Credit disintermediation and monetary policy*

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Abstract

Since the early 1990s, the share of loans in total debt of US firms appears to have declined. This paper explores the implications of this trend toward "disintermediation" for the transmission of monetary policy shocks. Empirically, investment among firms with high loan shares is significantly more responsive to monetary policy shocks. Moreover, this pass-through has declined since the early 1990s, when disintermediation started. A model where firms choose debt structure by trading off the flexibility of loans against the lower cost of bonds can account for the higher sensitivity of more bank-dependent firms to monetary shocks. In this model, disintermediation also leads to a decline in the overall pass-through of monetary shocks to investment.

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I Introduction

In recent decades, the role of banks in the provision of credit to corporations in the US appears to have shifted. Figure 1 reports the share of loans to non-financial firms, as a fraction of their total debt outstanding, constructed using Flow of Funds data. From the 1960s to the early 1990s, this loan share was stable, at around 50%. Since the 1990s, it has progressively declined, down to about 30%. In other words, since the early 1990s, corporate credit appears to have become progressively "disintermediated," that is, less reliant on banks and bank loans.

This paper studies what disintermediation might imply for the transmission of monetary policy shocks. This question speaks to the broader issue of the credit channel of monetary policy (Bernanke and Gertler, 1995), and how this channel has evolved over the past four decades. There are a number of reasons to suspect that the loan share of corporations might influence the strength of the credit channel. Some have to do with credit supply. An influential view of the monetary policy transmission mechanism is that it works through banks' balance sheets (Bernanke and Blinder, 1992), making firms that rely more on loans potentially more exposed to monetary policy shocks. Other reasons have to do with credit demand. Loans and bonds differ in their flexibility, interest rate exposure, or maturity, and these characteristics may imply different interest rate elasticities of demand for each type of debt. The goal of this paper is to provide evidence, and some theory, on whether debt composition indeed influences the credit channel, and whether secular trends in the loan share might have attenuated it.

I start by analyzing in more detail the decline in the aggregate loan share highlighted in Figure 1. Section II shows that this decline can be documented in other data than the Flow of Funds, though its timing and magnitude differ across sources. Perhaps more interestingly, the decline does not seem to be driven by composition effects. Rather, it reflects a within-firm shift away from loans and toward market-based forms of financing. The trend appears to be present among publicly traded firms, so that it does not reflect a reallocation of credit away from private firms. Additionally, among publicly traded firms, where firm-level data on debt composition is available, the decline in the importance of loans is primarily a within-firm phenomenon, as opposed to a reallocation of credit toward the largest (mainly bond-financed) corporations. The data thus suggest that, at least among public firms, the typical reliance on bank debt has declined over time.

Section III then asks whether firms that are less bank-dependent are also less responsive to monetary policy shocks.[1] I construct the pass-through of monetary policy shocks to borrowing, investment, and debt composition among publicly traded non-financial firms. I propose a method to construct a proxy for the loan share in quarterly Compustat data for the 1990-2007 period, and validate it using post-2000 data on firm-level debt composition from other sources. I use intra-day innovations to Fed Funds futures contracts during days of monetary policy announcements (Bernanke and Kuttner, 2005) to identify monetary policy shocks for the 1990-2007 period, and I construct firm-level responses using local projection methods analogous to Jordà (2005).

The results indicate that, for the 1990-2007 period, average investment among publicly traded firms falls significantly in response to a monetary policy contraction. Moreover, the effect is larger for initially more loan-dependent firms: the average four-quarter decline in fixed assets following a 100bps increase in the Fed Funds rate is approximately 4.1% for the average firm, and 5.4% for a firm with a loan share 1 s.d. above average. I then look at the response of borrowing to the shock. Average borrowing also declines in response to an increase in interest rates. However, by contrast with investment, the decline in borrowing is *smaller* among initially more loan-dependent firms, though the difference four quarters out is only marginally significant. Finally, after a monetary policy contraction, the loan share tends to *increase*; that is, the average firm appears to shift its debt mix toward loans. This effect is strongest among riskier firms, as proxied by their credit rating.

These results are limited to the 1990-2007 period, when Fed Funds futures data is available. This is also the period during which the loan share declined. In order to assess whether this decline coincided with a change in the strength of the credit channel, I extend the analysis backward. I use a measure of monetary policy surprises that is available prior to 1990: the deviation of the Fed Funds rate from Greenbook forecasts (Romer and Romer, 2004; Wieland and Yang, 2016). This proxy is different from the Fed Funds futures data (as the information set of the FOMC may differ from that of the market), but the two are positively and significantly correlated. Using that alternative proxy, results indicate that the pass-through of monetary policy to investment is approximately 35% lower in the post-1990 sample than in the pre-1990 sample. Thus, the strength of the pass-through of monetary policy shocks fell between the pre- and post-1990 period, along

[1] Throughout the text, I will refer to firms with a lower share of loans, as a fraction of total debt, as less "bank-dependent", or less "loan-dependent" firms.

with the decline in the aggregate loan share.

Since the decline in the loan share appears to be a within-firm phenomenon, and not simply be a side-effect of broader forces affecting the distribution of economic activity across firms, one needs to appeal to theories of debt structure within firm in order to figure out whether the declining loan share may indeed lead to an attenuation of the credit channel. Section IV describes a simple, partial equilibrium model of firm-level investment and debt structure, which I use to study the pass-through of monetary policy shocks to borrowing and investment.

This model has two key ingredients. First, it takes a particular stance on what makes loans different from bonds. Specifically, it assumes that banks charge firms higher intermediation spreads than bond markets, but that bank loans are easier to restructure in times of financial distress. Thus, debt structure in the model is driven by a trade-off between flexibility and cost.[2] Second, the model allows for banks and non-bank lenders to have different exposures to monetary policy shocks, so that the supply (or the cost) of loans and bonds may respond differently to monetary policy shocks.

I start by analyzing a version of the model in which the intermediation spread between banks and bonds does not depend on the level of interest rates. This version model has three key empirical predictions. First, total *borrowing* among predominantly loan-financed firms should be *less* sensitive to an increase in interest rates than among predominantly bond-financed firms. The intuition for this result is that the shock steepens both the loan and the bond supply curve, by making interest payments higher and thus (all other things equal) making liquidation more likely and deadweight losses higher. But the steepening of the loan supply curve is milder, because loans, which are renegotiable, make it easier to avoid liquidation. As a result, the total decline in borrowing is smaller among bank-financed firms. Second, total *investment* among predominantly bank-financed firms is nevertheless *more* sensitive to an increase in interest rates. This is because in the model, firms with a high loan share also tend to be more levered; this translates into a higher sensitivity of total investment despite a lower sensitivity of total borrowing.[3] Third, allowing for the debt structure of firms to adjust in response to the increase in interest rates, the average loan share can

[2] Section IV discusses the evidence in favor of this microfoundation for the choice between loans and bonds. It also discusses other dimensions than flexibility along which loans and bonds differ.

[3] In the model, firms differ in their initial internal funds, which is a state variable. Because investment opportunities are the same across firms, those with lower internal funds have higher desired leverage. These firms select into loans because their high desired leverage makes them likely to experience financial distress, so that they highly value the flexibility of loans.

either rise or decline in response to the shock, depending on how risky and leveraged a firm initially is: the riskier firms tend to increase their reliance on loans, while other tend to reduce it.

These results are broadly consistent with the empirical findings of Section III, with one exception: in the data, borrowing among firms with a higher initial loan share responds more, but the point estimate is not significant. However, I show that the model can generate a smaller differential response of borrowing among firms with a high loan share if the intermediation spread charged by banks is also sensitive to interest rates (and sufficiently so). This can be thought of as a reduced-form way of capturing bank balance sheet effects. If they are sufficiently strong, these balance sheet effects can offset the effects of loan flexibility on the supply of bank loans.

The model can thus account for the responses to monetary policy shocks in post-1990 data, making it a reasonable candidate environment for studying whether disintermediation could lead to a lower pass-through of monetary policy shocks. In order to do this, I study how this pass-through evolves when the average intermediation spreads charged by banks increases. A gradual increase in the relative intermediation spread of loans by about 2p.p. in the model leads to a decline in the loan share of a magnitude comparable with the data. Additionally, this increase would also have led to a decline in the pass-through of interest rate shocks to investment by about 25%. In the model, this occurs both because more firms become bond-financed as the intermediation spread rises, and because bank-financed firms become progressively less sensitive to interest rate shocks. Of course, while these results indicate that a rise in intermediation costs can provide a parsimonious account of both the trend in disintermediation, and the decline in pass-through, one cannot rule out that other forces contributed simultaneously to these structural changes.

The two key take-aways from this paper are the following. First, it provides some suggestive evidence that there has been a persistent shift in the loan-bond mix. Though the Great Recession accentuated it, the trend started before that, and has accelerated since. More research needs to be devoted to validating this shift empirically. Second, it adds to a body of evidence indicating that debt structure matters can influence the strength of the credit channel. The paper provides a way to rationalize this through the lens of a particular mechanism — the relative flexibility of loans —, and highlights some of the more specific predictions of this mechanism, but more research should be devoted to determining which of the many differences between loans and bonds matters most for the transmission of interest rate shocks.

Related literature On the empirical front, this paper relates to a recent literature that explores the link between corporate debt choices, business cycles, and monetary policy. A closely related paper, though not primarily focused on monetary policy, is Becker and Ivashina (2014). These authors construct an indicator for the cyclicality of bank credit supply, by estimating how the propensity of a firm to issue loans conditional on issuing debt varies with a number of indicator of the state of the business cycle. One of their business cycle indicators are unexpected deviations of the Fed Funds rate relative to the target implied by a Taylor rule. They show that positive deviations (tightenings) lead to a lower propensity to issue loans, conditional on issuing debt. By contrast, my results indicate that in response to an unanticipated tightening in monetary policy, the loan share increases, and particularly so among non-investment grade firms. One possible way to reconcile these results is that my debt composition measure captures both the intensive and extensive margins of debt issuance; that is, it may be that the decline in the value of the typical issuance is larger for bonds than for loans, even if loans are less likely to be issued as monetary policy tightens. Another, broader difference is that in this paper, I study a model in which changes in debt composition in response to monetary policy shocks (and to shocks in general) can occur even if there are no fluctuations in bank credit supply. These effects occur because in my model, bank and loans are not perfect substitutes for the firm.

Two other recent papers studying the relationship between monetary policy and the structure of financial intermediation Darmouni et al. (2019) and Ippolito et al. (2018). In a sample of European firms, Darmouni et al. (2019) show that stock prices and investment by firms that are more bond-financed respond more to monetary policy shocks. They rationalize their findings using a model where bond financing is less flexible, and firms hoard cash after a monetary policy expansion in order to lower refinancing risk. My model abstracts from the possibility of liquidity hoarding. Additionally, the sample of European firms with access to bond markets is likely composed of larger firms relative to the Compustat sample I study in this paper. Ippolito et al. (2018) also study the response of firms to monetary policy shocks as a function of their debt composition. They focus on the mix of floating- and fixed-rate debt, but use the loan share as a proxy for this mix. They document a sharper high-frequency response of equity prices to monetary policy shocks when firms have a higher share of floating-rate debt. Instead, I treat the loan share as primarily reflecting the flexibility of debt in times of distress, and I focus on lower-frequency responses of investment and borrowing, as well as long-run changes in the elasticities of these quantities to interest rates. Additionally, I show that the loan share tends to increase among non-investment grade firms after a monetary policy tightening. This result is more difficult to reconcile with the view that the loan share primarily proxies for the short-rate exposure of firms.[4]

On the theory front, the paper relates to a large corporate finance literature which studies the determinants of the debt mix of firms, and which I discuss in Section IV. However, relatively few papers have focused on how the debt mix might affect monetary policy transmission. A notable exception is Bolton and Freixas (2006), which studies the general equilibrium effects of monetary policy shocks when the composition of intermediation between bonds and loans is endogenous. Their analysis emphasizes the importance of the endogenous response of bank equity capital to monetary policy shocks, but takes a relatively simple view of the bond/loan choice; in particular, credit markets in their model are perfectly segmented according to risk. By contrast, in this paper, I take a more reduced-form approach to model banks' cost of funds, but I allow for a richer endogenous debt structure on the borrowing side, in particular by having firms choose "interior" debt structures that combine bonds and loans, consistent with the data.[5]

Finally, the paper relates to a literature on time variation in the effects of monetary policy shocks, and in particular to Boivin et al. (2010). These authors document a significantly smaller decline in real non-residential investment following a monetary policy contraction in the post-1984q1 sample than in the pre-1984q1 sample. Analogously, but in my sample of publicly traded firms, the estimated pass-through of monetary policy shocks to firm-level investment is significantly larger in the pre-1990q1 period than in the post-1990q1. The model I propose can generate this decline as a consequence of a secular increase in the relative cost of intermediation of banks, which also reduces the overall share of corporate credit intermediated by banks.

[4]Additionally, IMF (2016) provide broad evidence (in the US and elsewhere) of the effects of monetary policy shocks on the balance sheets of non-bank intermediaries, and discuss potential transmission mechanisms; but their focus is primarily on financial intermediaries, while this paper's focus is primarily on non-financial firms.

[5]Interestingly, the framework of Bolton and Freixas (2006) predicts that an increase in risk-free rates leads to a shift from bonds to loans among safer firms, because equilibrium bank spreads can fall after monetary policy contractions. This is consistent with some of the empirical findings of Section III, but harder to rationalize in the model I develop in this paper, where equilibrium bank spreads are assumed to be weakly increasing in the level of risk-free rates.

II Has corporate credit become less intermediated?

This section provides evidence on trends in the composition of credit to US non-financial firms, focusing on the distinction between intermediated credit (loans, for short), and arm's-length credit (bonds, for short).

II.A The composition of corporate credit in aggregate

All firms I start by constructing a measure of debt composition for the non-financial corporate sector as a whole, using Flow of Funds data (specifically, table L.103). The data run from 1960q1 to 2018q4, and encompass all domestic S- and C-firms (both public and private). I define loans as the sum of three items: mortgages, depository institution loans, and other loans and advances.[6] The latter two categories accounted respectively for 38.2% and 43.2% of total outstanding loans in 2015. I define bonds as the sum of three items: municipal securities, commercial paper, and corporate bonds.[7] Corporate bonds made up 87% of total outstanding bonds in 2015. Together, these "loan" and "bond" categories encompass all debt of the non-financial corporate sector.

Figure 1 reports the share of loans outstanding as a fraction of total debt (loans plus bonds). A striking feature of this graph is the break which occurs after the start of the 1990-1991 recession. The loan share is stable, at around 50% prior to 1990q3; it then steadily declines to 30% by 2018q4. Moreover, the decline accelerates during each of the three recessions of the 1990s, 2000s and 2010s.[8]

There are some potential issues with the measurement of loans outstanding in the Flow of Funds. The Flow of Funds does not only rely on balance sheet data from corporate borrowers; balance sheet data is generally not available for private firms, and for public firms, the available data does not necessarily classify bank loans separately from other debt. The Flow of Funds therefore combines balance sheet data on non-financial firms with data sources on the issuance of loan instruments by these firms and holdings of loans by commercial banks. It is possible that these sources do

[6]This latter category primarily includes loans by non-bank or non-domestic financial intermediaries, the detail of which are provided in table L.216. In 2015, the breakdown by loan type is the following: syndicated loans (37.7%), finance company loans (33.4%), foreign institution loans (19.1%), US government loans (6.9%), holding company loans (2.1%), and GSE loans (0.9%).

[7]Municipal securities are industrial revenue bonds issued and guaranteed by state and local governments, but the payments to which are made by the corporate entities recipient of the funds.

[8]The graph also reports the share of non-mortgage loans to total debt (grey circled line) and mortgage loans to total debt (crossed black line), which add up to the total loan share. This decomposition suggests that the bulk of the 1990-2018 decline in the loan share is driven by non-mortgage loans.

not adequately capture important changes in corporate credit markets. For instance, if banks' propensity to hold corporate loans off-balance sheet or sell them to non-bank intermediaries has increased over time, or if the importance of non-bank financial intermediaries in loan origination has become larger, Flow of Funds measures may be biased.

Figure 2 reports measures of the aggregate loan share constructed using other data sources than the Flow of Funds. The first source are the public releases of the Quarterly Financial Report (QFR) of the Census Bureau.[9] The QFR provides measures of the stock of loans and total debt outstanding for the manufacturing and trade sectors. These measures are constructed from balance sheet data reported by borrowers to the Census via a quarterly survey, and so, in principle, provide an accurate view of the stock of loans and bonds outstanding of firms in those sectors. For the manufacturing sector, the QFR data indicates that there was a decline in the aggregate loan share, from 26.3% in 2000q1 to 14.9% in 2017q4; note that the timing of the decline differs from the L.103 measure. For the trade sector, there is also a loan share decline, but only from 1974q1 (when the data become available) to 2005q1; after this, the loan share stabilizes.[10]

Figure 2 also reports another measure of the aggregate loan share, constructed from data from the Securities Industry and Financial Markets Association (SIFMA) and from the public releases of the Shared National Credit Program (SNC).[11] The former provides a measure of total corporate bonds outstanding (including bonds of financial firms), while the latter provides a measure of outstanding syndicated loans of at least $20m in value held by at least three financial institutions supervised by the Federal Reserve. This measure of the loan share shows a decline from 1990 to 2005, though of substantially smaller magnitude than in the Flow of Funds. However, the decline is followed by an increase in the loan share after 2005.[12]

[9]For work using the QFR public releases, see Gertler and Gilchrist (1994) and Kudlyak and Sanchez (2017). For work using the underlying firm-level data, see Crouzet and Mehrotra (2020). The Quarterly Financial Report publishes aggregate balance sheets for firms in the manufacturing sector with more than $250k in assets, constructed from survey responses on a representative sample of firms. The survey asks firms to separately report bank loans, and so survey responses can be used to construct an aggregate loan share. A similar figure can be constructed for the trade sector, though only firms with more than $50m in assets are surveyed in that sector.

[10]The level of the loan share is also lower in the QFR sources than in the Flow of Funds. There are a number of potential reasons for this: the definition of loans in the QFR is narrower (bank loans) than in the L.103 (where it also includes finance company loans, mortgages, loans from non-bank financial intermediaries, etc); and, at least for the trade sector, only relatively large firms that are less likely to be bank-dependent, are included in the survey.

[11]I thank Victoria Ivashina, my discussant, for suggesting to construct this measure of the aggregate loan share.

[12]There are a number of measurement differences between this data and the Flow of Funds. In particular, the SIFMA data includes bonds issued by financial firms. This lowers the level of the bond share relative to the L.103 measure. Additionally, the SNC data is restricted to syndications, which also lowers the level of the measured loan share. The effects on the trend are more ambiguous; they depend on whether the stock of bonds outstanding of

Publicly traded firms Other measures of the composition of corporate credit between loans and bonds can be constructed by restricting attention to publicly traded firms, specifically firms present in Compustat. This is a non-trivial restriction, since intermediated credit is likely to be less important among these firms. However, it is difficult to escape the fact that there is little systematic, long-run information on the balance sheet of private firms in the US.[13]

With these limitations in mind, Figure 3 compares the aggregate loan share obtained in the Flow of Funds, to two measures of the aggregate loan share (total loans, divided by total debt outstanding) constructed on the sample of US non-financial firms of Compustat.

I first use Compustat balance sheet data to construct a proxy for loans outstanding for public firms. In Compustat, loans are not reported separately from the rest of debt outstanding. Appendix I.B describes how to construct a proxy for loans outstanding in Compustat, using a combination of two Compustat items: notes payable and other long-term debt. While clearly imperfect, the main advantage of this measure is that it provides a comprehensive long-run proxy for the loan share, since the data necessary to construct the measure is available after 1970q1 for most firms.[14]

Using this measure of loans outstanding, Figure 3 constructs the aggregate loan share among publicly traded non-financial firms, and compares it with the aggregate loan share in the Flow of Funds.[15] The aggregate loan share is lower in Compustat than in the Flow of Funds, as should be expected given the absence of private firms in Compustat. However, the post-1990 decline in the loan share is similar. The Compustat aggregate loan share falls from 42% in 2001q4, to 25% in 2017q4; the fall accelerates during each of the three recessions that took place during this period, similar to the Flow of Funds measure.

Additionally, I merge Compustat with more detailed data on the composition of debt by type, from S&P's Capital IQ database. Capital IQ provides information on issuances and amounts outstanding by type of debt instrument.[16] For the purposes of this paper, in particular, it provides a measure of the stock of all bank debt outstanding. A drawback of Capital IQ, however, is that

financial firms is growing or shrinking, relative to the stock of bonds outstanding of non-financial firms. Finally, the SNC data includes syndications to foreign firms; the Flow of Funds data is restricted to domestic corporations.

[13] Appendix I.A discusses these issues and reports a comparison of Flow of Funds and Compustat data, which suggests that key trends in total debt and loans outstanding are similar, and that public firms account for approximately 40% of both.

[14] This long panel dimension will be useful in the empirical analysis of Section III.

[15] In the construction of the aggregate loan share, all publicly traded non-financial firms are kept in sample, including those with zero debt.

[16] For more details on Capital IQ, see, for instance, Mathers and Giacomini (2016).

it is relatively incomplete before 2001. Even after 2001, the data on bank loans outstanding is not populated for a large number of Compustat firms.[17] Therefore, I use only data after 2001. Using these data, I construct a firm-level measure of loans outstanding for Compustat firms with a match in Capital IQ, and then use this measure to compute an alternative estimate of the aggregate loan share for public firms. Figure 3 shows that this loan share measure is also declining, though less so than the either the Flow of Funds or the Compustat-only measure: it falls from approximately 30% in 2001 to 20% in 2017.[18]

A final measure of changes in the aggregate composition of corporate debt between loans and bonds for public firms is reported in Figure 4. The figure shows the ratio of total new syndications by publicly traded non-financial firms, to the sum of total new syndications and total new bond issuance. Relative to Figures 1 and 3, this ratio measures the composition of the *flow* of new debt, as opposed to the stock outstanding. Moreover, the data are again restricted to publicly traded firms. New syndications for publicly traded non-financial firms are obtained by merging Dealscan to Compsutat, while new bond issuance is obtained from the Fixed Income Securities Database (FISD).[19] These data are limited to the post-1988 period. Because loans are rolled over more frequently than bonds, the ratio is higher than the loan share reported in Figures 1 and 2. This data also shows a decline in the ratio of new syndications to new total debt throughout the sample, though it is considerably noisier than the decline shown, for the stock, by the Flow of Funds data.

A number of different data sources suggest that the aggregate loan share may have been declining in recent years. This is true both in aggregate data covering both private and public firms, and in aggregate data covering only public firms. It is worth noting, however, that the timing and magnitude of the decline differs substantially between data sources.

II.B The composition of corporate credit at the firm level

I next document whether the aggregate decline in the loan share reflects changes in firm-level debt composition or changes in the allocation of debt across firms. Because of the data limitations

[17] Appendix I.A discusses this issue in more detail, and shows that before 2001, Compustat firms with a match in Capital IQ account for less than 10% of total debt outstanding of all non-financial Compustat firms.

[18] Appendix I.B also uses from the data Capital IQ after 2002, along with data from FISD and Dealscan, to validate the Compustat proxy for bank loans.

[19] More discussion of Dealscan and Mergent is provided in Section IV and Appendix I.A.

mentioned above, I restrict attention to publicly traded firms.

In order to disentangle the drivers of the decline in the aggregate loan share among public firms, I decompose the change in the aggregate loan share as $\Delta S_t = \Delta S_t^{\text{within}} + \Delta S_t^{\text{between}} + cov_t$, where ΔS_t is the change in the aggregate loan share from 1990 to year t, $s_{i,t}$ is the firm-level loan share (the ratio of loans to total debt for firm i in year t), $w_{i,t}$ is the ratio of firm i's debt in year t to aggregate debt in year t, $\Delta S_t^{\text{within}} = \sum_i w_{i,0} \Delta s_{i,t}$, $\Delta S_t^{\text{between}} = \sum_i s_{i,0} \Delta w_{i,t}$, and $cov_t = \sum_i \Delta s_{i,t} \Delta w_{i,t}$. The term $\Delta S_t^{\text{within}}$ is the change in the aggregate loan share if the distribution of total debt across firms were kept constant. The term $\Delta S_t^{\text{between}}$ is the change in the aggregate loan share if firm-level loan shares were kept constant. The residual term is, up to a constant, the cross-sectional covariance between changes in firm's share of total debt and changes in its loan share.[20]

Figure 5 reports the elements of this decomposition, constructed in the balanced panel of Compustat non-financial firms.[21] This figure shows that the change in the loan share is also a within-firm phenomenon. Debt reallocation had a positive but limited impact on the aggregate loan share decline — it only accounts for approximately 5 p.p. of the total 25 p.p decline in the aggregate loan share. By contrast, the within-firm average loan share declined by 15 p.p. through 2017, and by as much as 25 p.p. (relative to 1990) in certain years, particularly at the height of the crisis.

Overall, this evidence indicates that the within-firm loan share may have declined since the 1990's, in line with the aggregate decline documented in the Flow of Funds. Appendix I.C reports further results on the within-firm loan share; in particular, the decline in the loan share does not seem to be an industry-specific phenomenon; moreover, it primarily affects firms with access to bond markets.

