted out as a response to the inward shift in the bank credit supply curve. Our finding echoes the earlier study by Kashyap, Stein, and Wilcox (1993), who pointed to the importance of shocks to the supply of intermediated credit as a key driver of financial frictions.

The evidence suggests a number of follow-up questions. Our second objective in this paper is to enumerate these questions and explore possible routes to answering them. What is so special about the banking sector? Why did the recent economic downturn affect the banking sector so differently from the bond investors? Kashyap, Stein, and Wilcox (1993) envisaged a specific shock to the banking sector through tighter reserve constraints coming from monetary policy tightening, thereby squeezing bank lending. However, the downturn from 2007 to 2009 was more widespread, hitting not only the banking sector but the broader economy. We still face the question of why the banking sector behaves in such a different way from the rest of the economy.

If banks were simply a veil, and merely reflected the preferences of the depositors who provide funding to the banks for on-lending, then banks would be irrelevant for financial conditions. A challenge for any macro model with a banking sector is to explain how one dollar that goes through the banking system is different from one dollar that goes directly to borrowers from savers. Holding savers' wealth fixed, when the banking sector contracts in a deleveraging episode, money that used to flow to borrowers through the banking sector now flows to borrowers directly through the bond market. Thus, showing that the banking sector "matters" in a macro context entails showing that the relative size of the direct and intermediated finance in an economy matters for financial conditions.

We begin in section II by laying out some aggregate evidence from the Flow of Funds and highlight the points of contact with the theoretical literature on financial frictions. In section III, we delve deeper into the micro evidence on firm-level financing decisions and find that it corroborates the evidence in the aggregate data. Based on the evidence,

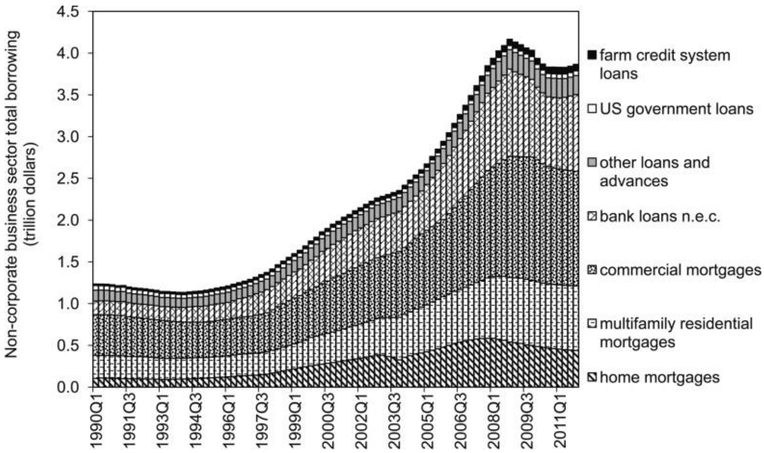

Fig. 1. Credit to US nonfinancial noncorporate businesses
Source: US Flow of Funds, tables L103, L104.

we draw up a checklist for a theory of financial frictions, and sketch a simple static model of direct and intermediated credit that attempts to address the checklist.

Along the way, we review the theoretical literature in the light of the evidence. Although many of the recent modeling innovations bring us closer to addressing the full set of facts, there are a number of areas where modeling innovations are still needed. We hope that our paper may be a spur to further efforts at closing these gaps.

II. Preliminaries

A. Aggregate Evidence

Most models of financial frictions share the feature that the total *quantity* of credit to the nonfinancial corporate sector decreases in a downturn, whether it is due to a decline in the demand for credit or its supply. However, even this basic proposition needs some qualification when we examine the evidence in any detail.

Figure 1 shows the total credit to the US nonfinancial *noncorporate* business sector from 1990 (both farm and nonfarm). Mortgages of various types figure prominently in the composition of total credit and suggest that the availability of collateral is an important determinant of credit to the noncorporate business sector. The trough in total credit comes in the second quarter of 2011, and the peak to trough (Q4:2008 to Q2:2011) decline in total credit is roughly 8 percent.

Figure 2 examines the evolution of credit to the *corporate* business sector in the United States (the nonfarm, nonfinancial corporate business sector). The left-hand panel is in levels, taken from table L.102 of the US Flow of Funds, while the right-hand panel plots the quarterly changes, taken from table F.102 of the Flow of Funds.

The plots reveal some distinctive divergent patterns in the various components of credit. In the left hand panel, the lower three components are (broadly speaking) credit that is provided by banks and other intermediaries, while the top series is the total credit obtained in the form of corporate bonds. The narrow strip between the bond and bank financing is the amount of commercial paper.

While the loan series show the typical procyclical pattern of rising during the boom and then contracting sharply in the downturn, bond financing behaves very differently. On the right-hand panel, we see that bond financing surges during the crisis period, making up most of the lost credit due to the contraction of loans.

The substitution away from intermediated credit toward the bond market is reminiscent of the finding in Kashyap, Stein, and Wilcox (1993), who documented that firms reacted to a tightening of credit by banks by issuing commercial paper. While commercial paper plays a relatively small role in the total quantity of credit in figure 2, the principle that firms switch to alternatives to bank financing is very much in evidence.

Nevertheless, the aggregate nature of the data from the Flow of Funds means that some caution is needed in drawing any firm conclusions. Several questions spring to mind. First, the Flow of Funds data are snapshots of the total amounts outstanding, rather than actual flows associated with new credit. Ideally, the evidence should be on the flow of new credit.

Second, to tell us whether the shock is demand- or supply-driven, information on the price of the new credit is crucial, but the Flow of Funds is silent on prices. A demand-driven fall in credit would exert less upward pressure on rates than a supply-driven shock. A simultaneous analysis of quantities and prices may enable to disentangle shocks to demand from shocks to supply.

Third, the aggregate nature of the Flow of Funds data masks differences in the composition of firms, both over time and in cross-section. The variation over time may simply reflect changes in the number of

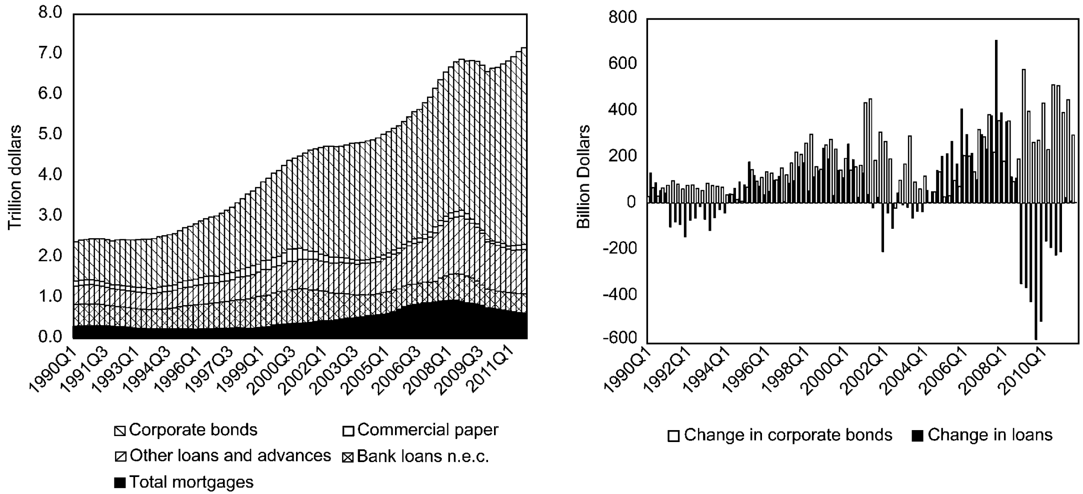

Fig. 2. Credit to US nonfinancial corporate sector (left-hand panel) and changes in outstanding corporate bonds and loans to US nonfinancial corporate sector (right-hand panel)

Notes: The left panel is from US Flow of Funds, table L102. Right panel is from table F102. Loans in right panel are defined as sum of mortgages, bank loans not elsewhere classified (n.e.c.), and other loans.

firms operating in the market. In cross-section, we should take account of corporate financing decisions (loan versus bond financing) that are related to firm characteristics.

To address these justified concerns, we construct a micro-level data set on new loans and bonds issued by nonfinancial US corporations between 1998 and 2010. Our data set includes information about quantities and prices of new credit, which give us insights on whether the quantity changes are due to demand or supply shocks. Second, our data set contains information on firm characteristics (asset size, Tobin's Q, tangibility, ratings, profitability, leverage, etc.) that previous studies have identified as drivers of the mix of loan and bond financing. The cross-section information gives us another perspective on how credit supply affects firms' corporate choices since we can control for demand-side proxies. Finally, we make use of the reported purpose of loan and bond issuances to single out new credit for "real investment"—that is, general corporate purposes, including capital expenditure, and liquidity management—which allows us to focus on corporate real activities (see Ivashina and Scharfstein 2010). By doing so, we exclude new debt that is issued for acquisitions (acquisition, takeover, and leveraged buyout/management buyout, LBO/MBO); capital structure management (debt repayment, recapitalization, and stock repurchase); as well as credit lines used as commercial paper backup.

We examine new issuances across all firms in our sample and ask whether the features we observe in the aggregate also hold at the micro level. We find that they do. During the economic downturn of 2007 to 2009, the total amount of new issuances decreased by 50 percent. When we look at loans and bonds separately, we uncover a 75 percent decrease in loans but a twofold increase in bonds. However, the cost of both types of financing show a steep increase (fourfold increase for new loans, and threefold increase for bonds). We take this as evidence of an increase in demand of bond financing and a simultaneous contraction in banks' supply of loan financing.

To shed further light on firm-level substitution between loan and bond financing, we conduct further disaggregated tests to be detailed later. Our tests are for firms that have access to the bond market—proxied by being rated—so that we can allow the demand and supply factors to play out in the open. We find that loan amounts decline but bond amounts increase, leaving total financing unchanged, while the cost of both loan and bond financing increases. Thus, the evidence points to a contraction in the supply of bank credit that pushes firms into the bond market, which raises the price of both types of credit. The micro evidence therefore corroborates the aggregate evidence from the Flow of Funds. We conclude that the decline in the supply of bank financing trains the spotlight on those firms that do not have access to the bond market (such as the noncorporate businesses in figure 1). It would be reasonable to conjecture that financial conditions tightened sharply for such firms.

To understand the substitution between loan and bond financing better, we follow Denis and Mihov (2003) and Becker and Ivashina (2011) to examine the choice of bond versus loan issuance in a discrete choice framework. Becker and Ivashina (2011) find evidence of substitution from loans to bonds during times of tight monetary policy, tight lending standards, high levels of nonperforming loans, and low bank equity prices. Controlling for demand factors, we find that the 2007 to 2009 crisis reduced the probability of obtaining a loan by 14 percent. We further corroborate the evidence in Becker and Ivashina (2011) by using two proxies for the financial sector risk-bearing capacity (for the growth in broker-dealer leverage, see Adrian, Moench, and Shin 2011; for the excess bond premium, see Gilchrist and Zakrajšek 2011) and document that a contraction in intermediaries' risk-bearing capacity reduces the probability of loan issuance between 18 and 24 percent depending on the proxy employed. Finally, we investigate which firm characteristics insulate borrowers from the effect of bank credit supply shocks in the 2007 to 2009 crisis. Our analysis highlights that firms that are larger or have more tangible assets, higher credit ratings, better project quality, less growth opportunities, and lower leverage were better equipped to withstand the contraction of bank credit during the crisis.

B. Modeling Financial Frictions

The evidence gives insights on how we should approach modeling financial frictions if we are to capture the observed features. Perhaps the three best-known workhorse models of financial frictions used in macroeconomics are Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Holmström and Tirole (1997). However, in the benchmark versions of these models, the lending sector is competitive and the focus of the attention is on the *borrower's* net worth instead. The results from the benchmark versions of these models should be contrasted with the approach that places the borrowing constraints on *the lender* (i.e., the bank) as in Gertler and Kiyotaki (2010).

Bernanke and Gertler (1989) use the costly state verification (CSV) approach to derive the feature that the borrower's net worth determines the cost of outside financing. The collateral constraint in Kiyotaki and Moore (1997) introduces a similar role for the borrower's net worth through the market value of collateral assets whereby an increase in borrower net worth due to an increase in collateral value serves to increase borrower debt capacity. But in both cases, the lenders are treated as being competitive and no meaningful comparisons are possible between bank and bond financing. In contrast, the evidence from figure 2 points to the importance of understanding the heterogeneity across lenders and the composition of credit. The role of the banking sector in the cyclical variation of credit emerges as being particularly important.

A bank is simultaneously both a borrower and a lender—it borrows in order to lend. As such, when the bank itself becomes credit-constrained, the supply of credit to the ultimate end-users of credit (nonfinancial businesses and households) will be impaired. In the version of the Holmström and Tirole (1997) model with banks, credit can flow either directly from savers to borrowers or indirectly through the banking sector. The ultimate borrowers face a borrowing constraint due to moral hazard, and must have a large enough equity stake in the project to receive funding. Banks also face a borrowing constraint imposed by depositors, but banks have the useful purpose of mitigating the moral hazard of ultimate borrowers through their monitoring. In Holmström and Tirole (1997), the greater monitoring capacity of banks eases the credit constraint for borrowers who would otherwise be shut out of the credit market altogether. Firms follow a pecking order of financing choices where low net worth firms can only obtain financing from banks and are shut out of the bond market, while firms with high net worth have access to both, but use the cheaper bond financing.

Repullo and Suarez's (2000) model is in a similar spirit. Bolton and Freixas (2000) focus instead on the greater flexibility of bank credit in the face of shocks, as discussed by Berlin and Mester (1992), with the implication that firms with higher default probability favor bank finance relative to bonds. De Fiore and Uhlig (2011, 2012) explore the implications of the greater adaptability of bank financing to informational shocks in the spirit of Berlin and Mester (1992) and examine the shift toward greater reliance on bond financing in the Eurozone during the recent crisis.

