Inflows and spillovers: Tracing the impact of bond market liberalization *

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Abstract

As bond markets grow, this affects not only the financing decisions of firms, but also the lending behavior of banks, and the resulting equilibrium allocation of credit and capital. This paper makes three contributions to understand the impact of bond market liberalization. First, using evidence from reforms in Japan that gave borrowers selective access to bond markets during the 1980s, it shows that firms that obtained access to the bond market used bond issuance to pay back bank debt. More importantly, this led banks to increase lending to small and medium enterprises and real estate firms. Second, it proposes a model of financial frictions that is consistent with the empirical findings, and uses the model to derive general conditions under which bond liberalization has this effect on banks. The model predicts that bond liberalization can significantly worsen the quality of the pool of bank borrowers, and so lower bank profitability. These results suggest that Japan's bond market liberalization contributed to both the real estate bubble in the 1980s and bank problems in the 1990s. Third, the model implies that bond markets amplify the effects of shocks to the risk-free rate and firm borrowing, in addition to attenuating the effects of financial shocks.

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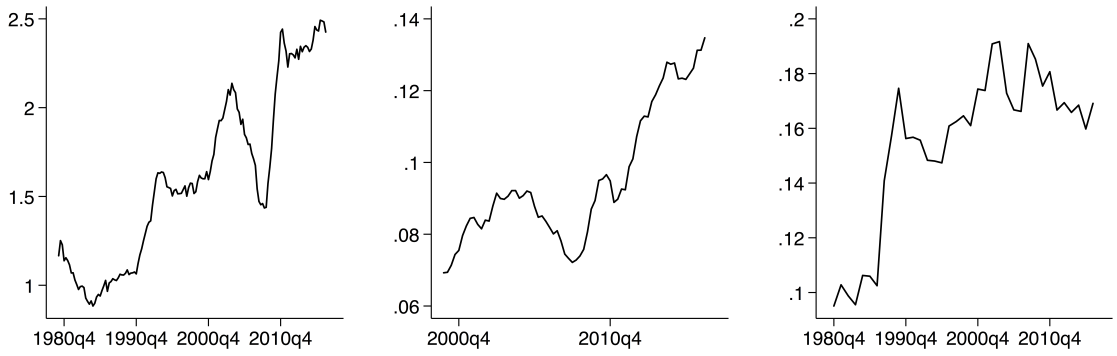
1 Introduction

Bond financing is growing in many markets. The total outstanding debt securities of US non-financial corporations grew from $3.2 to $5.8 trillion between 2006 and 2016, and relative to the stock of bank loans has more than doubled since 1990, as shown in Figure 1. Elsewhere in the world, including Europe and especially China, bond markets have also grown rapidly, as shown in Table 1. The shift to bond financing is partly a product of government support for market-based financing, and partly a result of borrowers seeking alternative forms of financing in the context of recent banking crises. This shift raises a number of important questions, of which this paper focuses on three. First, how does access to bond markets affect firm borrowing and bank lending? Second, what are the consequences of growing bond markets for the aggregate allocation of capital? Third, how do bond markets affect the reaction of an economy to capital inflows, financial crises, and other shocks?

In this paper, I exploit a natural experiment in Japan to study the consequences of a transition from bank-centered to market-based financing. Japan liberalized its bond markets during the 1980s, giving specific types of firms permission to issue bonds and legalizing both foreign and equity-linked bond issuance. Japan's experience offers a useful setting for studying the effect of an increased range of financing options because this bond liberalization initially allowed only certain types of firms access to bond markets. In addition, this liberalization took place during a period of relative calm: after the high growth period of the 1950s to mid-1970s, and before the collapse of the stock market and asset prices and subsequent wave of bank problems and consolidation in the 1990s. The liberalization was

Figure 1: Debt securities / bank loans of private non-financial corporations (%)



(a) U.S. (b) Euro Area (c) Japan

Sources: US Flow of Funds Table B.103, Euro Area Flow of Funds, Japan Flow of Funds.

Table 1: Total debt securities outstanding, non-financial corporations (US$ bn)

	Developed				Emerging	
Year	US	EU	Japan	Other	China	Other
2006	3,157	1,387	654	448	173	215
2016	5,825	1,978	669	945	5,116	534
Average growth rate (%)	6.3	3.6	0.2	7.7	40.3	9.5

Notes: The EU figures include the UK. Other developed markets includes Australia, Canada, and Singapore. China figures include HK issuance. Other emerging markets include Argentina, Chile, Israel, Malaysia, Peru, Russia, Thailand and Turkey. Source: BIS.

designed in stages, which generate variation in the exposure of firms and banks to bond markets. Finally, the existence of rich micro data from the period allows for close examination of the interaction between bond market liberalization and firm financial decisions, as well as how it affected Japanese banks.

There are two main empirical results. The first is that firms used bonds primarily as a substitute for bank loans. The criteria for access to unsecured bond markets were based on threshold levels of five to six firm characteristics, introduced in 1979 and revised in 1983, 1985, and 1987. Because the rules determining access to bond markets are specific, access can be used as an instrument for bond issuance, and a difference-in-discontinuity empirical strategy can be applied. While firm leverage was stable over the 1980s, the pace and timing of declines in firms' bank debt coincide with both regulatory reforms and bond issuance. Identifying the effect of access to bond markets on bank loans exploits the behavior of firms that obtain access to bond markets, relative to similar firms that do not have access. The panel dimension of the data to control for time-invariant firm characteristics, via firm fixed effects. I compare firms in the same industries and regions, and of similar size and profitability, to rule out the possibility that declines in bank borrowing are driven by characteristics that are correlated with access. Because each firm can be linked to its lenders, I run specifications that include lender-year fixed effects to absorb variation that is due to changes in banks' credit supply. The main identifying assumption here is that any trends among firm types are uncorrelated with the regulatory changes. I also control for smooth functions of the characteristics that determine access, and look at subsets of firms that are close to the regulatory thresholds. Provided that there are no jumps in other firm characteristics around the thresholds for access, this isolates the effect of liberalization from other drivers of changes in bank debt.

It is surprising that the firms directly affected by the liberalization of bond markets do not borrow more overall: their bond issuances are primarily used to pay back bank debt. One implication of this is that these firms were not financially constrained. Firms' total borrowing

quantities did not change in response to the availability of a new source of financing, although the mix of debt shifted away from bank debt towards greater use of the bond market.

The second main empirical result is that the shift away from bank debt by large firms gaining access to the bond market led banks to increase lending to other firms. Bond issuers' repayment of bank debt generated a shock to banks, which I measure using the predicted repayments of firms that gained access to bond markets and the network of bank-firm ties in Japan. These ties and the timing of the revisions to the access criteria generate both time and cross-sectional variation in the exposure of banks to firms making liberalization-related repayments. I show that these liquidity shocks are associated with increases in lending to other firms, relative to firms' borrowing from unshocked banks. Because firms borrow from multiple banks, I use firm fixed effects to demonstrate that spillovers are not being driven by differences in the borrowers that are matched to exposed versus unaffected banks. The main identifying assumption here is that these repayment shocks are uncorrelated with other factors affecting bank lending.

As a further consequence of liberalization-related repayments, banks increased lending to small and medium enterprises and real estate firms. Real estate lending in particular proved to be problematic after the collapse of the real estate bubble in the early 1990s. Banks' real estate lending during this period has been shown to contribute to regional variation in asset prices (Mora, 2008), as well as non-performing loan rates (Hoshi, 2001) and declines in lending and investment during the 1990s (Gan, 2007a,b).

It is striking that the main effects of the liberalization were therefore indirect. This policy change caused banks to lose profitable customers that banks then replace with lending to other firms. If one looked only at the direct effects of the liberalization on targeted firms, one might conclude that the liberalization did not matter much. However, the major effect of the bond market liberalization was to shift the lending patterns of banks. Ignoring these spillover effects of the liberalization, mediated via the banking sector, would substantially underestimate its importance.

These findings are inconsistent with frictionless models of banks, and with models that feature representative firms. Faced with decreased bank dependence among an important part of their customer base, banks could have invested in safe assets or returned funds to depositors. Instead banks reallocated funds from firms issuing bonds and repaying bank debt to a shifting pool of borrowers. That certain firms were able to borrow more as a consequence of the liberalization indicates that banks may have been constrained in their lending. A model with representative firms would be unable to capture the treatment of a specific subset of firms, and the resulting spillover effects. While the firms targeted by the

liberalization policy were not financially constrained, other firms that obtained loans from affected banks seem to have been financially constrained ex-ante.

While the empirical findings point to banks and heterogeneous firms as key features that lead to the results in Japan, this leaves open a number of other questions that are beyond the scope of reduced form empirical work. The empirical findings show relative rather than aggregate effects. One would like to know what other factors were critical in the Japanese case, and whether the Japanese experience has external validity in a more general setting. In addition, there are a number of counterfactual policy experiments for which we do not have data, but would be useful to think about in a model disciplined by the empirical results.

To address further questions regarding the causes and effects of bond market liberalization, I develop a new model of financial frictions with both banks and firm heterogeneity. The three agents in the model are heterogeneous entrepreneurs, banks, and foreign investors. Heterogeneous entrepreneurs decide whether to save or produce, and if they produce, whether to borrow from banks or bond markets. I model firms' demand for external finance as bounded, and bonds and loans as substitutes. All firms may borrow from a bank, but can only issue bonds in exchange for paying a fixed cost. The endogenous sorting of entrepreneurs into these options predicts that high productivity firms borrow, and that large firms issue bonds rather than borrow from banks.

Using the model, I explore the consequences of bond market liberalization for firms' borrowing decisions, bank lending portfolios, aggregate output, and productivity. In response to a reduction in the fixed cost of issuing bonds, firms issue bonds to repay bank debt. Only entrepreneurs with sufficient assets can afford to pay the fixed cost and issue bonds.

In a closed economy, the substitution away from bank debt among borrowers must be funded by savers shifting from bank deposits to investing in bonds. Importantly, the availability of bonds lowers the effective cost of financing for entrepreneurs with many assets. As a result, large firms with lower productivity find it profitable to borrow after the liberalization takes place. This increases the overall demand for funds, which causes an increase in the interest rate on bank loans. While this allows large marginal firms to grow, it crowds small firms with relatively higher productivity out of the borrowing market. As a result, this leads to a decline in both output and productivity. However, the Japanese economy was not closed.

The liberalization of bond markets in Japan coincided with both the deregulation of foreign exchange and the continuation of a postwar policy of financial repression. For much of the 1980s, foreign issuance was more than half of total bonds issued. In addition, reforms to deposit markets were not implemented until later in the decade, as a consequence of which

savers did not fully diversify away from bank deposits as the liberalization took place.

In the model, I show that financial repression and foreign inflows to bond markets - as well as a more general set of conditions in which there are foreign inflows to banks or banks are constrained - lead to a pattern of spillovers via banks that matches the empirical findings. When depositors are prevented from substituting investment in bonds for bank deposits and foreign investors purchase bonds, there is a decline in the interest rate on loans, and more entrepreneurs with low productivity endogenously decide to invest and produce. This leads to an increase in output but a decline in productivity, and in particular a decline in the size and productivity of firms that borrow from banks.

Japan is not the only country where understanding the transition from bank-centered to market-based financing is important. As shown in Table 1, bond finance is growing rapidly in many markets, and the macroeconomic implications of this have not yet fully been explored.

The model is consistent with existing empirical evidence and theory for other forms of capital account liberalization, and generates new predictions about how bond markets interact with shocks to the risk free rate, firm borrowing, and bank shocks. The effect of a fall in the risk free rate is similar to bond market liberalization, and consistent with the model and evidence of Gopinath et al. (2017). However, the increase in output caused by a decline in interest rates is amplified by the existence of bond markets, relative to an economy with banks alone.

In line with dynamic models of financial frictions (e.g., Midrigan and Xu, 2014; Buera and Moll, 2015) and evidence in Eastern Europe (Larrain and Stumpner, 2017), an increase in firm borrowing limits improves the allocation of capital, but only if banks are constrained. When banks are constrained, bond markets amplify the effect of an increase in firm borrowing on output, but attenuate the effect this has on improving the efficiency of capital allocation.

Finally, the model predicts a retrenchment in bank lending in response to bank shocks, as do De Fiore and Uhlig (2015) and Crouzet (2016). Here, the model highlights distributional consequences of how bond markets dampen the bank lending channel. Importantly, this framework suggests that the substitution of bonds for bank loans among high quality firms decreases bank profitability, as well as the pace of and scope for bank recovery.

The rest of the paper is structured as follows. The remainder of this section reviews related literature. Section 2 describes the institutional context in Japan in the 1970s and 80s, as well as the data I use in this paper. The empirical strategy and results are described in Section 3. The model is presented in Section 4, where the aggregate effects of bond market liberalization are explored. Further implications of the model are developed in Section 5. Section 6 concludes.

1.1 Related literature

This paper relates to work on financial frictions and bond markets, historical evidence on the period in Japan, and research on capital account liberalization and misallocation.

There is a large existing literature on how financial frictions affect firms, and the potential for bond markets to mitigate these frictions. While financial frictions can amplify and propagate shocks (e.g. Bernanke et al., 1999), this mechanism depends on firm financial constraints and the limited ability of firms to substitute other forms of finance for bank loans. In the model of Kiyotaki and Moore (1997), the expansion of credit is facilitated by the rising value of collateral. This is one reason Japanese banks favored real estate lending during the 1980s. Recent work also models borrowing constraints for the financial sector (Gertler and Kiyotaki, 2010). However, these papers focus primarily on shocks that affect banks, which bond markets then mitigate. In contrast, I focus on the reverse direction of causality: the effect of bond markets on banks.

There is an extensive theoretical literature on corporate debt structure, including Diamond (1991), Rajan (1992), and Besanko and Kanatas (1993). A key idea here is banks' incentives to monitor, which diffuse groups of investors do not have. Banks also provide firms with greater flexibility in times of financial distress, relative to market debt (Bolton and Scharfstein, 1996). Holmstrom and Tirole (1997) argue that complementarities between direct and intermediated finance allow some firms to borrow from bond markets alone, while others combine bonds and bank debt. Bolton and Freixas (2006) argue that monetary policy affects bank lending by changing the spread of bank loans over corporate bonds. In this paper, I make simplifying assumptions that build on the insights of this literature, for the sake of analytical tractability.