[20]The decomposition can be derived as follows:

$$\begin{aligned}
& \textstyle\sum_i w_{i,0} \Delta s_{i,t} + \sum_i s_{i,0} \Delta w_{i,t} + \sum_i \Delta s_{i,t} \Delta w_{i,t} \\
= & \textstyle\sum_i w_{i,0} \Delta s_{i,t} + \sum_i s_{i,0} \Delta w_{i,t} + \sum_i (s_{i,t} - s_{i,0}) \Delta w_{i,t} \\
= & \textstyle\sum_i w_{i,0} (s_{i,t} - s_{i,0}) + \sum_i s_{i,t} (w_{i,t} - w_{i,0}) \\
= & \textstyle\sum_i w_{i,t} s_{i,t} - \sum_i s_{i,0} w_{i,0} = S_t - S_0.
\end{aligned}$$

[21]The decomposition is exact only in the panel of firms which are present and have debt outstanding in every year after 1990, and so I construct it using the balanced panel of firms from 1990 to 2016 with positive debt outstanding in every year after 1990. It is in principle possible that the trends in the aggregate loan share differ substantially in this group of firms, relative to the overall Compustat non-financial sample. However, balanced panel firms are also much larger than average, implying that their borrowing behavior is likely to be a key driver of the aggregate loan share in Compustat. Appendix Figure A2 shows that the decline in the loan share among balanced-panel firms was similar in magnitude (in fact, somewhat larger) than in the overall Compustat sample.

III Disintermediation and monetary pass-through: evidence

This section provides evidence on how bank dependence influences monetary policy pass-through.

III.A Data

Monetary policy shocks The main measure of monetary policy shocks is derived from high-frequency movements in Federal Funds futures contracts, building on the work of Gürkaynak et al. (2005) and Gorodnichenko and Weber (2016). A monetary policy shock is defined as $\tilde{\eta}_{t_a}^{HF} = w(t_a) \times (ffr_{t_a+\Delta^+} - ffr_{t_a-\Delta^-})$. Here, ffr_{t_d} is the Federal funds rate implied, at time t_d, by the Federal Funds futures contract for the current month, t_a is a policy announcement date, Δ^- and Δ^+ are strictly positive numbers referring to times before and after the announcement, and $w(t_d)$ is an adjustment weight, which takes into account the fact that Fed Funds futures contracts pay out based on the average effective rate over the month. I focus on a window of one hour around each announcement ($\Delta^- = 15$ minutes before and $\Delta^+ = 45$ minutes after). I follow the procedure of Ottonello and Winberry (2017) to aggregate the daily shocks to a quarterly frequency, weighting them by the number of days remaining in the quarter after they occur.[22]

The quarterly shock series η_t^{HF} can only be constructed after 1990q1 (when the Fed Funds futures market started operating). This means that these shocks cannot be used to compute the pass-through of monetary policy shocks before 1990q1. In order to analyze monetary pass-through over a longer sample period, toward the end of this section I will use an alternative measure, proposed by Romer and Romer (2004) and extended by Wieland and Yang (2016). This measure defines monetary policy shocks as the deviation of the implemented Fed Funds rate from internal forecasts prior to the meeting date. This series, which I denote η_t^{RR}, is available monthly starting in 1969m10. I aggregate it to a quarterly frequency by summing the shocks over the quarter. Relative to the high-frequency identified shock, the main drawback of this time series is that revisions relative to internal forecasts may be correlated with market expectations about changes in the Federal Funds rate over the prior quarter, making it a potentially less accurate measure of *unexpected* changes in the stance of monetary policy.[23]

[22] I thank the authors for making their shock series available to me.

[23] I only use the two time series η_t^{HF} and η_t^{RR} up to and including 2007q4. This is primarily in order to focus the analysis on the transmission of conventional monetary policy shocks. Additionally, after 2007q4, innovations to Fed Funds futures are very small because of the zero lower bound.

Appendix Table A1 reports summary statistics for the two time series. It is worth noting that the standard deviation of η_t^{HF} is substantially smaller than the standard deviation of η_t^{RR}. In part, this is due to the fact that η_t^{RR} covers the Volcker recessions. However, even in the overlapping sample (1990q1-2007q4), measured innovations using η_t^{RR} are more volatile, though their correlation is positive and statistically significant. This is consistent with the possibility that deviations from internal forecasts may be overstating the unexpected component of monetary policy announcements.

Firm-level data The main source for firm-level balance sheet data is Compustat. These are the same data as in Section II, except that I use the quarterly instead of the annual version. I focus on three main outcome variables: fixed assets $k_{j,t+1}$, total debt $d_{j,t}$, and the loan share $s_{j,t}$.

Total debt is defined as as the sum of long- and short-term debt outstanding ($\texttt{dlcq}_{j,t}+\texttt{dlttq}_{j,t}$). I construct a measure of fixed assets $k_{j,t+1}$ for each firm adding the cumulative sum of quarterly net investment, computed as the change in net property, plant and equipment (`ppentq`), to the first observation of gross property, plant and equipment, `ppegtq`. This helps address the fact that observations of `ppegtq` are often missing in the quarterly data.

The loan share is measured using the Compustat variables described in section II, with one exception. Since other long-term debt (`dlto`) is not available at the quarterly frequency, I construct it as: $\texttt{dltoq}_{j,t} = \frac{\texttt{dlto}_{j,\tau(t)}}{\texttt{dltt}_{j,\tau(t)}}\texttt{dlttq}_{j,t}$ (or zero if $\texttt{dltt}_{j,\tau(t)} = 0$), where $\texttt{dlto}_{j,\tau(t)}$ and $\texttt{dltt}_{j,\tau(t)}$ are the balance sheet values from the firm's annual report at the annual reporting date $\tau(t)$ that immediately precedes quarter t. A validation of this loan share measure, using data on securities issuance from Dealscan and FISD, is discussed in Appendix I.A.

Appendix Table A1 also reports summary statistics for the sample used in the analysis. The sample is restricted to firms with spells of at least 40 quarters of consecutive data, in order to be able to precisely estimate firm-level averages of control variables, as described below.[24]

[24] Additionally, only firm-year observations with strictly positive values for total debt at time $t-1$ are kept in sample, as the loan share $s_{j,t-1}$ is otherwise undefined. Coverage of the quarterly sample used this analysis is on average 37% of firm-year observations and 84% of total assets of the annual sample used in the analysis of Section II.

III.B Bank dependence and monetary pass-through in the cross-section

Next, I study the pass-through of the monetary policy shocks η_t^{HF} to the investment and borrowing decisions of firms, contrasting firms that are initially more or less bank-dependent. I then look at how firms dynamically adjust their debt composition in response to the shocks.

III.B.i The response of investment and borrowing

I first focus on investment. I start by estimating the following model:

$$\Delta \log(k_{j,t+1}) = \alpha_j + \beta\eta_t^{HF} + \delta\left(\eta_t^{HF} \times s_{j,t-1}\right) + \Gamma_Z Z_{t-1} + \Gamma_X X_{j,t-1} + \varepsilon_{j,t}, \tag{1}$$

where $\Delta \log(k_{j,t+1})$ is the change in fixed capital following the shock; α_j is a firm fixed effect; η_t is the quarterly shock to the Federal Funds rate; $s_{j,t-1}$ is the lagged loan share; Z_{t-1} is a set of macroeconomic controls; and $X_{j,t-1}$ is a vector of firm-level controls.

Macroeconomic controls include the first lag of the change in the log of industrial production and the change in the log of the CPI. Firm controls consist of the log change in real sales (deflated using the CPI) as a proxy for investment opportunities, the log of total book assets as a proxy for size, the ratio of net current assets to total assets as a proxy for liquidity, and a set of dummies for fiscal quarters, all evaluated at the end of period $t-1$. These firm-level variables are all potential determinants of the pass-through of monetary policy shocks to borrowing and investment, though for reasons other than the loan supply or demand effects that this paper is focused on.

Columns (1) and (2) from Table 1 report estimates of the average response of investment (the coefficient β in the specification above), without controlling for the loan share. The top panel focuses on the impact response, while the bottom panel focuses on the one-year cumulative response. At both horizons, the average response to the shock is negative and significant. The point estimate suggests that following a 100bps surprise hike in the Fed Funds rate, net capital falls by approximately 4 p.p. by the end of the year. The magnitudes of the point estimates are consistent whether one controls for firm-level observables or not, so that the shock to the Fed Funds rate is relatively uncorrelated with time-series variation in these observables.

Column (3) introduces the loan share and its interaction with the shock as controls. I standardize the loan share, so that δ should be interpreted as the incremental response of a firm whose loan share is one standard deviation higher than average (i.e. 64.6% instead of 30.1% in the regression sample). The point estimate for the average effect of the shock is unchanged. Moreover, on impact, firms with a higher loan share are not differentially affected. However, over the following year, these firms experience a substantially larger contraction in investment. The point estimate indicates that the cumulative change in capital for these firms is approximately 1 p.p. (or 25%) larger than average.

Column (4) uses a more flexible specification in order to estimate this differential effect more precisely:

$$\Delta \log(k_{j,t+1}) = \alpha_j + \gamma_{k,t} + \delta \left(\eta_t^{HF} \times s_{j,t-1}\right) + \Gamma_X X_{j,t-1} + \varepsilon_{j,t}. \tag{2}$$

In this specification, k is the firm's sector, and $\gamma_{k,t}$ is a sector-by-quarter fixed effect, where sectors are defined using the Fama-French 10 classification. This specification estimates the incremental pass-through of more loan-dependent firms relative to other firms in the same industry and quarter. In the short-run, firms with a higher loan share respond similarly to their industry peers; but by the end of the year, they have cut back net investment by approximately 1.3 p.p. more than average, a magnitude consistent with the differential effect obtained without industry-by-time fixed effects.[25]

Figure 6 reports complete dynamic estimates of these average and relative effects over a two-year window following the monetary policy contraction. Average effects are obtained from specification (1), while relative effects are obtained from specification (2). The average investment trough occurs after 3 quarters. After the third quarter, however, the investment recovery is slower for firms with initially higher loan shares. Two years after the shock, the average firm's cumulative decline in capital is on average zero; by contrast, a firm with a one standard deviation higher initial loan share experiences a cumulative decline in capital of approximately 3 p.p.

Next, I look at the response of borrowing. Table 2, and the bottom panels of Figure 6, contain estimates of specifications identical to specifications (1) and (2), but using the cumulative growth rate of debt (that is, the change in $\log(1 + d_{j,t})$) over different horizons as outcome variables.

The results indicate a negative and persistent average effect of the increase in interest rates on borrowing. In response to a surprise 100bps tightening in monetary policy, borrowing declines by

[25] Appendix Table A9 shows that these results are robust to controlling for leverage, indicating that the coefficient estimates capture the effect of the loan share, not leverage. This is useful because, as discussed in IV, both the data and the model feature a negative correlation between leverage and the loan share. I thank an anonymous referee for pointing this out.

approximately 2 p.p. in the short-run, and 4.5 p.p. one year out. As for the case of capital, these average effects have the same magnitude whether or not one controls for firm-level observables. The dynamic response (the bottom left panel of Figure 6) indicates that the trough in the average response occurs three quarters after the shock, and that borrowing is still 2 p.p. below its initial level two years after the shock.

By contrast with investment, the differential response of initially more loan-dependent firms is positive. However, it is not statistically significant either on impact or one year-out, as indicated by Table 2.[26] The dynamic differential response reported on the bottom right panel of Figure 6 indicates that the differential effect peaks 1 to 2 quarters out (it is significant at the 10% level one quarter out). The magnitude of the point estimate indicates that a one standard deviation higher initial loan share mitigates the contraction in borrowing by about 1 p.p. (or about 25%) relative to average. This positive average effect disappears after 4 to 5 quarters; two years out, point estimates are negative but insignificant.

III.B.ii The response of debt composition

I next document how debt composition responds to a monetary policy contraction. I start by estimating regressions of the form:

$$\Delta s_{j,t} = \alpha_j + \beta \eta_t^{HF} + \delta \left(\eta_t^{HF} \times C_{j,t-1} \right) + \Gamma_Z Z_{t-1} + \Gamma_X X_{j,t-1} + \varepsilon_{j,t}. \tag{3}$$

Here, $\Delta s_{j,t}$ is the change in the loan share of firm j. The rest of the controls are the same as in specification (1), except for $C_{j,t-1}$. The variable $C_{j,t-1}$ is a dummy variable taking the value of 1 if a firm has a either no long-term credit rating, or a rating below $A-$, and 0 otherwise. This control is meant to capture whether firms adjust their debt composition differently in response to the shock depending on their riskiness. Indeed, as discussed in the introduction, the relative benefits of using intermediated vs. arm's-length debt may depend on how likely firms are to find themselves in a situation of financial distress in the near future. Finally, I restrict attention to the sample of firms

[26] The lack of significance could be due to measurement error in the proposed proxy for the loan share, $s_{j,t-1}$. As highlighted in Appendix Table A3, while the correlation between the Capital IQ loan share and $s_{j,t-1}$ is positive, it is not perfect. Additionally, measurement error in the loan share may also arise in Capital IQ, as indicated by Mathers and Giacomini (2016). I thank an anonymous referee for pointing this out.

with a strictly positive loan share at the time of the shock.[27]

The results of Table 3 indicate that among high-rated firms ($C_{j,t-1} = 0$) the loan share increases in response to a tightening in monetary policy, though the response is sluggish: the loan share does not respond immediately, but, within a year, it increases significantly. The point estimate suggests that a 100bps increase in Fed Funds rate raises the loan share among high-rated firms by approximately 2 p.p. (again, relative to a sample mean of 30%). Figure 7 shows that this increase continues in the second year after the shock; the point estimate for the cumulative change in the loan share after two years is 4 percentage points, and it is statistically significant.

Additionally, Table 3 and Figure 7 show that the change in the loan share is larger among low-rated firms. In the last columns of the top and bottom panel of Table 3, as well as in the right panel of Figure 7, I report estimates of the differential effect of $C_{j,t-1}$, using a specification analogous to (2). Compared to a firm with a high credit rating, the adjustment toward bank debt for firms with a low credit rating ($C_{j,t-1} = 1$) is 1.5% percentage point larger after two years (and the effect is statistically significant).

III.C Monetary pass-through before and after 1990

The evidence presented so far suggests that firms that rely more on intermediated credit (bank loans) also respond more strongly to monetary policy shocks. This evidence, in conjunction with the trend toward disintermediation documented in the previous section, suggests that the overall pass-through of monetary policy shocks may have declined in recent years, as firms shifted away from loans.

I next provide empirical evidence that monetary pass-through may indeed have declined after 1990. I replicate the previous analysis of the pass-through of monetary policy shocks to borrowing and investment, using a longer-run (but potentially less accurate) measure of monetary policy shocks. Specifically, as described in section III.A, I use deviations of changes in the Fed funds rate relative to internal forecasts, which I denote by η_t^{RR}. This longer-run measure allows me to construct monetary pass-through estimates in the pre-1990 and the post-1990 samples separately.

[27] I restrict the sample in this way because, in the model of Section IV, only firms with initially positive loan shares adjust their debt composition in response to an increase in interest rates. Including firms no loans outstanding lowers the magnitude of the average response of the loan, consistent with the model, which predicts no change in the debt composition of firms that do not borrow from banks,

I use an identical approach to section III.B in order to construct the average effect of the shock on investment and borrowing, and its relative effect on more bank-dependent firms, with specifications that control either for sector effects and macroeconomic variables (i.e., specification 1), or for sector-by-time effect (i.e., specification 2). Moreover, I focus on cumulative net investment or borrowing over a one-year window after the shock. The results are reported in Tables 4 and 5.

First, the results in the 1990q1-2007q4 sample, reported in the top panels of Tables 4 and 5, are broadly in line with those obtained using η_t^{FF}, the measure of monetary policy shocks constructed using short-run changes in Fed funds futures. Namely, investment and borrowing decline on average; moreover, investment declines more among initially loan-dependent firms, while borrowing declines less, though the statistically significance is only marginal. However, consistent with the view that the shock η_t^{RR} is more likely to be more correlated with expected changes in interest rates, the documented effects are generally weaker than those obtained in the analysis of section III.B.

The bottom panel of Tables 4 and 5 report results obtained in the pre-1990q1 sample. For comparison with the post-1990q1 sample, I use 72 quarters of data, going back to 1971q1. Average effects of interest rate shocks on borrowing and investment are substantially larger over this sample, with point estimates more than doubling for both investment and borrowing.

The relative pass-through to investment is also larger, though the economic magnitude of the difference is relatively small (approximately 0.5 p.p. larger in investment over the first year after the shock). Finally, the relative pass-through to borrowing is approximately unchanged (the point estimate declines slightly).[28]

III.D Summary of findings

The empirical findings of this section can be summarized as follows. First, more bank-dependent firms experience a larger decline in fixed investment following a monetary policy contraction. Second, differences in the response of borrowing are more muted; if anything, more bank-dependent firms experience a smaller decline in borrowing, especially in the short-run. Third, among bank-dependent firms, the loan share increases after a monetary policy tightening, and moreover, the

[28] At first sight, the finding that the economic magnitude of difference in relative pass-through to investment is relatively small could indicate that changes in financing structure explain only a portion of the decline in pass-through. However, as we will discuss in Section IV, average pass-through might decline as a consequence of changing financial structure without relative pass-through declining by a similar magnitude.

adjustment is stronger for firms that are ex-ante more risky, as proxied by their initial credit rating. Finally, the overall pass-through of monetary policy shocks to both investment and borrowing appears to have declined between the 1971q1-1989q4 and the 1990q1-2007q4 sample, at the same time that firm-level and aggregate bank shares started declining.

IV Disintermediation and monetary pass-through: a model

IV.A Model

A detailed description of the model is reported in Appendix II.A.i; here, I give an overview of its key elements.

The model has two periods, $t = 0$ and $t = 1$. There is a continuum of mass 1 of entrepreneurs, each characterized by their net worth e. The distribution of entrepreneurs across levels of net worth is denoted by $\mu(.)$ and is given exogenously.

In period 0, entrepreneurs use their net worth, in conjunction with funds borrowed from lenders, in order to invest in productive capital k. They finance this investment from three sources: their net worth e; loans, b; and bonds m, which together must satisfy:

$$k = e + b + m. \tag{4}$$

In exchange for receiving b and m, the entrepreneur promises to repay R_b to banks and R_m to bondholders in period 1. R_b and R_m are endogenous; their determination is described below.

Entrepreneurs operate a technology which takes k as an input, and produces output ϕk^{ζ}. Here, $\zeta < 1$, so that there are decreasing returns to capital, and $\phi \geq 0$ is a random variable realized in period 1. Capital fully depreciates after use, so that resources available for debt or dividend payments in period 1 are simply $\pi(\phi) = \phi k^{\zeta}$. In a frictionless model with a cost of capital given by the risk-free rate r, optimal investment k^* would be the same for all entrepreneurs, regardless of e:

$$k^* = \left(\frac{\zeta \mathbb{E}(\phi)}{1+r}\right)^{\frac{1}{1-\zeta}}. \tag{5}$$

In period 1, debt payments are settled once ϕ is realized. I model the debt settlement process as a two-stage game between the entrepreneur and creditors. In the first stage, the entrepreneur has three options: repay creditors in full; propose a lower repayment; or liquidate. In the second stage, creditors can either accept the entrepreneur's offer or force liquidation. In liquidation, creditors receive $\chi\pi(\phi)$, where $0 < \chi < 1$ captures deadweight losses — the main friction in this model.[29]

Creditors might be willing to accept a lower repayment because avoiding liquidation and the deadweight losses it entails creates a surplus. Most importantly, I assume that while bank debt can be renegotiated, bonds cannot. That is, the entrepreneur can make an offer to reduce the payments R_b promised to banks, but not the payments R_m promised to bondholders.[30] The debt settlement process and its outcomes, as a function of the realization of ϕ and the promised repayments R_b and R_m, are described in Appendix II.A.ii. In particular, only entrepreneurs with large amounts of loans R_b and intermediate realizations of productivity ϕ successfully renegotiate debt in period 1.

In period 0, banks and bondholders offer menus of debt prices to entrepreneurs, $R_b(e, b, m)$ and $R_m(e, b, m)$, such that given the period-1 debt settlement equilibria, and given their cost of funds, lenders expect to break even. For instance, bond prices must satisfy:

$$(1 + r)m = \big(1 - \underline{\phi}(e, b, m)\big)\, R_m(e, b, m) + \int_0^{\underline{\phi}(e,b,m)} \tilde{R}_m(e, b, m, \phi) dF(\phi),$$

where $\underline{\phi}(e, b, m)$ is the productivity threshold below which the firm is forced to liquidate, $\tilde{R}_m(e, b, m, \phi)$ is the conditional payoff to bondholders in liquidation states, and r is the risk-free rate.

The second key assumption I maintain is that while both types of lenders must break even, they may have different marginal (or opportunity) costs of funds. Specifically, while bondholders have a marginal cost of funds equal to the risk-free rate, banks have a cost of funds equal to $r + \gamma_b(r)$, where $\gamma_b(.)$ is a positive and increasing function. I discuss this assumption in more detail below.

The entrepreneur then chooses (b, m) so as to maximize expected dividends paid in period 1.

[29]The other key friction is that all external financing is assumed to occur through debt; equity issuance is ruled out. In a dynamic version of this model (Crouzet, 2017), I show that allowing for seasoned equity issuances does not affect the qualitative predictions of the model with respect to the optimal debt structure chosen by firms.

[30]Additionally, loans are assumed to be senior to bonds; this is not crucial for the equilibrium segmentation of firms across types of debt structures, though it matters for the overall level of the loan share.

Lemma 2 in Appendix II.A.iii shows that this is equivalent to solving the following problem:

$$\max_{b,m\in\mathcal{S}(e)} \quad \underbrace{\mathbb{E}(\pi(\phi)) - (1+r+\gamma_b(r))b - (1+r)m}_{\text{total expected surplus from investment}} - \underbrace{(1-\chi)\int_0^{\underline{\phi}(e,b,m)} \pi(\phi)dF(\phi)}_{\text{expected liquidation losses}}, \tag{6}$$

where $\mathcal{S}(e)$ denotes the set of debt contracts (b,m) that are feasible given the entrepreneur's net worth and lenders' breakeven conditions.[31]

The expression for the total expected surplus from investment reflects the second key assumption: banks incur an intermediation cost $\gamma_b(r) \geq 0$ per dollar lent over and above the cost of funds r, whereas bondholders do not. Each entrepreneur therefore faces a trade-off when choosing debt structure: on the one hand, loans offer more flexibility should financial distress arise; on the other hand, outside of financial distress, bonds are a cheaper source of funding since bondholders do not incur the intermediation cost $\gamma_b(r)$.

IV.B Discussion of key assumptions

The model makes two key assumptions. First, banks are capable of flexibility in times when the entrepreneurs are not able (or willing) to repay their debt. A natural question is whether this assumption is borne out in the data. Gilson, Kose, and Lang (1990) examine a sample of 169 financially distressed firms. About half (80 or 47% of the total) firms successfully restructure outside of formal judicial proceedings, while the other half (89 or 53% of the total) file for bankruptcy. Successful restructurings out of court involve, in 90% of cases, a firm that has outstanding bank loans, while only 37.5% of successful restructuring involves firms with outstanding bonds. Moreover, the existence of bank loans is the single most important determinant of whether firms successfully restructure out of court, more so than other firm characteristics such as size, age or leverage. More recent work by Becker and Josephson (2016) also stresses the role of bank lending for successful out-of-court restructuring, using variation in the quality of bankruptcy proceedings across countries. The paper shows that in countries where bankruptcy recovery rates are lower (and there is therefore more surplus created by avoiding bankruptcy), firms — particularly those that are high-risk, and therefore likely to enter financial distress — are more likely to have high loan shares.

[31] Expressions for the default threshold and a description of the feasible set $\mathcal{S}(e)$ are in Appendix II.A.iii.

A theoretical justification for why loans might be easier to restructure is developed by Gertner and Scharfstein (1991), who argue that coordination problems among dispersed bondholders may make them unable to agree to efficient restructurings.[32] Bolton and Scharfstein (1996) also study how free-riding problems can lead to inefficiencies during debt restructurings involving a large number of creditors.[33] The assumption of bank flexibility can thus be thought of as a reduced-form way of capturing the advantage of having a concentrated creditor base, namely, avoiding these coordination problems.[34]

Second, in the model, banks have higher per unit cost of lending than bondholders. The relative per unit intermediation cost $\gamma_b(r)$ cost can be thought of in two ways. First, it could capture differences in funding costs across intermediaries (which could be driven, for instance, by adverse selection, as in Stein et al. (1998), or alternatively by differences in regulatory treatment). Second, from a credit supply perspective, it could capture monitoring costs which loan providers have to incur in order to prepare for the eventuality of renegotiation should default occur. I allow the cost $\gamma_b(r)$ to vary with the level of interest rates as a reduced-form way of introducing a bank-lending channel: indeed, it implies that the credit supply curve for bank loans will shift differentially from the credit supply curve for bonds in response to movements in the risk-free rate r.