Our empirical results reported in the following suggest that the interaction between direct and intermediated finance should be high on

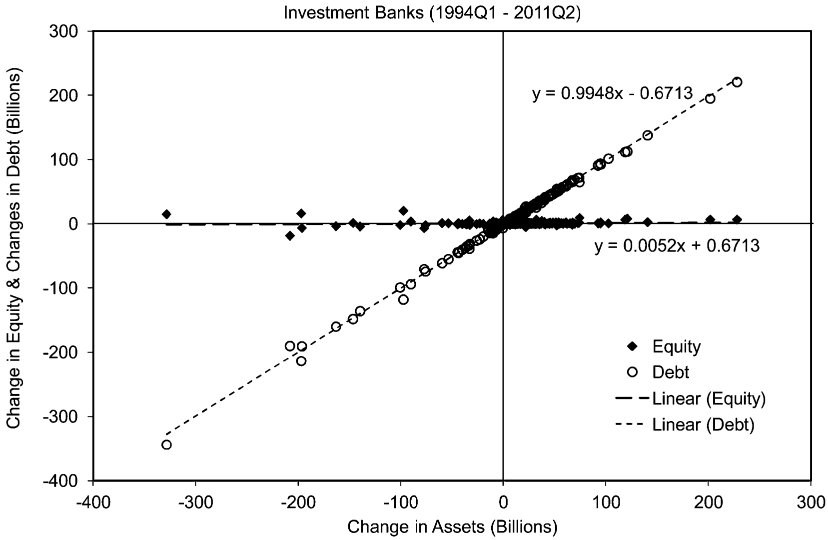

Fig. 3. Scatter chart of $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ for changes in assets, equity, and debt of US investment bank sector consisting of Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley between Q1:1994 and Q2:2011

Source: Securities and Exchange Commission (SEC) 10Q filings.

the agenda for researchers. We review the new theoretical literature on banking and intermediation in a later section.

C. *Focus on Banking Sector*

We are still left with a broader theoretical question of what makes the banking sector so special. In Kashyap, Stein, and Wilcox (1993), the shock envisaged was a monetary tightening that hit the banking sector specifically through tighter reserve requirements that led to a shrinking of bank balance sheets. However, the downturn in 2007 to 2009 was more widespread, hitting not only the banking sector but the broader economy.

A clue lies in the way that banks manage their balance sheets. Figure 3 is the scatter plot of the quarterly change in total assets of the sector consisting of the five US investment banks examined in Adrian and Shin (2008, 2010) where we plot both the changes in assets against equity, as well as changes in assets against debt. More precisely, it plots $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ where ΔA_t is the change in total assets of

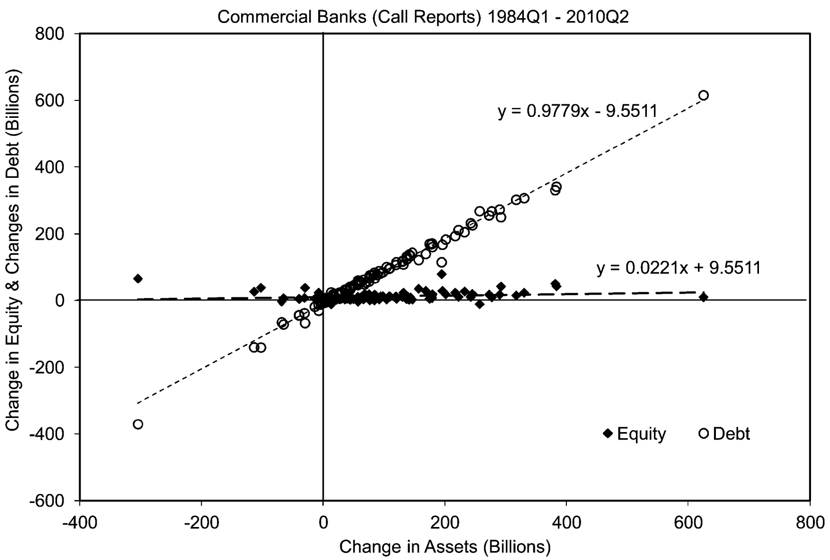

Fig. 4. Scatter chart of $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ for changes in assets, equity, and debt of US commercial bank sector at t between Q1:1984 and Q2:2010
Source: FDIC call reports.

the investment bank sector at quarter t, and where ΔE_t and ΔD_t are the change in equity and change in debt of the sector, respectively.

The fitted line through $\{(\Delta A_t, \Delta D_t)\}$ has slope very close to 1, meaning that the change in assets in any one quarter is almost all accounted for by the change in debt, while equity is virtually unchanged. The slope of the fitted line through the points $\{(\Delta A_t, \Delta E_t)\}$ is close to zero.[1]

Commercial banks show a similar pattern to investment banks. Figure 4 is the analogous scatter plot of the quarterly change in total assets of the US commercial bank sector, which plots $\{(\Delta A_t, \Delta E_t)\}$ and $\{(\Delta A_t, \Delta D_t)\}$ using the FDIC Call Reports. The sample period is between Q1:1984 and Q2:2010. We see essentially the same pattern as for investment banks, where every dollar of new assets is matched by a dollar in debt, with equity remaining virtually unchanged. Although we do not show here the scatter charts for individual banks, the charts for individual banks reveal the same pattern. Banks adjust their assets dollar for dollar through a change in debt with equity remaining "sticky."

The fact that banks tend to reduce debt during downturns could be explained by standard theories of debt overhang or adverse selection in equity issuance. However, what is notable in figures 3 and 4 is the

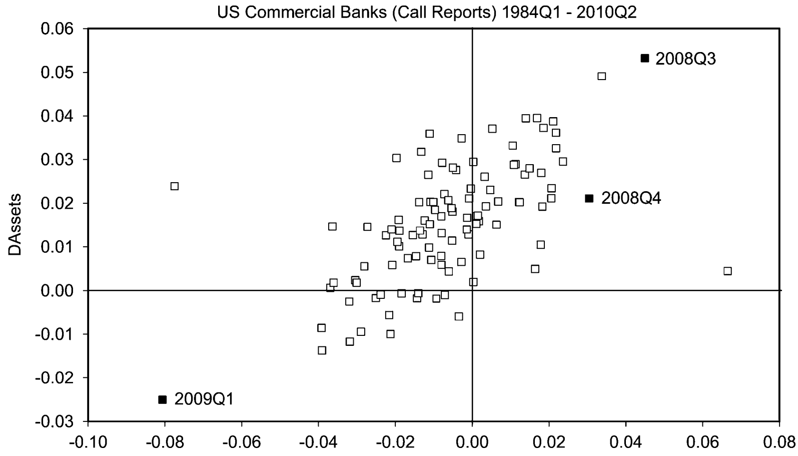

Fig. 5. Scatter chart of quarterly asset growth and quarterly leverage growth of the US commercial bank sector, Q1:1984 to Q2:2010
Source: FDIC Call Reports.

fact that banks do not issue equity even when assets are increasing. The fitted line through the debt issuance curve holds just as well when assets are increasing as it does when assets are decreasing. This feature presents challenges to an approach where the bank capital constraint binds only in downturns, or to models where the banking sector is a portfolio maximizer.

Figures 3 and 4 show that banks' equity is little changed from one quarter to the next, implying that total lending is closely mirrored by the bank's leverage decision. Bank lending expands when its leverage increases, while a sharp reduction in leverage ("deleveraging") results in a sharp contraction of lending. Adrian and Shin (2008, 2010) showed that US investment banks have *procyclical* leverage where leverage and total assets are positively related.

Figure 5 is the scatter chart of quarterly asset growth and quarterly leverage growth for US commercial banks for the period Q1:1984 to Q2:2010. We see that leverage is procyclical for US commercial banks also. However, we see that the sharp deleveraging in the recent crisis happened comparatively late, with the sharpest decline in assets and leverage taking place in Q1:2009. Even up to the end of 2008, assets and leverage were increasing, possibly reflecting the drawing down of credit lines that had been granted to borrowers prior to the crisis.

The equity series in the scatter charts in figures 3, 4, and 5 are of *book* *equity*, giving us the difference between the value of the bank's portfolio of claims and its liabilities. An alternative measure of equity would have been the bank's *market capitalization*, which gives the market price of its traded shares. Since our interest is in the supply of credit, which has to do with the portfolio decision of the banks, book equity is the appropriate notion. Market capitalization would have been more appropriate if we were interested in new share issuance or mergers and acquisitions decisions.

Crucially, it should be borne in mind that market capitalization is not the same thing as the *marked-to-market value of the book equity*, which is the difference between the market value of the bank's portfolio of claims and the market value of its liabilities. Take the example of a securities firm holding only marketable securities that finances those securities with repurchase agreements. Then, the book equity of the securities firm reflects the haircut on the repos, and the haircut will have to be financed with the firm's own book equity. This book equity is the archetypal example of the marked-to-market value of book equity.

In contrast, market capitalization is the discounted value of the future free cash flows of the securities firm, and will depend on cash flows such as fee income, which do not depend directly on the portfolio held by the bank.

Since we are interested in lending decisions of intermediaries, it is the portfolio choice of the banks that is our main concern. As such, book value of equity is the appropriate concept when measuring leverage. Consistent with our choice of book equity as the appropriate notion of equity for lending decisions, Adrian, Moench, and Shin (2011) find that market risk premiums depend on book leverage, rather than leverage defined in terms of market capitalization.

The scatter charts in figures 3, 4, and 5 also suggest another important conceptual distinction. They suggest that we should be distinguishing between two different hypotheses for the determination of risk premiums. In particular, consider the following pair of hypotheses.

Risk premium depends on the *net worth of the banking sector*.

Risk premium depends on the *net worth of the banking sector* and the *leverage of the banking sector*.

In most existing models of financial frictions, net worth is the state variable of interest. This is true even of those models that focus on the net worth of banking sector, such as Gertler and Kiyotaki (2010). However, the scatter charts in figures 3, 4, and 5 suggest that the leverage of the banks may be an important, separate factor in determining market conditions. Evidence from Adrian, Moench, and Shin (2011) suggests that book leverage is indeed the measure that has stronger explanatory power for risk premiums in comparison to the level of net worth as such.

The explicit recognition of the role of financial intermediaries holds some promise in explaining the economic impact of financial frictions. When intermediaries curtail lending, directly granted credit (such as bond financing) must substitute for bank credit, and market risk premiums must rise in order to induce nonbank investors to enter the market for risky corporate debt and take on a larger exposure to the credit risk of nonfinancial firms. The sharp increase in spreads during financial crises would be consistent with such a mechanism. The recent work of Gilchrist, Yankov, and Zakrajšek (2009) and Gilchrist and Zakrajšek (2011) point to the importance of the credit risk premium as measured by the "excess bond spreads" (EBP; that is, spreads in excess of firm fundamentals) as an important predictor of subsequent economic activity as measured by industrial production or employment. Adrian, Moench, and Shin (2011) and Adrian and Shin (2010) link credit risk premiums directly to financial intermediary balance sheet management, and real economic activity.

Motivated by the initial evidence, we turn to an empirical study that uses micro-level data in section III. We will see that the aggregate evidence is confirmed in the micro-level data. After sifting through the evidence, we turn our attention to sketching out a possible model of direct and intermediated credit. Our model represents a departure from the standard practice of modeling financial frictions in two key respects. First, it departs from the practice of imposing a bank capital constraint that binds only in the downturn. Instead, the capital constraint in the model will bind all the time—both in good times and bad. Second, our model is aimed at replicating the procyclicality of leverage where banks adjust their assets dollar for dollar through a change in debt, as revealed in the scatter plots in figures 3, 4, and 5. Procyclicality of leverage runs counter to the common modeling assumption that banks are portfolio optimizers with log utility, implying that leverage is high in downturns (we review the literature in a later section). To the extent that banking sector behavior is a key driver of the observed outcomes, our focus will be on capturing the cyclical features of financial frictions as faithfully as we can.

One feature of our model is that as bank lending contracts sharply through deleveraging, the direct credit from bond investors must expand to take up the slack. However, for this to happen, prices must adjust in order that the risk premium rises sufficiently to induce risk-averse bond investors to make up for the lost banking sector credit. Thus, a fall in the relative credit supplied by the banking sector is associated with a rise in risk premiums. Financial frictions during the crisis of 2007 to 2009 appear to have worked through the spike in spreads as well as through any contraction in the total quantity of credit. Having studied the microevidence in detail and the theory, we turn to a discussion of the recent macroeconomic modeling in section V. We argue that the evidence presented in this paper presents a challenge for many of the post-crisis general equilibrium models. Section VI concludes.

III. Evidence from Microdata

A. Sample

We use micro-level data to investigate the fluctuations in financing received by US listed firms during the period 1998 to 2010, with special focus on the 2007 to 2009 financial crisis. In our following data analysis, we will identify the eight quarters from Q3:2007 to Q2:2009 as the crisis period.

Our sample consists of nonfinancial (Standard Industrial Classification [SIC] codes 6000–6999) firms incorporated in the United States that lie in the intersection of the Compustat quarterly database, the Loan Pricing Corporation's Dealscan database of new loan issuances (LPC), and the Securities Data Corporation's New Bond Issuances database (SDC). For a firm to be included in our analysis, we require the firm-quarter observation in Compustat to have positive total assets (henceforth, Compustat sample), and have data available for its incremental financing from LPC and SDC. Our sample construction procedure, described following, identifies 3,896 firms (out of the 11,538 in the Compustat sample) with new financing between 1998 and 2010. Firm-quarter observations with new financing amount to 4 percent of the Compustat sample, and represent 13 percent of their total assets (see table 1).

Loan information comes from the June 2011 extract of LPC, and includes information on loan issuances (from the facility file: amount, is-

Table 1
Frequency of New Debt Issuances

	Firm-quarters		
	Observations	Total Assets	Firms
Compustat sample	308,184	533,472	11,538
	[100]	[100]	[100]
Our sample:			
With new debt issuances	11,463	68,637	3,896
	[3.72]	[12.87]	[33.77]
With new loan issuances	9,458	38,717	3,791
	[3.07]	[7.26]	[32.86]
With new bond issuances	2,322	34,454	902
	[0.75]	[6.27]	[7.82]

Notes: Compustat sample refers to all US incorporated nonfinancial (SIC codes 6000 to 6999) firm-quarters in the Compustat quarterly database with positive total assets. We merge the Compustat sample with loan issuances from the Loan Pricing Corporation's Dealscan database (LPC) and bond issuances from the Securities Data Corporation's New Bond Issuances database (SDC). Percentages of the Compustat sample are reported in square brackets. Total assets are expressed in January 1998 constant $bln.

sue date, type, purpose, maturity, and cost[2]) and borrowers (from the borrower file: identity, country, type, and public status). We apply the following filters: (1) the issue date is between January 1998 and December 2010 (172,243 loans); (2) the loan amount, maturity, and cost are nonmissing, and the loan type and purpose are disclosed (90,131 loans); (3) the loan is extended for real investment purposes[3] (42,979 loans). We then use the Compustat-LPC link provided by Michael Roberts (Chava and Roberts 2008) to match loan information with the Compustat sample, and end up with 12,373 loans issued by 3,791 unique firms.[4]

Our screening of bond issuances follows similar steps to the ones we use for loan issuances. We retrieve from SDC information on nonfinancial firms' bond issuances (amount, issue date, cost,[5] purpose, and maturity) and apply the following filters: (1) the issue date is between January 1998 and December 2010, and the borrower is a nonfinancial US firm (38,953 bonds); (2) the bond amount, maturity, purpose, and cost are nonmissing (9,706 bonds); (3) the bond is issued for real investment purposes[6] (7,480 bonds). We then merge bond information with the Compustat sample using issuer CUSIPs, and obtain 3,222 bonds issued by 902 unique firms.