There is also a substantial body of empirical evidence on firm corporate debt choices. Among rated U.S. firms, the majority borrow simultaneously from banks and bond markets (Rauh and Sufi, 2010). There is substantial empirical evidence that large firms substitute bonds for bank debt over the business cycle, while small firms are typically bank dependent. This substitution over cycles is documented by Kashyap et al. (1993), and again more recently by Adrian et al. (2013) and Becker and Ivashina (2014). The sorting of heterogenous firms between bank debt and bond markets is central to the predictions of my model.

A number of recent papers study the shift into bonds after 2008, and explore its macroeconomic consequences. Building on the idea that banks have greater flexibility to renegotiate debt, Crouzet (2016) develops a model in which large firms use market debt exclusively, while other firms mix bonds with bank debt. In his framework, a contraction in bank credit leads

to an increase in bond issuance that is insufficiently large to offset the decline in aggregate borrowing and investment, due to precautionary motives. De Fiore and Uhlig (2011) build an asymmetric information model to explain the long-run differences between the composition of corporate financing in Euro Area and the US, and in a companion paper (De Fiore and Uhlig, 2015) extend the model to see what shocks could account for the shift in borrowing behavior and increase in spreads observed in the Euro Area in 2008-2009. To match both the shift in the importance of market debt to firms and the observed rise in spreads, their model requires a decrease in bank efficiency, and two shocks to the uncertainty faced by firms. In addition to these findings, there are a number of other questions regarding the transition to increased reliance on bonds. Chang et al. (2017) examine the increased reliance of emerging market corporations on bond financing and explore the consequences this has for macro-dynamics. In comparison, the model presented here has implications for how bond markets affect the overall allocation of capital, and interact with different types of inflows, in addition to financial shocks.

Two recent empirical papers on the European Central Bank's expansion of quantitative easing into corporate bond purchases, formally called the Corporate Sector Purchase Program (CSPP), find evidence that is consistent with the spillover effects I document in Japan. Grosse-Rueschkamp et al. (2017) demonstrate that firms that are eligible for the CSPP substitute bonds for bank debt, and that banks with a high proportion of CSPP-eligible firms in their portfolios increase their lending to private ineligible firms. Using a sample of Spanish firms, Arce et al. (2017) similarly find an increase in bond issuance volume for eligible firms and an increase in bank lending to non-bond issuing firms.

Japan's financial liberalization in the 1980s is described in detail by Hoshi and Kashyap (2004). They provide suggestive evidence that bond market liberalization played a role in driving banks to invest in real estate, which may have contributed to the rise in land prices. I provide micro-evidence in support of this claim. Hoshi et al. (1989) demonstrate that decreased bank dependence among firms that gained access to bond markets increased the sensitivity of firms' investment to liquidity. Weinstein and Yafeh (1998) study the hold-up problem of firms in the pre-liberalization period, and Hoshi et al. (1993) focus on determining what characteristics increase firms' propensity to issue public debt. Mora (2008) links the bond market liberalization to regional variation in land prices, which peaked in 1991, and rules out that banks chose to lend to real estate because they perceived it to be a good opportunity. Mora instruments for the supply of real estate loans using the declining share of bank loans to keiretsu borrowers. In contrast, I use the bond issuance criteria as an instrument for firms' bond issuance, and link firms' repayment of bank debt to banks using

the network of bank-firm ties.

Several studies focus on the subsequent collapse of the Japanese stock market and land prices and its effects on the domestic economy (Gan, 2007a,b), real activity in the United States (Peek and Rosengren, 2000), and the behavior of Japanese banks in misallocating credit in the 1990s (Peek and Rosengren, 2005; Caballero et al., 2008). However, these studies of the later period take the problems of the banking sector as given. In contrast, I examine the period that precedes this, with the objective of better understanding why banks' exposures evolved in a manner that led the fallout from the asset price collapse to become so widespread. Hoshi (2001) finds a positive relationship between banks' level of non-performing loans in 1998 and their share of real estate lending in the 1980s. Ueda (2000) includes the bond market liberalization in his study of the causes of the Japanese banking sector's collapse, and links a proxy measure of liberalization to real estate lending and bad loans. In contrast, I trace these real estate exposures back to policy changes that began in the mid-1970s.

This paper also relates to studies of capital account liberalization, misallocation, and the limited absorptive capacity of financial systems. Reis (2013) argues that in Portugal in the 2000s, financial integration exceeded financial deepening. Building on Hsieh and Klenow (2009), Gopinath et al. (2017) present evidence of increased dispersion in the marginal revenue product of capital (MRPK) in Spain and Southern Europe over the decade following the introduction of the Euro. Asker et al. (2014) show that such dispersion arises naturally in response to idiosyncratic productivity shocks and investment adjustment costs. The evidence in Japan is partly between sectors, where services and real estate typically have lower productivity than traded goods firms (i.e. manufacturing), and partly regarding size, which has been robustly linked to productivity (Bartelsman et al., 2013). Khwaja et al. (2010) study a positive liquidity shock to Pakistani banks following the re-establishment of normal diplomatic relations with the US after 9/11. Banks were unable to intermediate the resulting inflows, which subsequently led to a bubble in real estate and stock prices. My results suggest that in the Japanese case banks channeled money to the real estate sector, a change that was caused in part by the liberalization of bond markets.

2 Institutional background and data

During the high-growth period from the mid-1950s to the early 1970s, Japanese firms depended primarily on banks for external funds, due to restrictions on bond issuance.[1] Prior

[1]Capital markets had dominated firm financing from the Meiji restoration until the 1930s, so this had not been the case historically. A wave of bond defaults in the 1920s, followed by increased government control

to 1975, all firms wanting to issue bonds had to apply to a Bond Issuance Committee. The amounts requested were typically rationed. All domestically issued bonds were required to be fully collateralized, whereas most bank debt was uncollateralized. Foreign bond issuances required government permission, which was not normally granted. In addition, interest rate ceilings reduced demand for bonds.[2] As a result, between 1970 and 1975, roughly 90 percent of firm external finance came from banks. In 1975, the committee began to allow firms to issue the amounts they requested, instead of rationing issuance quantities.

Beginning in 1976, the government introduced specific accounting criteria for access to secured bond markets. The criteria for bond issuance consisted of a minimum level of net worth, dividends and profits per share, plus either one or two additional requirements. The detailed criteria are shown in Panel A of Table A1, in the Appendix. Firms that met the criteria were permitted to issue secured convertible bonds.

In 1979, more stringent criteria were established for unsecured convertible bonds, as shown in Panel B of Table A1. The criteria were initially so strict that only two firms qualified. These criteria were relaxed several times at specific dates over the 1980s. A larger group of firms become eligible following the criteria revision in 1983, and a more significant revision was introduced in 1985, bringing the total number of firms eligible to issue unsecured bonds to more than 150. From July 1987, firms could instead meet ratings criteria to issue unsecured bonds, as shown in Table A2.

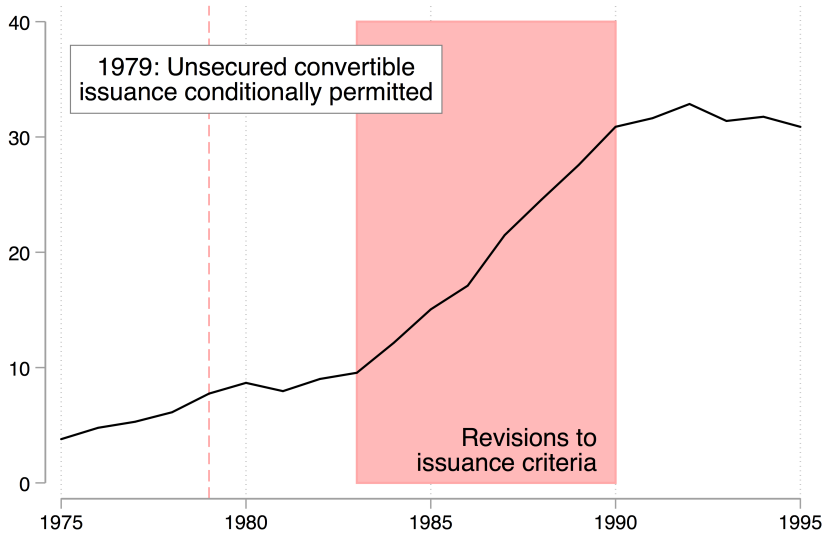
Over the 1980s, bond issuance increased rapidly, as shown in Figure 2. As a consequence of these reforms, firm borrowing patterns changed dramatically. In 1975, for example, firms borrowed on average less than 5 percent of their debt from bond markets. By 1990, the average was over 30 percent. The total number of firms qualified to issue in the unsecured bond market is shown in Figure 3.

Importantly, the rules governing foreign exchange were also substantially relaxed in 1980. Foreign issuance had previously required explicit government permission. Reforms to the Foreign Exchange Law in 1980 changed this to allowing companies to notify the Ministry of Finance, instead of requiring a formal permit (Kester, 1991). Firms issuing foreign bonds still had to meet the relevant issuance criteria, but foreign fees were significantly lower than

of the economy during World War II contributed to the importance of banks. After the war, the Japanese government continued to restrict the options of savers mainly to bank deposits, so as to give itself continued discretion over the allocation of scarce capital. This allowed the government to support industries deemed to be strategic through its influence over banks.

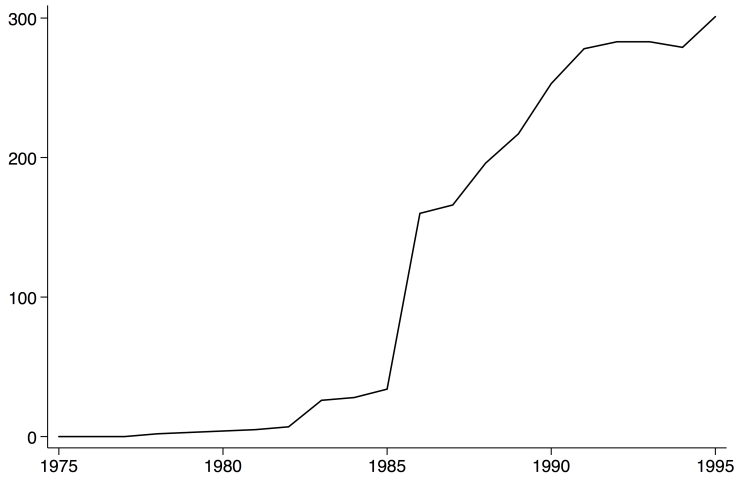
[2]Interest rates including deposit rates and loan rates were controlled from 1947 until 1992. Although interest rate ceilings also applied to bank loans, in practice banks circumvented these regulations by requiring that firms hold interest-free accounts at banks.

Figure 2: Major policy changes and bonds as a fraction of total debt



Notes: This figure shows the average bonds as a percentage of total debt of listed non-financial firms in Japan. Although bond issuance was possible prior to 1975, firms had to apply to a Bond Issuance Committtee for permission to issue bonds, and the amounts requested were often rationed. Reforms began in 1975 when firms were permitted to issue the amounts firms requested, followed by the liberalization of the secured convertible bond market in 1976. In this paper, I focus on the unsecured convertible bond market, which was liberalized in 1979.

Figure 3: Firms qualified to issue unsecured convertible bonds under accounting criteria

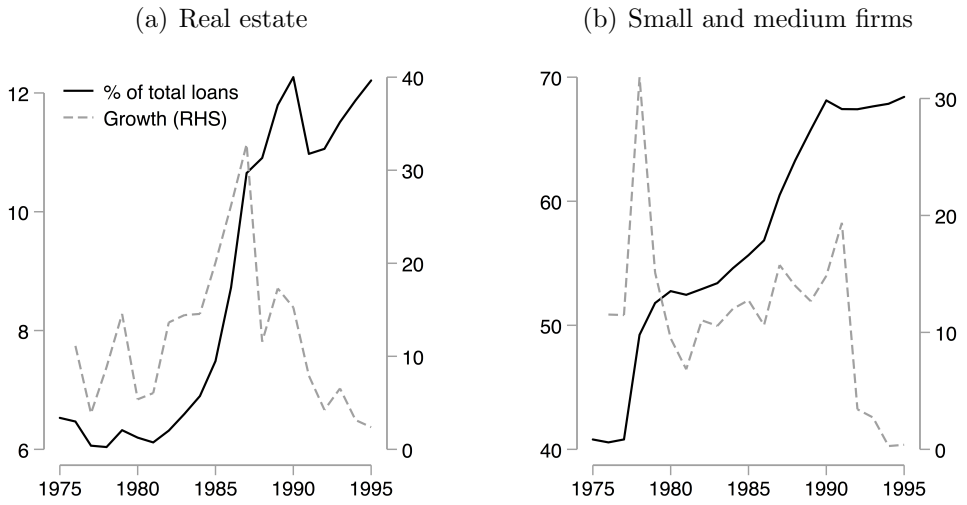


Notes: This figure shows the number of firms that qualify to issue unsecured convertible bonds in each year, according to the accounting criteria. Eligibility is determined using firm balance sheet data from DBJ. The accounting criteria are listed in Table A1 in the appendix. The number is qualified firms is underestimated after 1987, when ratings criteria were introduced; firms that qualify under the ratings criteria are not counted here.

the fees for domestic issuance.

Over the 1980s, there are several dimensions in which bank activity expanded. Banks grew substantially larger, extending credit to new firms, small and medium-sized firms in particular. Banks also increased their exposures to real estate through both loans and investments. These overall shifts are shown in Figure 4. There was also a rapid increase in asset prices in the late 1980s in Japan, both in the stock market and land prices. Most explanations for the bubble blame monetary policy (e.g. Ueda, 2000). Interest rates were low and had fallen from mid-1980 until May of 1989. The stock market peaked in 1989, and land prices began to fall in 1991. Following the collapse of equity and land prices, both banks and firms faced significant difficulties, which led to lower lending and investment, and eventually a wave of bank failures, mergers, and recapitalizations in the late 1990s. My results suggest that Japan's bond market liberalization contributed to both the real estate bubble in the 1980s and bank problems in the 1990s.

Figure 4: Loans to real estate and small firms as a % of total bank lending



Notes: These figures show the percentage of total bank lending that is allocated to real estate firms and small and medium firms over the period 1975-95, as well as the growth rate of lending to these categories. The percentages are calculated using the sum of bank-level financial reports from March 31 of each year shown, which is the fiscal year end for most major banks in Japan.