The model relies on two other assumptions, but these are more common in models on investment and financing. The first one is that liquidation is costly: that is, the transfer of control from shareholders to debtholders involves the deadweight loss of $(1-\chi)$ per unit of firms value. This is consistent with the findings of Bris et al. (2006) and Kermani and Ma (2020), among others; I use the estimates of the latter in order to calibrate the size of these losses in the model. Second,

[32] While the model's debt settlement stage does not clearly distinguish between private and formal (chapter 11) workouts, it assumes that they are costless, whereas liquidation (chapter 7) is assumed to be costly. The model's assumptions are thus consistent with the results of Bris, Welch, and Zhu (2006), who document substantial costs associated with in-court chapter 7 proceedings. The restructurings considered in the model are "efficient" in the sense that they avoid these costs.

[33] Other papers studying the idea that coordination problems might impede efficient restructuring of arm's-length debt include Berglöf and Von Thadden (1994), Bolton and Freixas (2000), and Hege and Mella-Barral (2005).

[34] It is worth noting that not all debt classified as "bank loans" in the data studied in Sections II and III is necessarily entirely owned by the originating bank. Estimating the degree of concentration in the ultimate ownership of loans originated by banks is a difficult task. For the sample of publicly traded firms considered in Section III, however, it is possible to compare total loans on a firms' balance sheet (from Compustat) to total new loan syndications (from Dealscan). On average over the 1980-2016 period, the ratio of the flow of new syndications to the stock total loans outstanding for the matched sample is 60%, suggesting that syndications account for a large part of total loans outstanding among publicly traded firms. Though they are not concentrated in a single creditor, syndications are still a more concentrated form of debt than bonds, especially because the syndicate is generally represented by its lead arranger, who retains a large portion of the syndication (Sufi, 2007; Ivashina, 2009).

the model assumes that all external financing takes the form of debt. This can be thought of as an extreme version of the more common modeling assumption that equity issuance is costly, and therefore seldom used as the marginal source of funding for investment (e.g. Hennessy and Whited 2007).[35]

IV.C Predictions for optimal debt structure

No deadweight losses ($\chi = 1$) A useful starting point to understand the optimal choices of entrepreneurs is the frictionless case: $\chi = 1$. In this case, banks have no incentive to restructure debt when a borrower is in financial distress. For entrepreneurs, the two forms of debt financing are perfect substitutes; only their relative price matters. If there is no loan intermediation premium ($\gamma_b(r) = 0$), they are indifferent across debt structures; otherwise ($\gamma_b(r) > 0$), they only use bonds.

Deadweight losses ($\chi < 1$) In this case, loans may be attractive to entrepreneurs that face some risk of financial distress in period 1. Recall that the unconstrained optimal investment level k^* is identical for all firms. Firms with lower internal funds e will therefore be more leveraged, and face a higher risk of default in period 1. Optimal policies can then be classified in three regions. The top left panel of Figure 8 describes these three regions graphically, and Lemmas 3 and 4 in Appendix II.A.i establishes their existence formally. Note, in particular, that the existence of these three regions is independent of the calibration of the model, so long as there are deadweight losses ($\chi < 1$) and the loan intermediation is positive ($\gamma_b(r) > 0$). The three regions are as follows:

> **Region 1:** Firms with the lowest levels of internal funds e borrow strictly positive amounts from banks, and their loan share of total borrowing *increases* with e. These are highly leveraged firms that are likely to need restructuring ex-post, making loans attractive to them. In fact, these firms borrow as much as banks are willing to lend, conditional on breaking even.
>
> **Region 2:** Firms with intermediate levels of e also use both loans and bonds, but in their case, the loan share *declines* with internal funds. These firms choose an interior debt structure,

[35] This assumption is also consistent with the fact that equity financing accounts for a small fraction of financial flows to the non-financial corporate business (NFCB) sector. For instance, Flow of Funds table F.103 indicates that, on average between 1990q1 and 2020q1, the ratio of equity issuance to capital expenditures was -15.9%, while the ratio of equity issuance to the total increase in financial liabilities was -82.1% (in the quarters when the total increase in financial liabilities is positive, i.e. when the NFCB is a net borrower from the rest of the world). These figures indicate that equity issuances are not, on average, a source of funds for the sector.

such that the marginal decrease in expected liquidation losses associated with a marginal increase in the share of loans (keeping total borrowing fixed) is exactly equal to $\gamma_b(r)$, the intermediation cost. As e increases, desired leverage falls, marginal liquidation losses decline, and the firm chooses a lower loan share.

Region 3: Finally, firms with sufficiently high e choose to bypass loans altogether. These firms don't require high leverage, and so their expected default risk is not sufficient to justify the intermediation cost $\gamma_b(r)$ associated with loans. They have a simple debt structure, with only senior bond debt, on which they default very infrequently.

This distribution of debt structure across firms with different levels of net worth matches qualitatively the findings of Rauh and Sufi (2010), who study detailed debt structure information on a sample of approximately 2000 publicly traded firms. They find that firms with the highest credit rating (those least likely to default, at least based on observables), have simple debt structures dominated by junior unsecured (bond) debt, analogous to the firms of Region 3. By contrast, firms with lower credit ratings tend to have more complex debt structures that mix senior bank debt to junior unsecured bonds, analogous to the firms of Regions 1 and 2. Leverage is also lower among firms with higher credit ratings and simpler debt structures.[36]

Appendix Table A4 provides further evidence on the cross-sectional relationship between leverage and the debt composition of firms, for firms in the Compustat sample studied in this paper. The bottom panel of the Table shows, in particular, that leverage among firms with strictly positive loan shares is significantly higher than among firms with zero loan shares. The difference is economically significant: approximately 8p.p., after controlling for other firm observables, compared to a sample median of approximately 31p.p.[37]

Finally, it should be noted that the model does not feature any firms with a 100% loan share — that is, firms that only borrow from banks. Note that in the sample of publicly traded firms studied in this paper, such observations are relatively rare: on average, only 14% of firm-year observations in the annual 2001-2017 sample have a 100% bank share, accounting on average for 3% of total

[36] See their Figure 1.

[37] The model has some starker implications. In particular, there is a discontinuous transition from a positive and relatively stable loan share (in Regions 1 and 2) to a zero loan share (in Region 3), whereas the variation in the loan share in the data is continuous. This stark prediction reflects the fact that the model is static. A more complex version of the model, with dynamic but costly adjustment of debt stocks, might produce smoother variation in the loan share.

assets of publicly traded firms. Nevertheless, among private firms, those borrowing only from banks are likely to be more frequently observed.[38] The model should thus be interpreted primarily as representing publicly traded firms, whose role in aggregate investment is nevertheless large.[39]

In what follows, given this segmentation of debt structure in equilibrium, I will refer to firms in Regions 1 and 2 as "loan-" or "bank"-dependent firms, and to firms in Region 3 as "bond-financed" firms.[40] I will compare the implications of the model for the pass-through of monetary policy across these two groups of firms, and contrast these implications with the empirical findings presented earlier.[41]

IV.D Cross-sectional implications

I next study the empirical predictions of the model. I first focus on cross-sectional predictions regarding monetary pass-through for a given set of structural parameters, and compare them to the results of Section III.B. I define monetary pass-through as the change in variables of interest (investment, borrowing, and debt structure) to a change in r, the risk-free rate. I then discuss the implications of the model for how *average* monetary pass-through changes when structural parameters change, and compare these implications with the results of Section III.C.

[38] Using balance sheet data on a sample of US manufacturing firms that includes a representative group of private, small firms, Crouzet and Mehrotra (2020) nevertheless find that only 26% of firm-quarter observations report having a loan share above 90%.

[39] In 2015, for instance, total capital expenditures of non-financial publicly traded firms accounted for approximately 65% of total investment in structures and equipment of non-financial corporations, as reported in the BEA Fixed asset tables; see, for instance, Crouzet and Eberly (2020), Appendix Figure IA3.

[40] In the sample of publicly traded firms, using the Capital IQ measure of the loan share, 12% of observations report having a loan share below 1% (the figure is 20% using the Compustat measure). However, by contrast with 100% loan-share firms, these firms account for a disproportionate amount of assets in the sample (26%, according to the Capital IQ measure, and 15% according to the Compustat measure). Moreover, their relative importance has been sharply increasing over time, peaking at 34% of total assets in 2016, according to the Capital IQ measure. Firms in Region 3, in the model, can be thought of as capturing this group of non bank-dependent firms. The model somewhat overestimates their relative size: Appendix Table A6 reports that in the baseline calibration, they account for the 44% of total assets.

[41] In order to test the implications of the model in the data, one method could be to sort firms on either proxies for net worth, leverage, distance to default, or credit spreads, since these variables are monotonically related to one another, and since they are also correlated with whether or not a firm belongs to Regions 1 and 2 or Region 3. Aside from whether or not empirical proxies for these model variables exist, an additional problem with this approach is that thresholds for belonging to Regions 1, 2 or 3 are not directly observed. More generally, in the data, firms that are not bank dependent do not have uniformly lower leverage, credit risk, or credit spreads than firms that use bank loans, suggesting that the simple model used in this paper, with a single state variable, cannot account for all the variation in debt structure and leverage observed in the data.

IV.D.i Model predictions

All the numerical results provided in this section are based on the calibration of the model described in Appendix Table A5. In particular, a subset of model parameters are calibrated using estimates from the literature, and the remainder are chosen so as to minimize the distance between data and model moments of the distribution of the bank share and of leverage, including average leverage and the average bank share. These moments are reported in Appendix Table A6; they are chosen to capture both the unweighted and asset-weighted cross-sectional distribution of leverage and the loan share. Appendix II.B describes the calibration of the model in more detail, and discusses model fit.[42]

Pass-through without a bank lending channel ($\gamma_b'(r) = 0$) I start with a special case of the model, in which there is no bank lending channel; that is, the relative intermediation cost of banks, $\gamma_b(r)$, is independent of r: $\gamma_b(r) = \gamma_b^0$. In this case, the model makes three qualitative predictions:

> **Prediction 1:** borrowing responds *less* among loan-dependent firms (Regions 1 and 2).
>
> **Prediction 2:** investment responds *more* among loan-dependent firms (Regions 1 and 2).
>
> **Prediction 3:** among loan-dependent firms, the sign of the response of the loan share is ambiguous: it is positive for firms in Region 1, and negative for firms in Region 2.

By contrast with the equilibrium debt structure described in IV.C, I have not been able to construct analytical proofs for these three predictions. However, Appendix Table A7 shows that these three predictions hold when parameters are individually perturbed around the calibration of Appendix Table A5.

In order to build intuition for these predictions, it is useful to write the first-order condition that pins down total borrowing $d = b + m$. Regardless of the region to which the firm belong, the first-order condition with respect to $d = b+m$ resulting from equation (6) takes the following form:

$$\zeta \mathbb{E}(\phi)(d+e)^{\zeta-1} - (1+r) = \gamma_b^0 s + \frac{\partial L}{\partial d}(e, d, s), \tag{7}$$

where $s = b/(b+m)$ is the share of loans in total debt, and $\tilde{r}(s) = r + \gamma_b^0 s$ is a weighted average

[42]The calibrated model matches key moments of the distribution of the loan share and leverage well, but it understates the share of total assets of firms with positive loan shares relative to the data.

cost of debt. The left-hand side is the marginal product of capital net of the risk-free rate, which captures credit demand. The right-hand side captures credit supply effects. $L(e, d, s)$ denotes total expected liquidation losses for a firm with internal funds e that chooses the debt structure (d, s).[43] $\partial L/\partial d$ represents the marginal increase in those losses associated with an extra dollar of borrowing.

The first-order effect of an increase in the risk-free rate is to shift firms' credit demand, that is, the left-hand side of equation (7). Note that the downward shift in credit demand is vertical, and identical for all firms. As a result of that shift, borrowing and investment decline for all firms.

The reason why borrowing among loan-dependent firms (firms from Regions 1 and 2) responds more (Prediction 1) is that banks are more flexible in financial distress. In response to the shock, the credit supply curve (the right-hand side of equation 7) steepens for all firms, because higher risk-free rates imply (all other things equal) higher interest payments, and therefore a higher likelihood of liquidation. But it steepens less for firms from Regions 1 and 2, since these firms can use renegotiation to avoid liquidation in some of those new default states. As a result, the response of borrowing for firms in Regions 1 and 2 is smaller.

The reason why this does not translate into a smaller response of investment (Prediction 2) is simply because firms in Regions 1 and 2 initially have higher overall leverage, as reported in the top right panel of Figure 8. The reason why higher leverage firms sort into using loans (i.e. in Regions 1 and 2) is that they are more likely to default ex-post, and therefore find the flexibility of loans more useful.

Finally, the model also predicts that firms in Region 1 — loan-dependent firms with the most leverage — *increase* their loan share in response to the hike in interest rates, while firms in Region 2 — loan-dependent firms with less leverage — *lower* their loan share. Recall that firms in Region 2 are at an interior solution, governed by the following first order condition:

$$\gamma_b^0 = -\frac{\partial L}{\partial s}(e, d, s), \tag{8}$$

where L, as before, represents total expected liquidation losses. The function $\partial L/\partial s$ is the marginal decrease in liquidation losses from keeping total leverage constant but replacing a dollar of bonds with a dollar of loans. As r increases, this schedule shifts down, causing a decline in the loan share.

[43] That is, in terms of the notation of equation (6), $L(e, d, s) = (1 - \chi) \int_0^{\phi(e, sd, (1-s)d)} \pi(\phi) dF(\phi)$.

By contrast, firms in Region 1 exhaust their bank borrowing capacity. This implies that they are in steepest part of their loan supply curve. The shift in credit demand has a low overall effect on the amount of loans they issue (while it does have a large effect on their price). As a result, even though these firms reduce borrowing overall, they do so less via reducing loans than via reducing bond issuance, and so their loan share rises.

Pass-through with a bank lending channel ($\gamma_b'(r) > 0$) I next turn to discussing a model with a bank lending channel, that is, the case in $\gamma_b'(r) > 0$. In what follows, I assume:

$$\gamma_b(r) = \gamma_b^0 + \nu_b\,(r - r_0)\,, \tag{9}$$

where $\nu_b > 0$, and r_0 is the baseline value around which the interest rate is perturbed in order to compute elasticities.[44] In this case, the model's main qualitative predictions change as follows:

> **<u>Prediction 1':</u>** borrowing responds *more* among loan-dependent firms (i.e. firms in Regions 1 and 2) *if the bank lending channel is sufficiently strong*, that is, if $\gamma_b'(r) = \nu_b$ is sufficiently large.

In order to understand this, note that the first-order condition for total borrowing becomes:

$$\zeta \mathbb{E}(\phi)(d+e)^{\zeta-1} - (1+r) = (\gamma_b^0 + \nu_b\,(r - r_0))s + \frac{\partial L}{\partial d}(d,s,e), \tag{10}$$

The credit demand curve (the left hand side) is unchanged, but the credit supply curve (the right hand side) now also depends on the risk-free rate. In addition to a downward shift in the credit demand curve, there is now also an upward shift in the credit supply curve, and therefore a larger decline in borrowing and investment. By contrast, the borrowing and investment responses for firms that do not rely on loans (firms in Region 3) are, unsurprisingly, unchanged, relative to the case of no bank lending channel.

The strength of this effect depends on how large the slope parameter ν_b, with a higher slope leading to stronger loan supply effects. As a result, when the bank lending channel is sufficiently strong, the model can imply a higher responsiveness of borrowing among loan-dependent firms

[44] In the numerical examples below, the parameter controlling the strength of the bank lending channel, ν_b, is set to $\nu_b = 1$, but all the results are qualitatively unchanged for different values of this elasticity.

(firms in Regions 1 and 2). Figure 9 reports the (cross-sectional) average elasticity of the borrowing, investment, and the loan share to interest rate shocks. These averages are computed separately for loan-dependent firms (Regions 1 and 2) and bond-financed firms (Region 3).[45] This graph shows that, for a sufficiently strong bank lending channel, the interest rate elasticity of borrowing among loan-dependent firms can fall below that of firms which only rely on bond financing.

IV.D.ii Relationship to the findings of Section III.B

These cross-sectional predictions line up with the empirical findings of Section III.B as follows.

Predictions 1 and 1' In both the data and model, borrowing declines in response to a rate hike. Moreover, the data suggest that borrowing among bank-dependent firms declines somewhat less in the short-run, though the difference is not statistically significant, and economically relatively small (only about a quarter of the average response).

Without bank lending channel (Prediction 1), the model indicates that borrowing should decline substantially *less* than among bond-financed firms. Prediction 1' suggests that this gap should vanish with a stronger bank lending channel. The empirical results would thus be consistent with a version of the model where a bank lending channel exists ($\gamma_b'(.) > 0$), but is relative small.

Prediction 2 In both the data and model, higher rates lead to a decline in investment. Moreover, consistent with the data, prediction 2 indicates that the effect is stronger among firms with high loan shares (i.e. Regions 1 and 2) than among firms with low loan shares (i.e. Region 3).

Prediction 3 Third, the evidence indicates that, among firms with a positive loan share, the loan share increases more for firms with lower credit ratings. The relative response of the loan share between low and high-rated firms is qualitatively consistent with prediction 3, which implies that the loan share of firms in Region 1 responds relatively more than in Region 2.

However, prediction 3 is sharper: firms with a lower ex-ante default probability (Region 2) substitute bonds for loans in response to the shock, so their loan share *declines*. In the data, by contrast, the loan share of firms with high credit ratings increases. It may be that credit ratings are

[45]For instance, let $\epsilon_d(e) \equiv \frac{\Delta \log(d)}{\Delta r}(e)$. Then the red line in the top right panel of Figure 9 is $(1/M_{LB}) \int_{e \leq e^*} \epsilon_d(e) d\mu(e)$, where $M_{LB} = \int_{e \leq e^*} d\mu(e)$, e^* is the net worth threshold between Regions 2 and 3 before the interest rate is perturbed, and $\mu(.)$ is the distribution of firms across levels of e.

a poor proxy for the unobservable firm characteristic upon which the sign of the response depends. In the model, what determines whether or not a firm's loan share responds positively is whether the firm is exhausting its loan issuance capacity. An alternative empirical proxy for this may be the frequency with which firms renegotiate their debt contracts.

IV.D.iii Implications for the cost of debt

I next briefly discuss the model's implications for the cost of debt. Appendix Figure A9 reports the model's predictions for the semi-elasticity of the average interest rate to the risk-free rate, for all firms jointly (black line), and for loan-dependent and bond-financed firms (red and blue lines). Average interest paid is defined as: $\hat{r} = \frac{R_b(e,d,s) + R_m(e,d,s)}{d} - 1$, where $R_b(e,d,s)$ and $R_m(e,d,s)$ are total repayments due to banks and to bondholders after productivity has been realized. The semi-elasticities are plotted as as a function of the strength of the bank lending channel $\nu_b = \gamma_b'(r)$.

When there is no bank lending channel ($\nu_b = 0$), the average and conditional semi-elasticities in the model are positive, but smaller than one. The deleveraging caused by an increase in r thus leads to a (small) *decline* in spreads. This is true of both loan-dependent and bond-financed firms. As the bank lending channel strengthens (ν_b increases), though, intermediation costs become more responsive to an increase in r; this eventually pushes the semi-elasticity of average interest rates above one. The model can thus generate semi-elasticities of average interest paid above one, but only when the bank lending channel is sufficiently strong. In that case, the semi-elasticity of the cost of credit is higher among more bank-dependent firms.

Appendix Table A8 reports summary empirical results on the response of the cost of borrowing in the sample of Section III. The dependent variable is a measure of average interest rate paid for the firm in the quarter, $\hat{r}_{j,t}$.[46] Table A8 reports how this measure responds to monetary policy shocks, using the same specification as Equation (1). Two things about these responses are worth noting. First, estimates of the semi-elasticity are higher than one. Second, average interest paid responds more among initially more bank-dependent firms. Both observations would be consistent with a sufficiently strong lending channel in the model.

The focus on average interest rate semi-elasticities here is motivated by data considerations:

[46] For firm j in quarter t, $\hat{r}_{j,t}$ is defined as four times the ratio of total quarterly interest expense (Compustat variable `xinty`, appropriately differenced) to total book debt, lagged one quarter. This variable is, essentially, an average of interest rate paid on different debt instruments, weighted by shares of total book value of debt.

Compustat does not have readily available measures of interest paid on credit instruments by type. While further linking firm-year observations in Compustat to yields on the individual securities they issued is beyond the scope of this paper, these results suggest that such work could potentially shed further light on the strength of the bank lending channel in the data.[47]

IV.D.iv Comparison to pass-through predicted by other transmission channels

I conclude by comparing the predictions of this model to two other views of the pass-through of monetary policy shocks to firms: the bank lending channel, and the floating rate channel.

The bank lending channel The bank lending channel (Bernanke and Gertler, 1995) states that a monetary tightening reduces loan supply by affecting banks' balance sheet constraints.[48]

This channel predicts that loan shares should decline in response to a monetary tightening. The strength of the decline depends on borrowers' substitutability between loans and bonds, as well as the responsiveness of the supply of bonds interest rates, but its sign should generally be negative.[49] By contrast, the model of this section predicts that loan shares may increase in response to a rate hike, moreso among constrained firms, consistent with the evidence provided in Section III.

The floating rate channel An important difference between loans and bonds is that while the vast majority of loans are floating-rate debt instruments, most bonds are fixed-rate instruments.[50] Ippolito et al. (2018) argue that not all firms hedge the interest rate risk implied by the use of loans. Interest rate payments could then be more responsive to hikes in the short rate among firms with higher loan shares, leading to a stronger decline in internal funds and (if the firm is financially

[47] Additionally, it should be noted that there are two empirical issues with the average interest rate measure available in Compustat. First, about a third of firms in the sample do not report interest expenses at the quarterly frequency. Second, among those that do, a non-negligible portion of firm-quarter observations (about 5%) have average interest rates that are larger than 50%, which is likely a sign of measurement error in the `xinty` variable.

[48] Stein et al. (1998) describes a banking with asymmetric information in which a reduction in non-borrowed reserves (or equivalently, an increase in the Fed Funds rate) leads to a reduction in the supply of loans by banks.

[49] More specifically, so long as bonds and loans are not perfect complements, and so long as the supply of loans is more responsive to monetary contractions, loan shares should drop in response to a monetary contraction. On the question of movements in the relative supply of loans and bonds, Kashyap et al. (1993) show that a proxy for the relative cost of loans over bonds (commercial paper, in their case) responds positively to monetary policy contractions.

[50] In a sample of loan syndications in the chemicals industry, Faulkender (2005) shows that more than 90% of syndications are floating rate. Vickery (2008) uses the survey of Small Business Finance to show that 54% of bank loans (among which 72% are lines of credit) are floating rate, while 80% of non-bank debt is fixed-rate. Ippolito et al. (2018) document a strong cross-sectional correlation between measures of the floating rate debt share and the loan share in the Capital IQ database.

constrained) in investment.[51]

Two qualitative differences between this channel and the model presented in this section are worth highlighting. First, according to the floating rate channel, borrowing by firms with a higher loan share should decline more, so long as their marginal source of funds is debt. By contrast, the model presented in this section implies that firms with a higher loan share experience a smaller decline in borrowing (except when the bank lending is sufficiently strong, as explained above). The findings of Section III suggest that there is no significant difference in the response of borrowing among firms with higher loan shares, and thus do not strongly favor any of the two mechanisms.

Second, the floating rate channel has ambiguous predictions for the response of the loan share itself. If the monetary contraction is transitory, the firm might prefer not to hedge new issuances, leading to an increase in the loan share. But if it is persistent, it might choose to hedge them, leading to a decline in the loan share. By contrast, both the model presented in this section, and the results of Section III, suggest that the loan share increases in response to a monetary contraction.

It should be noted that in all three models, the cross-sectional implications for investment are similar: investment should decline more among firms with higher loan shares.[52] The mechanisms are different across the three models, though. In pure bank lending channel models, it occurs because of a shift in the relative price of loans; in the floating rate channel, it occurs because of a decline in firm cash flows; and according to the "flexibility" channel of this paper, it occurs because more leveraged and more fragile firms endogenously sort into higher loan shares.

IV.E Implications for the evolution of the average monetary pass-through

IV.E.i Model predictions

The aggregate loan share, in the model, is defined as:

$$S = \frac{\int_e s(e)d(e)d\mu(e)}{\int_e d(e)d\mu(e)}, \tag{11}$$

[51] Using the loan share as a proxy for the share of floating-rate debt, Ippolito et al. (2018) provide evidence that stock prices of high floating-rate debt firms are indeed more responsive to monetary policy innovations.

[52] I thank an anonymous referee for raising this point.

where $s(e)$ is the firm-level loan share and $d(e)$ is firm-level borrowing. Figure 10 plots model elasticities (on the vertical axis) against the aggregate loan share S (on the horizontal axis). Each point represents a different calibration of the model. Across calibrations, all parameters are kept constant, except for the intercept of the intermediation cost function, γ_b^0. A higher intermediation cost γ_b^0 leads to fewer loan-dependent firms and a lower aggregate loan share; in the range I consider, the aggregate loan share falls from approximately 40% to approximately 15%.