The summary statistics in table 2 compare our restricted sample to the full sample of loans and bonds issued for real investment purposes.

Table 2
Characteristics of New Issuances

		Loan issuances			Bond issuances		
		Our sample	Full LPC sample	*t*-stat	Our sample	Full SDC sample	*t*-stat
Issuances	#	12,373	15,736		3,222	6,435	
Amount	(total)	2,952.74	3,411.90		1,050.60	1,831.72	
Amount		0.239	0.217	4.011***	0.326	0.285	5.728***
Maturity		43.00	42.57	1.583	100.09	98.90	1.110
Cost		216.71	220.27	–1.952*	265.84	264.95	0.185
Cost	(undrawn)	32.44	32.22	0.529			

Notes: This table presents means aggregated across all firms for our sample of new debt issuances. Full LPC sample includes tranches with valid amount, maturity, purpose, and spread issued by nonprivate US corporations for investment purposes. Full SDC sample includes tranches with valid amount, maturity, purpose, and spread issued by nonfinancial US public firms and subsidiaries for investment purposes. We report the *t*-statistic for the unpaired *t*-test for differences in amounts, maturities, and spreads between our sample and the full samples. For loan issuances, "Cost" is the all-in-drawn spread and "Cost (undrawn)" is the all-in-undrawn spread (available for credit lines only). There are 7,782 (resp., 8,817) issuances with nonmissing all-in-undrawn spread in our sample (resp. Full LPC sample). Amount is expressed in January 1998 constant $bln, cost is expressed in bps, and maturity is expressed in months.

In particular, our sample includes 79 percent of loans issued by nonprivate US corporations, and represents 87 percent in terms of dollar amount. Moreover, our sample captures 50 percent of US nonfinancial public firms and subsidiaries' bond issuances (about 57 percent in terms of dollar amount). On average, loans in our sample are issued for $239 million, have maturity of 43 months, and are priced at 217 bps (basis point) (32 bps for credit lines, using the all-in-undrawn spread). These are economically very similar to the average values in the full LPC sample. Relative to loans, bonds in our sample are on average issued for larger amounts ($326 million), longer maturities (100 months), and are more expensive (266 bps). Again, these values are very similar to their counterpart in the full SDC sample. The *t*-test for the difference in means detects significant differences between our sample and full LPC and SDC samples for the average issuance amount only.

B. Patterns of New Issuances

The pattern of total new credit that includes both loan and bond financing shows a marked decline in new debt issuances and a simultaneous increase in their cost during the recent financial crisis.

Total Financing

The evolution of total credit (both loans and bonds) presented in figure 6 shows a marked decrease in total amount and number of issuances from peak to trough. This can be seen from panel A, which graphs the quarterly total amount of new debt (loans plus bonds) issued expressed in billions of January 1998 dollars, with panel C showing the averages. Panel E graphs the total number of new debt issuances.

Due to seasonality in new debt financing activity, we include the smoothed version of all series (solid line) as a moving average straddling the current term with two lagged and two forward terms. Figure 6 highlights the steep reduction in total financing as the crisis unfolds; total credit halved from $182.25 billion in Q2:2007, the peak of the credit boom, to $90.65 billion during Q2:2009, the trough of the crisis. During the same period, the number of new issuances decreases by about 30 percent.

We turn to the cost of credit and its maturity. For every quarter, we use a weighted average of the cost (in bps) and the maturity (in months) of individual facilities, where the weights are given by the amount of each facility relative to the amount of issuances in that quarter. Panel B of figure 6 shows that the cost of new debt quadrupled during the crisis, from 99 bps in Q2:2007 to 403 bps in Q2:2009.[7]

Loan Financing

Bank financing was drastically reduced during the crisis; loan issuance at the trough of the cycle totaled $40 billion, about one-quarter of loan issuance at the peak of the credit boom ($155.69 billions during Q2:2007). The number of new loans more than halved from 318 issuances during Q2:2007 to 141 issuances during Q2:2009. This reduction in bank lending can be seen in figure 7, which presents the quarterly evolution of loan issuances. The total amount of loans are in panel A; the average amount of loans are in panel C; and the total number of loans issued are in panel E.

In parallel with the decline in loan financing activity, the cost of loans rose steeply. Loan spreads more than quadrupled during the financial crisis, from 90 bps in Q2:2007 to a peak of 362 bps in Q2:2009.[8] The 2001 recession did not show such a substantial increase in loan spreads; spreads oscillated between 128 bps (Q2:2001) and 152 bps (Q4:2001). Panel B of figure 7 graphs these results for the cost of loan financing.

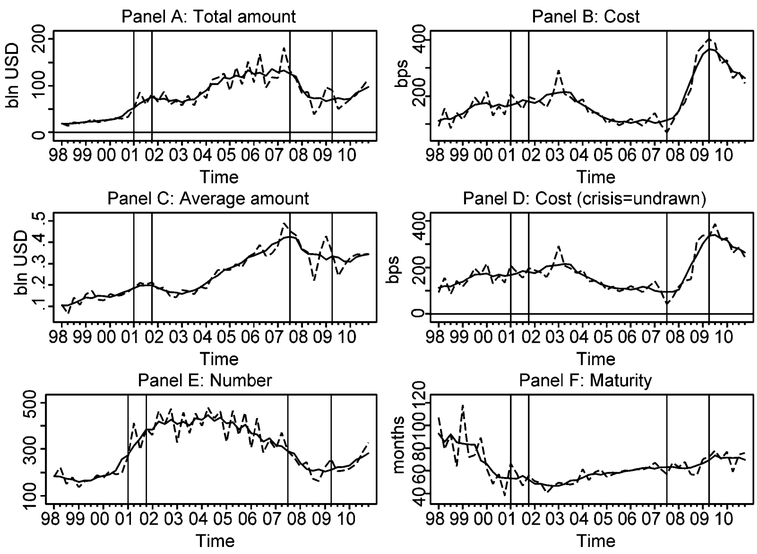

Fig. 6. New debt issuances

Notes: Panel A: total amount of debt issued (billion of January 1998 USD). Panels B and D: cost of debt issued (in bps). In panel D we use the all-in-undrawn spread for credit lines between Q3:2007 and Q2:2009. Panel C: average amount of debt issued. Panel E: number of debt issuances. Panel F: maturity of debt issued (in months). All panels report the raw series (dashed line) and its smoothed version (solid line).

Maturities of newly issued loans tend to shorten during recessions, and increase during booms, as can be seen from panel D in figure 7. Finally, in figure 7, panel F, we graph the quarterly total amount of loans by type (credit lines or term loans).[9] In the aftermath of the credit boom, both revolvers and term loans fell sharply. New credit lines totaled $24.15 billion in Q2:2009, which is roughly 25 percent of the credit lines initiated at the peak of the credit boom ($124.03 during Q2:2007). New term loans halved from $30.05 billion in Q2:2007 to $15.68 billion in Q2:2009. Issuances of revolvers start trending upwards from 2010 and, as of Q4:2010, total credit lines correspond to about 40 percent of their dollar values at the peak of the credit boom. Issuances of term loans increase at a slower pace, and during Q4:2010, reach about 25 percent of their Q2:2007 levels.

Bond Financing

In contrast to bank lending, bond issuance increased during the crisis; issuance of new bonds totaled $50.64 billion in Q2:2009—about twice

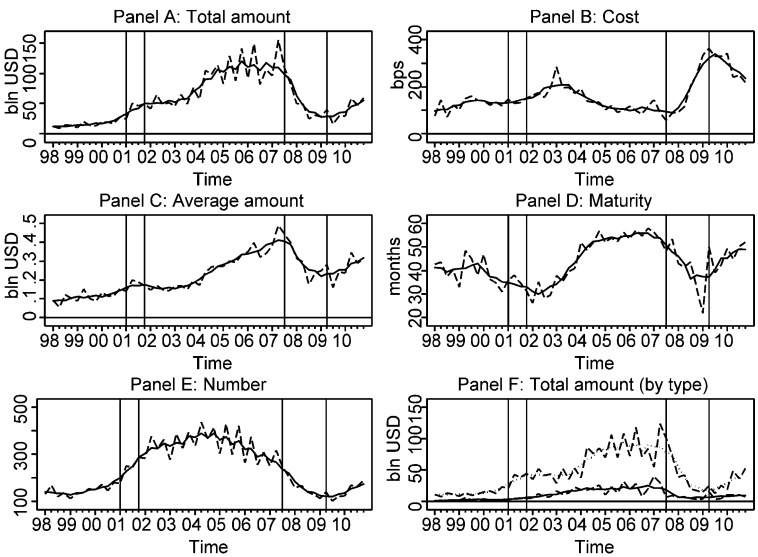

Fig. 7. New loan issuances

Notes: Panel A: total amount of loans issued (billion of January 1998 USD). Panel B: cost of loans issued (in bps). Panel C: average amount of loans issued. Panel D: maturity of loans issued (in months). Panel E: number of loans issued. Panel F: total amount of credit lines (dotted) and term loans (solid). All panels report the raw series (dashed line) and its smoothed version (solid line).

as much as during the peak of the credit boom ($26.56 billion during Q2:2007). This can be seen in figure 8. In addition, the number of newly issued bonds doubles from 54 during Q2:2007 to 116 during Q2:2009. Moreover, figure 8 confirms that the credit boom in the run-up to the crisis was not exclusively a bank credit boom, since total bond issuances increase from 2005 onwards also.

Figure 8 graphs the evolution of the cost and maturity of bonds (panels B and D, respectively). Several similarities emerge between loan and bond financing. First, bond maturities shorten during recessions and increase during booms; this is confirmed by comparing maturities during the years leading to the peak of the credit boom to maturities during the latest recession. Second, the credit boom preceding the recent financial crisis is accompanied by a reduction in spreads. Finally, bond spreads almost tripled during the financial crisis, from 156 bps during Q2:2007 to 436 bps during Q2:2009, similar to the increase experienced by loan spreads.

The micro-level evidence permits two conclusions. First, we confirm

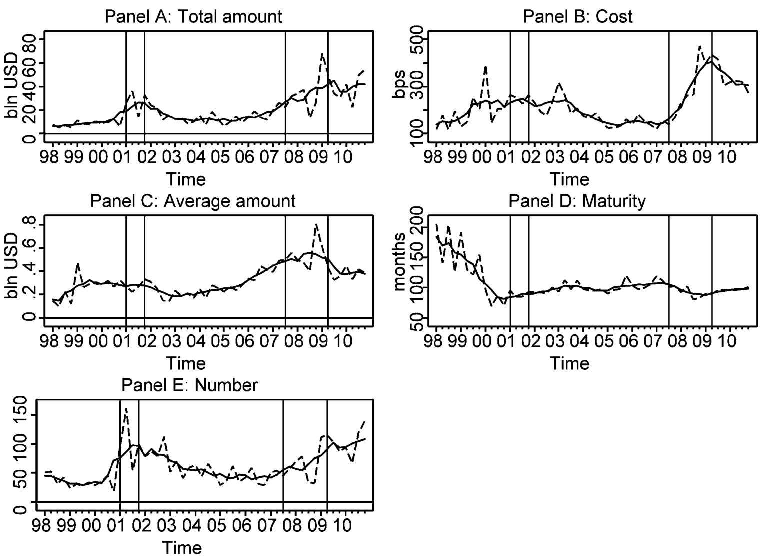

Fig. 8. New bond issuances

Notes: Panel A: total amount of bonds issued (billion of January 1998 USD). Panel B: cost of bonds issued (in bps). Panel C: average amount of bonds issued. Panel D: maturity of bonds issued (in months). Panel E: number of bonds issued. All panels report the raw series (dashed line) and its smoothed version (solid line).

the evidence from the Flow of Funds that nonfinancial corporations increased funding in the bond market, as bank loans shrank. Secondly, credit spreads increased sharply, for both loans and bonds. In the next two sections, we will investigate the extent to which the substitution from bank financing to bond financing is related to institutional characteristics.

Kashyap, Stein, and Wilcox (1993) showed that following monetary tightening, nonfinancial corporations tended to issue relatively more commercial paper. The authors link this substitution in external finance directly to monetary policy shocks, and argue that the evidence supports the lending channel of monetary policy over the traditional Keynesian demand channel, where tighter monetary policy leads to lower aggregate demand, and hence lower demand for credit. Under the lending channel, it is credit supply that shifts. Kashyap, Stein, and Wilcox's (1993) evidence that commercial paper issuance increases while bank lending declines points toward the bank lending channel. We will return to this interpretation later, when we present our model of financial intermediation.

Our empirical findings complement Kashyap, Stein, and Wilcox

(1993) in two ways. First, we highlight the relatively larger role of the bond market compared to commercial paper in offsetting the contraction in bank credit. As we saw for the corporate business sector in the United States, the increase in aggregate bond financing largely offsets the contraction in bank lending. Second, the micro-level data allow us to observe the yields at which the new bonds and loans are issued. We can therefore go beyond the aggregate data used by Kashyap, Stein, and Wilcox.

We are still left with a broader theoretical question of what makes the banking sector special. Kashyap, Stein, and Wilcox envisaged the shock to the economy as a monetary tightening that hit the banking sector specifically through tighter reserve constraints that hit the asset side of banks' balance sheets. In other words, they looked at a specific shock to the banking sector. However, the downturn in 2007 to 2009 was more widespread, hitting not only the banking sector but the broader economy. We still face the question of why the banking sector behaves in such a different way from the rest of the economy. We suggest one possible approach to this question in our theory section.

C. *Closer Look at Corporate Financing: Univariate Sorts*

We now investigate the effect of the crisis on firms' choices between bank and bond financing and the cross-sectional differences in new financing behavior. We work with a sample covering four years, which we divide equally into two subperiods—before crisis (from Q3:2005 to Q2:2007) and during the crisis (from Q3:2007 to Q2:2009). This balanced approach is designed to average out seasonal patterns in our quarterly data (see Duchin, Ozbas, and Sensoy 2010).