2.1 Data

I use two main sources of data in this paper: firm-level financial data from the Development Bank of Japan (DBJ), and bank financial statements from Nikkei NEEDS Financial Quest.

Firm financial data comes from the DBJ, which compiles regulatory findings from the universe of listed firms in Japan. This data begins in 1956, and by 1980 includes 1,599 firms. By 1990, the sample has grown to 2,133. The detailed firm level data is used to determine when firms become eligible to issue different types of bonds. In the empirical analysis, I use the subset of firms that report a fiscal year end of March, which is the majority of Japanese listed firms.[3]

In addition, the DBJ data includes disclosures on which banks lent to each firm in each year, which allows the firm-level effects of the bond market liberalization to be linked to the outcomes of banks they borrow from. This data is available beginning in 1982; in prior years, it is aggregated by bank type. In 1982, on average firms borrowed from 14 lenders (median 11). By 1990, this had fallen to 10 (median 8).

Finally, bank balance sheet data is taken from the Nikkei NEEDS Financial Quest database, to test the effect of liberalization on various bank outcomes and to control for other bank characteristics.

3 Empirical evidence

In this section I show that firms that gained access to bond markets issued bonds as a substitute for bank debt, and that as a result of the repayment of bank debt, banks lent more to other firms. In particular, the bond liberalization contributed to bank lending to small firms and real estate.

3.1 Firm level effects of bond liberalization

This section examines the impact of bond market liberalization on firms' repayment of bank debt, using the changes to the criteria for access to unsecured convertible bond markets as an instrument for bond issuance. In looking at firm-level effects I use an unbalanced panel of firms over the period 1977-1990, which includes the entire liberalization period.[4]

[3]This simplifies the analysis and is common in other studies of Japan (e.g. Amiti and Weinstein, 2017).

[4]Prior to the liberalization, some firms issued straight bonds, though the amounts were rationed up to 1975, and issuance volumes were low. Many firms had access to the secured convertible bond market, for

The first test is how the changes in policy that allowed certain firms to access the unsecured convertible bond market affected bond issuance. Using firm level data and the criteria for access, I determine when each firm gained access to the unsecured bond market, which is denoted by a dummy variable $Access_{j,t}$. By identifying when each firm obtained access to new bond instruments, the effect of access on bond issuance can be tested in a regression of the form:

$$B_{j,t} = \lambda \, Access_{j,t} + \eta_j + \delta_t + \gamma_1 \, Controls_{j,t} * \delta_t + e_{1j,t}, \tag{1}$$

where $B_{j,t}$ is the ratio of bonds to total assets of firm j in time t, η_j is a firm fixed effect, δ_t is a time fixed effect, and $Controls_{j,t}$ is a vector of additional control variables, interacted with year dummies. The coefficient of interest λ measures firms' bond issuance upon gaining access to the unsecured bond market. The control variables include firm characteristics such as size, profitability, industry, region, and lenders, and are discussed in more detail below.

The main empirical test of this section estimates how bond issuance affects firms' bank debt, using a regression of the form:

$$L_{j,t} = \beta \, B_{j,t} + \eta_j + \delta_t + \gamma_2 \, Controls_{j,t} * \delta_t + e_{2j,t}, \tag{2}$$

where $L_{j,t}$ is the bank debt to total assets ratio of firm j in time t. The coefficient β measures the extent to which bond issuance and bank debt are complements or substitutes. Firm fixed effects control for time-invariant firm characteristics that affect firms' choice of bank debt. Time fixed effects filter out the effects of common macroeconomic shocks on firms' bank borrowing. Importantly, OLS estimates of equation (2) do not have a causal interpretation, because a contraction in bank lending may cause firms to issue bonds.

To assess the effect of bond issuance on bank lending, I instrument for $B_{j,t}$ using the dummy variable that indicates whether firm j has access to bond markets in year t, $Access_{j,t}$. This empirical strategy uses equation (1) as a first stage for equation (2). This compares the outcomes of firms with access to the unsecured convertible bond market to firms without access, by looking at firms' bond issuance and bank debt before and after the policy changes are introduced. Because firms obtain access to the bond market at different times, one needs to rule out other reasons why firms' bank borrowing may have changed, insofar as other drivers may be correlated with reforms to the bond market. Further, because access is not randomly assigned, it is also necessary to control for characteristics that determine access.

which criteria were introduced in 1976. However, access to secured bond issuance did not have a large impact upon introduction, because most bank loans at the time were unsecured.

To control for changes in banks' credit supply, I run specifications that include lender-year fixed effects. Firms' lenders are reported in the DBJ data. Although firms borrow from multiple banks, lender-year fixed effects are added for the banks from which firms obtain the largest share of their loans, conditional on their share being larger than 20 percent.[5]

Since there may also be changes in firm demand for bank debt, such as demand shocks, I include specifications with industry-year and region-year fixed effects. Industry-year fixed effects control for demand shocks that are industry specific. Region-time dummies control for economic differences across Japan's prefectures, such as growth, unemployment, demographics, and inflation.

Because the rules granting firms access to bond markets were based on firm characteristics, firms that gained access to bond markets were larger and more profitable than firms that did not. Other firm characteristics interacted with year dummies control for the possibility that the change in bank debt is driven by firm characteristics in the same years that certain types of firms gain access.

In addition, I run specifications that include as controls linear functions of the characteristics that determine access, interacted with year dummies. Since access is based on observable characteristics, this is analogous to a difference-in-discontinuity design. To control for the effects of the observable characteristics on firm behavior, I include the characteristics that are used to determine access as control variables (i.e. running variables) interacted with year dummies. The identification assumption here is that there are no jumps in other firm characteristics around the thresholds for and timing of the regulatory changes to access. Because there is a panel dimension to the data, this implies that there are no changes in the trends for different groups of firms that happen to coincide with the threshold of a particular policy change. Finally, I run these same regressions on a sub-sample of the firms that are closer to the cutoffs, by discarding very large and very small firms.

These specifications aim to capture the variation in bank borrowing that is attributable to the liberalization policy. The interpretation of the coefficient β_{IV} estimated using access as an instrument is the effect of bond issuance on bank borrowing, for a firm that gains access, relative to a firm in the same industry and region, of the same size and profitability, controlling for bank credit supply.

3.1.1 Firm-level results

Table 2 shows the effect of bond market access on bond issuance. Access to domestic unsecured convertible bond markets is associated with an increase in bonds over assets of roughly 3 percentage points, on average, controlling for year and firm fixed effects, as shown in column 1. Controlling for lender-year fixed effects has little effect on the point estimate in column 2. Adding controls for industry-year and prefecture-year fixed effects reduces the size of this coefficient only slightly, shown in column 3, and controlling for the effects of size and profitability interacted with year dummies changes the estimates to 1.5 percentage points, as in column 4. Including linear control variables interacted with year dummies reduces the size of bond issuance associated with gaining access to bond markets to 1-2 percentage points of firm assets, as shown in columns 5-7. In column 7, all of the criteria on which access are based are included as control variables, with the exception of dividends. Because the dividend rule is discrete and backward looking, there is not a simple way to include this as a control variable. In all specifications, the estimated effects of access on bond issuance are statistically and economically significant.

[5]This is analogous to using firm-year fixed effects to control for changes in firm-level credit demand, which also exploits the fact that firms borrow from multiple banks.

Table 2: The effect of bond market access on bond issuance, 1977-90

Dependent variable: $\text{Bonds}_{j,t}$ / $\text{assets}_{j,t-1}$ ($B_{j,t}$)

	Baseline results				Linear control variables		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Access_{j,t}$	0.031***	0.029***	0.028***	0.016***	0.022***	0.012***	0.010**
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.005)
Firm and year fixed effects	Y	Y	Y	Y	Y	Y	Y
Controls*year dummies:							
Main bank		Y					
Industry & region			Y				
Size bin				Y			
Profitability bin				Y			
Net worth					Y	Y	Y
Capital ratio						Y	Y
Other criteria							Y
Observations	13,600	13,600	10,137	13,600	13,600	13,600	11,840
R-squared	0.62	0.64	0.68	0.65	0.63	0.64	0.66

Notes: $Access_{j,t}$ is a dummy variable denoting whether firm j meets accounting criteria to issue unsecured convertible bonds in year t. Bonds_t / assets_{t-1} is winsorized at the top and bottom one percent of observations. The size bins are divided at 1 million, 10 million, and 100 million. The profitability bins are divided at 4 percent and 9 percent, which correspond to the 25th and 75th percentiles of profitability in the sample. Other criteria includes business profits as a percentage of assets, the ratio of net worth to paid in capital, and the interest coverage ratio. Standard errors are clustered at the firm and year level, shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

In Figure 5 panel (a), the trends of the bonds to assets ratio of firms that gain access to the unsecured convertible bond market by 1990 are compared to the firms that do not gain access. The group of firms that gain access begin to issue bonds earlier and in larger volumes than the firms without access. In panel (b), I plot the estimated coefficients from a dynamic version of regression (1) that includes leads and lags of the year in which firms gain access ($t = 0$): $B_{j,t} = \sum_{k=-5}^{5} \lambda_{t-k} \, Access_{j,t-k} + \eta_j + \delta_t + \gamma_1 \, Controls_{j,t} * \delta_t + e_{1j,t}$. Although firms have some ability to issue bonds before gaining access to the unsecured market, upon gaining access, there is a significant and persistent increase in the bonds to assets ratio of firms.

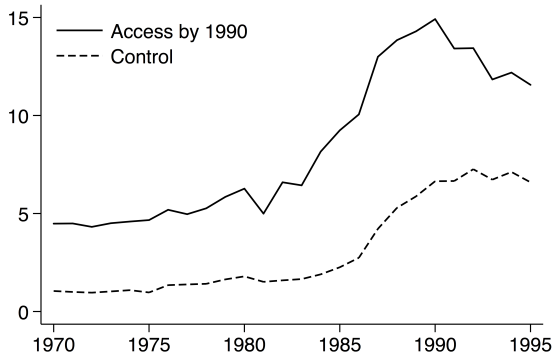
Similarly, in Figure 6 panel (a), the trends of the bank debt to assets ratio of firms that gain access to the unsecured convertible bond market by 1990 are compared to the firms that do not gain access. Although both groups of firms are deleveraging as they come out of the high growth period which ends in the early 1970s, the group of firms that does not gain access maintains a bank debt to asset ratio of roughly 25-30 percent throughout the 1980s. In contrast, the firms that gain access to the bond market are able to continue to shift away from banks, and reduce their bank debt to asset ratios to below 20 percent, on average. In panel (b), I plot the estimated coefficients estimated from a dynamic version of the reduced form regression that includes leads and lags of the time that firms gain access ($t = 0$): $L_{j,t} = \sum_{k=-5}^{5} \beta_{t-k} \, Access_{j,t-k} + \eta_j + \delta_t + \gamma_0 \, Controls_{j,t} * \delta_t + e_{0j,t}$. Although firms have some ability to anticipate that access will allow them to shift away from banks, and begin reducing their bank debt in the year prior to when they gain access, this shift continues after access is granted and persists for four years after firms obtain access to the bond market.

Table 3 shows the elasticity of bank debt to bond issuance, as estimated using regression (2). Using OLS, the relationship between bonds and bank loans is negative: as shown in column 1, a one percentage point increase in bonds to assets is associated with a 0.45 percentage point decrease in the ratio of bank loans to assets, controlling for year and firm fixed effects. The point estimate from the regression in which I instrument for the bonds to assets ratio using access to the unsecured bond market in column (2) reveals that a bond issuance of one percent of assets due to the liberalization results in a contemporaneous repayment of bank debt of one percent of assets. This estimate is fairly stable to the inclusion of additional fixed effects, with the smallest estimated coefficient being with the inclusion of industry-year and region-year fixed effects.

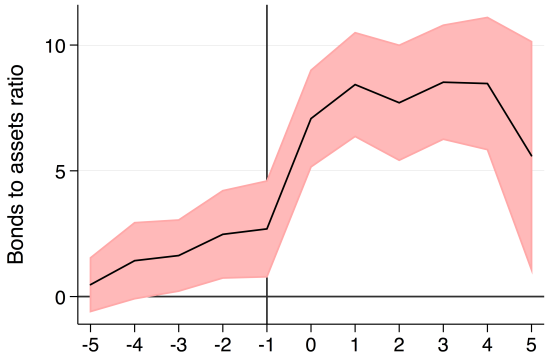
When linear functions of the main characteristics that determine access are included in columns (6) and (7), the point estimates are similar. The most saturated specification in column (8) is no longer statistically significant, but the point estimate also indicates that the sizes of bond issuance and bank debt repayment are roughly proportional. Finally, in Table

Figure 5: Bond issuance pre-trends and dynamics

(a) Average bonds to assets ratio



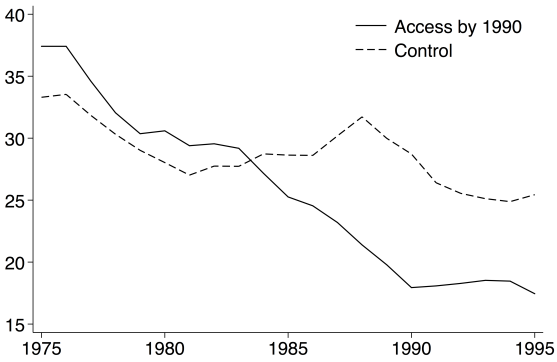
(b) Dynamics



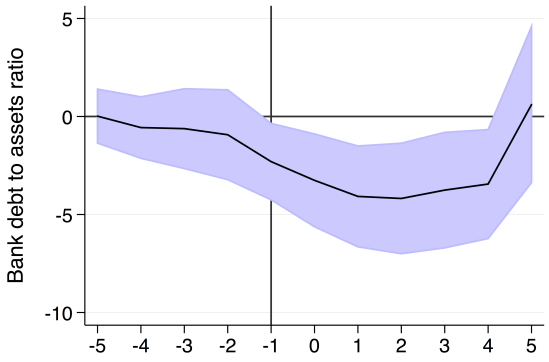
Notes: Panel (a) shows the average bond to assets ratio of firms that are granted access to the unsecured convertible bond market by 1990, compared to firms that do not obtain access. Panel (b) plots the coefficients estimated from a dynamic version of regression (1) that includes leads and lags of the year that firms gain access ($t = 0$): $B_{j,t} = \sum_{k=-5}^{5} \lambda_{t-k} \, Access_{j,t-k} + \eta_j + \delta_t + \gamma_1 \, Controls_{j,t} * \delta_t + e_{1j,t}$.