The top panel of Figure 10 plots the elasticity of investment against the aggregate loan share as γ_b^0 changes. Three things are worth noting. First, the average pass-through of monetary policy shocks to investment decreases (in absolute value) as the aggregate loan share rises. Second, the pass-through changes very little for firms that are purely bond-financed. Third, *even* conditional on being loan-dependent, the pass-through of monetary shocks declines.

The decline in the average pass-through of interest rates to investment thus reflects both a change in the composition of firms, and a decline in the pass-through of interest rates to loan-dependent firms. The reason for the latter effect is that as intermediation costs rise, loan-dependent firms (i.e., firms from Regions 1 and 2) become progressively more likely to exhaust their bank borrowing constraint (i.e. shift to Region 1). Region 1 firms are relatively less responsive, and so this shift lowers the overall sensitivity of investment to interest rates among loan-dependent firms.

The relative pass-through (the difference between blue and red lines) also declines as disintermediation advances, consistent with the findings reported in Table 4. However, we note that the relative pass-through declines *less* than the average pass-through, as is also the case in the data. Thus, the model suggests that a sharp decline in relative pass-through is not needed for disintermediation to explain the fall in average pass-through.

Figure 10 also reports comparative statics for the pass-through of interest rate shocks to borrowing. The average pass-through decreases (in absolute value) as intermediation costs γ_b^0 increase and the aggregate loan share declines. This reflects a decline in the pass-through to both loan-dependent and bond-financed firms. The pass-through to bond-financed firms is affected by a composition effect: the increase in γ_b^0 induces firms with lower internal funds to switch to a bond-financed debt structure (i.e from Region 2 to Region 3). These firms are the most constrained in Region 3, and therefore the least sensitive to movements in interest rates.

IV.E.ii Relationship to empirical findings of Section III.C

The empirical evidence of Section III.C indicates that the pass-through of monetary policy shocks to firms fell from the pre- to the post-1990 period. This is consistent with the implications of the model as the intermediation cost γ_b^0 changes. Quantitatively, in the calibration considered here, the average pass-through to investment declines by about 30% as the loan shares declines from 40% to 15%.

The model, however, substantially underestimates the decline in the pass-through to borrowing, which fell by more than two thirds in the data, as opposed to less than 20% in the model. Note that the static model studied here forces investment and borrowing to have closely related elasticities; but it also likely limits its ability to match the relative decline in the monetary pass-through to investment and borrowing.

Finally, these predictions hold regardless of whether or not one incorporates a bank lending channel into the model. They do, however, depend on the nature of the underlying structural change. For instance, a reduction in idiosyncratic shock volatility would also lead to a reduction in the aggregate loan share; but it would have opposite effects on the pass-through, as a lower volatility of idiosyncratic shocks tends to relax borrowing constraints.

V Conclusion

The results of this paper can be summarized as follows. First, the aggregate loan share — the share of bank loans in total corporate debt — seems to have declined after 1990. This decline is not driven by composition effects; rather, it reflects a within-firm change in debt structure. Second, in the data, investment by firms that rely more on bank loans declines significantly more in response to a monetary tightening; so does borrowing, though the difference with the average firm is not significant. Additionally, the average firm-level loan share increases in response to monetary tightenings. These effects appear to be weaker in the post-1990 sample, when the aggregate loan share is lower. Third, a model where debt structure is driven by a trade-off between flexibility and cost can account for these cross-sectional patterns. Moreover, it predicts a decline in average pass-through as the cost of bank loans rises and the aggregate loan share declines.

These results leave a number of open questions. First, the weak differential effects of monetary policy shocks on borrowing in the short-run (1 to 4 quarters out) suggest that the flexibility and the bank lending channels have partially offsetting effects. Further work to tease out effects the bank lending channel and isolate it from the flexibility channel could help confirm this. Second, I assumed that banks' relative intermediation costs increased since the early 1990s, as this change can correctly and transparently account for the patterns observed in the data since. What this reduced-form assumption captures is less clear, but surely relevant for understanding the policy implications of disintermediation. Third, I focused on publicly traded firms; since disintermediation was presumably less important among private firms, it is less clear how monetary pass-through might have evolved among them. Finally, this paper takes a particular stance on what makes loans different from bonds — their flexibility. As discussed in the paper, interest rate exposure (Ippolito et al., 2018) is another important dimension of divergence between loans and bonds, but the literature has emphasized a number of others, including monitoring intensity (Rajan, 1992), issuance costs (Smith, 1986), or maturity (Denis and Mihov, 2003). All are potentially important for understanding cross-sectional differences in the transmission of monetary policy shocks to firms, and offer avenues for future research.

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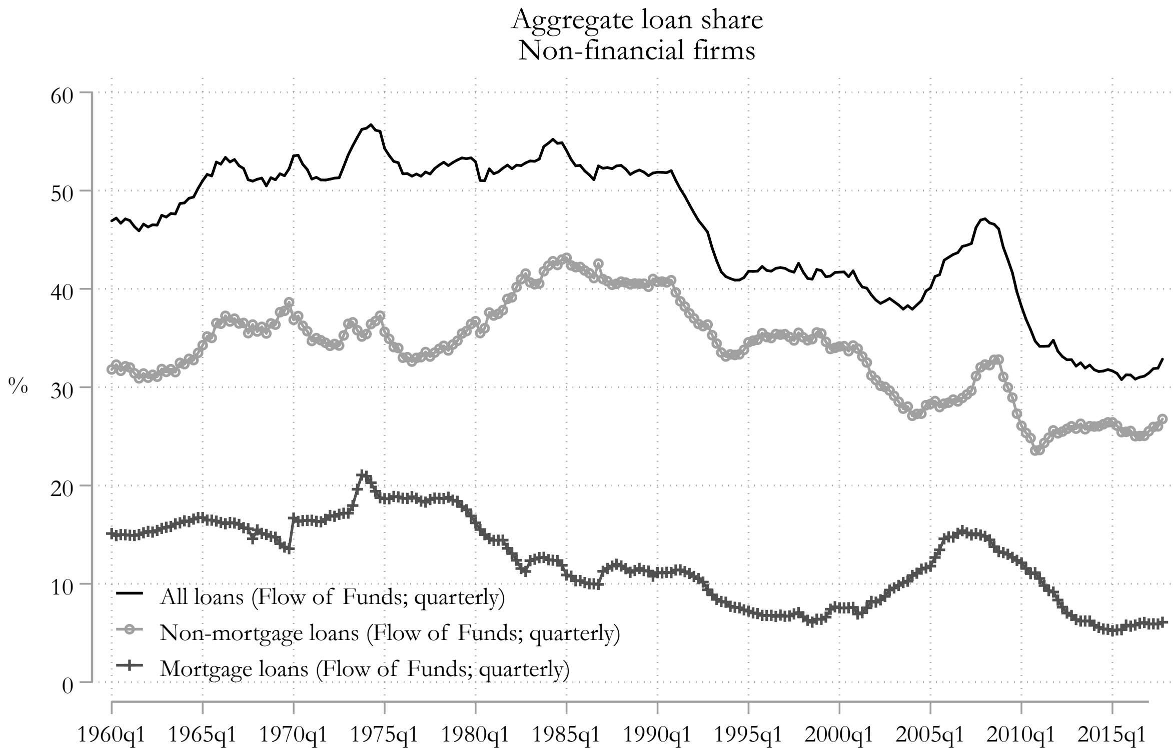


Figure 1: Total loans as a share of total debt in the non-financial corporate sector. Data are from Flow of Funds table L.103. Bonds are defined as data item FL104122005, "Debt Securities", which is the sum of corporate bonds, municipal securities, and commercial paper. Loans are defined as data item FL104123005, "Loans", which is the sum of depository institution loans, other loans and advances, and mortgages. The share plotted is the ratio of loans to the sum of bonds plus loans.

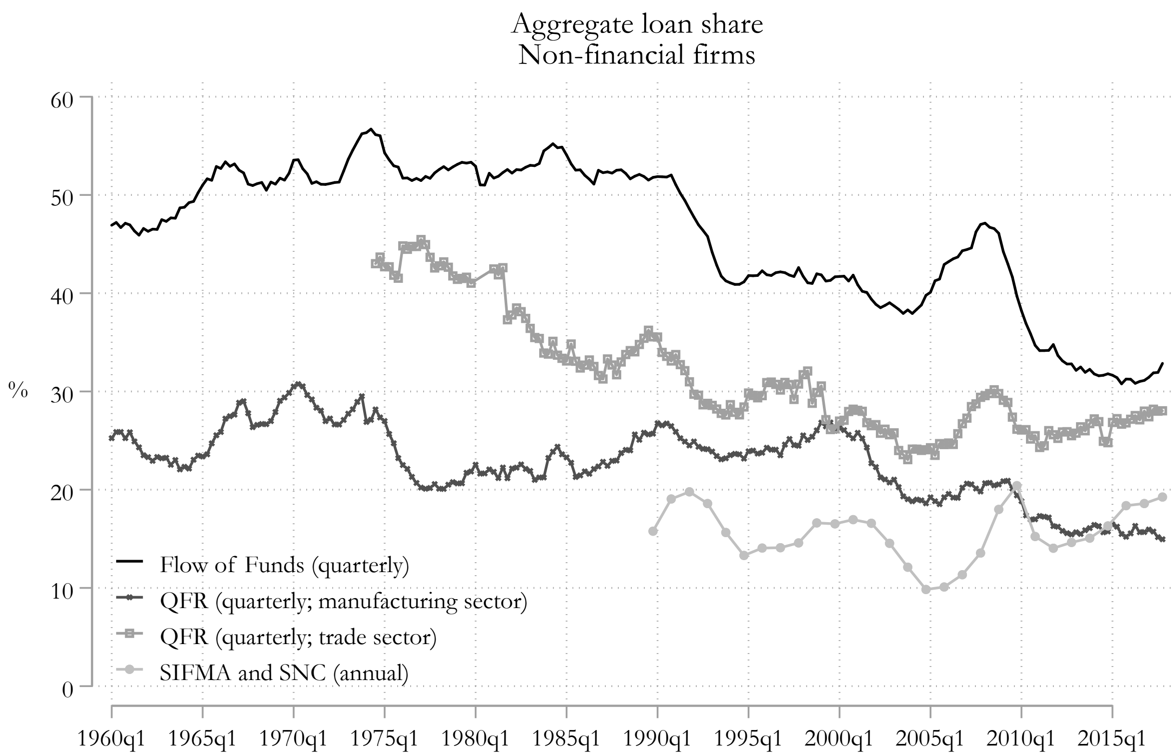


Figure 2: Total loans as a share of total debt in the non-financial corporate sector: other aggregate data sources. The Flow of Funds data is the same as in Figure 1. The QFR data is obtained from the public releases of the QFR. The loan share is defined as the sum of all bank loans outstanding (short and long-term) divided by all debt outstanding; debt outstanding is defined as the total liabilities minus net taxes payable, accounts payable, and other non-current liabilities. The SIFMA and SNC data is obtained from the SIFMA website and from the website of the Federal Reserve Board. The numerator is defined as total loans outstanding in SNC, and the denominator is defined as total loans plus total bonds outstanding, where total bonds outstanding are measured in SIFMA. Note that SIFMA corporate bonds outstanding include bonds issued by the financial sector. Additionally, the SNC only records syndications above $20m held by three or more supervised financial institutions.

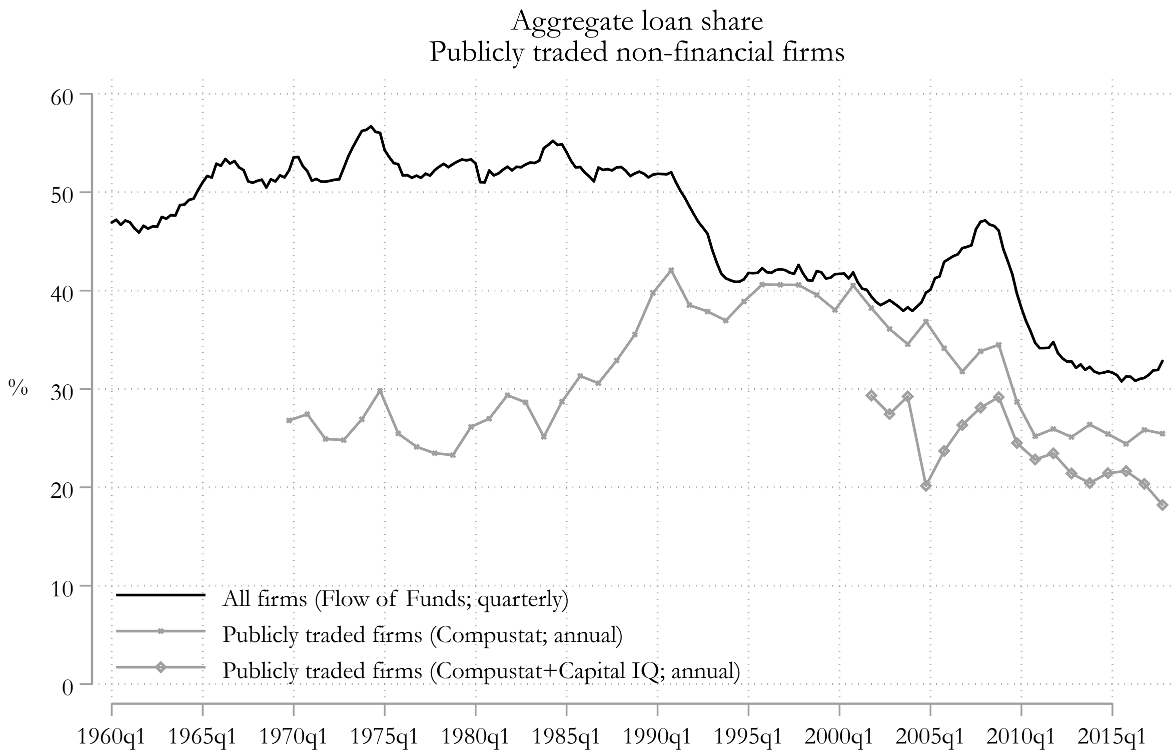


Figure 3: Total loans as a share of total debt among public firms. For Compustat, loans are defined as the sum of notes payable (`np`) and other long-term debt (`dlto`). The Compustat sample is restricted to the nonfinancial (NF) sector. For Compustat+Capital IQ, loans are defined as the share of bank loans as a percentage of total debt reported in Capital IQ, multiplied by total debt in Compustat, defined as sum of Compustat `dlc` and `dltt`. See Figure 1 for definition of data items for the Flow of Funds data. In all three time series, the denominator of the share is the book value of total debt.)

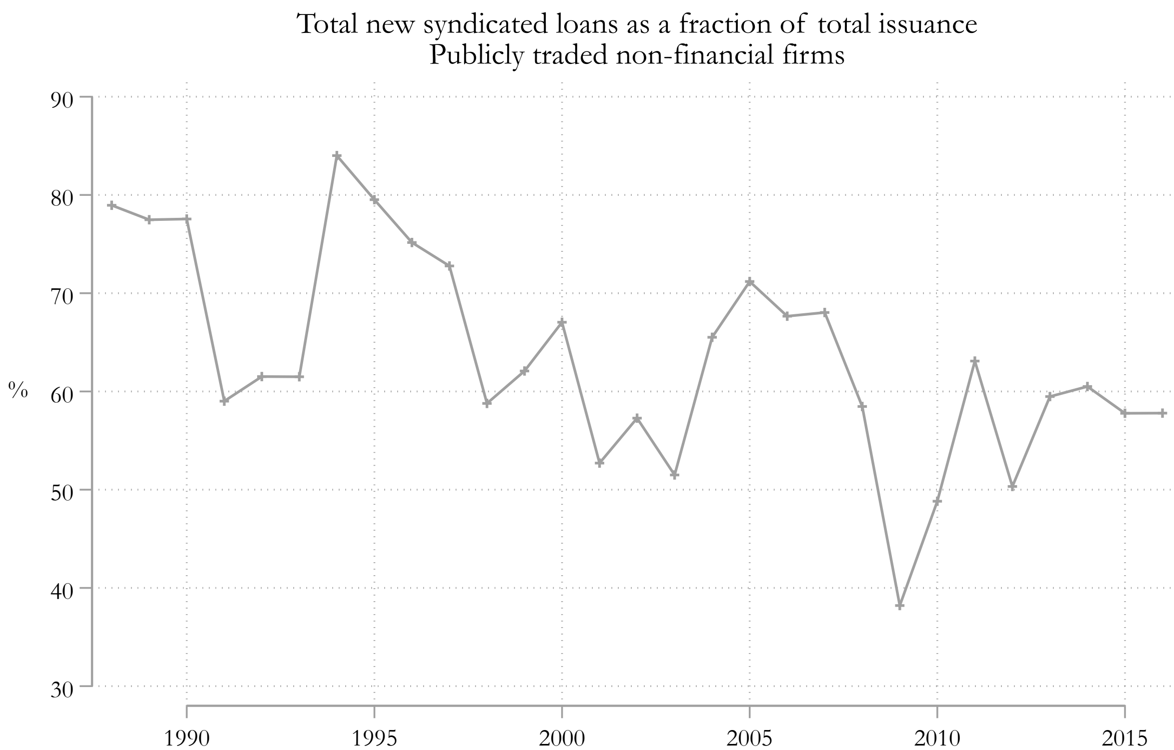


Figure 4: New syndications relative to new bond issuances for publicly traded, non-financial firms. The numerator is total new syndications in the sample of non-financial firms in Compustat, computed by merging Compustat with Dealscan. The denominator is total new bond issuances by US non-financial firms, computed using the Mergent Fixed Income Securities Database (FISD).

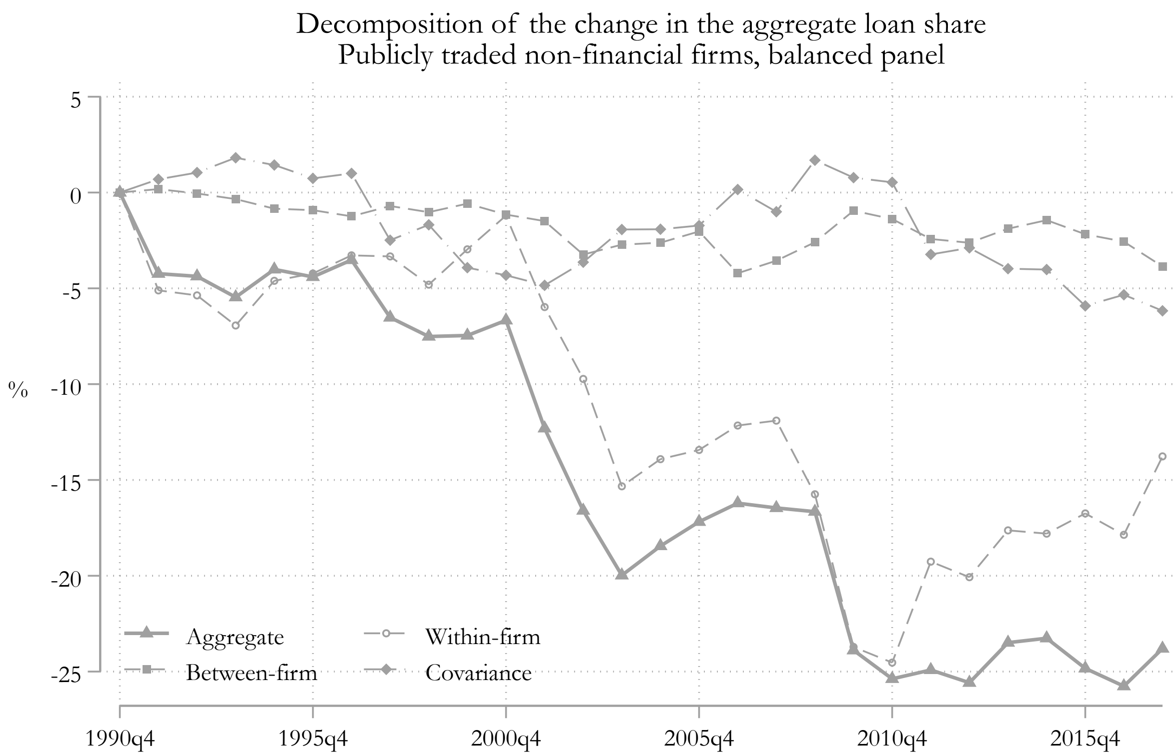


Figure 5: Decomposition of the aggregate loan share in the balanced panel of Compustat non-financial firms. Data is from the Compustat Fundamentals Annual file. The Compustat sample is restricted to the Non-Financial (NF) sector and to firms that are present in sample for each year from 1990 to 2017, and with strictly positive total debt at all dates. The crossed black line represents the decline in the ratio of total loans to total debt for this group of firms since 1990q4. The first term (the within-term) shows the evolution of the aggregate loan share if the distribution of total debt across firms were kept constant. The second term (the between-term) shows the aggregate loan share if the share of loans were kept constant. The residual term, up to a constant, is the cross-sectional covariance between changes in firm's share of total debt and changes in its loan share.

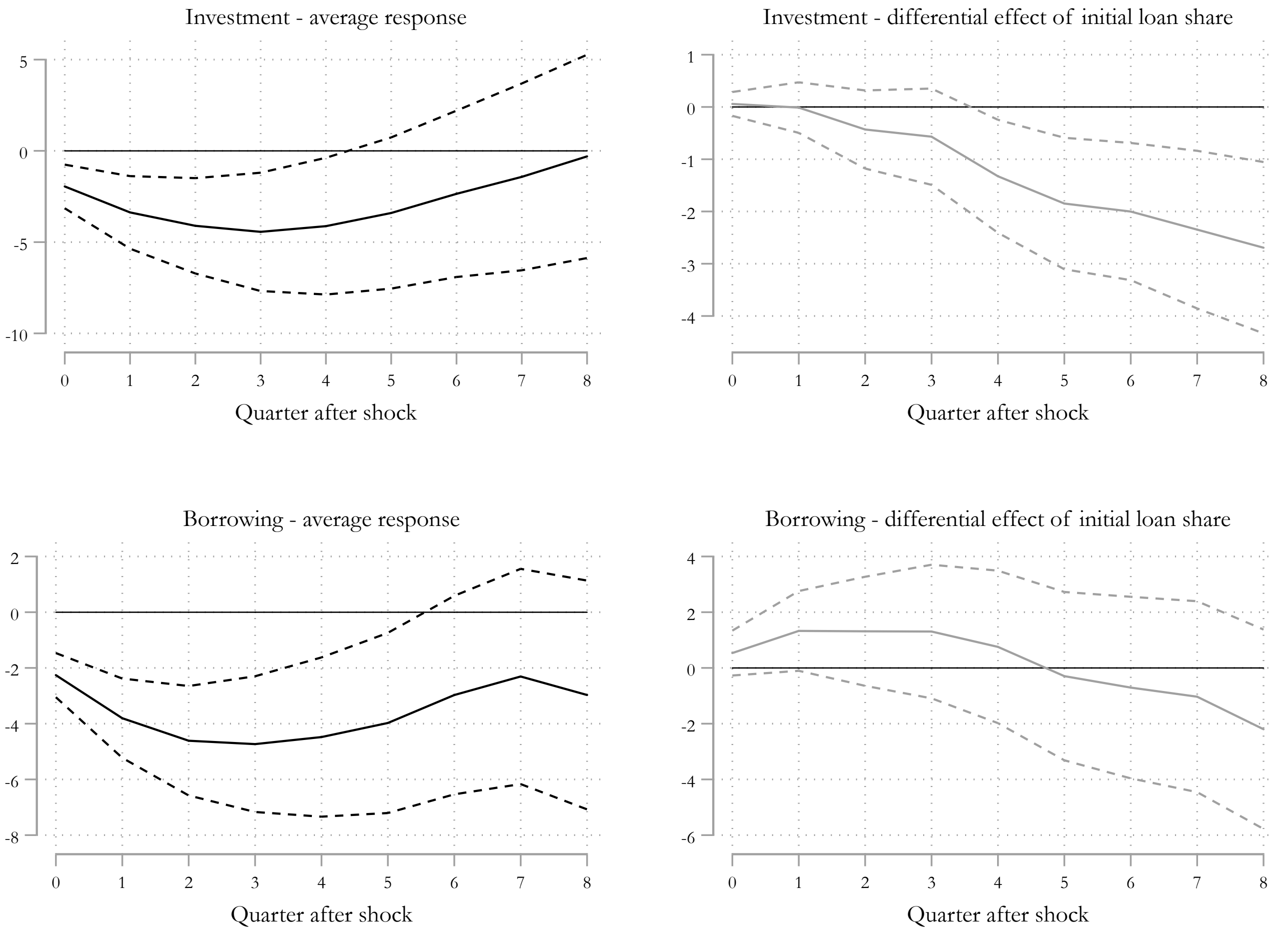


Figure 6: Dynamic response of investment and borrowing to a monetary policy tightening: average effects and differential effect of the loan share. The top graphs report results for the cumulative change in net property, plant and equipment, while the bottom graphs report results for the cumulative change in debt. The left column reports average effects. They are the coefficients β_h regressions of the form $\Delta_h y_{j,t} = \alpha_{j,h} + \beta_h \eta_t^{HF} + \delta_h(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_{Z,h} Z_{t-1} + \Gamma_{X,h} X_{j,t-1} + \varepsilon_{j,h,t}$. $\Delta_h y_{j,t}$ is the cumulative change in variable $y_{j,t}$ between the end of quarter $t-1$ and the end of quarter $t+h$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period), and $X_{j,t-1}$ are firm-level controls (aside from the loan share $s_{j,t-1}$, these include the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, all lagged one period, and a set of dummies for fiscal quarters.) The right column reports the differential effect of the shock based on the lagged loan share. This differential effect is the coefficient δ_h in regressions with sector-time fixed effects: $\Delta_h y_{j,k,t} = \alpha_{j,h} + \beta_{h,k,t} + \delta_h(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_{X,h} X_{j,t-1} + \varepsilon_{j,h,t}$, where k is the firm's sector. The loan share is standardized in the regression sample. The dashed lines are 90% confidence bands; standard errors are double-clustered by firm and quarter.