We restrict our attention to the sample of firms that issue loans and/or bonds during the financial crisis. By doing so, we select firms that have access to both types of funding and address the firm's choice between forms of credit. In selecting firms that have access to both types of credit, we do not imply that these firms are somehow typical. Instead, our aim is to use this sample in our identification strategy for distinguishing shocks to the demand or supply of credit. If the cost of both types of credit increased but the quantity of bank financing fell and bond financing rose, then this would be evidence of a negative shock to the supply of bank credit.

We first examine evidence on these firms' issuances before and during the crisis with univariate sorts, controlling for relevant firm characteristics. For a firm to be included in our analysis ("new debt issuer") we require that: (1) it issues at least one loan or one bond during the crisis, and has positive assets in at least one quarter during the crisis; (2) it has positive assets in at least one quarter before the crisis; (3) it has nonmissing observations for the relevant sorting variable in Q2:2005. Finally, in order to investigate possible substitution effects between the two sources of financing, we follow Faulkender and Petersen (2006) and require firms to be rated during Q2:2005, as a way of ensuring that we select firms that have access to the bond market.

For every firm that meets these criteria we measure cumulative new debt issuances over the precrisis and the crisis period to gauge the incremental financing immediately before the crisis (Q2:2007) and at the trough of the crisis (Q2:2009).[10] The firm-level spread on new debt is calculated as the value-weighted spread.

We build on previous literature (Houston and James 1996; Krishnaswami, Spindt, and Subramaniam 1999; Denis and Mihov 2003) to identify the firm-level characteristics that affect corporate reliance on bank and bond financing: size and tangibility (considered as proxies for information asymmetry), Tobin's Q (proxying for growth opportunities), credit rating, profitability (which proxies for project quality), and leverage. All variables are defined in table B1 (see appendix B) and measured during Q2:2005. Measuring firm-level characteristics well before the onset of the crisis mitigates endogeneity concerns.

Table 3 provides summary statistics of these variables. The last six columns in table 3 report the percentage of per-period new financing that is due to new debt issuers, conditional on the availability of each sorting variable: for instance, the top row indicates that our sample has 492 new debt issuers with valid total assets during Q2:2005, and these new debt issuers account for 52 percent and 80.7 percent, respectively, of the new issuances before and during the crisis.

We sort new issuers in two groups (below and above median) along each of the sorting variables, and report in table 4, panel A, cross-sectional means of firm-level cumulative total loan and bond financing before and during the crisis. We report the *t*-statistics for difference in means during and before the crisis for amounts and spreads.

For the vast majority of firms in our sample, we do not see statistically significant differences in the amount of total financing. We find some evidence that only the more indebted firms and those with lower ratings see lower credit during the crisis. This can be seen in panel A of table 4. Moreover, total financing increases during the crisis for the

Table 3
Summary Statistics

						Before crisis (%)			Crisis (%)		
Variable	Mean	Median	5%	95%	Obs	Total	Loan	Bond	Total	Loan	Bond
Size	8.232	8.147	6.161	10.467	492	52.0	50.4	62.9	80.7	74.0	89.1
Tobin's Q	1.716	1.454	0.991	3.525	364	37.4	35.9	47.9	62.3	54.9	71.5
Tangibility	0.377	0.317	0.042	0.828	487	51.0	49.4	61.9	80.0	72.7	88.9
Rating	BBB–	BBB	B	A+	492	52.0	50.4	62.9	80.7	74.0	89.1
Profitability	0.037	0.034	0.013	0.073	469	49.2	47.4	61.3	76.3	68.4	86.0
Leverage	0.323	0.287	0.087	0.656	476	49.0	47.8	56.8	77.2	69.0	87.3

Notes: This table reports summary statistics for the sample of new debt issuers. A new debt issuer is defined as a firm issuing new debt between Q3:2007 and Q2:2009, with positive assets during the quarter(s) of issuance and during at least one quarter between Q3:2005 and Q2:2007, and rated in Q2:2005. All variables are measured in Q2:2005. Definitions of the variables are provided in table B1.

Table 4
Financing before and during the Crisis

	A. Amount								
	Total			Loan			Bond		
Relative to Median	Before Crisis	Crisis	*t*-stat.	Before Crisis	Crisis	*t*-stat.	Before Crisis	Crisis	*t*-stat.
Size									
Below	0.313	0.383	2.476**	0.280	0.288	0.290	0.033	0.095	5.520***
Above	1.791	1.709	−0.532	1.491	0.770	−6.122***	0.300	0.939	6.255***
Tobin's Q									
Below	1.066	0.989	−0.665	0.914	0.574	−3.475***	0.152	0.415	3.289***
Above	0.981	1.193	1.499	0.789	0.487	−3.153***	0.192	0.706	5.037***
Tangibility									
Below	0.984	1.159	1.455	0.818	0.539	−3.164***	0.166	0.620	5.199***
Above	1.101	0.934	−1.622	0.935	0.511	−4.718***	0.166	0.423	4.236***
Rating									
Below	0.783	0.633	−2.414**	0.708	0.437	−4.526***	0.075	0.196	5.286***
Above	1.535	1.786	1.328	1.203	0.693	−3.715***	0.332	1.093	5.558***
Profitability									
Below	0.929	0.815	−1.138	0.797	0.477	−3.877***	0.132	0.338	3.178***
Above	1.158	1.259	0.804	0.950	0.548	−4.067***	0.209	0.711	5.696***
Leverage									
Below	1.105	1.369	2.041**	0.904	0.594	−3.200***	0.202	0.776	5.753***
Above	0.944	0.697	−2.762***	0.835	0.425	−4.871***	0.109	0.272	5.133***

B. Cost

Relative to Median	Total			Loan			Bond		
	Before Crisis	Crisis	t-stat.	Before Crisis	Crisis	t-stat.	Before Crisis	Crisis	t-stat.
Size									
Below	129.26	262.11	8.185***	116.87	205.69	6.205***	218.40	449.84	6.222***
Above	73.55	263.02	11.855***	66.18	144.32	6.858***	112.98	376.87	9.394***
Tobin's Q									
Below	106.80	269.23	9.027***	94.88	193.67	7.290***	178.81	479.21	7.847***
Above	84.87	244.24	10.670***	77.10	151.18	5.526***	126.13	347.37	8.203***
Tangibility									
Below	89.87	250.18	10.536***	81.33	170.47	7.265***	122.06	360.01	7.901***
Above	103.32	277.55	10.125***	92.00	190.32	7.086***	166.60	444.00	8.111***
Rating									
Below	132.94	302.43	10.949***	120.87	216.40	7.999***	208.02	528.24	10.055***
Above	42.54	190.99	10.868***	34.40	92.80	6.261***	81.00	280.24	8.784***
Profitability									
Below	106.25	269.22	9.071***	96.36	187.00	6.904***	174.30	464.32	6.513***
Above	86.48	254.27	11.009***	74.86	166.20	6.764***	134.75	366.32	8.740***
Leverage									
Below	68.47	243.26	10.678***	58.07	139.79	7.237***	103.95	362.72	8.854***
Above	122.82	280.38	9.529***	112.09	209.12	6.887***	197.46	448.91	6.971***

Notes: This table presents cross-sectional means of new debt issuers' financing. A new debt issuer is defined as a firm issuing new debt between Q3:2007 and Q2:2009, with positive assets during the quarter(s) of issuance and during at least one quarter between Q3:2005 and Q2:2007, and rated in Q2:2005. Sorting into below and above median groups is based on variables measured during Q2:2005. Definitions of the variables are provided in table B1. "Before crisis" (resp., "Crisis") refers to the eight quarters between Q3:2005 and Q2:2007 (resp., between Q3:2007 and Q2:2009). Firm-level amounts are cumulated over the relevant periods. Firm-level spreads are computed using the amount of each debt type relative to the total amount of debt issued as weights. Panel A (resp., B) reports cross-sectional means of loan, bond, and total amounts in $bln (resp., spreads in bps). We test for significant differences in corporate financing behavior during the crisis and report the t-statistic for the paired (unpaired) t-test for differences in amounts (spreads) during and before the crisis. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

smaller and less indebted firms. Panel B highlights that the main effect of the crisis is on the cost, rather than on the amount of new debt, with two to four times wider spreads.

Splitting new financing into loan and bond issuances reveals that loan financing significantly decreased during the crisis. New loans decreased by 35 to 50 percent relative to their precrisis levels, with the exception of smaller firms in our subsample that experienced a 3 percent increase in loan financing during the crisis (not statistically significant). We also find strong evidence that all firms resorted to more bond financing. The total amount of new bond issuances is about 2.5 to 4 times larger relative to its precrisis level. Moreover, the cost of both loan and bond financing increased significantly for all new debt issuers: loan spreads during the crisis are 175 percent and 265 percent larger than before the crisis, and the increase in bond spreads ranges between 200 and 350 percent.

Discussion

The evidence speaks in favor of a (firm-level) compositional effect during the recent financial crisis. Firms substitute loans for bonds, leaving the total amount of new financing unaltered. This evidence is consistent with the bird's-eye view of the US Flow of Funds reported at the outset and, importantly, is obtained tracking a constant sample of firms over time.

Taking the findings in the present subsection together with the aggregate patterns of new debt issuances documented earlier suggests that the substitution between loans and bonds was stronger for firms having access to both funding sources. Bank-dependent firms suffered a reduction in bank financing without being able to tap the bond market and, as a result, witnessed a marked decrease in the amount of new credit. Moreover, we uncover a significant (both economically and statistically) increase in the cost of new financing, thus corroborating the evidence from the aggregate patterns of new financing that we discussed earlier.

The evidence presented here may appear to be in contrast to Gertler and Gilchrist's (1993, 1994) finding that monetary contractions reallocate funding from small firms to large firms. However, we should bear in mind that we consider publicly-traded firms recorded in Compustat, and we further restrict our attention to rated firms, while Gertler and Gilchrist make use of the US Census Bureau's *Quarterly Financial Report for Manufacturing Corporations* (QFR). The QFR is likely to pick up a

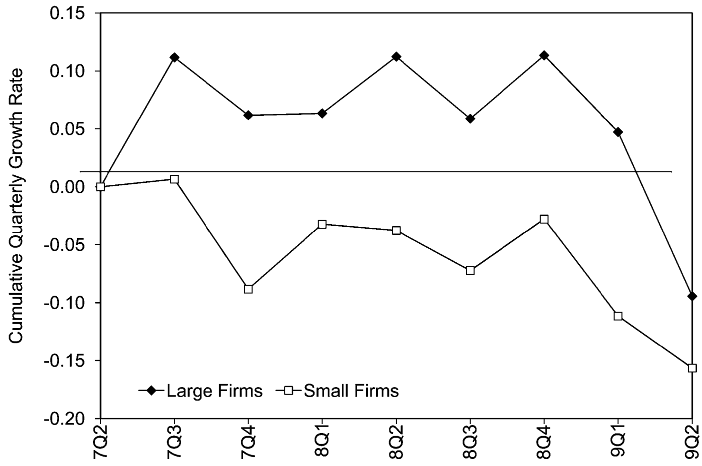

Fig. 9. Short-term debt for small and large firms

Notes: Cumulative quarterly growth rates as log-deviations from their Q2:2007 values. Large (resp., small) firms are those with total assets above $250 million (resp., below $50 million). Data on short-term debt are sourced from QFR and aggregated across firm class sizes.

relatively larger share of small firms. Indeed, the sorting of firms by size in our table 4 shows the smallest firm to have $230 million total assets and the first percentile value to be $322 million (nominal assets during Q2:2005). In addition, we consider a broad definition of credit (loans and bonds), while Gertler and Gilchrist focus on short-term debt, with maturity less than one year.

With these differences in mind, we have retrieved corporate liabilities' data from QFR for the period Q2:2007 to Q2:2010, by firm class size ("All Manufacturing" quarterly series). We compute short-term debt (the sum of loans from banks with maturity shorter than one year, commercial paper, and other short-term loans) for large firms as the sum of short-term debt for firms in the class size $250 million to $1 billion and those with total assets larger than $1 billion. We view these asset class sizes as the most comparable to firms in our sample. Similarly, we compute short-term debt for small firms by aggregating the two size classes with assets under $25 million and $25 to $50 million.

Figure 9 plots short-term debt cumulative quarterly growth rates as log-deviations from their Q2:2007 values. It shows a marked reduction in short-term debt for small firms relative to their precrisis levels. Therefore our findings on cross-sectional variation based on firm size can be reconciled with those in Gertler and Gilchrist.

To the extent that small firms are wholly reliant on bank lending, the brunt of any bank lending contraction will be felt most by such firms. In the Flow of Funds, the noncorporate business sector would correspond best to such firms. In the online appendix we report empirical findings for nonpublic firms in LPC and SDC. We find that the crisis decreases total amounts of loans by a similar magnitude as for our sample (28 percent at the trough, relative to peak), and the spreads register a five-fold increase. Bond volumes are very small, as expected for these firms.

D. *Financing Choices: Logit Evidence*

We now investigate the determinants of new issuances in a regression framework. Our results extend earlier studies of Denis and Mihov (2003) and Becker and Ivashina (2011). We adopt the methodology of Denis and Mihov (2003) to study the marginal choice between bank and bond financing.[11] We follow Becker and Ivashina (2011) by including aggregate proxies for bank credit supply.

To be included in our sample, we require a firm to have new credit in at least one quarter between 1998 and 2010. In addition, firms are required to have nonmissing firm characteristics (specified later) during the quarter prior to issuance.

For every firm-quarter (i, t) in our sample with new debt issuance—be it a loan or bond—we set the indicator variable Bond Issuance$_{i,t}$ to be one (resp., zero) if firm i issues a bond (resp., loan) during quarter t. For a firm issuing both types of debt during a given quarter we set Bond Issuance$_{i,t} = 1$ if the total amount of bond financing exceeds that of loan financing, and zero otherwise. Finally, we require a firm to be rated during the quarter prior to issuance. Our final sample includes 4,276 firm-quarter observations (2,940 loan issuances and 1,336 bond issuances, corresponding to 1,177 unique issuers) with complete information on all firm characteristics. All firm characteristics are measured in the quarter prior to issuance and, with the exception of rating, are winsorized at the 1 percent level. Table B1 details the construction of our variables, and panel A of table 5 reports summary statistics for our sample.

In table 6, column (1) reports the results of logit regression of Bond Issuance on firm characteristics. Consistent with the findings in Houston and James (1996); Krishnaswami, Spindt and Subramaniam (1999); and Denis and Mihov (2003) we find that reliance on bond financing is positively associated with size, project and credit quality, and leverage.