Figure 6: Bank debt pre-trends and dynamics

(a) Average bank debt to assets ratio



(b) Dynamics



Notes: Panel (a) shows the average bank debt to assets ratio of firms that are granted access to the unsecured convertible bond market by 1990, compared to firms that do not obtain access. Panel (b) plots the coefficients estimated from a dynamic version of the reduced form regression that includes leads and lags of the year that firms gain access ($t = 0$): $L_{j,t} = \sum_{k=-5}^{5} \beta_{t-k} \, Access_{j,t-k} + \eta_j + \delta_t + \gamma_0 \, Controls_{j,t} * \delta_t + e_{0j,t}$.

Table 3: The effect of bond issuance on bank borrowing, 1977-90

Dependent variable: Bank debt$_{j,t}$ / assets$_{j,t-1}$ ($L_{j,t}$)

		$B_{j,t}$ instrumented using $Access_{j,t}$						
	OLS	Baseline results				Linear control variables		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bonds$_{j,t}$/ assets$_{j,t-1}$ ($B_{j,t}$)	-0.45***	-1.08***	-1.02***	-0.51**	-1.33*	-0.84**	-0.89*	-0.86
	(0.02)	(0.28)	(0.29)	(0.25)	(0.74)	(0.38)	(0.49)	(0.61)
Firm and year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Controls*year dummies:								
Main bank			Y					
Industry & region				Y				
Size bin					Y			
Profitability bin					Y			
Net worth*year						Y	Y	Y
Capital ratio*year							Y	Y
Other criteria*year								Y
Observations	12,582	12,582	12,582	9,325	12,582	12,582	12,582	11,019
R-squared	0.81							
First stage F-stat		37.0	33.6	21.5	12.9	22.8	53.1	29.2

Notes: Notes: $Access_{j,t}$ is a dummy variable denoting whether firm j meets accounting criteria to issue unsecured convertible bonds in year t. Bonds$_t$ / assets$_{t-1}$ and bank debt$_t$ / assets$_{t-1}$ are winsorized at the top and bottom one percent of observations. The size bins are divided at 1 million, 10 million, and 100 million. The profitability bins are divided at 4 percent and 9 percent, which correspond to the 25th and 75th percentiles of profitability in the sample. Other criteria includes business profits as a percentage of assets, the ratio of net worth to paid in capital, and the interest coverage ratio. Standard errors are clustered at the firm and year level, shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 4: The effect of bond issuance on bank borrowing, discontinuity sample, 1977-90

Dependent variable: Bank debt$_{j,t}$ / assets$_{j,t-1}$ ($L_{j,t}$)

All columns: 2SLS	Discontinuity sample 1			Discontinuity sample 2		
	(1)	(2)	(3)	(4)	(5)	(6)
Bonds$_{j,t}$ / assets$_{j,t-1}$	-1.25*	-0.73	-0.73	-1.03	-1.17	-1.33
	(0.67)	(0.50)	(0.80)	(0.66)	(0.84)	(1.59)
Firm fixed effects	Y	Y	Y	Y	Y	Y
Controls*year dummies:						
Net worth	Y	Y	Y	Y	Y	Y
Capital ratio		Y	Y		Y	Y
Other criteria			Y			Y
Observations	3,700	3,700	3,421	2,452	2,452	2,291

Notes: $Access_{j,t}$ is a dummy variable denoting whether firm j meets accounting criteria to issue unsecured convertible bonds in year t. Bonds$_t$ / assets$_{t-1}$ and bank debt$_t$ / assets$_{t-1}$ are winsorized at the top and bottom one percent of observations. Other criteria includes business profits as a percentage of assets, the ratio of net worth to paid in capital, and the interest coverage ratio. Columns (1)-(3) include firms above the lowest and below the highest cutoff for equity, which are 20 bn and 600 bn, respectively. Columns (4)-(6) include firms with equity greater than 33 bn and less than 500 bn. Standard errors are clustered at the firm and year level, shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

4, the same specifications are run using two smaller subsamples of the data which exclude firms that are above or below specific sizes. It is not surprising that after discarding more that two-thirds of the sample, the estimates are no longer statistically significant. However, the point estimates remain very stable and indicate that most bond issuance is being used to repay bank debt.

I also explore the effect of bond market access on other firm outcomes. This is done using the regression specifications in equation (1), with other firm level-outcomes as the dependent variables. The results of these regressions are shown in Appendix B. Despite a fall in funding costs of approximately 1-2 percentage points (shown in panel 2 of Appendix B Table B1), firms' total leverage does not increase (panel 3).[6] There is also no effect of bond market access on investment, employment, asset growth, or sales growth (panels 4-7). In response to gaining access to bond markets, firms hold more cash, less inventory, and seem to reduce their book equity (panels 8-10). These outcomes are puzzling because they indicate that firms facing a decline in funding costs do not undertake marginal investment projects.

3.2 Spillovers via the banking system

In this section, I estimate how the shift away from banks among firms issuing bonds led to a positive liquidity shock for banks, and how this affected bank lending. By exploiting the timing of changes in liberalization policy and the relative exposure of banks to firms gaining access, these shocks are plausibly exogenous to other drivers of changes in the loan portfolio of banks. For this analysis I focus on the sub-period from 1983 to 1987. Specific data on the identity of matched borrower-lender pairs is not available until 1982, and I focus on the five year period following this, prior to the serious bubble years.

To construct a measure of the exposure of each bank to repayments arising from bond market liberalization, I first calculate the predicted repayments of each firm and then aggregate them at the bank level, using the network of bank-firm lending relationships. A firm's predicted repayment is calculated as follows. For firms that gain access to the bond market, the predicted issuance $\widehat{B}_{j,t}|Access_{j,t} = 1$ estimated in regression (1) is multiplied by the repayment coefficient estimated using regression (2):

$$\widehat{\Delta L_{j,t}} = \widehat{\beta}_{IV} * \left[\widehat{B}_{j,t}|Access_{j,t} = 1\right].$$

[6]The measure of funding costs used here is a crude proxy, since it does not value the cost of the convertible option embedded in equity-linked bond issuances, which were a substantial portion of corporate bond issuance in the 1980s in Japan. This implies the decline in funding costs is an upper bound estimate. The smaller the actual decline in funding costs, the less puzzling is the fact that leverage does not increase.

At the bank level, a predicted repayment $R_{i,t}$ is calculated as the sum of repayments made by firms that borrowed from bank i in period $t-1$ and that gained access to the bond market, denoted $j \in M_{i,t-1}|\text{Access}_{j,t}=1$:

$$\text{R}_{i,t} = \frac{\sum_{j \in M_i|\text{Access}_{j,t}=1} \Theta_{ij,t-1} \widehat{\Delta L_{j,t}} * \text{Assets}_{j,t-1}}{\sum_{j \in M_i} \ell_{ij,t-1}},$$

where the firm-level predicted repayment $\widehat{\Delta L_{j,t}}$ is multiplied by lagged firm assets to obtain a nominal firm-level repayment, and firm repayments are also weighted by the share of bank i in firm j's total borrowing: $\Theta_{ij} = \frac{\ell_{ij}}{\sum_{i \in M_j} \ell_{ij}}$, and ℓ_{ij} is the nominal size of a loan from bank i to firm j. For example, a firm that borrows equal amounts from two banks will have $\Theta_{ij} = \Theta_{i'j} = 0.5$, which scales the amount each bank is predicted to be repaid from that firm to half of the nominal total.[7] The denominator scales the repayments by total bank lending, i.e. the sum of bank loans to all firms, denoted $\sum_{j \in M_i} \ell_{ij,t-1}$.

One test of the effect of the repayment shocks on bank lending is to regress the growth rate of lending between bank i and firm j on the bank shock $R_{i,t}$:

$$\Delta \log \ell_{ij,t} = \beta R_{i,t} + \eta_{j,t} + \epsilon_{ij,t}. \tag{3}$$

where the dependent variable is approximately the growth rate of lending, and $\eta_{j,t}$ is a firm-year fixed effect. The firm-year fixed effects address the concern that results are being driven by demand shocks affecting firms that also happen to borrow from shocked banks. The coefficient on $R_{i,t}$ measures the effects of the bank-level repayment shock at bank i on firm j, relative to firm j's borrowing from other unshocked banks. A positive coefficient indicates that a bank shock is associated with higher lending, relative to firm borrowing from other banks without repayment shocks.

Another test of where capital allocated as a result of the liberalization is whether the repayment shocks cause banks to lend more to other specific groups of firms or industries. Regression (4) tests whether the repayment shocks are associated with increased lending to real estate or small firms, measured as a share of bank assets, and denoted by $Y_{i,t}$:

$$Y_{i,t} = \beta \widetilde{R}_{i,t} + \zeta_i + \delta_t + \gamma \, Controls_{i,t} + e_{i,t}, \tag{4}$$

[7] One concern is whether firms indeed repay their banks in proportion to the past lending shares. Since firms borrowed from many banks (14 on average in 1982), it is possible that strategic considerations were taken into account when firms decided which banks to repay. This is more likely to be endogenous to bank characteristics, so I omit it from the construction of the repayment shocks.

where $Y_{i,t}$ is the change in loans to real estate or small firms divided by total assets, $\widetilde{R}_{i,t} = R_{i,t} * \frac{\sum_{j \in M_i} \ell_{ij,t-1}}{\text{Total assets}_{ij,t-1}}$ rescales the repayment shock described in the previous section to adjust for the total assets of each bank, ζ_i is a bank fixed effect, and δ_t is a time fixed effect. The vector of additional control variables includes changes in other sources of bank funding, and bank characteristics. Rescaling the repayment shocks allows β to be interpreted as a pass-through coefficient.

In linking the bond liberalization shocks to bank outcomes, the key identifying assumption is that the timing and relative exposure of banks to firms that gain access to bond markets is uncorrelated with other shocks that affect bank lending. In other words, banks did not lend to large, profitable firms that gain access to bond markets because of characteristics of the rest of their loan portfolio. Although banks that lend to large, profitable firms and are therefore disproportionately affected by the bond market liberalization may lend to different types of firms than other banks, the within-firm comparisons provide a good test of the supply side effects of the repayment shocks. Using predicted rather than actual bond issuance in constructing the shocks furthers this argument.

3.2.1 Bank-level results

The repayment shocks are constructed using the coefficients in column 1 of Table 2 in the years each firm has access, multiplied by lagged firm assets. Given the results in Tables 3 and 4, I construct firm level repayments by assuming that each yen of this issuance was repaid. Using the credit registry to determine which firms borrowed from what banks, and the shares of each predicted repayment to attribute to each bank, the predicted firm-level repayments are added up at the bank level in each year. The average repayment shock associated with access to the unsecured convertible bond market is 1.5 percent of bank assets. Although the average shocks are small, certain banks were more affected than others.

Table 5 compares the characteristics of banks by their exposure to the repayment shocks. Although banks below the 50th percentile are smaller than banks above it, on other observable characteristics the groups are closely comparable. They have similar levels of leverage, return on assets, and profitability. In addition, the shares of lending to real estate and small firms are relatively close in 1982, and there are almost no changes in the shares of loans to these sectors in the two years prior to the period in which the repayment shocks are calculated.

Table 6 shows the effects of the repayment shock on bank lending to listed firms, which corresponds to regression (3). In columns 1 and 2, the sample includes firms without access

to unsecured bond markets. Column 1 shows that a one percentage point increase in the repayment shock is associated with an increase in borrowing of 1.7 percentage points relative to firm borrowing from an unaffected bank, i.e. controlling for firm-year fixed effects. If instead we control for firm and year fixed effects, the size of the coefficient is essentially unchanged. Columns 3 and 4 restrict the sample further to firms with no bonds at all, and finds smaller but still statistically and economically significant responses. The coefficients with and without firm-year fixed effects are closely comparable, which indicates that it is unlikely that demand shocks are positively correlated with the repayment shocks.

Table 7 shows the effect of the repayment shock on lending to real estate firms and small and medium enterprises, which corresponds to regression (4). For each dollar of repayments made due to the bond market liberalization, roughly 10 cents is lent on to real estate, as shown in columns 1-3. The repayment shocks alone explain roughly 40 percent of the variation in real estate lending as a fraction of bank assets, as indicated by the R-squared in column 1. In columns 4-6, the pass-through to small and medium firm lending is larger, roughly 14 cents per dollar of repayment shock. The repayment shocks explain less variation in the changes in lending to small firms, on the order of 4 percent. Both sets of results are robust to controlling for other sources of funding, including deposits, other liabilities (including, for example, bond issuance), equity issuance, and other bank characteristics: total assets, leverage, and deposit dependence. An alternate specification using the growth rate (change in logs) of lending to real estate and small firms is shown in Appendix B.

Figure 7 plots the lending behavior of banks with higher than median repayment shocks, compared to those below it. While the patterns of lending are similar in the early years of the liberalization, as shown in Table 5, there is a substantial divergence between the growth rates of lending to real estate beginning in 1984, and to small and medium firms beginning in 1983.

The evidence presented in this section demonstrates that the bond market liberalization in Japan led firms to issue bonds and pay back bank debt. Among banks, these repayments led to more lending to other listed firms, as well as lending to small firms and real estate. This suggests that Japan's bond market liberalization contributed to banks' exposures to riskier sectors, which relates to the economic problems that Japan began to face a few years later, following the collapse of asset prices and the stock market bubble. However, to explore the aggregate implications of bond market liberalization, to determine the key factors driving the outcomes observed in Japan, and to explore how general these results can be expected to be, however, requires a model. I turn to this task in the following section.