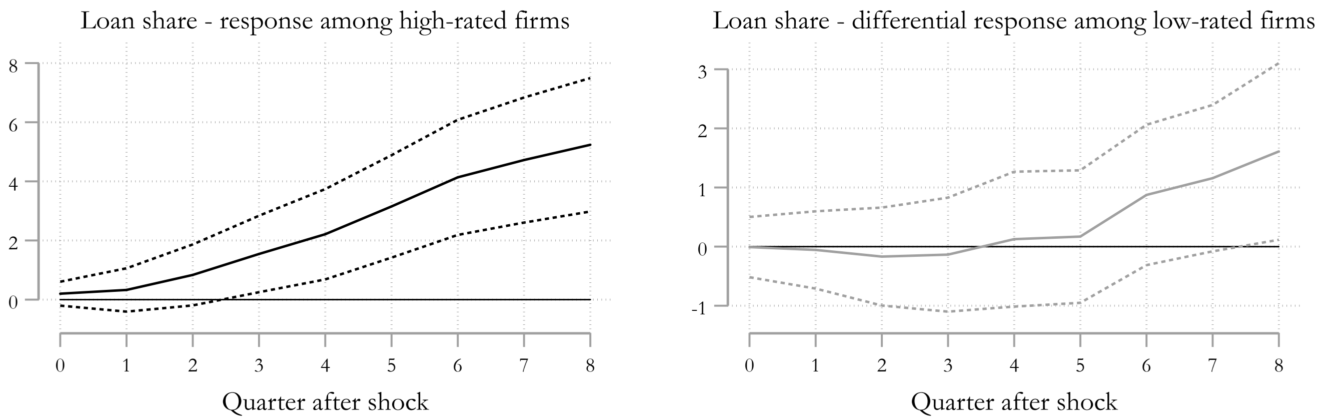


Figure 7: Dynamic response of the loan share to a monetary policy tightening: average effects and differential effect of credit ratings. The results reported are for the 1990q1-2007q4 sample. The top graphs report results for the cumulative change in net property, plant and equipment, while the bottom graphs report results for the cumulative change in debt. The left column reports average effects. They are the coefficients β_h regressions of the form $\Delta_h s_{j,t} = \alpha_{j,h} + \beta_h \eta_t^{HF} + \delta_h(\eta_t^{HF} \times C_{j,t-1}) + \Gamma_{Z,h} Z_{t-1} + \Gamma_{X,h} X_{j,t-1} + \varepsilon_{j,h,t}$. $\Delta_h s_{j,t}$ is the cumulative change in the loan share between the end of quarter $t-1$ and the end of quarter $t+h$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period), and $X_{j,t-1}$ are firm-level controls (these include the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, all lagged one period, the credit rating group $C_{j,t-1}$, and a set of dummies for fiscal quarters.) The right column reports the differential effect of the shock based on the credit rating group $C_{j,t-1}$. This differential effect is the coefficient δ_h in regressions with sector-time fixed effects: $\Delta_h s_{j,k,t} = \alpha_{j,h} + \beta_{h,k,t} + \delta_h(\eta_t^{HF} \times C_{j,t-1}) + \Gamma_{X,h} X_{j,t-1} + \varepsilon_{j,h,t}$, where k is the firm's sector. The credit rating group is coded so that $C_{j,t-1}$ corresponds to a rating of $A-$ or less. The dashed lines are 90% confidence bands; standard errors are double-clustered by firm and quarter.

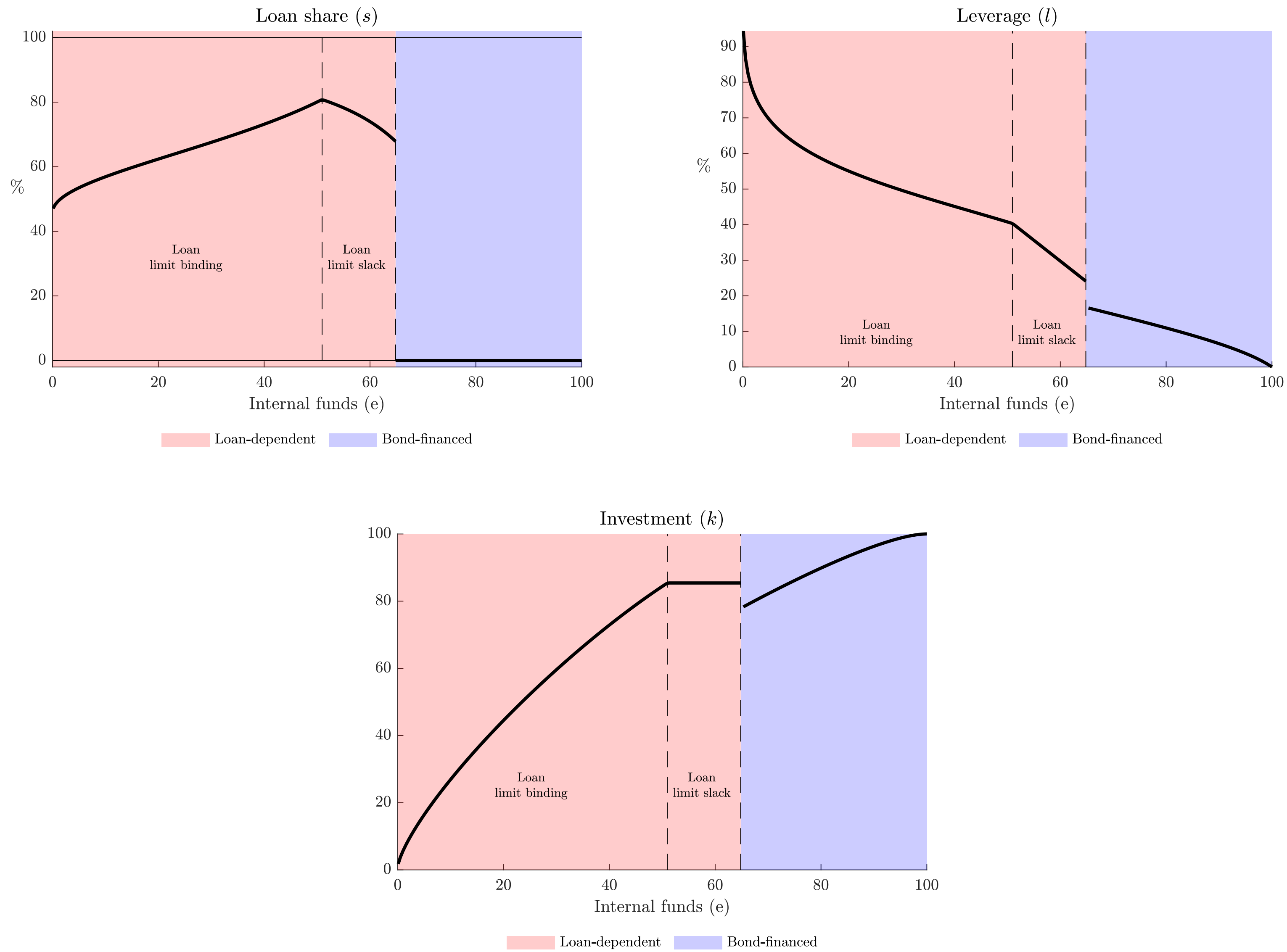
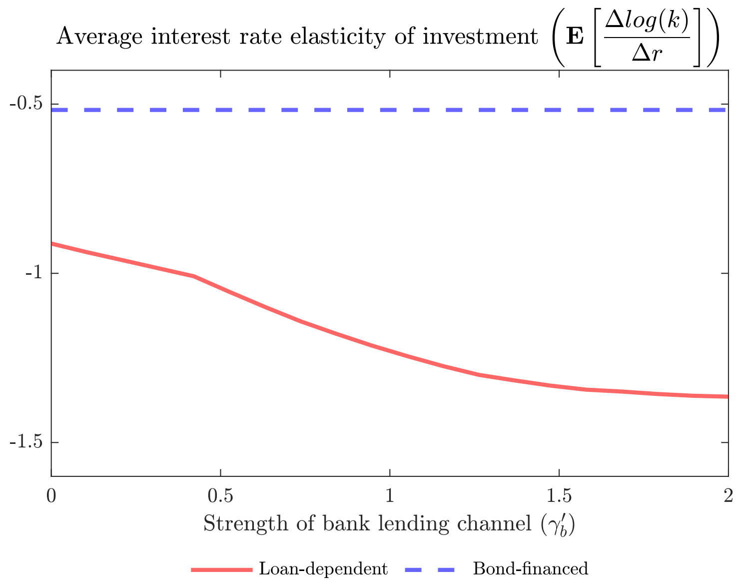


Figure 8: Policy functions in the model of section IV. The state variable, on the horizontal axis, is internal funds (or net worth) e. The red shaded region corresponds to firms that choose to issue both loans and bonds, while the blue shaded region corresponds to firms that choose to issue only bonds. Among firms that issue both loans and bonds (the red region), the dashed black line separates those whose bank borrowing constraint is binding, from those who choose an interior solution for debt composition. The calibration used to construct the graphs is reported in Appendix Table A5.



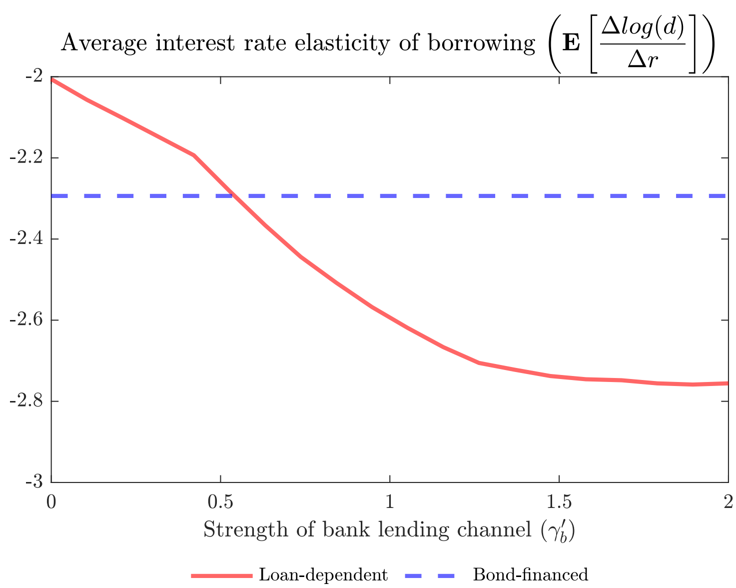


Figure 9: Average interest rate elasticities as a function of the strength of the bank lending channel. In order to construct these graphs, we assume that $\gamma_b(r) = \gamma_b^0 + \nu_b(r - r_0)$, where ν_b is a constant, and r_0 is the level of risk-free rates used in the baseline calibration of the model. On the horizontal axis, the interest rate elasticity $\gamma_b' = \nu_b$ is reported. For each value of γ_b', the elasticities reported are the cross-sectional average percent change in a variable of interest (or the percentage point change, for the loan share) for a $50bps$ increase in the risk-free rate, r. The cross-sectional averages are computed using the same distribution of net worth as in the baseline calibration. The red solid line reports the conditional average elasticity among firms which continue issuing both loans and bonds in response to the interest rate hike, while the dashed blue line reports the conditional average elasticity among firms which issue only bonds both before and after the interest rate hike. Other than the strength of the bank lending channel, the calibration of the model is the same as in Figure 8.

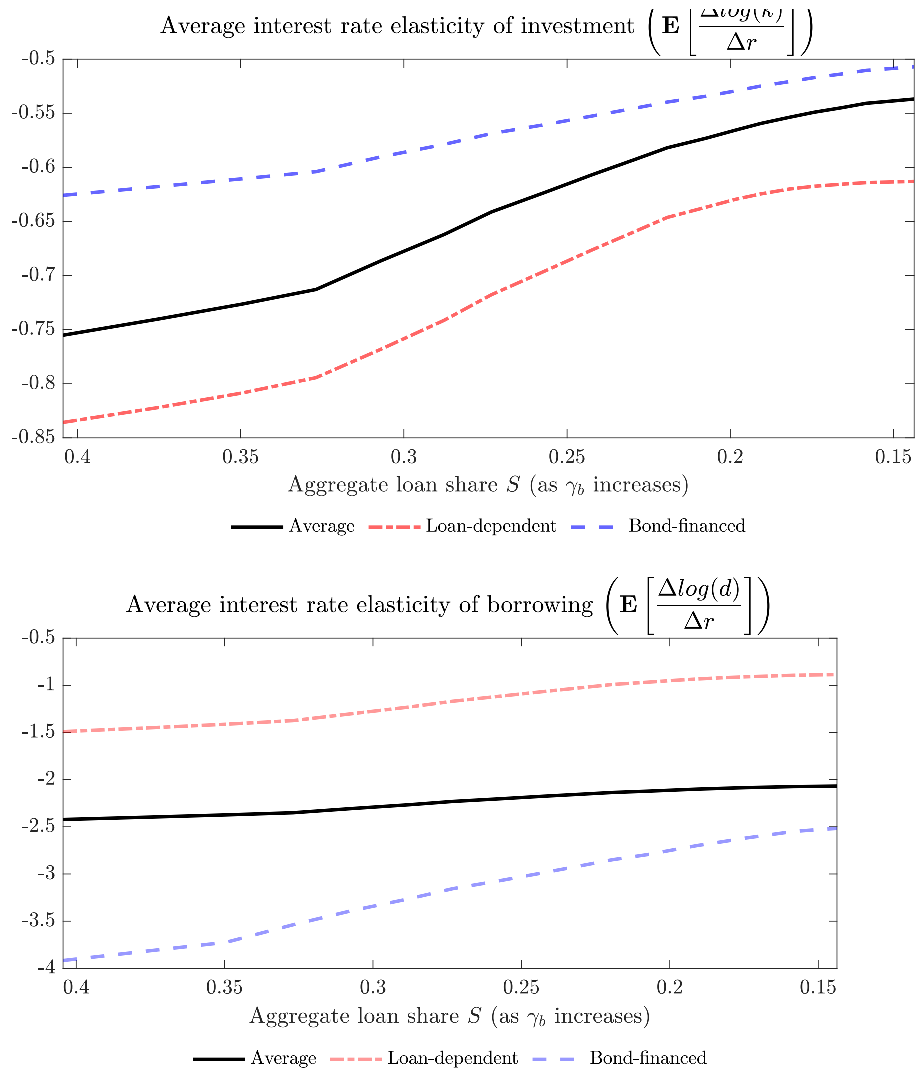


Figure 10: Disintermediation and the pass-through of interest rate shocks. The horizontal axis reports the aggregate loan share, while the vertical axes report the cross-sectional average elasticity of various quantities to interest rates. In each of the two panels, a point corresponds to a different calibration of the model. Across calibrations, only the intermediation spread γ_b changes: it varies between 0.02 (for the point with highest aggregate loan share) and 0.04 (for the point with the lowest aggregate loan share.) In all calibrations, the bank lending channel is active ($\nu_b > 0$ in the model of Section IV). The elasticities reported are the cross-sectional average percent change in a variable of interest (or the percentage point change, for the loan share) for a $50bps$ increase in the risk-free rate, r; for instance, for investment, they are the cross-sectional average of $\Delta log(k)/\Delta r$, with $\Delta r = 50bps$. The black line reports the unconditional average elasticity; the blue, short-dashed lined reports the elasticity among bond-financed firms; and the red, long-dashed line reports the elasticity among loan-dependent firms. Other than the intermediation spread γ_b, the calibration of the model is the same as in Figure 8.

(a) Investment: impact response

	(1)	(2)	(3)	(4)
η_t^{HF}	-2.35***	-1.95***	-1.95***	
	(0.77)	(0.73)	(0.73)	
$\eta_t^{HF} \times s_{j,t-1}$			0.13	0.06
			(0.15)	(0.14)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.107	0.122	0.122	0.140
N	200358	200358	200358	200358

(b) Investment: cumulative 4-quarter response

	(1)	(2)	(3)	(4)
η_t^{HF}	-5.24**	-4.15*	-4.12*	
	(2.40)	(2.28)	(2.28)	
$\eta_t^{HF} \times s_{j,t-1}$			-1.07	-1.33**
			(0.67)	(0.66)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.226	0.259	0.259	0.274
N	189794	189794	189794	189794

Table 1: Response of investment to a monetary policy tightening. The top panel reports estimates for the impact response, while the bottom panel reports estimates for one-year ahead cumulative response. Columns (1) to (3) report estimates from: $\Delta y_{j,t} = \alpha_j + \beta\eta_t^{HF} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta y_{j,t}$ is the change in $log(k_{j,t})$, either from the end of quarter $t-1$ to the end of quarter t (top panel) or to the end of quarter $t+4$ (bottom panel). Additionally, η_t^{HF} is the shock to the Federal Funds rate; $s_{j,t-1}$ is the share of bank loans in total debt at the end of quarter $t-1$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the loan share, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta y_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. In all specifications, the loan share is expressed in terms of its deviation from the within-firm average, and standardized in the regression sample. Standard errors are double-clustered by firm and quarter.

(a) Borrowing: impact response

	(1)	(2)	(3)	(4)
η_t^{HF}	-1.92***	-2.25***	-2.26***	
	(0.48)	(0.48)	(0.48)	
$\eta_t^{HF} \times s_{j,t-1}$			0.50	0.53
			(0.49)	(0.49)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.056	0.071	0.071	0.080
N	200358	200358	200358	200358

(b) Borrowing: cumulative 4-quarter response

	(1)	(2)	(3)	(4)
η_t^{HF}	-5.07***	-4.47**	-4.48***	
	(1.74)	(1.74)	(1.74)	
$\eta_t^{HF} \times s_{j,t-1}$			0.44	0.76
			(1.66)	(1.66)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.109	0.111	0.111	0.122
N	189794	189794	189794	189794

Table 2: Response of borrowing to a monetary policy tightening. The top panel reports estimates for the impact response, while the bottom panel reports estimates for one-year ahead cumulative response. Columns (1) to (3) report estimates from: $\Delta y_{j,t} = \alpha_j + \beta\eta_t^{HF} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta y_{j,t}$ is the change in $log(1 + d_{j,t})$, either from the end of quarter $t-1$ to the end of quarter t (top panel) or to the end of quarter $t+4$ (bottom panel). Additionally, η_t^{HF} is the shock to the Federal Funds rate; $s_{j,t-1}$ is the share of bank loans in total debt at the end of quarter $t-1$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the loan share, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta y_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. In all specifications, the loan share is expressed in terms of its deviation from the within-firm average, and standardized in the regression sample. Standard errors are double-clustered by firm and quarter. Finally, the outcome variable is $1 + d_{j,t}$ because, while all firms in the regression sample have strictly positive debt at time t (and therefore a well-defined bank share), a few firms reach 0 debt outstanding in the quarters following quarter t. Units of $d_{j,t}$ are millions of \$, deflated by the GDP deflator (FRED series GDPDEF).

(a) Loan share: impact response

	(1)	(2)	(3)	(4)
η_t^{HF}	0.14	0.20	0.20	
	(0.25)	(0.25)	(0.25)	
$\eta_t^{HF} \times C_{j,t-1}$			-0.01	-0.01
			(0.32)	(0.31)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.059	0.059	0.059	0.064
N	140783	140783	140783	140783

(b) Loan share: cumulative 4-quarter response

	(1)	(2)	(3)	(4)
η_t^{HF}	1.81*	2.21**	2.21**	
	(0.93)	(0.93)	(0.93)	
$\eta_t^{HF} \times C_{j,t-1}$			0.05	0.13
			(0.69)	(0.69)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.114	0.116	0.116	0.124
N	120900	120900	120900	120900

Table 3: Response of the loan share to a monetary policy tightening. The results reported are for the 1990q1-2007q4 sample. Columns (1) to (3) report estimates from: $\Delta s_{j,t} = \alpha_j + \beta\eta_t^{HF} + \delta(\eta_t^{HF} \times C_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta s_{j,t}$ is the change in the loan share $s_{j,t}$, either from the end of quarter $t-1$ to the end of quarter t (top panel) or to the end of quarter t+4 (bottom panel). Additionally, η_t^{HF} is the shock to the Federal Funds rate; $C_{j,t-1}$ is the credit rating group; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the credit rating group, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta s_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{HF} \times C_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. The credit rating group is coded so that $C_{j,t-1}$ corresponds to a rating of $A-$ or less. Standard errors are double-clustered by firm and quarter in all specifications.

(a) Investment: 4-quarter response, post-1990q1 sample

	(1)	(2)	(3)	(4)
η_t^{RR}	-3.39**	-2.81**	-2.79**	
	(1.49)	(1.32)	(1.32)	
$\eta_t^{RR} \times s_{j,t-1}$			-0.85***	-1.00***
			(0.29)	(0.28)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.228	0.260	0.260	0.274
N	189794	189794	189794	189794

(b) Investment: 4-quarter response, pre-1990q1 sample

	(1)	(2)	(3)	(4)
η_t^{RR}	-6.67**	-4.33*	-4.31*	
	(2.67)	(2.48)	(2.48)	
$\eta_t^{RR} \times s_{j,t-1}$			-1.48***	-1.61***
			(0.27)	(0.14)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.285	0.323	0.323	0.344
N	111913	111913	111913	111909

Table 4: Response of investment to a monetary policy tightening in the pre- and post-1990q1 periods. The top panel reports estimates for the post-1990 period, while the bottom panel reports estimates for the pre-1990 period. Columns (1) to (3) report estimates from: $\Delta y_{j,t} = \alpha_j + \beta\eta_t^{RR} + \delta(\eta_t^{RR} \times s_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta y_{j,t}$ is the change in $log(k_{j,t})$ over the year following the shock. Additionally, η_t^{RR} is the shock to the Federal Funds rate, identified using the narrative approach of Romer and Romer (2004) instead of data on Fed funds futures; $s_{j,t-1}$ is the share of bank loans in total debt at the end of quarter $t-1$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the loan share, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta y_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{RR} \times s_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. In all specifications, the loan share is expressed in terms of its deviation from the within-firm average, and standardized in the regression sample. Standard errors are double-clustered by firm and quarter.

(a) Borrowing: 4-quarter response, post-1990q1 sample

	(1)	(2)	(3)	(4)
η_t^{RR}	-1.03***	-1.11***	-1.11***	
	(0.26)	(0.27)	(0.27)	
$\eta_t^{RR} \times s_{j,t-1}$			0.60*	0.66*
			(0.34)	(0.34)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.110	0.111	0.111	0.122
N	189794	189794	189794	189794

(b) Borrowing: 4-quarter response, pre-1990q1 sample

	(1)	(2)	(3)	(4)
η_t^{RR}	-5.62***	-5.54***	-5.55***	
	(1.15)	(1.14)	(1.14)	
$\eta_t^{RR} \times s_{j,t-1}$			0.38	0.12
			(0.83)	(0.82)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.150	0.153	0.153	0.173
N	111913	111913	111913	111909

Table 5: Response of borrowing to a monetary policy tightening in the pre- and post-1990q1 periods. The top panel reports estimates for the post-1990 period, while the bottom panel reports estimates for the pre-1990 period. Columns (1) to (3) report estimates from: $\Delta y_{j,t} = \alpha_j + \beta\eta_t^{RR} + \delta(\eta_t^{RR} \times s_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta y_{j,t}$ is the change in $log(1 + d_{j,t})$ over the year following the shock. Additionally, η_t^{RR} is the shock to the Federal Funds rate, identified using the narrative approach of Romer and Romer (2004) instead of data on Fed funds futures; $s_{j,t-1}$ is the share of bank loans in total debt at the end of quarter $t-1$; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the loan share, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta y_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{RR} \times s_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. In all specifications, the loan share is expressed in terms of its deviation from the within-firm average, and standardized in the regression sample. Standard errors are double-clustered by firm and quarter.