Table 5
Descriptive Statistics

A. Firm Characteristics					
Variable	Mean	Median	5th %	95th %	N. of Obs.
Size	8.186	8.034	5.486	10.489	4,276
Tobin's Q	1.546	1.316	0.862	3.004	4,276
Tangibility	0.402	0.369	0.052	0.853	4,276
Rating	11.72(BBB–)	12(BBB–)	6.67(B)	17(A)	4,276
Profitability	0.034	0.032	0.004	0.072	4,276
Leverage	0.360	0.335	0.112	0.689	4,276
B. Bank Credit Supply Indicators					
BD Leverage	5.192	4.069	–46.057	56.760	52
EBP	0.061	–0.169	–0.696	1.224	51

Notes: This table presents summary statistics of firm characteristics and bank credit supply indicators for the sample used in our multivariate analysis. We require a firm to issue new debt in at least one quarter between 1998 and 2010, to be rated the quarter prior to issuance, and to have nonmissing values for the firm characteristics in panel A. All firm characteristics are measured the quarter before issuance. Bank credit supply indicators in panel B are observed every quarter between Q1:1998 and Q4:2010 with the sole exception of EBP, which is not available in Q4:2010. Definitions of the variables are provided in table B1.

As with Denis and Mihov (2003), we do not find evidence of a significant relation between growth opportunities and financing sources, suggesting that firms may resolve the underinvestment problem through some unobserved characteristics of debt (such as maturity or covenants) rather than the debt source. To gauge the economic importance of our findings, we compute in panel B of table 6 the implied changes in the probability of issuing bonds for hypothetical changes in our independent variables, assuming that each firm characteristic changes from its fifth percentile value to its ninety-fifth percentile value while the other variables are kept at their means. Our results highlight that financing choices are most strongly linked with firm size. Moreover, table 6, panel B, indicates that changes in Tobin's Q and tangibility are not only statistically insignificant, but have a relatively small impact on the implied probability of bond issuance.

To understand the impact of the recent financial crisis on corporate financing we reestimate a logit model adding Crisis (an indicator variable equal to one for each of the eight quarters between Q3:2007 and Q2:2009, and zero otherwise) to the above-mentioned control variables. Column (2) of table 6 shows that the crisis significantly decreases the

Table 6
Corporate Financing Choices and Bank Credit Supply Contraction

	Dep. Variable: Prob. of Bond vs. Loan Issuance			
Bank credit supply	(1)	Crisis (2)	BD leverage (3)	EBP (4)
A. Logit Regressions				
Size	0.358***	0.337***	0.366***	0.354***
	(0.042)	(0.042)	(0.042)	(0.042)
Tobin's Q	0.062	0.061	0.119	0.087
	(0.074)	(0.075)	(0.076)	(0.075)
Tangibility	–0.266	–0.285	–0.236	–0.244
	(0.205)	(0.203)	(0.206)	(0.211)
Rating	0.049**	0.052***	0.045**	0.039*
	(0.019)	(0.019)	(0.019)	(0.020)
Profitability	11.559***	11.286***	11.733***	12.622***
	(2.508)	(2.506)	(2.503)	(2.538)
Leverage	0.935***	1.007***	0.798***	0.796***
	(0.255)	(0.255)	(0.263)	(0.259)
Bank credit supply		0.621***	–0.009***	0.591***
		(0.087)	(0.001)	(0.046)
Observations	4,276	4,276	4,276	4,153
Pseudo R^2	0.067	0.075	0.079	0.095
B. Changes in Implied Probabilities				
Size	0.326	0.308	0.331	0.317
Tobin's Q	0.028	0.028	0.054	0.039
Tangibility	–0.044	–0.047	–0.039	–0.04
Rating	0.106	0.113	0.097	0.081
Profitability	0.164	0.161	0.167	0.177
Leverage	0.114	0.122	0.097	0.095
Bank credit supply		0.140	–0.179	0.238

Notes: This table presents logit regression results to explain corporate financing choices. To be included in the analysis, we require a firm to issue new debt in at least one quarter between 1998 and 2010, to be rated the quarter prior to issuance, and to have nonmissing values for the firm characteristics in panel A. The dependent variable is Bond Issuance, a dummy variable that takes a value of one if a firm issues a bond in a given quarter, and zero if it issues a loan. Panel A reports logit regression results of Bond Issuance on a set of control variables defined in table B1. Controls in column (1) include firm characteristics only, which we augment with the Crisis indicator in column (2), or with different bank credit supply indicators in columns (3) and (4). Firm characteristics are measured the quarter prior to debt issuance. All regressions include a constant (untabulated). Panel B reports the implied change in Bond Issuance when each control variable increases from its fifth to its ninety-fifth percentile value and the other variables are kept at their means. The implied probability change for Crisis is computed when Crisis changes from 0 to 1 and the other variables are kept at their means. Standard errors are clustered at the firm level and reported in parentheses. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

probability of obtaining credit. The estimates in column (2) imply an increase in the probability of issuing bonds during the crisis of 14 percent, keeping firm characteristics at their mean values.

In order to understand better the importance of bank credit supply over the business cycle (not just the recent financial crisis), we employ a variety of quarterly time-series variables proxying for bank credit (panel B of table 5 contains descriptive statistics of these variables between Q1:1998 and Q4:2010):

- BD leverage. Annual growth in broker-dealer leverage computed from the Flow of Funds. High values of BD leverage indicate easier credit conditions. The broker-dealer leverage variable has been used by Adrian, Moench, and Shin (2011) to price both the cross-section and time series of asset returns. The authors show that the broker-dealer leverage variable is thus a good proxy for both the time series and the cross-section of asset returns.
- EBP. Excess bond premium (in percentage points) as computed in Gilchrist and Zakrajšek (2011).[12] Higher values correspond to a reduction in the effective risk-bearing capacity of the financial sector, and thus a contraction in credit supply. The excess bond premium is a measure of the risk premium embedded in the cross-section of corporate bond yields, and has strong forecasting power for real activity.

Columns (3) and (4) of table 6 report logit regression results of *Bond Issuance* on firm characteristics and the above measures of bank credit supply in lieu of the crisis indicator. The previously highlighted dependence of firms' financing choices on firm-characteristics remains valid across all specifications. Firms with lower information asymmetries, better credit and project quality, and more indebtedness are more likely to resort to bond financing. Moreover, all our measures of bank credit supply measures significantly affect firms' financing decisions, and in the direction we expected.

In order to gauge the economic significance of our results, we consider in panel B changes in implied probabilities when each variable—be it a firm characteristic or a proxy for bank credit—increases from its fifth percentile value to its ninety-fifth percentile value while the other variables are kept at their means. We find that, depending on the proxy employed, a contraction in bank credit supply increases the probability of bond issuances between 17.90 percent (BD leverage) and 23.8 percent (EBP).[13]

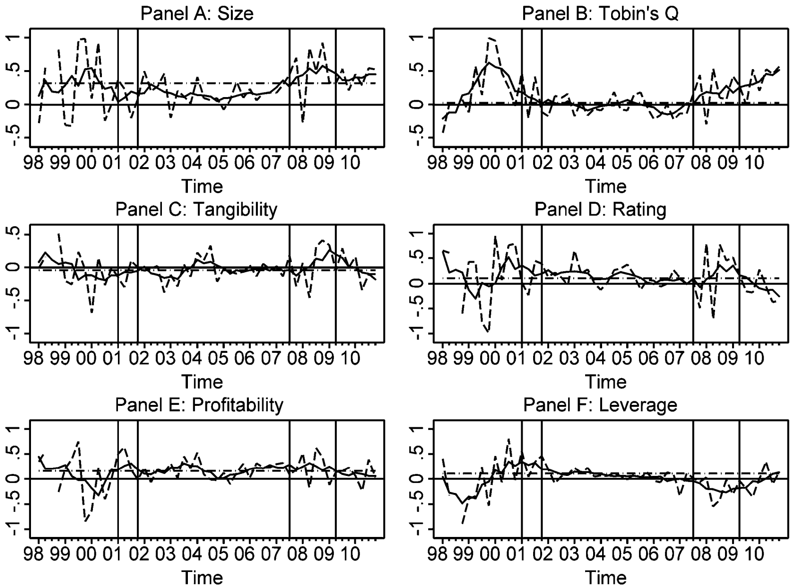

Fig. 10. Time varying sensitivities

Notes: Every quarter we first estimate cross-sectional logit regressions of Bond Issuance (a dummy variable that takes a value of one if a firm issues a bond in a given quarter, and zero if it issues a loan) on a series of firm characteristics (see table 6, specification (1)). Every quarter we then compute the implied change in Bond Issuance when each firm characteristic increases from its fifth to its ninety-fifth percentile value and the other variables are kept at their means. The figure plots the time series of these implied changes (dashed line) and their smoothed version (solid line).

Magnitudes

Having established impact of the financial crisis on corporate financing choices, we now turn to investigate which characteristics insulate firms from contractions in bank credit during the crisis. Our first empirical exercise consists of reestimating the logit regression every quarter, with firm characteristics only (see table 6, column (1)). We then compute the implied change in the dependent variable when each firm characteristic changes from its fifth percentile value to its ninety-fifth percentile value, while the other variables are kept at their means. Figure 10 graphs the quarterly time-series of implied probability changes together with a five-quarter moving average (solid line) and the implied probability changes from the panel estimation in table 6, column (1) (dash-dot line).[14] For example, during Q4:2010 the estimates from the logit regression predict a 26.3 percent and 79.4 percent probability of bond issuance, respectively, for a firm with Size equal to 6.278 (fifth percentile) and 10.386 (ninety-fifth percentile) while the other firm characteristics are stuck at their Q4:2010 mean values. The rightmost point in figure 10, panel A, corresponds to 53.1 percent; that is, the difference between these two probabilities. Figure 10 provides suggestive evidence that the larger and more profitable firms, and those with more tangible assets and better ratings, were more likely to resort to bond financing during the crisis, while heavily indebted firms were more likely to issue loans.

Interaction Effects

Further insights on the sensitivity of financing choice to firm characteristics can be obtained by augmenting the logit regression in column (2) of table 6 with an interaction term between a given firm characteristic and the crisis indicator.[15]

Regression results are reported in table 7. In line with our previous findings of table 6, the probability of bond issuance is positively related to firm size, credit and project quality, and leverage. In addition, firms are more likely to resort to bond financing during the crisis.

Due to the nonlinearity, the sign of the interaction term need not correspond to the direction of the effect of firm characteristics during the crisis. Moreover, the statistical significance of the interaction effect cannot be evaluated by looking at the standard error of the interaction term (Huang and Shields 2000). We therefore compute implied probabilities of bond issuance outside and during the crisis, and test for significant differences between them.

Figure 11 graphs the results for the different firm characteristics. We first consider the coefficient estimates of the logit model with the interaction term between size and the crisis indicator (see table 7, column (1)) and compute the implied probabilities of bond issuance during the crisis over the entire range of values for firm size, keeping the other firm characteristics at their means. The solid line in the left panel of figure 11, panel A, plots these probabilities (Crisis = 1) as a function of Size, and the dotted line portrays the same probabilities evaluated outside of the crisis (Crisis = 0). In the right panel of figure 11, panel A, we plot the difference in these predicted probabilities associated with a change in the crisis indicator (solid line) together with its 95 percent confidence interval (shaded region).[16] We then repeat the same steps for the logit models in table 7, columns (2) to (6).

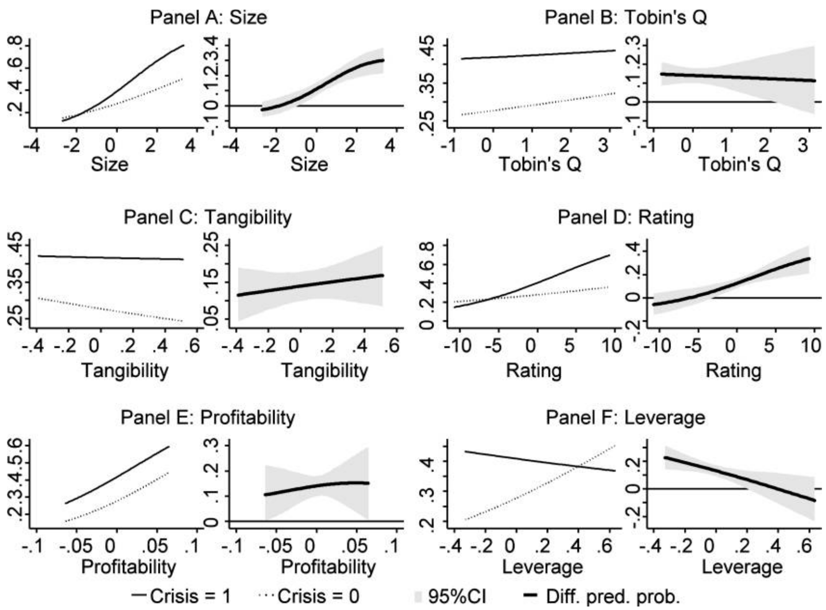

Fig. 11. Sensitivity during crisis

Notes: Sensitivity of bond issuance probability to firm characteristics during and outside the crisis. Implied probabilities are based on the logit regression specifications of table 7, which include a series of firm characteristics, the crisis indicator, and an interaction term between the crisis indicator and one selected firm characteristic. For every specification, the left panel plots the probability of bond issuance during (Crisis = 1, solid line) and outside the crisis (Crisis = 0, dotted line) over the entire range of values of the selected firm characteristic, keeping the other control variables at their mean levels. The right panel plots the difference in these predicted probabilities (solid line) together with its 95 percent confidence interval (shaded).

Figure 11 shows that, *conditional on the crisis*, more profitable firms and those with more tangible assets are more likely to issue bonds; the difference in predicted probabilities increases with both *tangibility* and *profitability* and is statistically significant for all firms (figure 11, panels C and E).