Table 5: Balancing of covariates in the sample, 1983-87 (%)

	Unaffected banks $R_{i,t} < p50(R_{i,t})$	Exposed banks $R_{i,t} \geq p50(R_{i,t})$	Memo: Std. dev.
Total Assets (¥tr)	2,070	9,680	7,970
Leverage (x)	37.9	41.2	12.5
ROA (%)	0.53	0.51	0.16
NIM (%)	2.1	1.2	0.6
Real estate loans / total assets, 1982 (%)	3.9	5.7	4.1
Δ share, 1980-1982 (%)	0.2	-0.7	1.5
Small firms loans / total assets, 1982 (%)	46.9	33.1	13.7
Δ share, 1980-1982 (%)	-0.2	-3.0	4.1
Listed borrowers	23.2	132.7	104.0
Issuers / borrowers (%)	28.9	30.8	12.9
Loans to issuers / loans to listed firms (%)	36.0	48.1	24.6
Loans to listed firms / total loans (%)	0.62	23.2	6.4
Loans / assets (%)	63.1	58.9	12.8
Predicted repayments / total assets (%)	0.0	3.4	4.6

Notes: This table compares the characteristics of banks above the 50th percentile of $R_{i,t}$ in the sample, to those below the 50th percentile. Leverage is calculated as bank assets divided by the book value of equity.

Table 6: The effect of repayment shocks on bank lending, 1983-1987

Dependent variable: Δ Log loan size$_{ij,t}$	Firms with Access$_{j,t} = 0$		Bank dependent firms only	
	(1)	(2)	(3)	(4)
Repayment shock$_{i,t}$	1.69***	1.74***	1.00***	0.86**
	(0.24)	(0.25)	(0.35)	(0.36)
Firm*year f.e.s	Y		Y	
Year fixed effects		Y		Y
Firm fixed effects		Y		Y
Observations	44,295	44,295	19,844	19,844
R-squared	0.16	0.37	0.14	0.38

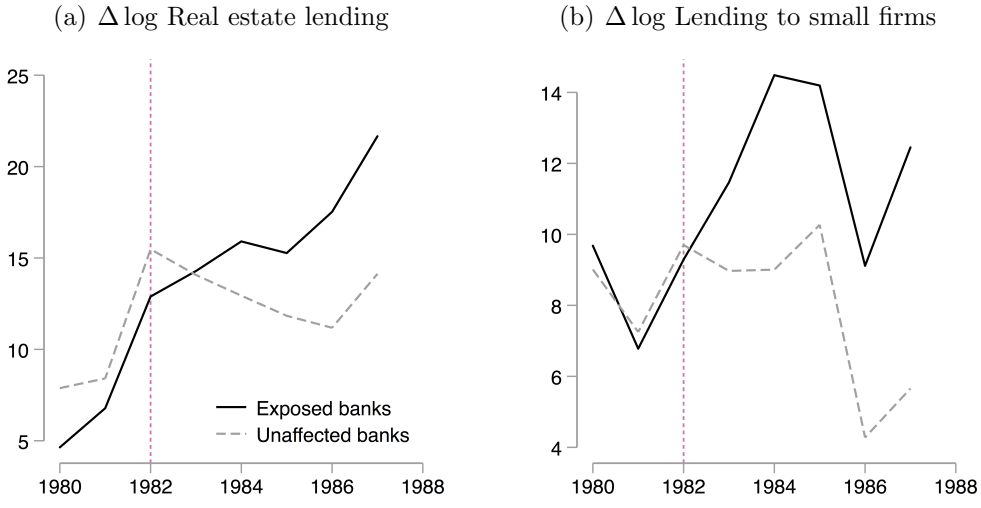
Notes: The dependent variables are calculated as changes in logs (i.e. percentages). Repayment shock$_{i,t}$ is measured as a fraction of the total loan portfolio to listed firms. The interpretation of the coefficient for example in column 2 is that a one percentage point increase in the repayment shock is associated with a 1.7 percentage point increase increase in lending to other firms. The repayment shocks and the dependent variables are winsorized at the top and bottom one percent of observations. Standard errors are clustered at the bank and year level, and shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table 7: The effect of repayment shocks on bank lending, 1983-1987

Dependent variable:	Δ Real estate loans$_{i,t}$ / assets$_{i,t-1}$			Δ Loans to small firms$_{i,t}$ / assets$_{i,t-1}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Repayment shock$_{i,t}$ / assets$_{i,t-1}$	0.139***	0.094***	0.095***	0.110***	0.153***	0.141***
	(0.013)	(0.014)	(0.013)	(0.029)	(0.034)	(0.033)
Δ Deposits$_{i,t}$ / assets$_{i,t-1}$			0.030***			0.102***
			(0.007)			(0.031)
Δ Other liabilities$_{i,t}$ / assets$_{i,t-1}$			0.026			0.113*
			(0.018)			(0.061)
Δ Equity$_{i,t}$ / assets$_{i,t-1}$			0.062			1.192
			(0.258)			(0.990)
Other bank controls			Y			Y
Year fixed effects		Y	Y		Y	Y
Bank fixed effects		Y	Y		Y	Y
Observations	415	415	415	422	422	422
R-squared	0.41	0.83	0.86	0.04	0.62	0.69

Notes: The interpretation of the coefficients is that the pass through of repayment shocks to lending to real estate is on the order of 10 percent; for lending to small firms it is 14 percent. The repayment shocks are winsorized at the top and bottom one percent of observations. Other bank characteristics are: total assets, leverage, deposit/liabilities ratio. Standard errors are bootstrapped to adjust for the constructed repayment shock, and shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Figure 7: Comparison between affected and unaffected banks



Notes: Panel (a) shows the average change in the log of lending to real estate firms of banks with positive repayment shocks compared with the average among banks with no repayments, and panel (b) shows the comparison for the average change in the log of lending to small and medium firms. While the patterns of lending are similar in the early years of the liberalization, there is a divergence between the growth rates of lending to real estate beginning in 1984, and to small and medium firms beginning in 1983.

4 Model

In this section, I present a model in which firms can finance themselves using bonds in addition to borrowing from banks. By modeling both bond markets and banks, I provide a simple framework to characterize the interaction between the two markets. Using this framework, I demonstrate how the empirical finding that bond liberalization led banks to increase lending to less productive firms depended in Japan's case on inflows to bond markets and financial repression of savers. However, these outcomes also result from more general conditions of capital inflows or bank financial constraints.

4.1 Setup

There are three types of agents in the model: entrepreneurs, banks, and foreign investors.

4.1.1 Entrepreneurs

Entrepreneurs exist on a joint distribution $G(a, z)$ of assets a and productivities z. Each unit decides whether to save, invest without borrowing, or borrow bank debt ℓ or bonds b to invest, in which case their capital is:

$$k = \ell + b + a. \tag{5}$$

Production is constant returns to scale, so output is the product of capital and entrepreneurs' productivity: $y = zk$. Output is homogenous.

Firms' total borrowing is limited to some multiple of the value of their assets:

$$\ell + b \leq \theta a, \tag{6}$$

where $\theta > 1$ represents in a reduced form way the fact that firms' demand for external finance is bounded. This constraint limits firms' demand for debt.[8]

[8]The model does not address the inelasticity of firms' investment to the to the availability of new financing options or a decline in funding costs. Since in the empirical findings firms do not borrow more in response to a decline in borrowing costs, the constraint in equation (6) is consistent with the empirical findings of Section 3. While this empirical finding is surprising, it is an assumption in the model that can be relaxed to demonstrate its effect on the results. One potential explanation for firms' lack of investment is that both the economy and these specific firms were at a stage of development in which cash flows were sufficient to fund investment needs, as in Zetlin-Jones and Shourideh (2017). Another way to model firms' demand for external funds would be for production to be decreasing returns to scale.

The gross interest rate on bank loans is r. Bond funding is cheaper than bank loans, assumed to be equal to the interest rate paid on deposits, r_f.[9] However, to gain access to bond markets, firms must pay a fixed cost f. This prevents small firms from issuing bonds, and can be thought of as either the actual costs involved in arranging a bond issuance, or a reduced form way to represent the size threshold necessary for bonds to be sufficiently liquid to attract investor interest.[10] To further simplify the analysis, assume firms can fully substitute bonds for bank debt.[11]

If an entrepreneur decides not to produce, they can save in banks and/or invest in bonds. The return on savings is r_f. The return on bonds is the same as bank deposits, so households are indifferent between the two assets. Aggregate savings S are invested in both bank deposits D and bonds B:

$$S = D + B, \tag{7}$$

where capital letters are used to denote aggregate variables. Aggregate loan demand is denoted by L, and total bond supply B^S.

Entrepreneurs choose whether to save or invest in order to maximize:

$$\max_{\{b,m\}} \{za, zk - r\ell - r_f b - f \cdot \mathbb{1}\{b > 0\}, r_f a\}, \tag{8}$$

where the first term is the return to investing without debt (i.e. self-financing), the second term is the return to borrowing and investing, and the third term is the return to saving. This choice depends on the interest rates r and r_f, which are taken as given by entrepreneurs, and subject to the capital constraint equation (5), and the borrowing constraint (6).

[9] An interest rate on bonds equal to the risk-free rate is of course a simplification. The spread on bonds over the risk-free rate varies over time and has been shown to exceed the interest rate on loans in times of stress. However, adding bond spreads is inessential to the main results, and omitting them allows for greater analytical tractability. A model of households with mean-variance preferences and endogenous bond spreads is Adrian et al. (2013).

[10] Blackwell and Kidwell (1988) show that public debt has greater fixed costs relative to bank debt, and that this makes large firms more likely to issue public debt.

[11] It is also straightforward to model firms mixing between bank debt and bonds. If all firms that borrow require a bank to monitor production, and banks' monitoring cost $m(a)$ must be covered by the loan spread $(r - r_f)\ell$, this reduced form constraint pins down the mix of funding demanded by firms. While there is substantial theoretical evidence on the monitoring role of banks (e.g. Diamond, 1991), the complementarity between informed (i.e. bank) and uninformed capital (Holmstrom and Tirole, 1997), and banks' flexibility to renegotiate in financial distress (Bolton and Scharfstein, 1996), having firms with both sources of finance is inessential to the results of this paper.

4.1.2 Banks

Banks have an endowment of initial equity E, raise deposits, and lend to firms. The bank balance sheet consists of bank loans L on the asset side, and the sum of household deposits D, foreign deposits D^F, and equity E on the liability side:

$$L = D + D^F + E. \tag{9}$$

The banking sector is perfectly competitive and chooses the supply of loans L and deposit demand D to maximize profits:

$$\Pi = rL - r_f D, \tag{10}$$

subject to the balance sheet identity (9).

4.1.3 Foreign investors

When permitted, foreign investors provide bank deposits and demand bonds according to supply schedules that depend on the risk free rate: $D^F(r_f)$ and $B^F(r_f)$.

4.2 Equilibrium

In a competitive equilibrium, entrepreneurs and banks maximize subject to constraints, and the markets for loans, bonds, and savings clear:

$$\begin{aligned} L &= D + D^F + E, \\ B^S &= B + B^F, \\ S &= D + B. \end{aligned} \tag{11}$$

Bank equity E, the risk free rate r_f, entrepreneurs' assets and productivities $G(a, z)$, and foreign supply schedules D^F and B^F are taken as given, and r is determined in equilibrium. To see this, note that the sum of bank loans and bond supply must equal the sum of household savings, bank equity, foreign deposits, and foreign demand for bonds:

$$L + B^S = S + E + D^F + B^F. \tag{12}$$

The demand for funds is decreasing in r, because fewer entrepreneurs choose to borrow when the interest rate is high. Since r_f is taken as given, in equilibrium r rises or falls until investment demand equals the sum of savings, bank equity, and inflows to banks or bonds.

In an economy without bond markets, i.e. $f = \infty$, all entrepreneurs with productivity higher than r_f invest in production, and those with productivity greater than r borrow to invest. When $f = \infty$, entrepreneurs' decision to save or invest depends on the return to saving, relative to the profits of production funded with or without bank debt. Comparing the returns to investing only one's own assets to the returns to saving yields a simple rule to invest in production if $z > r_f$. Comparing the returns to investing without bank debt to the returns to investing using bank debt leads entrepreneurs to borrow if their productivity exceeds the interest rate on bank debt, i.e. $z > r$. These thresholds are plotted in (a, z) space in panel (a) of Figure 8, assuming finite bounds on both entrepreneurs' assets $[\underline{a}, \overline{a}]$ and productivity $[\underline{z}, \overline{z}]$.

When bond markets exist, i.e. $f < \infty$, firms pay to access bond markets if the cost savings that result from bond issuance exceed the fixed cost of issuing a bond:

$$r\theta a \geq r_f \theta a - f$$

This can be simplified to a decision to issue bonds if assets are larger than a^*:

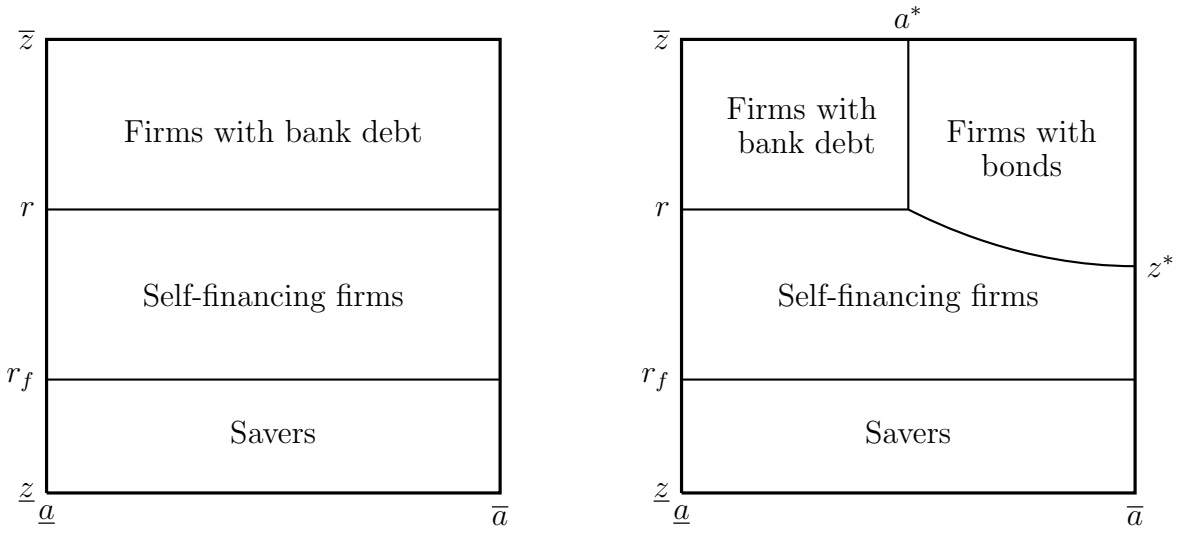
$$a \geq a^* \equiv \frac{f}{\theta(r - r_f)}. \tag{13}$$

Only entrepreneurs with sufficient assets can issue enough bonds to make paying the fixed cost worthwhile. For firms with assets a below the threshold a^*, the participation decision remains to invest if $z > r$. However, for firms with enough assets to enter the bond market $a \geq a^*$, the lower average cost of funding encourages lower productivity firms to enter production, leading to a decision to invest if:

$$z > z^*(a) \equiv r_f + \frac{f}{\theta a} \quad \text{if } a \geq a^*. \tag{14}$$

When both bank debt and bonds are available, the decision to invest depends on not only productivity but also assets, which allow firms to take advantage of the lower cost of bond finance. The entrepreneurs' decisions with both funding options are shown in Figure 8 panel (b). In contrast to panel (a), entrepreneurs with high productivity and high assets issue bonds. The advantage conferred by size decreases the borrowing threshold for large firms, leading to a lower threshold $z^* < r$ that is decreasing in the level of assets. As a consequence,

Figure 8: Entrepreneurs' decisions



(a) Bank debt only (b) Bank debt and bonds

Notes: Panel (a) shows the decisions of a joint distribution of entrepreneurs that are heterogenous in assets and productivity, in the case when bond issuance is infinitely costly, i.e. $f = \infty$, and banks are the only source of capital. Panel (b) shows the pattern of entrepreneurs' decisions for a finite $f' < f = \infty$.

the interest rate also affects the source of funding demanded by a subset of firms. When r rises, demand for bank loans decreases because some entrepreneurs no longer borrow from banks, and because firms switch to issuing bonds.