A Additional empirical results

I.A Comparison of Compustat and the Flow of Funds

Compustat data only includes publicly traded firms. This is an important limitation, particularly because private firms seldom issue publicly traded debt securities. Thus, private firms' debt composition is likely to differ substantially from public firms', especially from large public firms. However, to my knowledge, there is no alternative publicly available data source with a sufficiently long panel dimension and good private sector coverage. For the US, the two main publicly available data sources with some coverage of private sector firms are Orbis (Kalemli-Ozcan et al., 2015) and Sageworks (Farre-Mensa and Ljungqvist, 2016), but neither have sufficiently long time dimensions to document trends.[53]

Figure A1a compares Flow of Funds and Compustat data on the stock of outstanding debt in the NFCB sector. This Figure suggests that public firms account for approximately half of all debt outstanding in the NFCB sector, a share that has been stable over time. The stability of the share is fairly important: it implies that changes in the aggregate loan share cannot have been driven purely by a reallocation of debt toward publicly traded (and presumably less loan-dependent) firms. Moreover, the medium-run fluctuations in debt outstanding in the two datasets are similar (with the notable exception of the 2005-2009 period, where debt growth in the Flow of Funds far outpaced debt growth in Compustat.) Figure A1b compares total loans outstanding in Compustat and in the Flow of Funds. By this measure, publicly traded firms account for about 40% of total loans outstanding. Again, medium-run fluctuations in aggregates are similar except in the 2005-2009 period.

Additionally, figures A1a and A1b report aggregates for total debt outstanding and total loans outstanding constructed using data from Capital IQ. Specifically, I merge the Compustat non-financial sample with Capital IQ in every year from 1990 onward.[54] Figure A4 reports total debt outstanding for Compustat non-financial firms which (a) have a match in Capital IQ, and (b) have non-missing information on bank loans outstanding in Capital IQ. The figure indicates that coverage of the Compustat sample by Capital IQ is poor before 2001, with matched firms accounting for less than 10% of total debt outstanding. Coverage improves, though it remains somewhat incomplete after 2001, and is close to comprehensive after 2009.

I.B Measuring the loan share in Compustat

A second limitation of Compustat balance sheets is that they do not report loans separately from the rest of debt outstanding.[55] In what follows, I will approximate the firm-level loan share using the sum of two variables: a short-term debt variable, notes payable (`np`) and long-term debt variables, other long-term debt (`dlto`). The advantage of this definition is that it provides a comprehensive long-run measure of the loan share at the firm level, since data on both items is available after

[53]An additional challenge in comparing Flow of Funds and Compustat data is that even for domestically incorporated firms, Compustat balance sheet data are international consolidations, so that some of the debt reported on balance sheet might correspond to consolidated foreign entities. By contrast, the Flow of Funds only consolidates domestic subsidiaries' balance sheets. This would affect trends in debt composition if foreign subsidiaries' debt structure differed substantially from their domestic parents. It is unclear whether the Compustat data can be corrected to address this issue, but the similarity of aggregate trends for different debt categories between Compustat and Flow of Funds data suggest that it may not be substantial.

[54]I use the summary table of Capital IQ produced by WRDS, which contains a bridge between Capital IQ identifiers and Compustat `gvkey`.

[55]To my knowledge, the only publicly available dataset providing information on debt structure for a sufficiently large sample of firms is Capital IQ, but the data are only available after 2001, and at the annual frequency.

1970q1 for most firms. The choice of the two Compustat items used to define loans is based on the definitions of debt components in the Compustat manuals. In particular, for short-term debt, `np` includes bank acceptances, bank overdrafts, and loans payable. For long-term debt, `dlto` includes all revolving credit agreements, as well as all construction and equipment loans. It excludes senior nonconvertible bonds (which are included in debentures, `dd`), convertible or subordinate bonds (included in `dcvt` and `ds`, respectively). The main drawback is that both `np` and `dlto` include commercial paper outstanding.

Table A2 provides supportive evidence for the fact that this measure of the loan share indeed captures the ratio of total loans to total debt outstanding. The table documents the correlation between measures of the loan share at the firm level, $s_{j,t}$, and measures of the ratio of new syndicated loans to the sum of new syndicated loans plus new bonds issued. The loan share is measured as the total of notes payable plus other long-term debt. In the validation exercise of table A2, as in the main empirical analysis of section III, I use quarterly data. Since other long-term debt (`dlto`) is not available at the quarterly frequency, I construct it as: $\mathtt{dltoq}_{j,t} = \frac{\mathtt{dlto}_{j,\tau(t)}}{\mathtt{dltt}_{j,\tau(t)}}\mathtt{dlttq}_{j,t}$ (or zero if $\mathtt{dltt}_{j,\tau(t)} = 0$), where $\mathtt{dlto}_{j,\tau(t)}$ and $\mathtt{dltt}_{j,\tau(t)}$ are the balance sheet values from the firm's annual report at the annual reporting date $\tau(t)$ that immediately precedes quarter t. New bonds are obtained from FISD, while new loans are obtained by merging the Compustat data with Dealscan.[56]

Note that the conceptual difference is that the Dealscan and FISD loan share captures gross issuances, while the Compustat loan share captures net stocks outstanding. Nevertheless, the correlation between the Compustat loan share, and the Dealscan-FISD measure of the composition of new issuances is positive and significant. Moreover, it remains significant even after controlling for firm and sector-time effects and for a number of firm-level observables (size, growth, liquidity, and leverage.) The estimates suggest that a 1% increase in the loan share of new issuances translates into an approximately 0.15% increase in the loan share of outstanding debt. Finally, the Compustat loan share is also robustly negatively associated with the indicators for past bond issuance. Overall, these results are consistent with the view that the Compustat loan share $s_{j,t}$ is indeed informative about the composition of debt between loans and bonds.

Additionally, table A3 provides a validation of this measure using data from Capital IQ. For reasons discussed above, I use the Capital IQ sample only after 2001. Moreover, I limit the sample to observations for which the reported share of bank debt in total debt is positive and below 100%. With this measure, in the sample of Compustat non-financial firms with a match in Capital IQ, non-missing Capital IQ data on the bank share, and after 2001, table A3 documents the correlation between the loan share measured using the Compustat proxy, and the Capital IQ measure of total bank debt as a fraction of total debt. This correlation is strong, and robust to introducing a number of additional controls; note, in particular, that all specifications include firm fixed effects. A simple regression of the Compustat based loan share on the Capital IQ loan share (results not reported), with no additional controls and no fixed effects, has an R-square of 0.40, suggesting that the measures are closely related.

I.C Additional results on the loan share in Compustat

Figure A2 plots together the aggregate loan share in the Flow of Funds (from figure 1), the aggregate loan share in Compustat (from figure 3) and the aggregate loan share in the balanced panel of Compustat firms from 1990 to 2016. It shows that the trend of declining aggregate loan share in Compsutat overall, and in the balanced panel, are similar.

[56] I use the latest version of the Dealscan-Compustat bridge of Chava and Roberts (2008).

Figure A3 reports the average within-firm loan share, by year and by either industry group (top panel) or credit rating group (bottom panel). For consistency with the decomposition of Figure 5, the sample considered here is the balanced sample. The top panel indicates that industry composition does not explain the trend in the loan share; the loan share decline is common to all industries in the sample. On the other hand, the bottom panel shows that unrated firms did not experience a large decline in their loan share, while rated firms did, regardless of their rating category, though investment-grade firms seem to have experienced a slightly larger decline in their loan share. This suggests that the evolution of the aggregate loan share is largely driven by intensive margin changes in debt composition, by firms with access to alternatives to bank credit.

B More details on the model of Section IV

II.A Model description

This section provides a more detailed description of the model studied in section IV. There are a continuum of firms, characterized by their net worth (or internal funds), which I denote by e. An entrepreneur with internal funds e finances a project by borrowing from two lenders: a bank, and the market. The only friction of the model is that there is limited liability; the entrepreneur can choose to default on her debt obligations. However, doing so may involve output losses, if the project is liquidated.

II.A.i Production structure and timing

Each entrepreneur operates a technology which takes physical assets k as an input, and produces output:

$$y = \phi k^{\zeta}$$

Here, ϕ, the productivity of the technology employed by the entrepreneur, is a random variable, the realization of which is unknown to both the entrepreneur and the lenders at the time when investment in physical assets is carried out. In what follows, I denote the CDF of ϕ by $F(.)$. ζ governs the degree of returns to scale of the technology operated by the entrepreneur. Assets depreciate at rate $\delta \in [0, 1]$. After production has been carried out and depreciation has taken place, the following resources are available to the entrepreneur to either consume or repay creditors:

$$\pi(\phi) = \phi k^{\zeta} + (1 - \delta)k \tag{12}$$

I make the following assumptions about the production structure:

Assumption 1. *The firm's production technology has the following characteristics:*

- *Production has decreasing returns to scale: $\zeta < 1$;*
- *The productivity shock ϕ is a positive, continuous random variable with density f. Moreover, $f(0) = 0$ and the hazard rate of ϕ is strictly increasing.*

The first part of the assumption is standard in models of firm investment, and guarantees that firms have a finite optimal scale of operation. The second part of the assumption consists of restrictions on the distribution of productivity shocks. Restricting the shock ϕ to be a positive random variable implies that there is a positive lower bound on resources, $(1 - \delta)k$, so that riskless lending may occur, to the extent that $\delta < 1$. The increasing hazard rate is a technical assumption which guarantees the unicity of lending contracts.[57]

The entrepreneur finances investment in physical assets, k, from three sources: internal finance e, with which it is initially endowed; bank debt, b, and market debt m. The resulting balance sheet constraint is thus simply:

$$k = e + b + m.$$

The timing of actions and events, for an entrepreneur with internal finance e, is summarized in Figure A3. The model has two periods. At $t = 0$, the entrepreneur, the bank lender and the market lender agree about a debt structure (b, m), and promised repayments, R_b to the bank, and R_m for the market lender. Investment in k then takes place, and the productivity of the firm, ϕ, is realized. At time $t = 1$, debt payments are settled; that is, the firm can choose to make good on promised repayments, restructure its debt, or proceed to bankruptcy.

Finally, in this section, I only assume that all agents are utility maximizers and have preferences that are weakly increasing in their monetary payoffs. In the next section, I will focus on optimal choices in the case of a risk-neutral entrepreneur; however, all the results presented in this section on the settlement of debt are independent of the assumption of risk-neutrality, and hold for general preference specifications so long as preferences are increasing in payoffs. In particular, the set of feasible debt structures described in this section is identical across preference specifications.

II.A.ii Debt settlement

The debt settlement stage takes place once the productivity of the firm has been observed by all parties. I model the debt settlement process as a two-stage game. In the first stage, the entrepreneur can choose between three alternatives, summarized in Figure A4: repay in full both its bank and market creditors; make a restructuring offer to the bank; or file for bankruptcy. If the entrepreneur chooses to repay in full both its creditors, her payoff is:

$$\pi_P(\phi) = \pi(\phi) - R_m - R_b \tag{13}$$

while the payoff to the bank and market lender are, respectively, R_b and R_m, as initially promised. I next turn to describing each party's payoff under the two other alternatives, bankruptcy and restructuring.

Bankruptcy If the entrepreneur chooses to file for bankruptcy, the project is terminated and liquidated, and the proceeds from liquidation are distributed to creditors. Once bankruptcy is declared, the entrepreneur has no claim to liquidation proceeds; that is, her liquidation payments are assumed to be 0, so that the monetary payoff to the entrepreneur in bankruptcy is:[58]

$$\pi_B(\phi) = 0. \tag{14}$$

I make the following assumption about the impact of liquidation on output:

Assumption 2 (Liquidation losses)**.** *Under bankruptcy, the proceeds $\tilde{\pi}(\phi)$ to be distributed to*

[57] The proof is available in the appendix to the earlier version of this paper, Crouzet (2015).

[58] This is without loss of generality. Allowing for the entrepreneur to be a residual claimant in bankruptcy would not alter the results, since in the debt settlement stage, bankruptcy would never be declared in states in which the entrepreneur has sufficient resources to repay both lenders. I omit this possibility to alleviate notation.

creditors and the entrepreneur are a fraction χ of the project's value:

$$\tilde{\pi}(\phi) = \chi\pi(\phi) \quad , \quad 0 \leq \chi < 1.$$

Liquidation leads to inefficient losses of output; that is, the liquidation value of the project is strictly smaller than the value of the project under restructuring or repayment. Specifically, liquidation losses are equal to $(1-\chi)\pi(\phi)$. Consistent with the evidence presented in Bris et al. (2006), this assumption captures the fact that bankruptcy proceedings are typically costly, both administratively and because they halt production activities. Moreover, asset values of firms after cash auction proceedings are typically only a fraction of pre-bankruptcy values. This is the key friction in the static model with risk-neutrality: absent bankruptcy losses, lending would be unconstrained, as I will discuss below.

I assume that bankruptcy proceeds are distributed among creditors according to an agreed-upon priority structure, in line with the Absolute Priority Rule (APR) that governs chapter 7 proceedings in the US.[59] In this section, I assume that bank debt is senior to market debt. Under this priority structure, the payoff to bank lenders and market lenders, are:

$$\begin{aligned} \tilde{R}_b^K(\phi) &= \min\left(R_b, \chi\pi(\phi)\right), & (15) \\ \tilde{R}_m^K(\phi) &= \max\left(\chi\pi(\phi) - R_b, 0\right). & (16) \end{aligned}$$

The first line states that the bank's payoff in bankruptcy is at most equal to its promised repayment R_b. The second payoff states that market lenders are residual claimants. Note that this formulation does not, a priori, preclude cases in which $\tilde{R}_m(\phi) \geq R_m$, that is, market lenders receiving a residual payment larger than their initial claim. I will however show that this never occurs in the equilibrium of the debt settlement game.

Restructuring Instead of filing for bankruptcy, I assume that the entrepreneur can enter a private workout process with her creditors. Because going bankrupt implies losses of output, it may sometimes be in the interest of creditors and the entrepreneur to arrive at a compromise. I make the following restriction to the workout process.

Assumption 3 (Bank debt flexibility)**.** *The entrepreneur may only restructure debt payments owed to the bank, R_b; payments to the market lender, R_m, cannot be renegotiated.*

This is the key distinction between bank and market lending in the model; I delay its discussion to the next paragraph, and first describe its implications for the debt settlement process. I assume that the private workout operates as follows: the entrepreneur makes a one-time offer to the bank which takes the form of a reduction in promised repayments $l_b \leq R_b$. In case the offer is accepted, the bank obtains l_b, and the entrepreneur obtains:

$$\pi_R(\phi) = \pi(\phi) - R_m - l_b(\phi). \tag{17}$$

If, on the other hand, the bank refuses the entrepreneur's offer, the private workout fails, and the project is liquidated. In this case, the payoff to the bank is given by equation (15). The participation constraint of the bank is thus:

$$l_b \geq \tilde{R}_b^K(\phi).$$

[59] See White (1989) for institutional details on the APR.

The entrepreneur will choose her restructuring offer to maximize her net payoff under restructuring, subject to the participation constraint of the bank. Formally:

$$\begin{aligned}\pi_R(\phi) &= \max_{l_b} \quad \pi(\phi) - R_m - l_b \quad \text{s.t.} \quad l_b \geq \tilde{R}_b^K(\phi) \\ &= \begin{cases} \pi(\phi) - R_b - R_m & \text{if } R_b \leq \chi\pi(\phi) \\ (1-\chi)\pi(\phi) - R_m & \text{if } R_b > \chi\pi(\phi) \end{cases} \end{aligned} \tag{18}$$

Intuitively, this result indicates that the entrepreneur will choose to make a restructuring offer only when its cash on hand is small enough, relative to promised repayments to the bank. Note that the larger the value of χ, the higher the restructuring threshold; that is, potential bankruptcy losses effectively allow the entrepreneur to extract concessions from the bank.

Debt settlement equilibria Given the realization of ϕ, the entrepreneur chooses whether to repay, restructure or file for bankruptcy, by comparing her payoffs $\pi_P(\phi)$, $\pi_B(\phi)$ and $\pi_R(\phi)$ under each option. The following lemma describes the resulting perfect equilibria in pure strategies of the debt settlement game described in Figure A4. There is a unique equilibrium for each realization of ϕ; however, the set of possible equilibria, parameterized by ϕ, depends on the terms of the debt contracts.

Lemma 1 (Debt settlement equilibria)**.**

*If $\frac{R_m}{1-\chi} < \frac{R_b}{\chi}$ (**R-contracts**), there are some realizations of ϕ for which the entrepreneur chooses to use her restructuring option. Specifically, the entrepreneur chooses to repay her creditors when $\pi(\phi) \geq \frac{R_b}{\chi}$; to restructure debt when $\frac{R_m}{1-\chi} \leq \pi(\phi) < \frac{R_b}{\chi}$; and to file for bankruptcy when $\pi(\phi) < \frac{R_m}{1-\chi}$.*

*If $\frac{R_m}{1-\chi} \geq \frac{R_b}{\chi}$ (**K-contracts**), there are no realizations of ϕ such that the entrepreneur attempts to restructure debt with the bank. Instead, she chooses to repay her creditors when $\pi(\phi) \geq R_m + R_b$, and otherwise, she files for bankruptcy.*

Moreover, in bankruptcy or restructuring, market and bank lenders never obtain more than their promised repayments: $\tilde{R}_m(\phi) \leq R_m$ and $\tilde{R}_b(\phi) \leq R_b$, regardless of whether the debt contract is an $R - contract$ or a $K - contract$.

The proof for this and all following lemmas are reported in the appendix to the earlier version of this paper, Crouzet (2015). Figure A6 illustrates sets of equilibria for each type of contract. In the case of a K-contract ($\frac{R_b}{\chi} < \frac{R_m}{1-\chi}$), no restructuring ever occurs, and bankruptcy losses cannot be avoided when the cash on hand of the firm, $\pi(\phi)$, falls below the threshold at which the firm prefers declaring bankruptcy over repayment, $R_m + R_b$. This occurs because the stake of the flexible creditors, R_b, is too small for restructuring to bring about sufficient gains for the entrepreneur to avoid default on market debt.

On the other hand, in the case of an R-contract, ($\frac{R_b}{\chi} \geq \frac{R_m}{1-\chi}$), the flexibility of bank debt sometimes allows the entrepreneur to make good on its payments on market debt (this corresponds to restructuring region below $R_m + R_b$ in Figure A6). Some R-equilibria will see the entrepreneur exert a degree of bargaining power over the bank: indeed, the bank will be forced to accept a settlement, even though the firm has enough cash on hand to make good on both its promises (this corresponds to the restructuring region above $R_m + R_b$ in Figure A6). This region corresponds to strategic restructurings on the part of the entrepreneur, who takes advantage of the fact that the bank can never extract from her more than its reservation value under restructuring, $\chi\pi(\phi)$, in any private workout.

II.A.iii Equilibrium debt structure

I conclude the description of the model by describing the features of the equilibrium debt structure of firms in the model.

Preliminaries In addition to the assumption that risk-neutral intermediaries make zero expected profits given their cost of funds r (for the bond market) and $r + \gamma_b(r)$ (for banks), I make the two following assumptions:

Assumption 4. *The enterpreneur is risk-neutral, and her assets completely depreciate after productivity is realized and output is produced:* $\delta = 1$.

I first assume that assets fully depreciate at the end of period 1, that is, $\delta = 1$. This is a natural assumption, given the static nature of the model; furthermore, it simplifies the analytic characterization of the optimal debt structure. It is however is not crucial to any of the results below. The second assumption I maintain in this section is that the entrepreneur is risk-neutral. With these two assumptions, the optimal debt structure of an entrepreneur with own equity e solves:

$$\hat{\pi}(e) = \max_{b,m \in \mathcal{S}(e)} \mathbb{E}\left[\tilde{\pi}(\phi; e, b, m)\right],$$

where $\tilde{\pi}(\phi; e, b, m)$ denotes the profits accruing to the entrepreneur, conditional on the debt structure (b, m) and therefore the associated contract (R_b, R_m), and the realization of the shock ϕ.

Here, $\mathcal{S}$ denotes the "lending menu," that is, the set of feasible debt structures given the net worth of the entrepreneur, e. This lending menu is described and characterized analytically in an earlier version of this paper, Crouzet (2015). In particular, I show that $\mathcal{S}(e)$ can be partitioned into two subsets, $\mathcal{S}_K(e)$ and $\mathcal{S}_R(e)$. The set of feasible debt structures $(b, m) \in \mathcal{S}_K(e)$ lead to K-contracts (i.e. debt structures without any renegotiation ex-post), while debt structures $(b, m) \in \mathcal{S}_R(e)$ lead to R-contracts (i.e. debt structures with renegotiation ex-post.)

The risk-neutrality assumption leads to the following expression for the objective of the entrepreneur:

Lemma 2. *for* $(b, m) \in \mathcal{S}(e)$*, the objective function of the entrepreneur is given by:*

$$\mathbb{E}\left[\tilde{\pi}(\phi; e, b, m)\right] = \underbrace{\mathbb{E}(\pi(\phi)) - (1 + r + \gamma_b(r))b - (1 + r)m}_{\text{total expected surplus from investment}} - \underbrace{(1 - \chi) \int_0^{\underline{\phi}(e,b,m)} \pi(\phi) dF(\phi)}_{\text{expected liquidation losses}}, \quad (19)$$

where:

$$\underline{\phi}(e, b, m) = \begin{cases} \frac{R_K(b,m,e)}{(e+b+m)^\zeta} & \text{if } (b, m) \in \mathcal{S}_K(e) \\ \frac{R_{m,l}(b,m,e)}{(1-\chi)(e+b+m)^\zeta} & \text{if } (b, m) \in \mathcal{S}_R(e) \end{cases}$$

Under risk-neutrality, profit maximization for the entrepreneur is equivalent to the maximization of total expected surplus, net of the losses incurred in case liquidation is carried out. In particular, in the absence of bankruptcy costs (that is, when $\chi = 1$), profit maximization for the firm is equivalent to maximization of total surplus. In this case, it is clear that the optimal debt structure is always a corner solution, with the entrepreneur borrowing only from the lender with the smallest cost of funds.

Results When banks have a higher marginal cost of funds ($\gamma_b(r) > 0$), and assumption 4 holds, two key results about optimal debt structure hold. Here, I state them formally; they are discussed in more detail in Section IV. The proofs of these two results are reported in Appendix B of Crouzet (2015).

First, firms select into debt structures with either full bond (market) finance, or debt structures with a mix of loans and bonds. The latter correspond to firms in Regions 1 and 2 in the discussion of Section IV, while the former correspond to firms in Region 3.

Lemma 3 (Bond-financed vs. loan-dependent firms)**.** *Assume that banks have a larger marginal cost of funds than markets, that is, $\gamma_b(r) > 0$. Let $(\hat{b}(e), \hat{m}(e))$ denote the optimal debt structure of an entrepreneur with equity e. There exists $e^* > 0$ such that:*

- *if $e > e^*$, $(\hat{b}(e), \hat{m}(e)) \in \mathcal{S}_K(e)$; moreover, the optimal debt structure only features bonds:*

$$\hat{m}(e) > 0 \quad , \quad \hat{b}(e) = 0;$$

- *if $e < e^*$, $(\hat{b}(e), \hat{m}(e)) \in \mathcal{S}_R(e)$; moreover, the optimal debt structure features a mix of loans and bonds:*

$$\hat{m}(e) \geq 0 \quad , \quad \hat{b}(e) > 0.$$

Second, firms that use a mix of loan and bonds can either exhaust their loan limit, or be at an interior solution. The former correspond to firms in Region 1 in the discussion of Section IV, while the latter correspond to firms in Region 2.

Lemma 4 (The optimal debt structure when $e \leq e^*$)**.** *Assume $\gamma_b(r) > 0$. Consider an entrepreneur with internal funds $e < e^*$ and let $\hat{s}(e) = \frac{\hat{b}(e)}{\hat{b}(e)+\hat{m}(e)}$ denote the fraction of total liabilities that are bank debt in her optimal debt structure, and let $\hat{d}(e) = \hat{b}(e) + \hat{m}(e)$ denote total borrowing. Then, there exists $\tilde{e} < e^*$ such that:*

- *For $0 \leq e < \tilde{e}$, the bank borrowing constraint is binding at the optimal debt structure, $\frac{\partial \hat{s}}{\partial e} > 0$ and $\frac{\partial \hat{d}}{\partial e} < 0$;*
- *For $\tilde{e} \leq e \leq e^*$, the optimal debt structure of the firm satisfies:*

$$\hat{s}(e) = 1 - \frac{\Gamma}{1 + r_m} \frac{(\hat{k}_{int})^{\zeta}}{\hat{k}_{int} - e}, \quad \hat{d}(e) = \hat{k}_{int} - e \tag{20}$$

where the expression of Γ and $\hat{k}_{int}$ are given in the appendix of Crouzet (2015). In particular, $\frac{\partial \hat{s}}{\partial e} \leq 0$ and $\frac{\partial \hat{d}}{\partial e} \leq 0$.

II.B Model calibration

The model with no bank lending channel ($\gamma_b'(r) = 0$) has eight parameters: $(r, \zeta, \chi, \gamma_b^0, \lambda, \xi, a, b)$. Here, λ and ξ denote the scale and shape parameters of the Weibull distribution of productivity ϕ, and a and b denote the shape parameters of the Beta distribution $\mu(e)$ for net worth e.