Similarly, larger and better rated firms resort more to bond financing during the crisis; the difference in implied probabilities is positive and statistically significant for all firms with "Size" larger than the twenty-fifth percentile value (total assets larger than $1,405 million, figure 11, panel A) and those with "Rating" above the twentieth percentile value (Standard and Poor's long-term issuer rating class BB- or higher, figure 11, panel D). We also document in figure 11, panels B and F, that the difference in predicted probabilities is decreasing in growth opportunities

Table 7
Sensitivity of Firm Characteristics during the Crisis

	Dep. Variable: Probability of Bond vs. Loan Issuance					
Firm characteristic	Size (1)	Tobin's Q (2)	Tangibility (3)	Rating (4)	Profitability (5)	Leverage (6)
Size	0.293***	0.337***	0.337***	0.331***	0.337***	0.333***
	(0.044)	(0.042)	(0.042)	(0.042)	(0.042)	(0.042)
Tobin's Q	0.069	0.067	0.059	0.065	0.061	0.066
	(0.075)	(0.077)	(0.075)	(0.074)	(0.075)	(0.075)
Tangibility	–0.266	–0.286	–0.345	–0.250	–0.285	–0.275
	(0.204)	(0.203)	(0.217)	(0.204)	(0.203)	(0.203)
Rating	0.051***	0.053***	0.053***	0.039**	0.052***	0.054***
	(0.020)	(0.019)	(0.020)	(0.020)	(0.020)	(0.020)
Profitability	11.041***	11.327***	11.323***	11.019***	11.294***	11.046***
	(2.505)	(2.506)	(2.509)	(2.498)	(2.829)	(2.509)
Leverage	1.004***	1.010***	1.014***	0.981***	1.007***	1.212***
	(0.255)	(0.255)	(0.255)	(0.255)	(0.255)	(0.266)
Crisis	0.497***	0.622***	0.617***	0.558***	0.621***	0.584***
	(0.095)	(0.087)	(0.087)	(0.092)	(0.088)	(0.088)
Crisis × Firm characteristic	0.276***	–0.045	0.314	0.094***	–0.041	–1.492***
	(0.070)	(0.124)	(0.328)	(0.030)	(4.660)	(0.534)
Observations	4,276	4,276	4,276	4,276	4,276	4,276
Pseudo R^2	0.078	0.075	0.075	0.077	0.075	0.076

Notes: This table presents logit regression results to explain the sensitivity of corporate financing choices to firm characteristics during the crisis. To be included in the analysis, we require a firm to issue new debt in at least one quarter between 1998 and 2010, to be rated the quarter prior to issuance, and to have nonmissing values for firm characteristics measured one quarter prior to debt issuance. The dependent variable is Bond Issuance, a dummy variable that takes a value of one if a firm issues a bond in a given quarter, and zero if it issues a loan. We report logit regression results of Bond Issuance on a set of firm characteristics defined in table B1 and an interaction term defined as the product between the Crisis indicator and the firm characteristic indicated in the column header. All regressions include a constant (untabulated). Standard errors are clustered at the firm level and reported in parentheses. ***, **, and * denote statistical significance at the 1 percent, 5 percent, and 10 percent levels, respectively.

and indebtedness, and significantly larger than zero for firms with Tobin's Q less than 3.552 (slightly above the ninety-fifth percentile value) and those with "Leverage" below 0.197 (75 percent percentile value).

Our analysis shows that firms that are larger or have more tangible assets, higher credit ratings, better project quality, less growth opportunities, and lower leverage, were better equipped to withstand the contraction of bank credit during the crisis.

Discussion

The full range of results in the present subsection can be pieced together to draw some tentative conclusions. First of all, the decomposition of borrowing into bank and bond finance, and the finding that bank and bond finance evolve in opposite directions during the crisis allows us to conclude that the contraction of bank credit was due to a fall in supply. This finding is robust to the exclusion of firm quarters with simultaneous issuance of both loans and bonds, as well as to the inclusion of industry fixed effects (see the online appendix posted on the authors' homepages). This conclusion is in line with Kashyap, Stein, and Wilcox (1993), and points to a credit channel or risk-taking channel of monetary policy.

A further identification assumption in our analysis of corporate financing choices is the conditioning on firm characteristics lagged one quarter. This may raise concerns since inference may be confounded if variation in firm characteristics is endogenous to unobserved variation in financing choices. We have therefore repeated the analysis in tables 6 and 7 and figure 11 measuring firm characteristics eight quarters prior to debt issuance. This way the probability of issuing bonds at the onset of the crisis (Q3:2007) is related to firm-level control variables measured during Q3:2005, and the same probability at the trough of the crisis (Q2:2009) depends on firm characteristics measured during Q2:2007. Our results are unchanged when we use variables measured eight quarters prior to debt issuance.

Finally, we corroborate evidence in Becker and Ivashina (2011) that financing choices are significantly associated with aggregate proxies for credit supply. A decrease in broker-dealer leverage or an increase in EBP trigger a substitution from loans to bonds.

We have further investigated the role played by firm characteristics during quarters of reduced bank credit supply. We have repeated the analysis in table 7 by replacing the crisis indicator with our proxies for credit supply, and adding the interaction between firm characteristics and credit supply proxies. We confirm the significant association between financing sources and the credit supply proxies we uncover in table 7 (direct effect).

To understand whether (and how) firm characteristics affect the substitution from loans to bonds during episodes of credit supply contraction, we have reproduced the analysis in figure 11 using credit supply proxies in lieu of the crisis indicator. Consistent with our previous results, we find that, regardless of the credit supply proxy employed, larger firms resort more to bond financing when banks credit supply contracts. We find overall evidence that the same holds true for less indebted firms, while the relevance of other firm characteristics is mixed.

IV. Model of Bank and Bond Finance

Motivated by our empirical results, we now sketch a model of direct and intermediated credit. To set the stage, it is useful to take stock of the desired empirical features encountered along the way.

- First, the contrast between loan and bond financing points to the importance of accommodating both direct and intermediated credit.
- Second, during the recent downturn, loan financing contracted but bond financing increased to make up some of the gap.
- Third, even as the two categories of credit diverged in *quantity*, the spreads on both types of credit rose.
- Fourth, bank lending changes dollar for dollar with a change in debt, with equity being "sticky." Thus, credit supply by banks is the consequence of their choice of leverage for a given level of equity.
- Fifth, as a consequence, bank leverage is procyclical. Leverage is high when assets are large.

We sketch a model that accommodates these five features. It is a model of direct and intermediated credit where lending by banks is seen as the flip side of a credit risk model.[17] Our model represents a departure from existing approaches to modeling financial frictions in two respects. First, it departs from the practice of imposing a bank capital constraint that binds only in the downturn. Instead, the capital constraint in our model binds all the time—both in good times and bad. Indeed, during the booms, the constraint binds *in spite of* the dampened risks.

Second, it is a model that is aimed at replicating as faithfully as possible the procyclicality of leverage. We have seen from the scatter charts of bank balance sheet management that banks adjust their assets dollar for dollar through a change in debt, with equity remaining "sticky." To the extent that banking sector behavior is a key driver of the observed outcomes, capturing these two features is important, and we address our modeling task to replicating these features.

A. *Bank Credit Supply*

Bank credit supply is modeled as the flip side of a credit risk model, where banks adjust lending so as to satisfy a risk constraint. In particular, banks are risk neutral and maximize profit subject only to a value-at-risk (VaR) constraint that limits the probability of bank failure. The VaR constraint stipulates that the probability of bank failure has to be no higher than some (small) threshold level $\alpha > 0$.[18] In keeping with market practice, the particular model of credit risk that drives the VaR constraint will be the Vasicek (2002) model, adopted by the Basel Committee for Banking Supervision (BCBS 2005).

The notation to be used is as follows. The bank lends out amount C (with "C" standing for "credit") at date 0 at the lending rate r, so that the bank is owed $(1 + r)C$ in date 1 (its notional assets). The lending is financed from the combination of equity E and debt funding L, where L encompasses deposit and money market funding. The cost of debt financing is f so that the bank owes $(1 + f)L$ at date 1 (its notional liabilities).

The economy has a continuum of binary projects, each of which succeeds with probability $1 - \varepsilon$ and fails with probability ε. Each project uses debt financing of 1, which the borrower will default on if the project fails. Thus, if the project fails, the lender suffers a credit loss of 1. The correlation in defaults across loans follows the Vasicek (2002) model. Project j succeeds (so that borrower j repays the loan) when $Z_j > 0$, where Z_j is the random variable

$$Z_j = -\Phi^{-1}(\varepsilon) + \sqrt{\rho}Y + \sqrt{1 - \rho}X_j \quad (1)$$

where $\Phi(\cdot)$ is the cumulative distribution function (c.d.f.) of the standard normal, Y and $\{X_j\}$ are independent standard normals, and ρ is a constant between zero and one. Variable Y has the interpretation of the economy-wide fundamental factor that affects all projects, while X_j is the idiosyncratic factor for project j. The parameter ρ is the weight on the common factor, which limits the extent of diversification that lenders can achieve. Note that the probability of default is given by

$$\begin{aligned}\Pr(Z_j < 0) &= \Pr(\sqrt{\rho}Y + \sqrt{1-\rho}X_j < \Phi^{-1}(\varepsilon)) \\ &= \Phi(\Phi^{-1}(\varepsilon)) = \varepsilon.\end{aligned} \tag{2}$$

Conditional on Y, defaults are independent. The bank can remove idiosyncratic risk by keeping C fixed but diversifying across borrowers. We assume that loans are packaged into bonds and banks hold such diversified bonds, rather than loans directly. By holding bonds, banks can diversify away all idiosyncratic risk, and only the systematic risk from the common factor Y is reflected in the credit risk. The realized value of the bank's assets at date 1 is then given by the random variable $w(Y)$ where

$$\begin{aligned}w(Y) &\equiv (1+r)C \cdot \Pr(Z_j \geq 0 | Y) \\ &= (1+r)C \cdot \Pr(\sqrt{\rho}Y + \sqrt{1-\rho}X_j \geq \Phi^{-1}(\varepsilon)|Y) \\ &= (1+r)C \cdot \Phi\left(\frac{\sqrt{\rho}Y - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right).\end{aligned} \tag{3}$$

Then, the c.d.f. of $w(Y)$ is given by

$$\begin{aligned}F(z) &= \Pr(w \leq z) \\ &= \Pr(Y \leq w^{-1}(z)) \\ &= \Phi(w^{-1}(z)) \\ &= \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\Phi^{-1}[z/(1+r)C]}{\sqrt{\rho}}\right).\end{aligned} \tag{4}$$

The density over the realized assets of the bank is the derivative of (4) with respect to z. Figure 12 plots the densities over asset realizations, and shows how the density shifts to changes in the default probability ε (left-hand panel) or to changes in ρ (right-hand panel). Higher values of ε imply a first degree stochastic dominance shift left for the asset realization density, while shifts in ρ imply a mean-preserving shift in the density around the mean realization $1 - \varepsilon$.

The bank adjusts the size of its asset book C and funding L given equity E so as to keep its probability of default to $\alpha > 0$. Since the bank is risk-neutral and maximizes profit, the VaR constraint binds whenever expected return from the bond is positive. The constraint is that the bank limits total assets so as to keep the probability of its own failure to

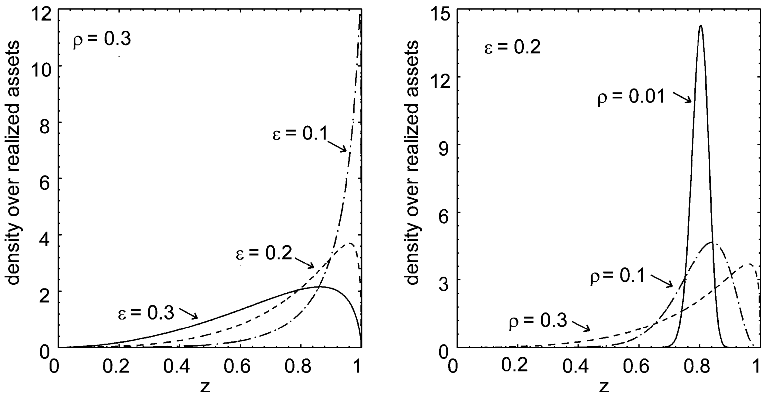

Fig. 12. The two charts plot the densities over realized assets when $C(1 + r) = 1$
Notes: The left-hand chart plots the density over asset realizations of the bank when $\rho = 0.1$ and ε is varied from 0.1 to 0.3. The right-hand chart plots the asset realization density when $\varepsilon = 0.2$ and ρ varies from 0.01 to 0.3.

α. Since the bank fails when the asset realization falls below its notional liabilities $(1 + f)L$, the bank's total assets C satisfies

$$\Pr(w < (1 + f)L) = \Phi\left(\frac{\Phi^{-1}(\varepsilon) + \sqrt{1-\rho}\,\Phi^{-1}[(1 + f)L/(1 + r)C]}{\sqrt{\rho}}\right) = \alpha. \quad (5)$$

Rearranging (5), we can derive an expression for the ratio of notional liabilities to notional assets for the bank.

$$\frac{\text{Notional liabilities}}{\text{Notional assets}} = \frac{(1 + f)L}{(1 + r)C} = \Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right) \quad (6)$$

From here on, we will use the shorthand φ to denote this ratio of notional liabilities to notational assets. That is,

$$\varphi(\alpha, \varepsilon, \rho) \equiv \Phi\left(\frac{\sqrt{\rho}\,\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon)}{\sqrt{1-\rho}}\right), \quad (7)$$

where φ is a monotonic transformation of the leverage ratio, lying between zero and one. The higher is φ, the higher is bank leverage and the greater is credit supply.

We can solve for the bank's total assets C and liability aggregate L from (6) and the balance sheet identity $C = E + L$ to give

$$C = \frac{E}{1 - [(1 + r)/(1 + f)] \cdot \varphi} \quad \text{and} \quad L = \frac{E}{[(1 + f)/(1 + r)] \cdot (1/\varphi) - 1}. \quad (8)$$

Note that both C and L are proportional to bank equity E, so that an aggregation property holds for bank lending and bank funding. Therefore, the leverage of the *bank* and the *banking sector* are interchangeable in our model, and is given by

$$\text{Leverage} = \frac{C}{E} = \frac{1}{1-(1+r)/(1+f)\cdot\varphi}. \tag{9}$$

B. Direct Credit

Now consider the credit coming directly from bond investors. Bond investors ("households") are risk averse with mean-variance preferences, and have identical risk tolerance τ. Households hold a portfolio consisting of three component assets—risky bonds, cash, and deposits in the bank. As stated already, deposits include claims on money market funds that serve as the base of the shadow banking system. We assume that deposits are guaranteed by the government (at least implicitly) so that households treat cash and deposits as being perfect substitutes. We also assume that the households have sufficient endowments so that the wealth constraint is not binding in their choice of holding for the risky bonds. The demand for bonds (supply of credit) of mean-variance investor i with risk tolerance τ is then given by the first-order condition:

$$C_i = \frac{\tau[(1-\varepsilon)(1+r)-1]}{\sigma^2(1+r)^2}, \tag{10}$$

where σ^2 is the variance of the bond with unit notional value.[19] Clearly, σ^2 is a function of ρ and ε. The variance σ^2 reflects the fundamentals of the asset realization density given in figure 12.