The aggregate outcomes in the economy are expressed as functions of the distribution of entrepreneurs' assets and productivity $G(a, z)$. Savings are given by:

$$S = \int_{\underline{a}}^{\overline{a}} \int_{\underline{z}}^{r_f} a \, dG(a, z), \tag{15}$$

while the demand for bank debt is:

$$L = \int_{\underline{a}}^{a^*} \int_{r}^{\overline{z}} \theta a \, dG(a, z). \tag{16}$$

The supply of bonds is:

$$B^S = \int_{a^*}^{\overline{a}} \int_{z^*(a)}^{\overline{z}} \theta a \, dG(a, z). \tag{17}$$

Total demand for funds in the economy is the sum of demand for bank loans and bond

issuance, which together add up to each entrepreneurs' borrowing constraint.

Total output in the economy is:

$$Y = \int_{\underline{a}}^{\overline{a}} \int_{r_f}^{\min\{r,z^*\}} za \, dG(a,z) + \int_{\underline{a}}^{\overline{a}} \int_{\min\{r,z^*\}}^{\overline{z}} z\theta a \, dG(a,z), \tag{18}$$

which includes both the output of self-financed entrepreneurs (first term) and the output of firms that borrow up to θ and produce (second term). An expression for aggregate productivity is:

$$Z = \frac{Y}{S + D^F + B^F} \tag{19}$$

which is the ratio of output to inputs, so the denominator includes both domestic capital and any foreign inflows.

In this economy, the optimal allocation of capital absent borrowing constraints would be for the highest productivity firms to invest all of the capital in the economy. Misallocation arises because firms' bounded demand for debt θ prevents capital from being allocated optimally. As the threshold for entry into borrowing markets falls, this decreases productivity Z, because the marginal borrowers entering have lower productivity than existing market participants. In addition, the bias towards large firms introduced by bond markets leads to further declines in productivity, or equivalently, increases in misallocation.

4.3 Results

To consider the impact of bond market liberalization, I compare the effect of a decline in the fixed cost of issuing bonds from infinite to some lower $f < \infty$. Since the equilibrium described above is static, the results are discussed using comparative statics.[12]

First, assume the economy is closed, i.e. $D^F = B^F = 0$. Under this assumption, the main effect of bond market liberalization is to increase the demand for funds of marginal firms that can access bond markets. Absent additional capital, this diverts funds from smaller firms through an increase in the lending rate. This result is formalized in Proposition 1.

Proposition 1. Closed economy bond market liberalization. *If $D^F = B^F = 0$, (i) domestic savers invest in bonds $B = B^S$, and (ii) a reduction in the fixed cost of issuing bonds to $f = \infty$:*

[12] Dynamics can be considered as a sequence of static equilibria with evolving bank equity and entrepreneur asset holdings.

1. *decreases a^* (new issuers);*

2. *decreases z^* (marginal large firms enter);*

3. *increases r (marginal small firms exit);*

4. *decreases Y (output); and,*

5. *decreases Z (productivity).*

The results of the introduction of a bond market on entrepreneurs' sorting is shown graphically in panel (a) of Figure 9. Decreasing the fixed cost of bond issuance leads more firms to issue bonds. Firms with $a > a^*$ and $z > r$ issue bonds, and use the bonds as a substitute for bank debt. Taken alone, the shift in a^* has no impact on the interest rate because savers are indifferent between bank deposits and bonds.

However, marginal entrepreneurs with many assets begin to borrow from banks and bond markets instead of self-financing, because the lower fixed cost improves the return to borrowing and investing. This arises because the threshold z^* at which large firms borrow is lower than r, and increases overall demand for loans and bonds. The increase in demand leads to an increase in the equilibrium interest rate r, which discourages marginal small firms from borrowing. Higher bank lending rates also encourage additional firms to issue bonds instead of bank debt, which adds to the downwards shift in the bond issuance cutoff a^*.

Because the closed economy bond market liberalization reallocates capital from small productive firms to less productive large firms, this decreases both output and aggregate productivity.

To more closely capture the dynamics of the bond market liberalization in Japan, now consider modified version of Proposition 1. As the fixed cost of issuing bonds is reduced to $f < \infty$, consider the impact of also allowing inflows (i.e. inflows start from zero, pre-liberalization). If there are sufficient inflows to the bond market (B^F) or inflows to banks (D^F), bond market liberalization will lead to a decline in r instead of an increase. This result is formalized in Proposition 2.

Proposition 2. Open economy bond market liberalization. *A reduction in the fixed cost of issuing bonds to $f < \infty$ leads to a decrease in r if:*

$$D^F + B^F > \int_{a^*}^{\overline{a}} \int_{z^*(a)}^{r} \theta a \, dG(a, z). \tag{20}$$

When this condition holds, the bond market liberalization:

1. *decreases a^* (new issuers);*

2. *decreases z^* (marginal large firms enter);*

3. *decreases r (marginal small firms enter);*

4. *increases Y (output); and,*

5. *decreases Z (productivity).*

These results are shown in panel (b) of Figure 9. As in the case of a closed economy liberalization, the assets threshold a^* for bond issuance falls because of the fall in f, and more firms issue bonds. Firms that switch from bank to bond financing repay bank debt, and marginal large firms choose to enter the borrowing market as f declines, as before. These firms issue bonds, which leads to a decline in demand for loans.

To make clear the effect of bond inflows, consider the case in which domestic savers are not permitted to invest in bonds, i.e. $B = 0$, and foreign investors purchase bonds. When $B = 0$, savers retain all of their savings at banks: $S = D$, and all bonds are purchased by foreign investors, i.e. $B^S = B^F$. Preventing savers from substituting from deposits to bonds leads to excess deposits relative to declining loan demand. A fall in the lending rate brings the market back into equilibrium, but necessitates more lending to entrepreneurs with low productivity. Although output rises due to the increases in entrepreneurs who borrow and invest, productivity falls.

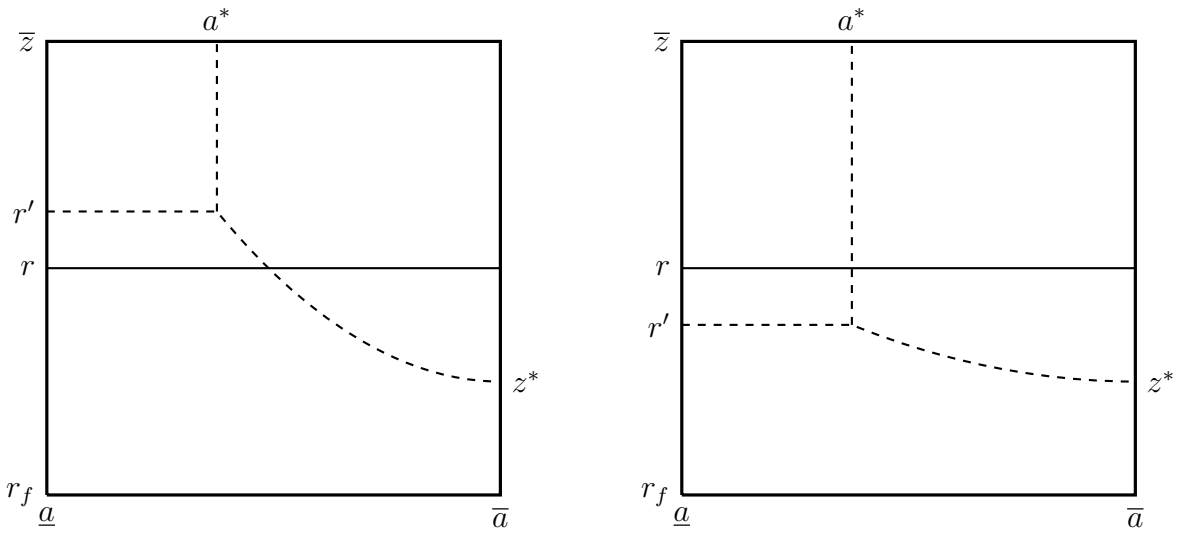
In the more general case when $B \neq 0$, foreign inflows to the bond market still cause some savers to be crowded out of investing in bonds. This leads to the same effect as described above, although to a lesser extent if domestic households have some ability to shift savings into the bond market.

The bond liberalization leads to spillovers because banks lose a portion of their loan volume to bond issuance, and then hold excess deposits relative to their remaining portfolio of loans. Returning deposits to households is ruled out by the exogenous risk-free rate. Absent other safe assets or investment options, and assuming firms' total borrowing remains unchanged, banks lend to marginal firms.[13]

More generally, an increase in capital in the economy through either inflow channel dampens the increase in interest rates caused by the growth of the bond market. Provided that inflows exceed the new demand for capital as in equation (20), the interest rate falls, and banks lend to marginal firms.

[13]The implications of altering the risk-free rate or borrowing limits are explored in Section 5.

Figure 9: Bond market liberalization



(a) Closed economy (b) Open economy

Notes: The solid lines represent the decision thresholds of entrepreneurs when the fixed cost to issue a bond is infinite, and the dashed lines represent the equilibrium result for $f < \infty$. Panel (a) shows the effect of a liberalization without foreign investment, while in panel (b) inflows are greater than the marginal issuance of bonds by firms that did not borrow from banks prior to the liberalization.

4.4 Discussion

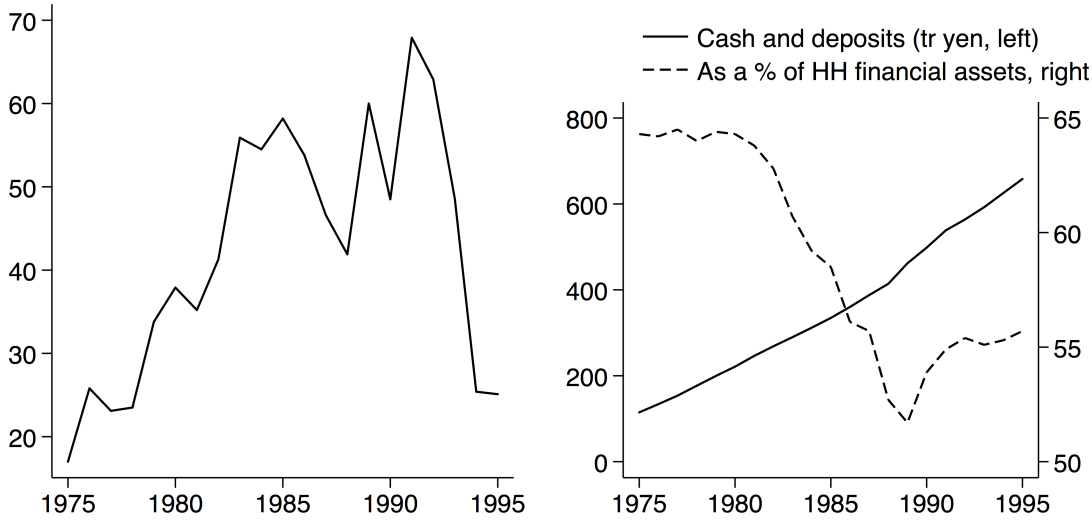
This model generates predictions consistent with the empirical finding that bond market liberalization indirectly affected bank lending. Firms that gained access to bond markets used bonds primarily as a substitute for bank debt. Bonds and bank loans are assumed to be substitutes in the model. As the fixed cost of bond issuance f falls, the threshold for bond issuance a^* falls. Banks face repayments due to the decline in a^*, which leads to a fall in demand for bank loans. That banks repaid as a result of the liberalization lend more to smaller firms and real estate is captured in the model results by declines in the lending rate r and the threshold for borrowing for firms with assets z^*.

In Japan, bond liberalization coincided with reduced restrictions on foreign exchange. The initial reforms to issuance criteria were followed by reforms in 1980 that allowed foreign bond issuances. Although firms still had to meet issuance requirements, less restrictive regulations applied to foreign bond issuance than to domestic bonds. Domestic issuances were required to be managed by trustee banks that charged high fees, and the fees for foreign issuance were much lower. A substantial portion of bonds issued from 1983 to 1993 went to foreign investors, as shown in Figure 10 panel (a).

Over the same period, deposits in the Japanese banking system grew steadily. This was partly due to the fact that savings options had been restricted during the post-war period, to allow the government control over which projects obtained funding through state influence over banks. Regulatory changes to deposit markets began after the liberalization of bond markets was well under way. Reforms to deposit markets allowed households to access a slowly expanding range of savings instruments, however, deposits in the banking system remained more than half of household financial assets over the 1980s, as shown in Figure 10 panel (b).

Together, the inflows to Japan's bond market and the growth of bank deposits suggest that foreign capital flowed into the bond market and was then used to repay bank debts, which banks lent on to marginal firms. The results indicate that these outcomes are also what would occur in an environment with inflows to the banking sector. However, it leaves open questions as to how generalizable these findings are, and how the size of bond markets has an impact on how an economy reacts to other shocks. These questions are explored in Section 5.