I calibrate three parameters, (r, ζ, χ), to existing estimates in the literature. I choose $r = 0.04$, close to the average annual return on 3-month T-bills of 4.23% for the period 1980-2019.[60] I set $\zeta = 0.92$, in the range of the estimates of Basu and Fernald (1997), who document decreasing

[60] This average was computed using St Louis FRED series DTB3.

returns among US manufacturing firms. Additionally, I rely on the estimates of Kermani and Ma (2020) in order to calibrate χ, the size of deadweight losses in liquidation, expressed as a fraction of the book value of assets; I use $\chi = 0.33$, consistent with their average estimates.

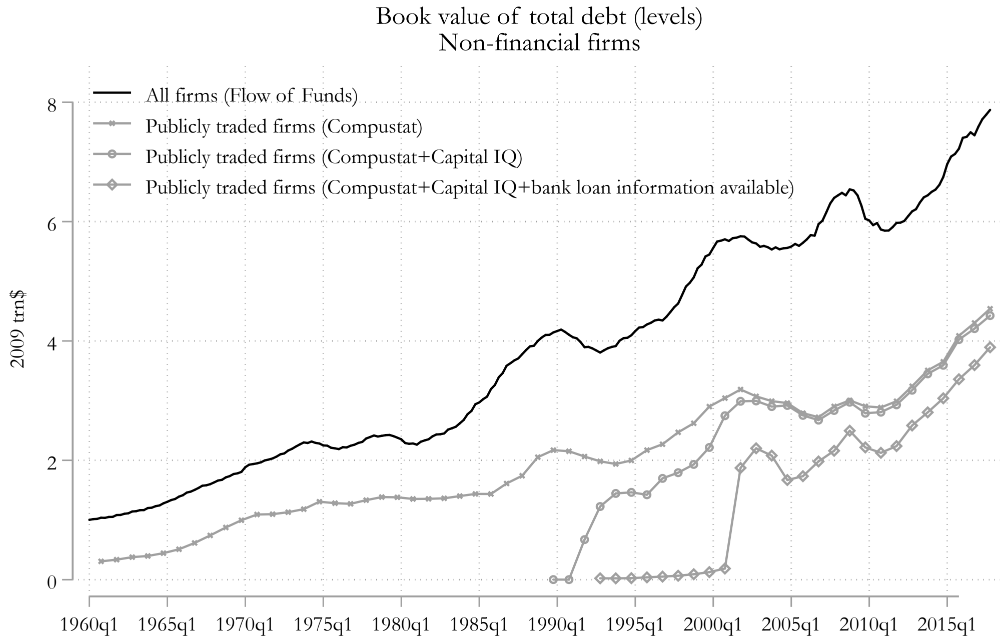
Next, I choose four parameters, (γ_b^0, ξ, a, b), in order to minimize the unweighted square distance between model and data moments, for a set of seven chosen moments of the distribution of leverage and debt composition. These moments, and details of their computation in the annual Compustat sample, are reported in Appendix Table A6. I choose empirical moments in order to assess whether the model can match both the unweighted and the asset-weighted distributions of leverage and the loan share, given that some of the results of Section IV focus on aggregate pass-through.

The first three moments capture the distribution of the loan share; they are primarily influenced by γ_b^0, the relative intermediation cost of banks. The other four moments capture the distribution of leverage. The unweighted average leverage is influenced particularly by the volatility of idiosyncratic productivity shocks, which is governed by the shape parameter ξ, while the other three moments capture higher-order moments of the distribution of leverage weighted by assets, and are therefore influenced by the shape parameters (a, b) governing the distribution of net worth across firms.

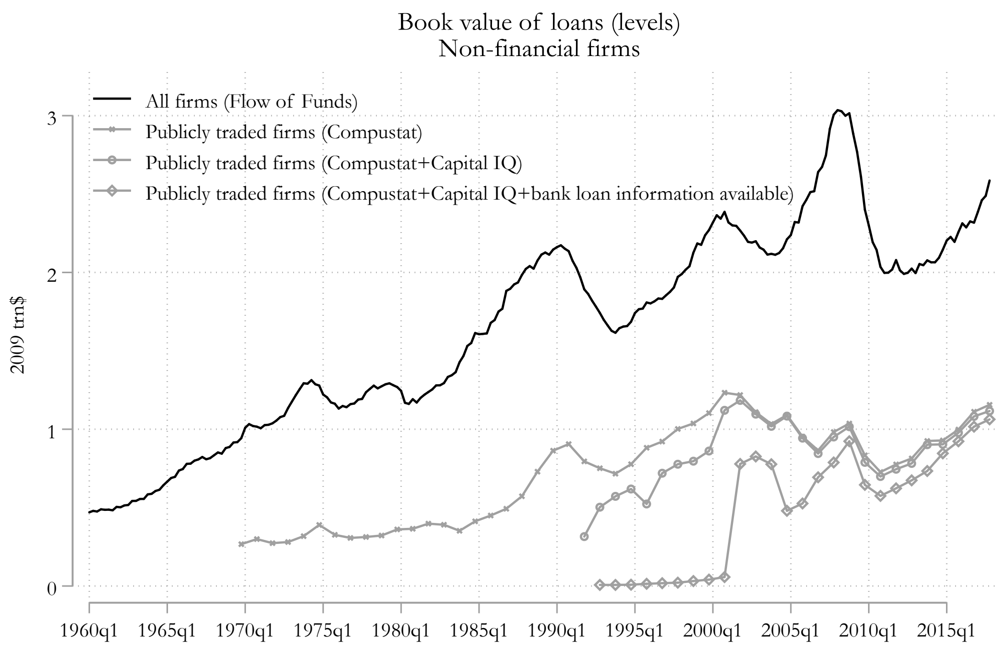
Finally, given all other parameters, the scale parameter of the productivity distribution, λ, is chosen so as to normalize the optimal unconstrained firms size, k^*, to 100. The resulting calibration is reported in Appendix Table A5.

Appendix Table A6 reports a comparison between data moments and their model counterparts. The calibrated model matches well the unweighted average share of loans in total debt (for firms that use both loans and bonds), as well as the fraction of firms using loans, and the unweighted average leverage. It also captures the concentration of assets across levels of leverage relatively well, with, for instance, firms with book leverage above 20% accounting for 68% of total assets in the model, versus 64% in the data. The main dimension among which model fit is poor is that firms with positive loan shares account for more of total assets in the data (85%) than they do in the model (56%). The model is therefore likely to understate the contribution of firms with positive loan shares to the aggregate response of investment to interest rate shocks.

C Appendix Tables and Figures



(a)



(b)

Figure A1: A comparison of total debt outstanding for the NFCB sector, between Flow of Funds (public plus private) and Compustat (public) firms. Data are from Flow of Funds table L.103 and from the Compustat Fundamentals Annual. For Flow of Funds, total debt is defined as the sum of debt securities (item FL104122005) and loans (item FL104122005). For Compustat annual, total debt is defined as the sum of debt in current liabilities (item dlc) and total long-term debt (item dltt), and loans are defined as the sum of notes payable (np) and other long-term debt (dlto). Notes payable are not reported as a separate item before 1970q1 and so we start the sample for total loans there. The Compustat sample is restricted to the Non-Financial (NF) sector, while the Flow of Funds data measures only the liabilities of the NFCB sector. All series are deflated using the CPI.

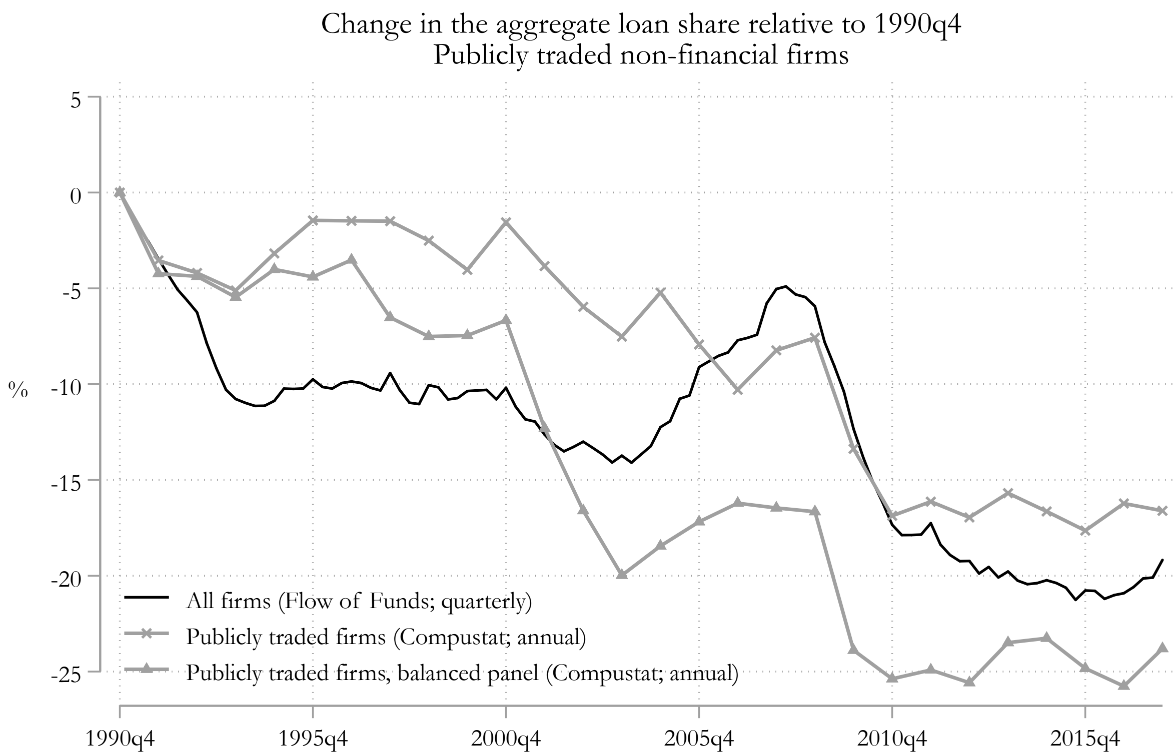
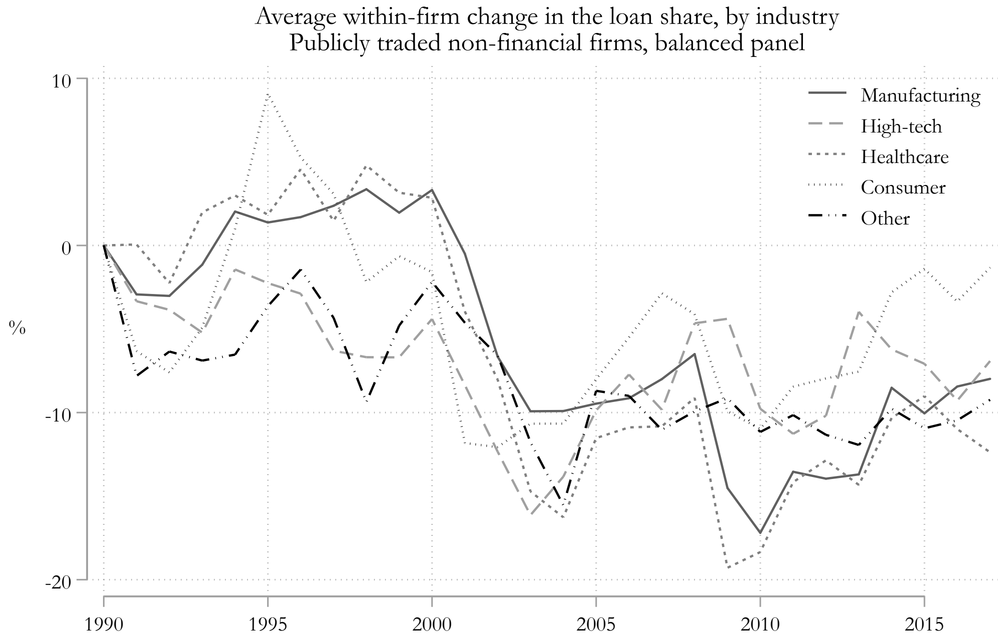
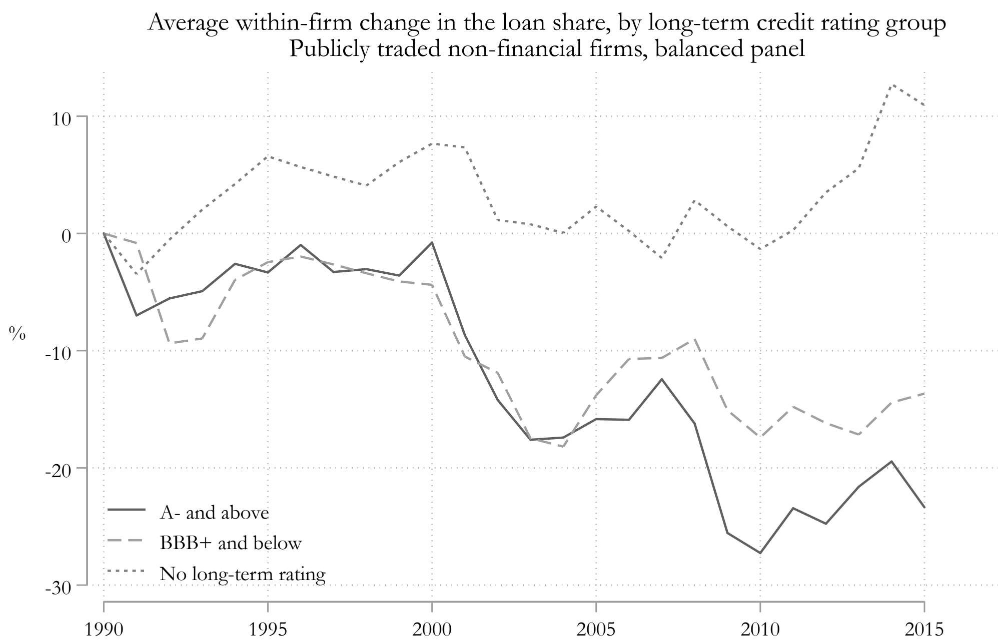


Figure A2: Change in aggregate loan shares since 1990q4. Data are from Flow of Funds table L.103 and from the Compustat Fundamentals Annual files. Variables are defined as in Figure 3, and the Compustat sample is restricted to non-financials. All the loan shares are aggregate and expressed relative to their level in 1990q4. The two lines drawn for the Compustat sample are the aggregate loan share in the overall sample, and in the balanced sample.



(a)



(b)

Figure A3: Change in within-firm loan share, by firm group. The data are from the Compustat annual files. The sample is restricted to non-financial firms that are present in every year of the panel from 1990 to 2017. The top panel reports the average within-firm loan share by broad industry category; the industry categories are based on Fama-French industry classifications, and are constant within firm. The bottom panel reports the loan share by groups of long-term credit rating.

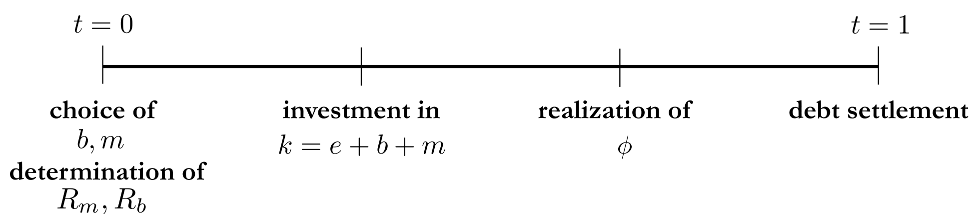


Figure A4: Timing of model.

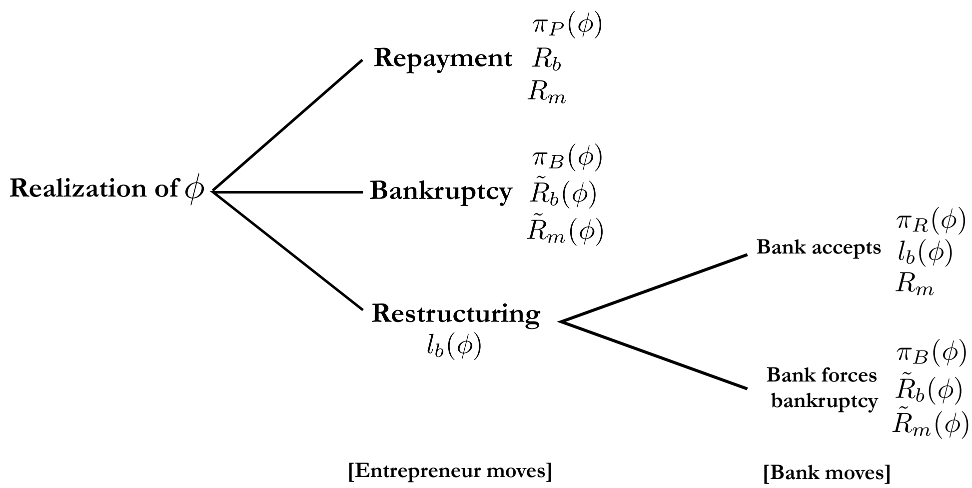


Figure A5: Two-stage game describing debt settlement.

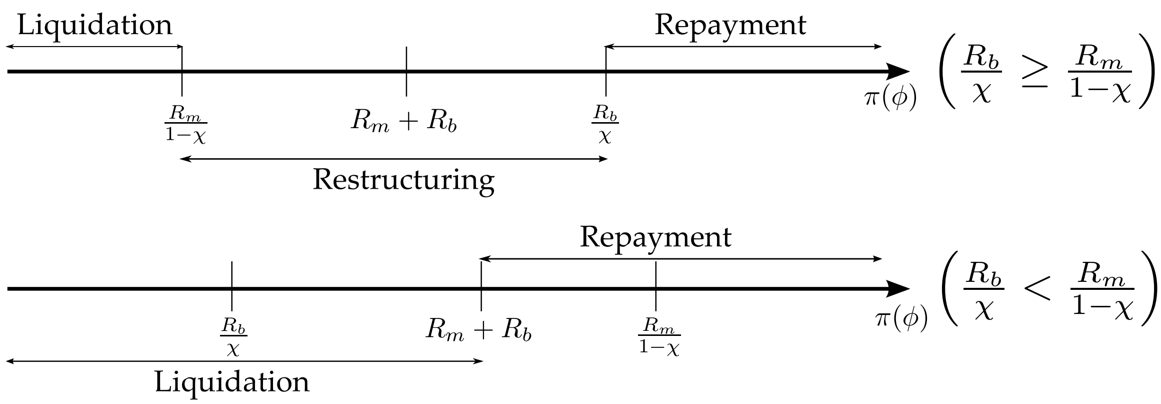


Figure A6: Debt settlement equilibria.

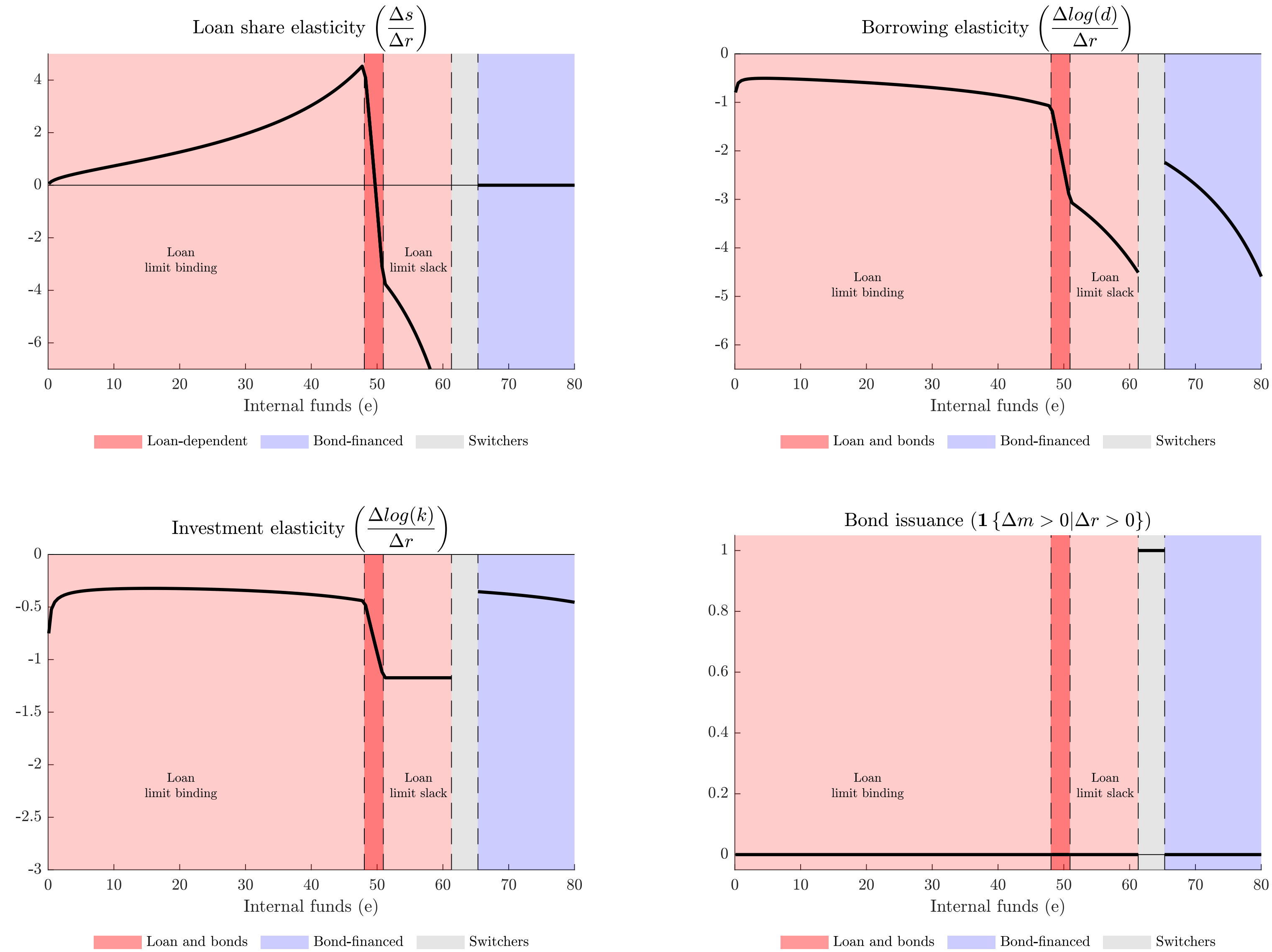


Figure A7: Interest rate elasticities in the model of section IV, in the case of no bank lending channel ($\gamma_b'(r) = 0$.) The elasticities reported are the percent change in a variable of interest (or the percentage point change, for the loan share) for a $50bps$ increase in the risk-free rate, r. These elasticities are plotted as a function of internal funds e, the state variable. The blue shaded region corresponds to firms that only issue bonds both before and after the interest rate hike. The red shaded regions correspond to firms that issue a mix of bank loans, both before and after the interest rate hike. The darker red region corresponds to firms who switch to an interior debt structure after the interest rate hike. Finally, the light gray region corresponds to firms that switch from issuing both loans and bonds, to issuing only bonds, after the interest rate hike. The calibration of the model is the same as in Figure 8.