Suppose there is measure N of mean-variance investors in the economy, and that $T = \tau N$. Aggregating the bond holdings across all households, the aggregate supply of credit from bond investors is thus given by:

$$C_H = \frac{T[(1-\varepsilon)(1+r)-1]}{\sigma^2(1+r)^2}, \tag{11}$$

where H stands for the household sector. In Appendix A, we show that the variance σ^2 is given by

$$\sigma^2 = \Phi_2(\Phi^{-1}(\varepsilon), \Phi^{-1}(\varepsilon); \rho) - \varepsilon^2, \tag{12}$$

where $\Phi_2(\cdot,\cdot;\rho)$ is the cumulative bivariate standard normal with correlation ρ.[20]

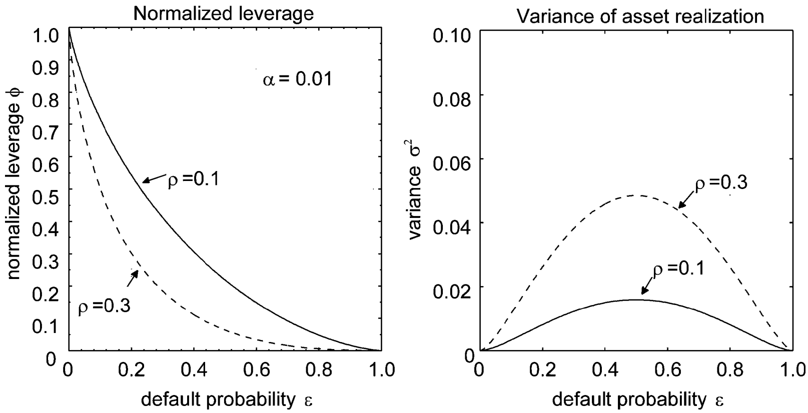

Fig. 13. Left-hand panel plots the normalized leverage φ as a function of ε; right-hand panel plots the variance σ^2 as a function of epsilon for two values of ρ

The right-hand panel of figure 13 plots the variance σ^2 as a function of ε. The variance is maximized when $\varepsilon = 0.5$, and is increasing in ρ. The left-hand panel of figure 13 plots the normalized leverage φ as a function of ε.

Since bank liabilities are fully guaranteed by the government they earn the risk-free rate. Further, let the risk-free rate be zero, so that $f = 0$. Since bank credit supply is increasing in φ while bond investor credit supply is decreasing in σ^2, the effect of an increase in ε (assuming that $\varepsilon < 0.5$) is to decrease credit supply from both groups of creditors.

C. *Comparative Statics of Credit Supply*

The risk premium on the bond is given by its expected return in excess of the risk-free rate. Given our assumption that the risk-free rate is zero, the risk premium π is given by

$$\pi = (1 - \varepsilon)(1 + r) - 1. \tag{13}$$

Consider the iso-lending curves for banks that plot the combination of default probability ε and risk premium π that give rise to the same credit supply by banks. The iso-lending curve for banks corresponding to bank credit C_B is given by

$$\pi(\varepsilon) = \left(1 - \frac{E}{C_B}\right)\frac{1 - \varepsilon}{\varphi(\varepsilon)} - 1. \tag{14}$$

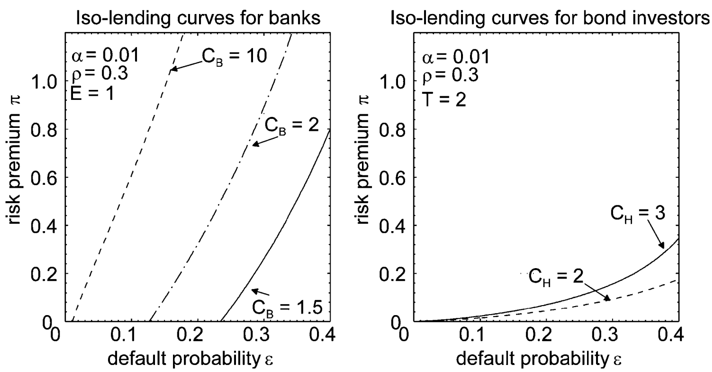

Fig. 14. Iso-lending curves in (ε, π)-space for banks (left panel) and bond investors (right panel)

Note: Parameter values are as indicated in the boxes.

For banks, the iso-lending curve has the property that when ε is small, the iso-lending curve is close to being vertical in (ε, π)-space. From (14), we have

$$\pi'(\varepsilon) = -\left(1 - \frac{E}{C_B}\right)\left[\frac{1-\varepsilon}{\varphi^2}\varphi'(\varepsilon) + \frac{1}{\varphi}\right], \quad (15)$$

where $\varphi'(\varepsilon) \to -\infty$ as $\varepsilon \to 0$. Hence, the slope of the iso-lending curve tends to $+\infty$ as $\varepsilon \to 0$. Figure 14 plots the iso-lending curves in (ε, π)-space for banks (left panel) and bond investors (right panel).

The vertical limiting case of the bank iso-lending curves is revealing about the behavioral traits of banks. To say that the iso-lending curve is vertical is to say that bank lending decisions depend only on the "physical" risk ε, rather than the risk premium π. This feature comes from the combination of the risk-neutrality of the bank, and the constraint that limits its probability of failure. Risk neutrality means that the risk premium π enters only through its VaR constraint. Conventional risk-averse portfolio investors would focus on the trade-off between physical risk ε and the risk premium π. The right-hand panel of figure 14 shows the iso-lending curves of the bond investors, to be derived shortly. Although we have used mean-variance preferences for convenience for the bond investors, any conventional risk averse preferences would imply a nontrivial trade-off between physical risk and risk premium.

The bond investors' iso-lending curves in (ε, π)-space follow from the supply of credit by households given by (11), from which we can derive the following quadratic equation in π

$$\frac{C_H \sigma^2}{T(1-\varepsilon)^2}(1+\pi)^2 - (1+\pi) + 1 = 0. \tag{16}$$

The iso-lending curve for bond investors corresponding to bond credit supply of C_H is given by

$$\pi(\varepsilon) = \frac{1 - \sqrt{1 - 4C_H \sigma^2 / T(1-\varepsilon)^2}}{2C_H \sigma^2 / T(1-\varepsilon)^2} - 1. \tag{17}$$

Let us now close the model by positing an aggregate demand for credit. The demand for credit is a decreasing function of the risk premium, and is denoted by $K(\pi)$. The market clearing condition is then

$$\underbrace{\frac{E}{1 - [(1+\pi)/(1-\varepsilon)]\varphi}}_{C_B} + T\underbrace{\frac{(1-\varepsilon)^2 \pi}{\sigma^2 (1+\pi)^2}}_{C_H} = K(\pi). \tag{18}$$

How does the risk premium π vary to shifts in the physical risks ε? Provided that ε is small—so that it lies in the plausible range for the probability of default—and provided that the risk premium is not too large, we can show that the risk premium π is an increasing function of ε.

Proposition 1. *Suppose* ε *is small so that* $|\partial\varphi/\partial\varepsilon| > \varphi/(1-\varepsilon)$ *and the risk premium is small so that* $\pi < 1$. *Then the market risk premium* π *is strictly increasing in* ε.

In other words, an increase in physical risk also raises the market risk premium. To prove proposition 1, note first that credit supply by bond investors is declining in ε, and that bank lending declines in ε if $|\partial\varphi/\partial\varepsilon| > \varphi/(1-\varepsilon)$. Meanwhile, we can also show $\partial C_B/\partial\pi > 0$ and—assuming $\pi < 1$—we also have $\partial C_H/\partial\pi > 0$. Defining the excess supply of credit function $G(\varepsilon, \pi) \equiv C_B + C_H - K(\pi)$, we have

$$\frac{d\pi}{d\varepsilon} = -\frac{\partial G/\partial\varepsilon}{\partial G/\partial\pi} = -\frac{(\partial C_B/\partial\varepsilon) + (\partial C_H/\partial\varepsilon)}{(\partial C_B/\partial\pi) + (\partial C_H/\partial\pi) - K'(\pi)} > 0. \tag{19}$$

Since bank credit is declining in ε, the balance sheet identity implies that the funding L used by banks is also declining.

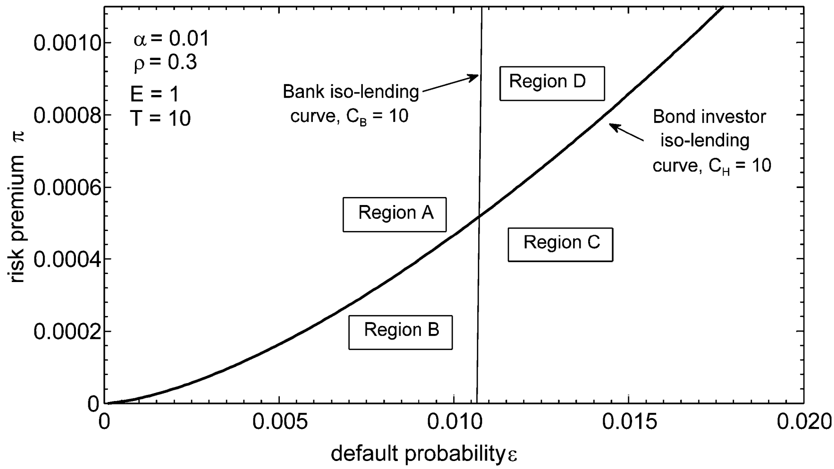

Fig. 15. Crossing point for the iso-lending curves of banks and households

D. Relative Size of Banking Sector

We now come to our key result, which addresses the relative size of the banking sector and its relationship to risk premiums. Provided that credit demand $K(\pi)$ is not too elastic, a decline in ε is followed by an increase in the size of the banking sector, both in absolute terms and as a proportion to the total credit provided in the economy.

PROPOSITION 2. *Suppose that ε is small enough so that the iso-lending curve of banks is steeper than the iso-lending curve of bond investors. Then, there is $M > 0$ such that, provided $K'(\pi) \leq M$, an increase in ε is associated with a contraction of banking sector assets, both in absolute terms and as a proportion of the total credit received by borrowers.*

Proposition 2 can be demonstrated using a graphical argument using the iso-lending curves for banks and bond investors. Figure 15 illustrates an initial equilibrium given by the crossing point for the iso-lending curves for banks and bond investors. In this illustration, total credit supply is 20, with 10 coming from banks and 10 coming from bond investors. The four regions indicated in figure 15 correspond to the four combinations of credit supply changes by banks and bond investors. Region A is when both banks and bond investors increase credit supply, while region C is where both reduce credit supply.

Now, consider a negative economic shock that raises the default probability ε. Such a shock shifts the economy to the right-hand side of the banks' iso-lending curve, implying a decrease in bank credit. In addition, the market risk premium π rises, as a consequence of proposition 1. Since bank credit supply contracts, bond credit supply must increase for the market to clear. Thus, the new equilibrium (ε, π) pair must lie in region D in figure 15. In region D, bank credit supply contacts while bond credit supply expands.

In this way, when default risk starts to increase as the financial cycle turns, there will be an amplifying effect through the risk premium π. As ε increases due to the deterioration of fundamentals, we have the combination of sharply higher risk premiums and the contraction in bank lending. Bond investors are then induced by the higher risk premiums to close the credit supply gap in the market. The recoiling from risks, sharply higher risk premiums, and the substitution of bank lending by bond financing explains the substitution away from bank financing to bond financing that we see in the data. Given a fairly inelastic credit demand curve (at least in the short run), the sharp contraction in loans from financial intermediaries will have to be made up somehow. The slack is taken up by the increase in bond financing. However, for this to happen, prices must adjust in order that the risk premium rises sufficiently to induce risk-averse bond investors to make up for the lost banking sector credit. Thus, a fall in the relative credit supplied by the banking sector is associated with a rise in risk premiums.

For macro activity, such a rise in the risk premium exerts contractionary effects on the real economy. Gilchrist, Yankov, and Zakrajšek (2009) documents evidence that credit spreads have substantial effect on macro activity measures. Thus, the financial friction that such a mechanism generates is one that works through prices, rather than through a shrinkage in the total quantity of credit. Exactly how increased spreads impact the real economy is a subject that is ripe for further investigation.

V. Modeling Financial Frictions

Since the financial crisis, a new wave of dynamic, general equilibrium macro models that incorporate financial frictions have been developed. The evidence in our study presents a challenge to many of these models, as we point to a very specific set of empirical facts, with tight implications for the modeling of financial frictions. The challenge for the theory is to capture the five stylized facts that we documented earlier: (1) coexistence of bank and bond finance; (2) substitution from bank to bond finance during recessions and crisis; (3) increasing credit spreads; (4) stickiness of equity; (5) procyclicality of bank leverage. Our model from the previous section presents a microfoundation that is rationalizing all five stylized facts. However, no dynamic general equilibrium model has, to date, incorporated such a setup for the financial sector. In this section, we review the recent macroeconomic literature with financial frictions in light of our evidence.[21]

In the seminal contributions of Bernanke and Gertler (1989) and Bernanke, Gertler, and Gilchrist (1999), the financial accelerator generates only one of the five stylized facts: credit spreads increase during downturns. However, in the financial accelerator approach, the financial friction resides with the corporate borrower. There are no banks, and hence the model has nothing to say about the substitutability between loans and bonds. In a recent extension of the Bernanke, Gertler, and Gilchrist setting, Gertler and Kiyotaki (2010) use the frictions of Bernanke and Gertler (1989) and apply them to both the corporate sector and the banking sector. As a result, Gertler and Kiyotaki (2010) are able to talk about the role of the banking sector in business cycle fluctuations. However, Gertler and Kiyotaki (2010) still do not generate procyclical leverage of the financial intermediaries. This is because of their assumption of the particular financing constraint.

Perhaps the most distinctive feature of bank balance sheet management is the fact that banks adjust assets dollar for dollar through a change in debt, with equity remaining sticky. We have not attempted to resolve the microfoundations for such behavior, but understanding the underlying corporate finance behind this feature seems critical. For banks that adjust lending to shifts in VaR, a good rule of thumb is that they adjust their balance sheets in order to keep their probability of failure constant in the face of changing financial conditions. In periods of heightened market stress, banks contract lending and shed risky exposures, while in tranquil conditions, banks expand lending so as to utilize any slack in the balance sheet.