Figure 10: Foreign bond issuance and bank deposits



(a) $\frac{\text{Foreign bonds}}{\text{Total bond issuance}}$ (%) (b) Household cash and deposits

Notes: Over the 1980s, a significant portion of bond issuance consisted of foreign bonds. Over the same period, deposits remained more than half of total household financial assets, and the deposits in the banking system grew steadily in nominal terms. Source: Hoshi and Kashyap (2004).

5 Implications

The experience of Japan during the 1980s is informative for other episodes of bond market growth. In this section, I explore the generalizability of the model results in the previous section, and discuss how the size of bond markets affects the reaction of an economy to other shocks.

5.1 External validity

One striking result in the Japanese setting is the inelasticity of firm investment to the new availability of bond financing. If firms invest more as a result of policies that promote bond market growth, this can be captured by an increase in the parameter θ, which bounds the demand of firms for external financing. Increasing θ can be interpreted either as a loosening of a binding firm borrowing constraint, an increase in the collateralizability of firm assets, or a demand shock. In any case, the leverage firms can obtain is higher as a result of the increase in θ.

Increasing θ in response to a decline in f dampens the spillover effect a liberalization episode is likely to have on banks. For a given supply of funds, an increase in the demand for debt or borrowing limits of individual firms allows higher productivity firms to reach a larger scale, and leads to a greater increase in output and productivity.[14]

A second key consideration in the reaction of banks to bond markets is the responsiveness of depositors and other sources of bank funding to firms' substitution away from bank debt. Whether banks shrink or not directly affects whether capital remains within banks to be reallocated (and potentially misallocated). That said, a key motivating argument for the design of quantitative easing in Europe has been bank financial constraints, rather than constraints at the firm level. Bond markets are expanding in other regions in part because of banks' financial constraints. To consider this in the context of the model, I propose a simple extension. To allow banks to be financially constrained, assume that the deposits banks can attract are limited to a multiple of bank equity, in the spirit of Gertler and Kiyotaki (2010):

$$D + D^F \leq \phi E, \tag{21}$$

where $\phi > 0$ is a bank borrowing constraint. When equation (21) binds, the banks' balance

[14]This relates to the CSPP in Europe, where Grosse-Rueschkamp et al. (2017) find AAA-A rated firms to increase their acquisition activity after the introduction of the program.

sheet equation (9) becomes:

$$L = (\phi + 1)E. \tag{22}$$

This constraint implies either that banks have a limited capacity to intermediate domestic savings, in which case some domestic savings are invested abroad, or else that banks raise more deposits from foreign sources than they are able to raise domestically, in which case the constraint bounds banks' size.

The effect of a fall in f when banks are constrained is very similar to the effects described in Proposition 2: in response to more firms issuing bonds, a binding bank financial constraint requires a decline in r, which draws in additional marginal borrowers.

This reframes the results in Section 4 in a more positive light. When constrained banks limit productive investment, bond market liberalization allows more firms to invest. Substitution away from banks frees up bank funds to lend to other firms, which leads to declines in the participation thresholds for borrowing among other firms too small to issue bonds.

In relaxing banks' borrowing constraints, bonds can be particularly useful in allowing the economy to grow. Consider the case in which banks do not have sufficient equity to intermediate domestic savings ($S > \phi E$). In this case, banks' borrowing constraint limits their ability to lend. By allowing firms other financing options, bond markets provide an alternative asset in which households can save, and firms switching to bond issuance free up capital that banks can lend elsewhere. By providing an alternate form of financing, bond markets increase output relative to a case in which there are constrained banks.

A third consideration likely to impact the outcomes of bond market growth for banks is what alternative assets banks can invest in. It is puzzling that the banks in Japan do not invest in safe assets such as government bonds, or invest in the bond market, instead of lending more money to small firms and real estate firms. The underlying agency problems within banks may encourage them to take on excessive risk. Understanding the options banks have and the incentives of bank managers is central to what choices banks ultimately make when faced with competition from bond markets.

5.2 Further implications

The exercises in this final section demonstrate how bond markets affect the reaction of an economy to other shocks. In particular, I consider three specific macroeconomic shocks. First, I show how bond markets can amplify the macroeconomic response to a decline in the

risk free rate and a shock to firm borrowing. Second, bond markets are understood to dampen bank shocks, which I demonstrate in the context of the model, along with implications bond markets have for bank profitability.

5.2.1 Amplification results

Because bond markets help to dampen the effects of bank shocks, there is a presumption that bond markets add to financial stability. In this section, I demonstrate how bond markets may actually amplify the effect of shocks to the risk free rate and increases in firm borrowing, in particular when banks are constrained.

Capital account liberalization is often modeled is as a decline in the risk free rate. For example, a closed economy with a high internal risk-free rate opens its financial markets to abroad, and domestic agents can borrow more cheaply. This implies an increase in D^F and/or B^F leads to a decline in r_f, in the model. The reduction in r_f passes through to the lending rate r, due to competition among banks.[15] The decline in r increases the incentives of bank-dependent firms to borrow. This leads to an increase in output and a decrease in productivity, as in the bond liberalization case.

When banks are constrained, bond markets amplify the effects of a decline in r_f because the substitution of bonds for bank debt relaxes bank constraints and allows banks to lend more. Banks' constraint limits the ability of banks to expand, which also limits the pass through of r_f to r. As a result, a^* shifts to the left, and more firms issue bonds. This not only amplifies the effect of the decline in r_f among firms large enough to issue bonds, but also allows bank-dependent firms to borrow at a cheaper rate.

The changes that result from a decline in r_f are summarized in Proposition 3, and shown in panel (a) of Figure 11.

Proposition 3. Inflows and a decline in the risk free rate. *A shift in D^F and/or B^F that causes a decrease in r_f:*

1. *weakly decreases a^* (new issuers);*
2. *decreases z^* (marginal large firms enter), provided $f < \infty$;*
3. *decreases r (marginal small firms enter), by more for $f' < f$;*
4. *increases Y (output), by more for $f' < f$; and,*

[15] The extent of pass through observed empirically varies, see Harimohan et al. (2016), for example.

5. *decreases Z (productivity), by more for $f' < f$.*

That is, bond markets amplify effects on r, Y, and Z, i.e. 3-5 are decreasing in f.

The decline in productivity predicted here is consistent with the evidence of Reis (2013) in Portugal during the 2000s, in which entrepreneurs' participation in production is also based on the relative returns of investing versus saving. These predictions also relate to the model and empirical findings of Gopinath et al. (2017), who examine the efficiency of capital allocation in Spain and Southern Europe following the adoption of the Euro. The authors show increasing dispersion of the marginal revenue product of capital within manufacturing industries, which is consistent with the broader range of participation in production that results from a fall in the risk free rate in this framework.

Another common explanation for the real estate and stock market bubbles of the 1980s in Japan was the decline in Japanese interest rates, which fell from late 1980 until May of 1989. From comparing Propositions 2 and 3, the aggregate implications of a fall in the risk free rate go in the same direction as a bond market liberalization, potentially amplifying the bond market liberalization's effects.

Banks attenuate the full consequences of a decline in r_f, in particular when they are constrained. This could be seen as an impediment to growth, which bond markets alleviate. However, in the context of inflows, bank constraints would limit excessive capital from entering an economy. In this vein, bond markets may augment the ability of an economy to attract foreign capital. As a result, bond markets amplify the effects of a decline in r_f on interest rates, output, and productivity.

Bond markets also amplify the effects of a shock that increases firm borrowing, modeled as an increase in θ. Increased demand for funds causes an increase in r, and marginal entrepreneurs no longer borrow and invest. Firms obtain more funds, which is positive for output. If banks are limited by the extent that they can increase lending because of capital requirements, such as in equation (21), bond markets' interaction with banks relaxes the constraint. As the rise in r encourages large firms to issue bonds, banks' capital is freed up to lend to other borrowers. These effects are summarized in Proposition 4, and shown in panel (b) of Figure 11.

Proposition 4. Increase in firms' borrowing. *An increase in θ:*

1. *decreases a^* (new issuers);*

2. *decreases z^* (marginal large firms enter), provided $f < \infty$;*

3. *increases r (marginal small firms exit), by less for $f' < f$;*

4. *increases Y (output), by more for $f' < f$; and,*

5. *increases Z (productivity), by less for $f' < f$.*

That is, bond markets amplify increases in Y, but attenuate changes in r and Z.

This result relates to recent research on capital misallocation and financial frictions. Dynamic models of financial frictions predict that financial liberalization is associated with a better allocation of resources across firms (Midrigan and Xu, 2014; Buera et al., 2011). This conclusion is supported by empirical evidence in Eastern Europe since the collapse of the Soviet Union (Larrain and Stumpner, 2017), where lower borrowing costs are understood as having allowed firms to borrow greater amounts against existing collateral. However, bank constraints are actually helpful in this context, since the more funding banks can intermediate, the lower the productivity of the marginal borrower.

When banks have a limited capacity to intermediate funds, bond markets provide an additional source of financing for firms. With banks alone and a fixed supply of capital, a rise in θ leads to an improvement in the efficiency of capital allocation, as higher productivity firms are able to produce more, and some marginal firms are crowded out of the borrowing market. With bond markets, the substitution of bonds for bank debt helps to relax banks' financial constraints. Bond markets attenuate the productivity gains from capital misallocation, because relaxing bank financial constraints also has the effect of allowing more marginal firms to remain in the borrowing market. Further, the preference for large issuers in the bond markets distorts the allocation of capital towards large firms, and may crowd smaller firms out of the market.

The results of this section suggest that the growing influence of market-based financing can amplify the effects of declines in interest rates or increases in firm borrowing. This is important because the macroeconomic implications of the recent growth of bond markets are not yet fully understood.

5.2.2 Bond markets dampen bank shocks

As a final exercise, I revisit the idea that bond markets dampen the effects of bank shocks. The availability of substitutable forms of finance is understood to dampen the impact of bank shocks, and yet such shocks still played a significant role in the fall in output post-2008 (e.g., Chodorow-Reich, 2014). Similarly, banks in Japan suffered a large shock following

the collapse of land prices and the stock market bubble in the early 1990s. In the model presented here, a shock of this nature corresponds to a decline in either banks' borrowing constraint ϕ or bank equity E. Bond markets dampen the shock's effects, as formalized in Proposition 5.

Proposition 5. Bond markets damped bank shocks. *A decrease in ϕ when $D = \phi E$, or a decrease in E:*

1. *decreases a^* (new issuers);*
2. *does not change z^* (no change for large firms);*
3. *increases r (marginal small firms exit), by less for $f' < f$;*
4. *decreases Y (output), by less for $f' < f$; and,*
5. *increases Z (productivity), by less for $f' < f$.*

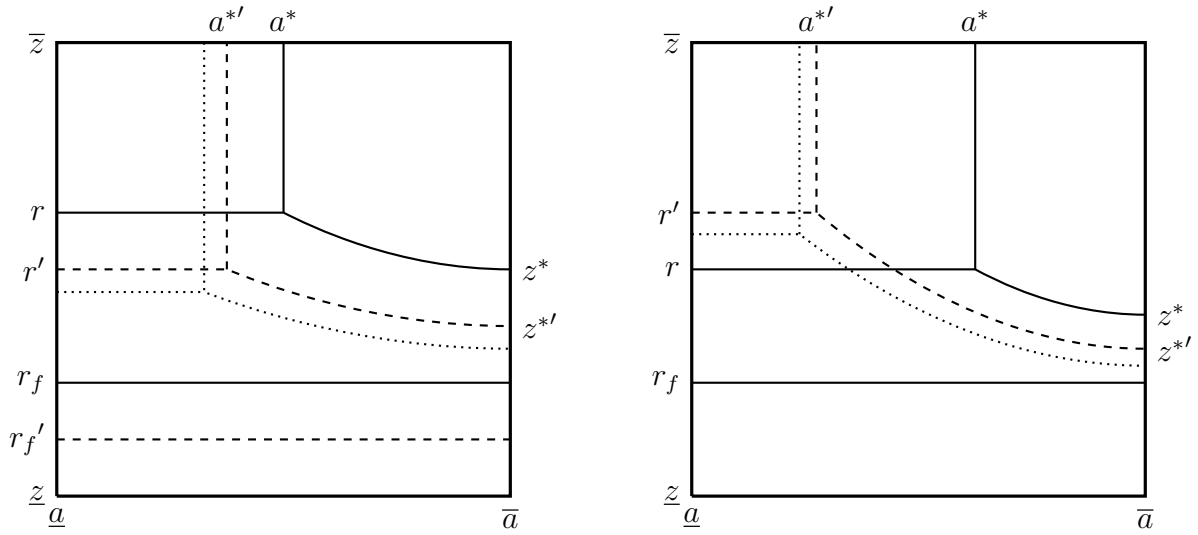
That is, bond markets attenuate the increases in r and Z, and the decreases in Y.

A shock to bank borrowing ϕ or bank equity E causes loan supply to fall, leading to an increase in r. When loans are more expensive, fewer firms borrow, and more firms issue bonds (i.e. a^* falls), as shown in Figure 12. Output contracts and productivity improves, because firms that continue to have access to external finance are more productive than firms that can no longer borrow. The increase in r increases bank profits, and decreases entrepreneurs' profits.

Bond markets cushion the impact of the initial shock on interest rates: as r rises, more firms issue bonds instead of bank debt, which allows for more production than if banks were to intermediate capital alone. To see this, consider an economy without bonds. A shock to bank equity leads to a decline in loan supply. For the lending market to clear, a large increase in r is necessary. With bond markets, the increase in r not only discourages borrowing from banks, but also makes issuing bonds more attractive. As a result, r increases by less, relative to the case in which there is no direct finance. Bond markets thus attenuate the decline in output.

In dampening the effects of a financial shock on the economy, however, bond markets also slow the pace of bank recovery. At a lower r, bank profits are lower. Consequently, there is slower growth in bank net worth. This has implications for policies that encourage bond issuance. For example, in reducing bond yields, quantitative easing may limit the prospects for bank recovery.