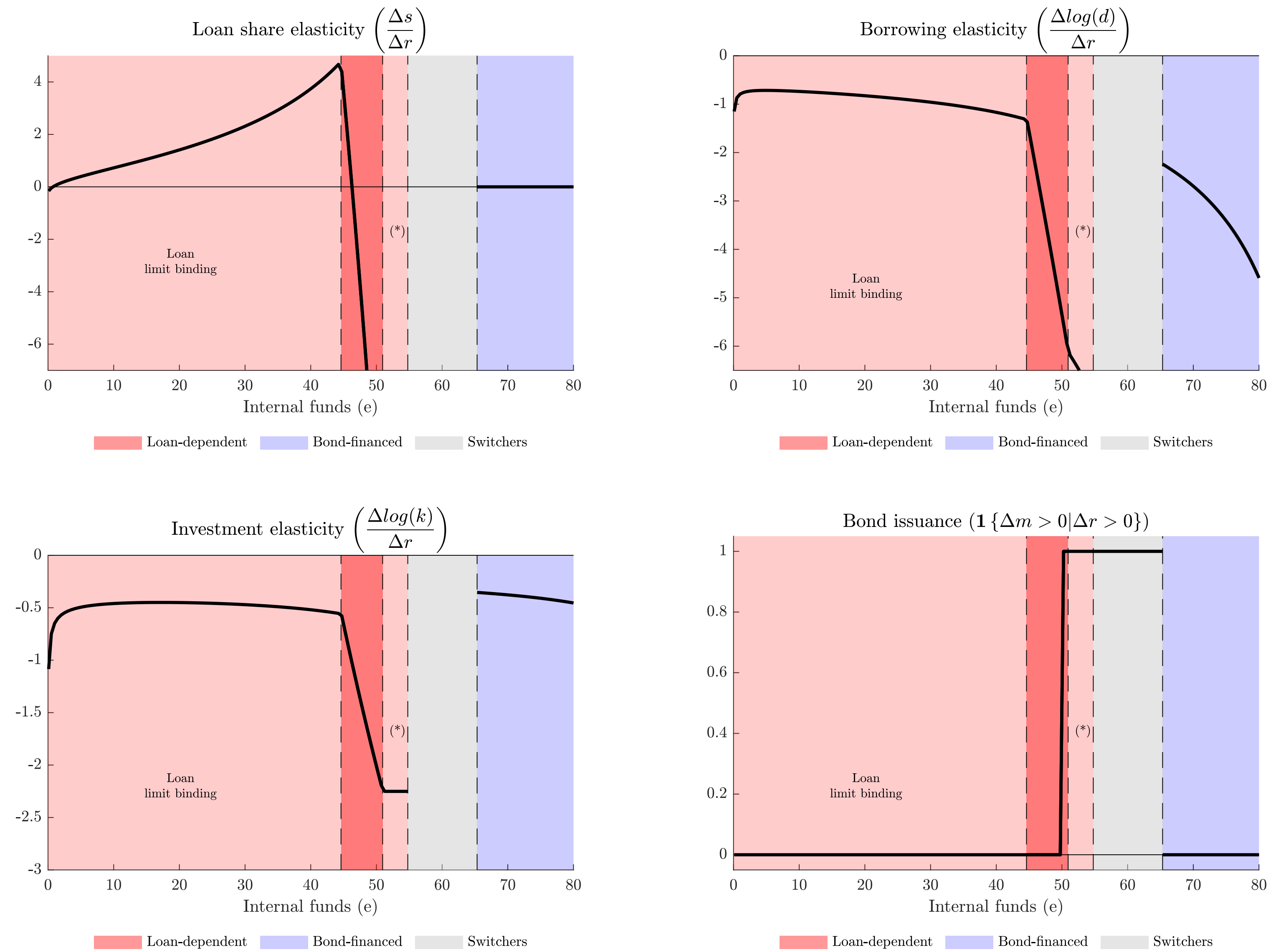


Figure A8: Interest rate elasticities in the model of section IV, with an active bank lending channel ($\gamma_b'(r) > 0$.) The elasticities reported are the percent change in a variable of interest (or the percentage point change, for the loan share) for a 50bps increase in the risk-free rate, r. These elasticities are plotted as a function of internal funds e, the state variable. The blue shaded region corresponds to firms that only issue bonds both before and after the interest rate hike. The red shaded regions correspond to firms that issue a mix of bank loans both before and after the interest rate hike. The darker red region corresponds to firms who switch to an interior debt structure after the interest rate hike. Finally, the light grey region corresponds to firms that switch from issuing both loans and bonds, to issuing only bonds, after the interest rate hike. The calibration of the model is the same as in Figure 8, except for the interest rate elasticity, which is set to $\gamma_b(r) = \gamma_b^0 + r - r_0$, where $\gamma_b^0 = 0.02$, and $r_0 = 0.04$.

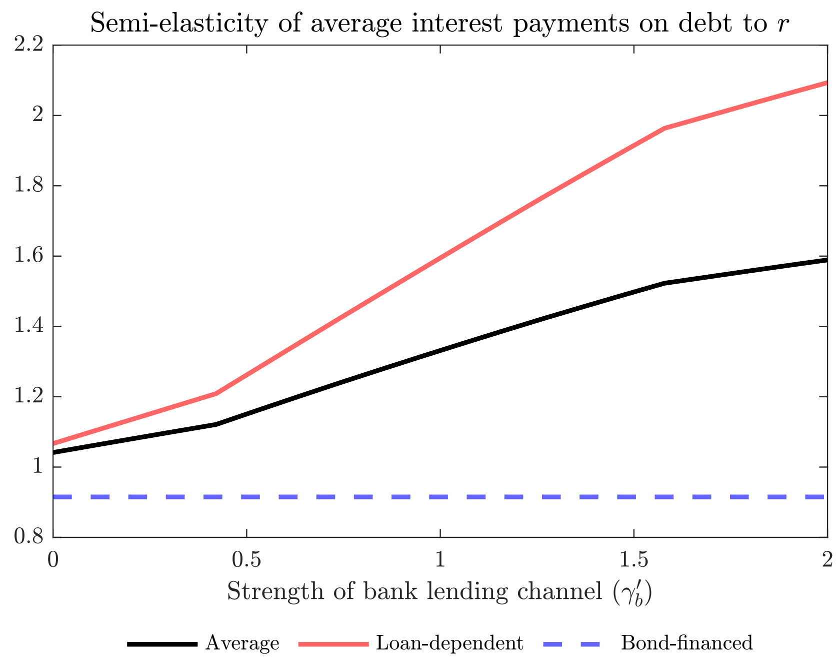


Figure A9: Semi-elasticity of average interest paid on debt, with respect to r, as a function of the strength of the bank lending channel in the model of section IV. In order to construct these graphs, we assume that $\gamma_b(r) = \gamma_b^0 + \nu_b(r - r_0)$, where ν_b is a constant, and r_0 is the level of risk-free rates used in the baseline calibration of the model. On the horizontal axis, the interest rate elasticity $\gamma_b' = \nu_b$ is reported. For each value of γ_b', the elasticities reported are the cross-sectional average percent change in average interest paid for a 50*bps* increase in the risk-free rate, r. The cross-sectional averages are computed using the same distribution of net worth as in the baseline calibration. The red solid line reports the conditional average semi-elasticity among firms which continue issuing both loans and bonds in response to the interest rate hike; the dashed blue line reports the conditional average semi-elasticity among firms which issue only bonds both before and after the interest rate hike; and the black line reports the unconditional average semi-elasticity.

(a) Time-series variables

	η_t^{HF}	η_t^{RR}	η_t^{RR} (post-90q1)
mean	-0.042	0.005	0.045
s.d.	0.124	0.588	0.284
min	-0.479	-4.046	-0.570
max	0.261	2.514	0.759
N	72	153	72
$corr(\eta_t^{HF}, \eta_t^{RR}) = 0.34$ $(p = 0.003)$			

(b) Firm-level variables: summary statistics

	$\Delta log(k_{j,t+1})$	$\Delta log(1 + d_{j,t})$	$s_{j,t}$
mean	0.009	0.001	0.301
s.d.	0.114	0.085	0.345
5th pctile	-0.068	-0.103	0.000
median	0.001	0.000	0.149
95th pctile	0.124	0.113	1.000
N	202395	202395	202395

Table A1: Summary statistics for the Compustat sample. The top panel reports summary statistics for the two monetary policy shock series used in the analysis, and their raw correlation. η_t^{HF} refers to shocks identified using high-frequency changes in Fed Funds futures, while η_t^{RR} refers to the Romer and Romer shock series. The bottom panel reports summary statistics for investment $\Delta log(k_{j,t+1})$, defined as the change in $log(k_{j,t+1})$ between the end of quarter $t-1$ and the end of quarter t; borrowing $\Delta log(1 + d_{j,t})$, defined as the change in total debt outstanding, $d_{j,t}$, between the end of quarter $t-1$ and the end of quarter t; and the loan share $s_{j,t}$. The summary statistics are reported for the sample ranging from 1990q1 to 2007q4, when the shock η_t^{HF} is available.

(a) Raw correlations

	$s_{j,t}$
$s_{j,t-1}^{(new)}$	0.277^{***}
$s_{j,t-2}^{(new)}$	0.250^{***}
$\mathbf{1}\left(\Delta m_{j,t-1} > 0\right)$	-0.124^{***}
$\mathbf{1}\left(\Delta m_{j,t-2} > 0\right)$	-0.108^{***}

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Controlling for other covariates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$s_{j,t-1}^{(new)}$	0.13^{***}	0.08^{***}	0.12^{***}	0.08^{***}	0.12^{***}	0.08^{***}		
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		
$s_{j,t-2}^{(new)}$		0.07^{***}		0.07^{***}		0.07^{***}		
		(0.01)		(0.01)		(0.01)		
$\mathbf{1}\left(\Delta m_{j,t-1} > 0\right)$							-9.08^{***}	-8.12^{***}
							(0.48)	(0.46)
$\mathbf{1}\left(\Delta m_{j,t-2} > 0\right)$								-5.10^{***}
								(0.59)
Firm controls	no	no	yes	yes	yes	yes	yes	yes
Sector-time FE	no	no	no	no	yes	yes	yes	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.555	0.617	0.573	0.631	0.606	0.681	0.518	0.555
N	27446	12552	26921	12419	26829	12231	97892	72368

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Validation of the loan share measure $s_{j,t}$ using FISD and Dealscan data. The top panel reports the raw correlation of the lagged loan share, $s_{j,t-1}$ with measures of debt composition from securities-level databases. $s_{j,t-1}^{(new)}$ and $s_{j,t-2}^{(new)}$ are the ratio of the dollar value of new loan contracts (from Dealscan data) to the sum of new loan contracts plus new bonds issued (from FISD), lagged, respectively, one and two years. $\mathbf{1}(\Delta m_{j,t-1})$ and $\mathbf{1}(\Delta m_{j,t-2})$ are dummies for whether a firm issued a bond in year $t-1$ or in year $t-2$, constructed from FISD. Columns (1) through (4) report estimates of the coefficients δ_1 and δ_2 in specifications of the form: $s_{j,t} = \alpha_j + \gamma_t + \delta_1 s_{j,t-1}^{(new)} + \delta_2 s_{j,t-2}^{(new)} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where α_j is a firm fixed effect; γ_t is a time effect; $X_{j,t-1}$ is a vector of firm-level controls (the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, lagged leverage, and a set of dummies for fiscal quarters, all lagged one period.) Columns (1) through (2) report results without firm-level controls, and columns (3) and (4) report results with firm-level controls. Columns (5) and (6) report estimates from a specification with industry-time effects: $s_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta_1 s_{j,t-1}^{(new)} + \delta_2 s_{j,t-2}^{(new)} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. Standard errors are double-clustered by firm and quarter in all specifications. The sample is annual Compustat firms from the non-financial sector, from 1990 to 2017.

(a) Raw correlations

	$s_{j,t}$
$s^{(ciq)}_{j,t}$	0.619^{***}
$s^{(ciq)}_{j,t-1}$	0.457^{***}
$s^{(ciq)}_{j,t-2}$	0.382^{***}

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Controlling for other covariates

	(1)	(2)	(3)	(4)	(5)	(6)
$s^{(ciq)}_{j,t}$	0.59^{***}	0.58^{***}	0.60^{***}	0.57^{***}	0.60^{***}	0.56^{***}
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
$s^{(ciq)}_{j,t-1}$		0.04^{**}		0.07^{***}		0.07^{***}
		(0.02)		(0.01)		(0.01)
Firm controls	no	no	yes	yes	yes	yes
Sector-time FE	no	no	no	no	yes	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.724	0.754	0.744	0.759	0.753	0.767
N	37517	28875	32014	27931	31981	27895

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Validation of the loan share measure $s_{j,t}$ using Capital IQ data. The top panel reports the raw correlation of the lagged loan share, $s_{j,t}$ with the loan share measured using Capital IQ. $s^{(ciq)}_{j,t}$, $s^{(ciq)}_{j,t-1}$ and $s^{(ciq)}_{j,t-2}$ are contemporaneous, one and two year lagged measures of the loan share obtained from Capital IQ, specifically, variable `totbankdbtpct` in WRDS' Capital IQ summary table file. Columns (1) through (4) report estimates of the coefficients δ_0 and δ_1 in specifications of the form: $s_{j,t} = \alpha_j + \gamma_t + \delta_0 s^{(ciq)}_{j,t} + \delta_1 s^{(ciq)}_{j,t-2} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where α_j is a firm fixed effect; γ_t is a time effect; $X_{j,t-1}$ is a vector of firm-level controls (the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, and lagged leverage, all lagged one period.) Columns (1) through (2) report results without firm-level controls, and columns (3) and (4) report results with firm-level controls. Columns (5) and (6) report estimates from a specification with industry-time effects: $s_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta_0 s^{(ciq)}_{j,t-1} + \delta_1 s^{(ciq)}_{j,t-2} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k the firm's sector. Standard errors are double-clustered by firm and quarter in all specifications. The sample is annual Compustat firms from the non-financial sector with a match in Capital IQ and non-missing bank share in Capital IQ, from 2001 to 2017.

(a) Cross-sectional correlation between leverage and the loan share

	(1)	(2)	(3)	(4)	(5)	(6)
$s_{j,t}$	0.34***	0.15***	0.08**	0.33***	0.13**	0.05
	(0.05)	(0.04)	(0.03)	(0.06)	(0.05)	(0.04)
Time FE	yes	yes	yes	yes	yes	yes
Firm FE	no	yes	yes	no	yes	yes
Firm controls	no	no	yes	no	no	yes
Positive debt only	no	no	no	yes	yes	yes
Clustering	year	firm + year	firm + year	year	firm + year	firm + year
R^2	0.007	0.392	0.452	0.007	0.405	0.461
N	117935	116900	98138	98970	97478	81532

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

(b) Difference in leverage between zero and positive loan share firms

	(1)	(2)	(3)	(4)	(5)	(6)
$1\{s_{j,t} > 0\}$	18.56***	11.52***	10.84***	8.88***	7.59**	8.50***
	(2.06)	(2.43)	(1.65)	(2.28)	(3.13)	(2.13)
Time FE	yes	yes	yes	yes	yes	yes
Firm FE	no	yes	yes	no	yes	yes
Firm controls	no	no	yes	no	no	yes
Positive debt only	no	no	no	yes	yes	yes
Clustering	year	firm + year	firm + year	year	firm + year	firm + year
R^2	0.006	0.392	0.452	0.006	0.405	0.462
N	117935	116900	98138	98970	97478	81532

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Cross-sectional correlation between the loan share measure and leverage in annual data. The top panel reports the coefficients in regressions of leverage $l_{j,t}$ on the loan share $s_{j,t}$, the loan share is defined as in Appendix I.B and where leverage is defined as (100 times) the ratio of total debt (the sum of Compustat variable `dltt` and `dlc`) to total assets (Compustat variable `at`). In the top panel, columns (1) through (3) report estimates of the coefficient δ in specifications of the form: $l_{j,t} = \alpha_j + \gamma_t + \delta s_{j,t} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where α_j is a firm fixed effect; γ_t is a time effect; $X_{j,t-1}$ is a vector of firm-level controls (the log change in real sales, the log of total book assets, and the ratio of net current assets to total assets, all lagged one period.) Column (1) reports results without firm fixed effects or firm controls; column (2) reports results with firm fixed effects but no firm controls; and column (3) reports results with firm-level controls. Columns (4) through (6) report estimates from the same model, restricting to observations with a leverage of at least 5%. The bottom panel reports results from similar specifications, where the independent variable is an indicator function for whether the observation has a strictly positive loan share, so that the coefficient estimates can be interpreted as conditional average differences in leverage between firms with positive and zero loan shares. Standard errors are double-clustered by firm and quarter in all specifications. The sample is annual Compustat firms from the non-financial sector, from 1990 to 2017.

Parameter	Value	Description	Source
r	0.04	Risk-free rate	Return on 3m T-bills, 80-19
ζ	0.92	Degree of returns to scale	Basu and Fernald (1997)
χ	0.33	Deadweight losses in liquidation	Kermani and Ma (2020)
γ_b^0	0.01	Bank intermediation cost	Estimated
ξ	2.98	Shape parameter of productivity distribution	Estimated
a	0.83	Shape parameter of net worth distribution	Estimated
b	0.96	Shape parameter of net worth distribution	Estimated
λ	1.82	Scale parameter of productivity distribution	$k^* = 100$ (normalization)

Table A5: Calibration of the model of Section IV, in the baseline case of no bank lending channel ($\gamma_b'(r) = 0$). The distribution for productivity shocks is assumed to be Weibull with scale and shape parameters λ and ξ, respectively, while the exogenous distribution of net worth is assumed to be a Beta distribution, supported on $[0, k^*]$, with shape parameters a and b. Parameters in the first panel are calibrated; parameters in the second panel are chosen to minimize the square distance between selected moments in the model and in the data (the moments are reported in Appendix Table A6); and the scale parameter of the productivity distribution is chosen so that $k^* = 100$ given other parameters. More details on targets and estimation are described in Appendix II.B.

Moment		Data	Model
Average loan share among firms with $s > 0$	$\mathbb{E}(s \mid s > 0)$	0.56	0.62
Fraction of firms with $s > 0$	$\mathbb{E}(\mathbf{1}(s > 0))$	0.70	0.65
Assets of firms with $s > 0$, as a share of total assets	$\mathbb{E}(w\mathbf{1}(s > 0))$	0.85	0.56
Average leverage	$\mathbb{E}(l)$	0.40	0.44
Assets of firms with $l > 0.10$, as a share of total assets	$\mathbb{E}(w\mathbf{1}(l > 0.10))$	0.86	0.86
Assets of firms with with $l > 0.20$, as a share of total assets	$\mathbb{E}(w\mathbf{1}(l > 0.20))$	0.64	0.68
Assets of firms with with $l > 0.30$, as a share of total assets	$\mathbb{E}(w\mathbf{1}(l > 0.30))$	0.38	0.56

Table A6: Distribution of the loan share and leverage in the data and in the model. The sample used to construct the moments is annual Compustat firms from the non-financial sector. The variable s is the loan share, computed as described in Appendix I.B. The variable l is leverage, defined as the ratio of total debt (the sum of Compustat variable `dltt` and `dlc`) to total assets (Compustat variable `at`). The weight w is the ratio of total assets of the firm-year observation to the sum of total assets for all observations in a given year. The moments are computed year by year for the period 1990-2017, then averaged across years. The calibration of the model used to compute the corresponding moments is described in Table A5.

(a) Bank intermediation cost γ_b

Moment	Firm group	Parameter value 0.01	0.015	0.02	0.025	0.03
$\mathbb{E}\left(\frac{\Delta log(d)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−2.8	−2.8	−2.8	−2.7	−2.7
	Bond-financed (R3)	−4.3	−4.1	−3.6	−3.2	−3.0
$\mathbb{E}\left(\frac{\Delta log(k)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−1.6	−1.6	−1.6	−1.6	−1.6
	Bond-financed (R3)	−0.4	−0.4	−0.4	−0.4	−0.4
$\mathbb{E}\left(\frac{\Delta s}{\Delta r}\right)$	Loan limit binding (R1)	1.6	1.5	1.5	1.4	1.4
	Loan limit slack (R3)	−3.6	−3.3	−3.2	−3.0	−2.9

(b) Shape parameter of productivity distribution ξ

Moment	Firm group	Parameter value 0.5	1.0	1.5	2.0	2.5
$\mathbb{E}\left(\frac{\Delta log(d)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−2.9	−3.1	−2.8	−2.6	−2.5
	Bond-financed (R3)	−9.8	−4.4	−3.7	−3.1	−2.8
$\mathbb{E}\left(\frac{\Delta log(k)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−1.4	−1.5	−1.6	−1.6	−1.7
	Bond-financed (R3)	0.0	−0.2	−0.3	−0.4	−0.5
$\mathbb{E}\left(\frac{\Delta s}{\Delta r}\right)$	Loan limit binding (R1)	0.5	1.2	1.4	1.5	1.4
	Loan limit slack (R3)	−0.1	−1.6	−3.0	−3.6	−3.9

(c) Shape parameter of net worth distribution a

Moment	Firm group	Parameter value 1	2	3	4	5
$\mathbb{E}\left(\frac{\Delta log(d)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−1.8	−2.2	−2.6	−3.0	−3.4
	Bond-financed (R3)	−1.5	−1.5	−1.6	−1.6	−1.6
$\mathbb{E}\left(\frac{\Delta log(k)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−1.2	−1.4	−1.5	−1.7	−1.8
	Bond-financed (R3)	−0.4	−0.4	−0.4	−0.4	−0.4
$\mathbb{E}\left(\frac{\Delta s}{\Delta r}\right)$	Loan limit binding (R1)	1.0	1.2	1.4	1.5	1.6
	Loan limit slack (R3)	−3.0	−3.1	−3.1	−3.2	−3.3

(d) Shape parameter of net worth distribution b

Moment	Firm group	Parameter value 3	4	5	6	7
$\mathbb{E}\left(\frac{\Delta log(d)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−2.9	−2.8	−2.7	−2.5	−2.4
	Bond-financed (R3)	−3.5	−3.5	−3.4	−3.4	−3.4
$\mathbb{E}\left(\frac{\Delta log(k)}{\Delta r}\right)$	Loan-dependent (R1+R2)	−1.6	−1.6	−1.6	−1.5	−1.5
	Bond-financed (R3)	−0.4	−0.4	−0.4	−0.4	−0.4
$\mathbb{E}\left(\frac{\Delta s}{\Delta r}\right)$	Loan limit binding (R1)	1.5	1.5	1.5	1.4	1.4
	Loan limit slack (R3)	−3.2	−3.2	−3.1	−3.1	−3.0

Table A7: Robustness of the predictions of the model to alternative calibrations. Each panel reports the values of six different moments, when all but one parameters are set as in the baseline calibration of Table A5 (with no bank lending channel). The remaining parameter varies in the range reported on top of each panel. Moments are reported by firm group: $R1$ denotes the group of loan-dependent firms with a binding loan limit; $R2$ denotes the group of loan-dependent firms with a slack loan limit; and $R3$ denotes the group of exclusively bond-financed firms.

(a) Average interest rate: impact response

	(1)	(2)	(3)	(4)
η_t^{HF}	1.44***	1.45***	1.45***	
	(0.27)	(0.24)	(0.24)	
$\eta_t^{HF} \times s_{j,t-1}$			0.31**	0.32**
			(0.14)	(0.14)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering of s.e.	firm + quarter	firm + quarter	firm + quarter	firm + quarter
N	104538	104538	104538	104532

(b) Average interest rate: 4-quarter response

	(1)	(2)	(3)	(4)
η_t^{HF}	2.40**	2.36***	2.29***	
	(0.91)	(0.86)	(0.85)	
$\eta_t^{HF} \times s_{j,t-1}$			1.01***	1.04***
			(0.36)	(0.34)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering of s.e.	firm + quarter	firm + quarter	firm + quarter	firm + quarter
N	87706	87706	87706	87695

Table A8: The response of average interest rates to a monetary policy contraction. The average interest rate $\hat{r}_{j,t}$ is defined as 4 times the ratio of quarterly interest payment (Compustat variable `xinty`, appropriately differenced) to total book debt. Firm-quarter observations with implied average interest rates that are either missing or above 50% are dropped. The average interest rate in the remaining sample is 8.8%, with a 95th percentile of 19.8%. The dependent variable in the top panel is the one-quarter change in average interest rate, while the dependent variable in the bottom panel is the one-year change in average interest rate. The specification estimated is the same as Equation (1); in particular, the monetary policy shock is the high-frequency innovation in Fed Funds rates around FOMC dates, and only data after 1990 is used.

(a) Investment: impact response

	(1)	(2)	(3)	(4)
η_t^{HF}	-2.35***	-1.95***	-2.61***	
	(0.77)	(0.73)	(0.81)	
$\eta_t^{HF} \times s_{j,t-1}$			0.11	0.04
			(0.15)	(0.14)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.107	0.122	0.122	0.140
N	200358	200358	200358	200358

(b) Investment: cumulative 4-quarter response

	(1)	(2)	(3)	(4)
η_t^{HF}	-5.24**	-4.10*	-5.49**	
	(2.40)	(2.26)	(2.40)	
$\eta_t^{HF} \times s_{j,t-1}$			-1.13*	-1.42**
			(0.67)	(0.66)
Macro controls	yes	yes	yes	no
Firm controls	no	yes	yes	yes
Sector-time FE	no	no	no	yes
Clustering	firm + quarter	firm + quarter	firm + quarter	firm + quarter
R^2	0.226	0.259	0.259	0.275
N	189794	189794	189794	189794

Table A9: Response of investment to a monetary policy tightening when controlling for leverage. Relative to Table 1, the specifications are identical, except that a control for leverage is added. Leverage is defined the ratio of total book debt to book assets, lagged one quarter. The top panel reports estimates for the impact response, while the bottom panel reports estimates for one-year ahead cumulative response. Columns (1) to (3) report estimates from: $\Delta y_{j,t} = \alpha_j + \beta\eta_t^{HF} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \zeta(\eta_t^{HF} \times l_{j,t-1}) + \Gamma_z Z_{t-1} + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$. $\Delta y_{j,t}$ is the change in $log(k_{j,t})$, either from the end of quarter $t-1$ to the end of quarter t (top panel) or to the end of quarter $t+4$ (bottom panel). Additionally, η_t^{HF} is the shock to the Federal Funds rate; $s_{j,t-1}$ is the share of bank loans in total debt at the end of quarter $t-1$; $l_{j,t-1}$ is leverage; Z_{t-1} are macro controls (the log change in the industrial production index and the log change in the CPI, both lagged one period); and $X_{j,t-1}$ is a vector containing the log change in real sales, the log of total book assets, the ratio of net current assets to total assets, the loan share, and leverage, all lagged one period, and a set of dummies for fiscal quarters. Column (4) reports estimates from a model with sector-time fixed effects: $\Delta y_{j,k,t} = \alpha_j + \gamma_{k,t} + \delta(\eta_t^{HF} \times s_{j,t-1}) + \zeta(\eta_t^{HF} \times l_{j,t-1}) + \Gamma_x X_{j,t-1} + \varepsilon_{j,t}$, where k is the firm's sector. In all specifications, the loan share is expressed in terms of its deviation from the within-firm average, and standardized in the regression sample. Standard errors are double-clustered by firm and quarter.