The banks' practice of adjusting their assets dollar for dollar through debt also poses some conceptual challenges for modeling of financial frictions. Many attempts at modeling financial frictions have employed log preferences, or constraints that bind only in the downturn. Recent examples of analyses where one or both of these assumptions are employed are Brunnermeier and Sannikov (2009, 2010) and He and Krishnamurthy (2010, 2012a, 2012b). The determination of risk premiums and spillovers using log utility was examined by Xiong (2001).

Log utility has been a convenient means to simplify the dynamic portfolio problem, as portfolio choices based on log utility imply leverage that is proportional to the ratio of the risk premium to the variance of returns (Merton 1969). In order for leverage to be procyclical, the ratio of risk premium to variance of returns (equivalently, the Sharpe ratio divided by volatility) must also be procyclical. However, supporting evidence is lacking. If anything, to the extent that the Sharpe ratio tends to be low in booms and high in busts, it would be plausible to find that log utility investors show countercyclical leverage, rather than procyclical leverage. To the extent that banking sector behavior is a key driver of the observed outcomes, capturing procyclical leverage seems crucial. On this score, it would be fair to say that existing macro models of financial frictions are still some way off from being fully satisfactory.

Imposing additional constraints on banks so that their lending contracts would be one way to bring the model closer to observed behavior, but such an approach implies constraints that bind only in the downturn, rather than binding all the time. The scatter charts we have seen for the balance sheet management of banks suggest that such an asymmetric approach may not be completely satisfactory.

In an international context, Mendoza (2010) develops a model of emerging market crisis that does feature procyclical leverage of the economy in the aggregate. Bianchi and Mendoza (2010) study a quantitative model of systemic risk, where agents do not take externalities of financial fragility on others into account. The model features overleveraging in the boom, countercyclical risk premiums, and excessive volatility associated with the systemic risk externality. Jermann and Quadrini (2012) study the financial policies of the corporate sector in a model that features procyclical leverage for the business sector. The crucial ingredients to the model are adjustments at both the debt and equity issuance margin. However, this model does not feature a banking sector, and therefore does not capture the substitution between loan and bond financing.

There is also a recent literature that is extending standard dynamic stochastic general equilibrium (DSGE) models to include a banking sector. Gertler and Karadi (2011) present a parsimonious DSGE model with a banking sector, production, and sticky prices, allowing them to study monetary policy. The model again captures increases in spreads during crisis, but does not produce a substitution between loans and bonds. In addition, the paper does not feature the procyclicality of the banking sector that we documented earlier. Christiano, Motto, and Rostagno (2009) offer a rich quantitative DSGE model with three production sectors, and a banking sector. Curdia and Woodford (2009) incorporate banks that intermediate between households. Nevertheless, the relative size of the banking sector is not well addressed in these papers, where all credit is intermediated credit.

One important message from our investigation is that net worth, by itself, cannot serve as the state variable that fully determines financial conditions. The leverage of the banking sector emerges as being a key determinant (and reflection) of financial conditions. As such, understanding how the leverage of financial intermediaries fluctuates over the cycle emerges as perhaps the most pressing question in the study of macroeconomic fluctuations.

VI. Conclusion

The financial crisis of 2007 to 2009 has sparked keen interest in models of financial frictions and their impact on macro activity. Most models share the feature that corporate borrowers suffer a contraction in the quantity of credit. However, the evidence suggests that although bank lending contracts during the crisis, bond financing actually increases to make up much of the gap. This paper reviews both aggregate and micro-level data and highlights the shift in the composition of credit between loans and bonds.

The review of the evidence on the fluctuations in credit to nonfinancial firms allows us to draw up a checklist of key empirical stylized facts that may be used to guide the modeling exercise at the micro level. Although the workhorse models of financial frictions used in macroeconomics capture some key empirical features, they fail to address others. We documented five stylized facts:

1. Both bank and bond financing are quantitatively important in providing credit to nonfinancial corporations.
2. In the recent financial crisis, and downturns more generally, credit in the form of loans contract, but bond financing increases to make up most of the gap.
3. Credit spreads for both types of credit rise in downturns.
4. Bank lending changes dollar for dollar with a change in debt, with equity being sticky. Thus, credit supply by banks is the consequence of their choice of leverage.
5. Bank leverage is procyclical.

Motivated by this evidence, we have formulated a model of direct and intermediated credit that captures these five stylized facts. In our model, the impact on real activity comes from the spike in risk premiums, rather than contraction in the total quantity of credit. However, to date, none of the macroeconomic equilibrium models have adequately addressed all five stylized facts. In reviewing the recent literature, we uncover that some models capture the procyclicality, others offer a substitution between bond and loan financing, but no model captures all five stylized facts. Embedding a model such as the one we present within a general equilibrium framework appears as a promising avenue for research.

Appendix A

Variance of Asset Realizations in Vasicek (2002)

In this appendix, we present the derivation of the variance of the normalized asset realization $\hat{w}(Y) = w(Y)/C(1 + r)$ in Vasicek (2002). Let $k = \Phi^{-1}(\varepsilon)$ and $X_1, X_2, \ldots, X_n$ be i.i.d. standard normal. Thus,

$$
\begin{aligned}
E[\hat{w}^n] &= E\left[\left(\Phi\left(\frac{Y\sqrt{\rho} - k}{\sqrt{1-\rho}}\right)\right)^n\right] \\
&= E\left[\prod_{i=1}^{n} \Pr\left[\sqrt{\rho}Y + \sqrt{1-\rho}X_i > k \middle| Y\right]\right] \\
&= E\left[\Pr\left[\sqrt{\rho}Y + \sqrt{1-\rho}X_1 > k, \ldots, \sqrt{\rho}Y + \sqrt{1-\rho}X_n > k \middle| Y\right]\right] \\
&= \Pr\left[\sqrt{\rho}Y + \sqrt{1-\rho}X_1 > k, \ldots, \sqrt{\rho}Y + \sqrt{1-\rho}X_n > k\right] \\
&= \Pr[Z_1 > k, \ldots, Z_n > k],
\end{aligned}
$$

where $(Z_1, \ldots, Z_n)$ is multivariate standard normal with correlation ρ. Hence

$$E[w] = 1 - \varepsilon$$

and

$$
\begin{aligned}
\sigma^2 &= var[w] = var[1 - w] \\
&= \Pr[1 - Z_1 \le k, 1 - Z_2 \le k] - \varepsilon^2 \\
&= \Phi_2(k, k; \rho) - \varepsilon^2 \\
&= \Phi_2(\Phi^{-1}(\varepsilon), \Phi^{-1}(\varepsilon); \rho) - \varepsilon^2,
\end{aligned}
$$

where $\Phi_2(\cdot, \cdot; \rho)$ is the cumulative bivariate standard normal with correlation ρ.

Appendix B

Variable Construction

Table B1
Variable Description

Variable	Description	Source
	A. Issue Level Indicators	
Loan	Primary purpose “Capital expenditure”, “Corporate purposes”, “Equipment purchase”, “Infrastructure”, “Real estate”, “Trade finance”, or “Working capital”	LPC
Revolver	Loan type is “Revolver/Line <1 Yr.”, “Revolver/Line >= Yr.”, “Revolver/Term Loan”, or “364-Day Facility”	LPC
Term loan	Loan type is “Term Loan”, or “Term Loan” with tranche indicator A to H	LPC
Bond	Primary use “Buildings”, “Capital expenditures”, “Construction”, “General corporate purpose”, “Property development”, “Railways”, “Working capital”	SDC
	B. Firm Level Variables	
Size	ln(Assets [atq], expressed in January 1998 constant USD mln.)	Compustat
Tobin’s Q	(Assets + Market value of equity [prccq*cshprq] – Common equity [ceqq] – Deferred taxes [txditcq]) / Assets. Bounded above at 10.	Compustat
Tangibility	Net property, plant, and equipment (ppentq) / Assets	Compustat
Rating	Each monthly S&P long-term issuer rating (splticrm) is assigned an integer number ranging from 1 (SD or D) to 21 (A). Rating is the quarterly average of monthly ratings.	Compustat
Profitability	Operating income before depreciation (oibdqp) / Assets	Compustat
Leverage	(Debt in current liabilities (dlcq) + Long-term debt (dlttq)) / Assets	Compustat

(*continued*)

Table B1
Continued

Variable	Description	Source
	C. time series variables	
Crisis	Indicator variable equal to one for each of the eight quarters between Q3:2007 and Q2:2009, and zero otherwise.	
BD leverage	Annual growth in broker-dealer leverage.	Federal Reserve
EBP	Excess bond premium (in percentage points).	Gilchrist and Zakrajšek (2011)

Notes: This table provides a detailed description of our variable construction. Characteristics of new debt issuances in panel A are retrieved from the Loan Pricing Corporation's Dealscan database of new loan issuances (LPC) and the Securities Data Corporation's New Bond Issuances database (SDC). Firm characteristics in panel B are retrieved from the Compustat quarterly database. Time series variables in panel C are observed at quarterly frequency.

Endnotes

Paper for the NBER Macro Annual Conference, April 20–21, 2012. We thank Daron Acemoglu, Olivier Blanchard, Thomas Eisenbach, Mark Gertler, Simon Gilchrist, Arvind Krishnamurthy, Guido Lorenzoni, Jonathan Parker, Michael Woodford, and participants at the Chicago Macroeconomic Fragility conference and the 2012 AEA meetings for comments on earlier versions of the paper. We also thank Michael Roberts and Simon Gilchrist for making available data used in this paper. For acknowledgments, sources of research support, and disclosure of the authors' material financial relationships, if any, please see http://www.nber.org/chapters/c12741.ack.

1. Notice that the slopes of the two fitted lines add up to 1 in figure 3. This is a consequence of the balance sheet identity: $\Delta A_t = \Delta E_t + \Delta D_t$, and the additivity of covariance.

2. We measure the cost of loans with the all-in-drawn spread, which is defined as total (recurring fees plus interest) spread paid over six-month London Interbank Offered Rate (LIBOR) for each dollar drawn down. On occasions, we also make use of the all-in undrawn spread as a measure of the cost a borrower pays for each dollar available (but not drawn down) under a credit line. Bradley and Roberts (2004) and Strahan (1999) contain further details on how LPC computes spreads.

3. Loan financing may be intended for a variety of purposes. Stated purposes (based on the LPC field "primary purpose") can be broadly grouped into M&A (acquisition, takeover, LBO/MBO), refinancing/capital structure management (debt repayment, recapitalization, and stock repurchase), liquidity management (working capital and trade finance), and general corporate purposes (corporate purposes and capital expenditure); credit lines may also serve as commercial paper backup (see, among others, Drucker and Puri [2009] for a classification of loan purposes). Following Ivashina and Scharfstein (2010), we consider as real investment loans those used for general corporate purposes and liquidity management. Specifically, we define as real investment loans those with LPC primary purpose "Capital expenditure", "Corporate purposes", "Equipment purchase", "Infrastructure", "Real estate", "Trade finance", or "Working capital." After merging LPC with Compustat the vast majority of loan facilities in our final sample are extended for corporate purposes (7,029 issuances, corresponding to 56.81 percent of our sample) or working capital (4,971 issuances, 40.18 percent of our sample).

4. The May 2010 linking table provided by Michael Roberts enables us to match 11,765 loans with our Compustat sample; we further link 608 loans issued in 2010. We match a loan (and a bond) issued in a given quarter with Compustat data for the same quarter.

5. We measure the cost of bonds with the spread to benchmark, which is defined by SDC as the number of basis points over the comparable maturity treasury. Our results are qualitatively unchanged if we measure the cost of bonds subtracting the six-month LIBOR from the yield to maturity (see the online appendix).

6. Mirroring our classification of loans, we define a real investment bond as having primary purpose (based on the SDC field "primary use of proceeds") "Buildings", "Capital expenditures", "Construction", "General corporate purpose", "Property development", "Railways", "Working capital."

7. With our data sets we cannot determine whether a credit line, after being extended, is indeed used. However, Campello et al. (2011) show that firms drew down on their lines during the crisis, which suggests that the all-in-drawn spread is indeed the proper measure of the cost of revolvers during the crisis. An alternative measure for the cost of credit lines during the crisis by using the all-in-undrawn spread, is shown in figure 6, panel D. Even here, we uncover a steep increase in the cost of new financing during the crisis, which tripled relative to precrisis levels (331 bps during Q2:2009).

8. If we used the all-in-undrawn spread for revolvers during the financial crisis, the cost of bank financing would more than double to 215 bps during Q2:2009.

9. Our type split (credit lines and term loans) covers 97 percent of all loans in our sample, which is why the sum of loan types does not add to total loan financing in figure 7, panel A. Loans that are not classified include bridge loans, delay draw term loans, synthetic leases, and other loans.

10. We exclude new debt tranches (and thus, possibly firms) issued before the crisis that mature before Q2:2007, and those issued during the crisis that mature before Q2:2009.

11. We include only firm-level variables in an attempt to isolate the effect of borrower's preferences. Relative to Denis and Mihov (2003) we therefore exclude the amount issued because it may partially reflect supply.

12. We thank Simon Gilchrist for sharing this series with us.

13. We refer to a contraction in bank credit supply as an increase in EBP from its fifth to ninety-fifth percentile, or a decrease in BD leverage from its ninety-fifth to fifth percentile.

14. Figure 10 does not include Q3:1998 because a linear combination of the control variables exactly predicts Bond Issuance (eight bond and eleven loan issuances).

15. The interaction term is very highly correlated with the crisis indicator—correlations range between 0.82 and 0.98. To avoid multicollinearity concerns, we therefore demean firm characteristics before creating the interaction terms. As a result, correlations between the interaction term and Crisis oscillate between –0.16 and 0.28.

16. To assess statistical significance we use 1,000 draws from a multivariate normal distribution with mean equal to the estimated coefficient vector from the logit model, and variance matrix equal to the estimated variance-covariance matrix for the coefficient estimates (King, Tomz, and Wittenberg 2000; Zelner 2009).

17. The model was introduced in Shin (2011) in the context of cross-border banking and capital flows.

18. See Adrian and Shin (2008) for a possible microfoundation for the VaR constraint as a consequence of constraints imposed by creditors.

19. Equivalently, σ^2 is the variance of $w(Y)/(1 + r)C$.

20. See Vasicek (2002) for additional properties of the asset realization function $w(Y)$.

21. Brunnermeier, Eisenbach, and Sannikov (2011) and Quadrini (2011) offer more comprehensive surveys of the literature on general equilibrium macroeconomic models with financial frictions.

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