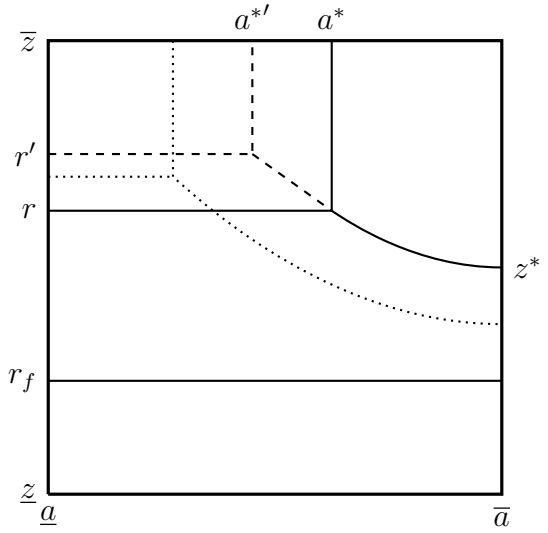
Figure 11: Amplification results



(a) Decline in the risk free rate (b) Increase in firm borrowing

Notes: Panel (a) shows the effect of a decline in the risk-free rate. The solid lines represent the decision thresholds of entrepreneurs for some initial r_f, while the dashed lines represent a decrease in the risk-free rate to $r_f{}' < r_f$. The dotted line indicates the implications of larger bond markets on the change. Panel (b) shows the effect of a increase in firm borrowing to $\theta' > \theta$ for the case when banks are unconstrained. The solid lines represent the decision thresholds of entrepreneurs for some initial θ, while the dashed lines represent a decrease in the risk-free rate to $\theta' > \theta$. The dotted line indicates the implications of larger bond markets on the change.

Figure 12: Bank shocks



Note: The solid line shows the initial participation decisions, while the dashed lines represent the outcomes at $\phi' < \phi$, and the dotted line demonstrates how a larger bond markets further dampens the effects of the shock.

6 Conclusion

This paper revisits the bond market liberalization in the 1980s in Japan as a case that highlights the interactions between bond markets and banks. I demonstrate that the liberalization led firms to issue bonds that were primarily used to repay bank debt. The repayment of bank debt was a positive liquidity shock for banks that lent to firms affected by the liberalization shock. This liquidity shock was transmitted by banks to firms in other parts of the economy, namely bank dependent firms, small and medium firms and real estate companies. This increased banks' exposure to riskier segments of the economy.

I develop a model to make sense of the empirical evidence, in which firms borrow from banks and issue bonds. The model matches the empirical evidence and demonstrates that two factors that led the bond market liberalization to have spillover effects via banks were the repression of domestic savers, combined with foreign investment in the bond market. This in particular contributed to excess deposits at banks, which then drove lending to marginal borrowers in the economy. The Japanese case is in this respect similar to other liberalization episodes. However, the channel by which inflows affected Japan differed, by flowing through corporate borrowers and indirectly reaching banks and other firms.

The transition to greater market-based financing is also relevant in other markets. China has successfully established a large and fast-growing corporate bond market over the past decade. Despite increased offshore issuance in recent years, foreign investment in Chinese bond markets remains limited. However, new programs introduced to allow foreign investors to buy onshore bonds via the Hong Kong bond market are estimated to spark inflows, and China's inclusion in emerging-market bond indices is likely to encourage further foreign investment in Chinese bonds. The model and results presented here suggest policymakers should be wary of how this impacts Chinese lenders.

In developed markets also, the importance of bond markets has grown steadily in recent years, encouraged by both the slow post-crisis recoveries of many banks and policies that facilitate bond issuance and/or reduce bond yields. The evidence in this paper suggests that this will affect not only bank outcomes but also the reaction of economies to future shocks. In particular, bond markets appear to amplify positive shocks such as increases in firm borrowing and declines in the risk-free rate, while attenuating the impact of negative financial shocks. In relaxing bank borrowing constraints, bond markets surge both in booms, and when there are financial crises. These results suggest that characterizing bond markets and these interactions is important to refining the approaches that incorporate financial frictions in macroeconomic models.

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Appendix

A Issuance criteria

Table A1: Accounting Criteria for Issuance of Domestic Convertible Bonds

Panel A: Secured bonds

	Minimum net worth (billion yen)	Hurdles	Capital Ratio	Dividends per share	Ratio of net worth to paid-in-capital	Business profits as a % of total assets	Ordinary after-tax profit per share
1976 Oct to 1987 Jul	10	1	15	5*	1.2	4	7*
	6	2	20	5*	1.5	5	7*
1987 Jul to 1990 Dec	10	1	10	5*	1.2	5	7*
	6	2	12	5*	1.5	6	7*
	3	2	15	5*	2.0	7	7*

Panel B: Unsecured bonds

	Minimum net worth (billion yen)	Hurdles	Capital Ratio	Dividends rule	Ratio of net worth to paid-in-capital	Business profits as a % of total assets	Interest coverage
1979 Mar to 1982 Dec	600	3	40*	a	10	4	4
	300	3	45*	a	14	8	6
	150	3	50*	a	18	12	8
1983 Jan to 1985 Jun	110	3	40*	a	10	4	4
1985 Jul to 1987 Jan	150	2	15	b*	6	1.2	1.5
	110	2	20	b*	7	1.5	2
	55	3	40*	a	10	4	4
	33	3	50*	a	12	5	5
1987 Feb to 1990 Oct	110	2	15	c*	6	1.2	1.5
	55	3	30*	a	8	3	3
	33	3	40*	a	10	4	4
	20	3	50*	a	12	5	5

Notes: * An asterisk indicates criteria that must be met, in addition to the minimum net worth. In addition, one to three other conditions must be satisfied, as indicated in the hurdles column. The capital ratio is calculated as the ratio of equity plus reserves to total assets. Business profits are not explicitly defined in the source, but are calculated using the common definition of operating profits + interest income + dividend income. Interest coverage is also not explicitly defined, but is commonly defined as either business profits divided by interest payments, or income before tax + interest payments divided by interest payments. The dividend rules are defined as follows: (a) dividends per share greater than ¥6 in the five most recent accounting periods, (b) positive dividends in the five most recent accounting periods, and dividends per share greater than ¥5 in the three most recent periods, and (c) dividends per share greater than ¥5 in the three most recent accounting periods. Source: Ministry of Finance, Ōkurashō Shōkenkyoku nenpō (various issues), Hoshi and Kashyap (2001).

Table A2: Ratings criteria for Issuance of Domestic Convertible Bonds

Panel A: Secured Bonds

1989 May to 1995 Dec	Rating of BB or higher, dividends per share greater than 5 yen, ordinary after-tax profit greater than 7 yen.

Panel B: Unsecured Bonds

1987 Jul to 1988 Oct	Rating of A or higher; or rating of BBB or higher if net worth is greater than 55 billion yen
1988 Nov to 1990 Oct	Rating of A or higher; or rating of BBB or higher if net worth is greater than 33 billion yen
1990 Nov to 1995 Dec	Rating of BBB or higher

Notes: There were no ratings criteria prior to July 1987, and they were abolished in January 1996. Source: Hoshi and Kashyap (2001).

B Additional empirical results

Table B1: The effect of bond market access on other firm outcomes, 1977-90

	Baseline results				Linear control variables		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 1. Dependent variable: Bank debt$_{j,t}$ / assets$_{j,t-1}$ ($L_{j,t}$)							
$Access_{j,t}$	-0.029***	-0.026***	-0.011**	-0.016***	-0.014***	-0.009*	-0.007
	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)
Observations	12,582	12,582	9,325	12,582	12,582	12,582	11,019
R-squared	0.80	0.81	0.84	0.82	0.80	0.86	0.87
Panel 2. Dependent variable: Interest payments$_t$ / debt$_{t-1}$							
$Access_{j,t}$	-0.015**	-0.015**	-0.003	-0.020**	-0.025***	-0.008	-0.005
	(0.006)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)
Observations	12,531	12,531	9,295	12,531	12,531	12,531	10,972
R-squared	0.59	0.60	0.63	0.59	0.59	0.60	0.62
Panel 3. Dependent variable: Total debt$_{j,t}$ / Assets$_{j,t-1}$							
$Access_{j,t}$	-0.025***	-0.025***	-0.009	-0.004	-0.013	-0.000	0.003
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Observations	13,132	13,132	9,787	13,132	13,132	13,132	11,416
R-squared	0.49	0.52	0.58	0.51	0.49	0.50	0.56
Panel 4. Dependent variable: Investment$_{j,t}$ / Tangible fixed assets$_{j,t-1}$							
$Access_{j,t}$	-0.040***	-0.034***	-0.013	-0.011	-0.032***	-0.005	0.001
	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Observations	12,526	12,526	9,326	12,526	12,526	12,526	10,887
R-squared	0.26	0.29	0.34	0.27	0.26	0.26	0.29
Panel 5. Dependent variable: Employees$_t$ / employees$_{t-1}$ − 1							
$Access_{j,t}$	-0.004*	-0.003	-0.005	0.006**	-0.003	0.003	0.004
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	13,117	13,117	9,777	13,117	13,117	13,117	11,401
R-squared	0.32	0.36	0.43	0.35	0.33	0.34	0.39
Control variables in all regressions:							
Firm and year fixed effects	Y	Y	Y	Y	Y	Y	Y
Controls*year dummies:							
Main bank		Y					
Industry & region			Y				
Size bin				Y			
Profitability bin				Y			
Net worth					Y	Y	Y
Capital ratio						Y	Y
Other criteria							Y

Notes: $Access_{j,t}$ is a dummy variable denoting whether firm j meets accounting criteria to issue unsecured convertible bonds in year t. The dependent variables are winsorized at the top and bottom one percent of observations. The size bins are divided at 1 million, 10 million, and 100 million. The profitability bins are divided at 4 percent and 9 percent, which correspond to the 25th and 75th percentiles of profitability in the sample. Other criteria includes business profits as a percentage of assets, the ratio of net worth to paid in capital, and the interest coverage ratio. Standard errors are clustered at the firm and year level, shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table B2: The effect of bond market access on other firm outcomes, continued, 1977-90

	Baseline results				Linear control variables		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 6. Dependent variable: Assets$_{j,t}$ / Assets$_{j,t-1} - 1$							
Access$_{j,t}$	-0.027***	-0.026***	-0.012*	-0.010	-0.033***	-0.016**	-0.010
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Observations	13,132	13,132	9,787	13,132	13,132	13,132	11,416
R-squared	0.36	0.39	0.47	0.38	0.37	0.37	0.42
Panel 7. Dependent variable: Sales$_{j,t}$ / Sales$_{j,t-1} - 1$							
Access$_{j,t}$	-0.025***	-0.025***	-0.009	-0.004	-0.013	-0.000	0.003
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Observations	13,132	13,132	9,787	13,132	13,132	13,132	11,416
R-squared	0.49	0.52	0.58	0.51	0.49	0.50	0.56
Panel 8. Dependent variable: Cash and cash equivalents$_{j,t}$ / Assets$_{j,t-1}$							
Access$_{j,t}$	0.032***	0.032***	0.031***	0.028***	0.025***	0.009**	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	13,903	13,903	10,332	13,903	13,903	13,903	12,094
R-squared	0.72	0.73	0.76	0.73	0.72	0.73	0.75
Panel 9. Dependent variable: Inventory$_{j,t}$ / Assets$_{j,t-1}$							
Access$_{j,t}$	-0.009***	-0.008***	-0.006***	-0.014***	-0.007***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	13,835	13,835	10,265	13,835	13,835	13,835	12,031
R-squared	0.89	0.90	0.91	0.89	0.89	0.89	0.91
Panel 10. Dependent variable: Book equity$_{j,t}$ / Book equity$_{j,t-1} - 1$							
Access$_{j,t}$	-0.078***	-0.074***	-0.059***	-0.060***	-0.110***	-0.024*	-0.007
	(0.011)	(0.011)	(0.013)	(0.013)	(0.012)	(0.013)	(0.013)
Observations	13,140	13,140	9,794	13,140	13,140	13,140	11,424
R-squared	0.24	0.29	0.37	0.30	0.25	0.28	0.37
Control variables in all regressions:							
Firm and year fixed effects	Y	Y	Y	Y	Y	Y	Y
Controls*year dummies:							
Main bank		Y					
Industry & region			Y				
Size bin				Y			
Profitability bin				Y			
Net worth					Y	Y	Y
Capital ratio						Y	Y
Other criteria							Y

Notes: *Access*$_{j,t}$ is a dummy variable denoting whether firm j meets accounting criteria to issue unsecured convertible bonds in year t. The dependent variables are winsorized at the top and bottom one percent of observations. The size bins are divided at 1 million, 10 million, and 100 million. The profitability bins are divided at 4 percent and 9 percent, which correspond to the 25th and 75th percentiles of profitability in the sample. Other criteria includes business profits as a percentage of assets, the ratio of net worth to paid in capital, and the interest coverage ratio. Standard errors are clustered at the firm and year level, shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

Table B3: The effect of repayment shocks on bank lending, 1983-1987

Dependent variable:	Δ log Real estate loans$_{i,t}$			Δ log Loans to small firms$_{i,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Repayment shock$_{i,t}$ / assets$_{i,t-1}$	0.778***	0.744***	0.682***	0.629***	0.517***	0.452***
	(0.105)	(0.114)	(0.163)	(0.071)	(0.097)	(0.112)
Δ Deposits$_{i,t}$ / assets$_{i,t-1}$			0.400***			0.235***
			(0.094)			(0.074)
Δ Other liabilities$_{i,t}$ / assets$_{i,t-1}$			0.127			0.161
			(0.176)			(0.143)
Δ Equity$_{i,t}$ / assets$_{i,t-1}$			-0.780			1.329
			(5.037)			(2.476)
Other bank controls			Y			Y
Year fixed effects		Y	Y		Y	Y
Bank fixed effects		Y	Y		Y	Y
Observations	415	415	415	422	422	422
R-squared	0.11	0.61	0.67	0.22	0.66	0.72

Notes: The interpretation of the coefficients is that a one percentage point increase in the size of the repayment shock relative to assets is associated with an increase in the growth rate of lending to real estate of 0.7 percentage points, and an increase in the growth rate of lending to small and medium firms of 0.5 percentage points. The repayment shocks and dependent variables are winsorized at the top and bottom one percent of observations. Standard errors are bootstrapped to adjust for the constructed repayment shock, and shown in parentheses. *, **, and *** indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

C Proofs

C.1 Proof of Proposition 1

Proof. Part (i) follows directly from equation (11). Part (ii.1) follows from the derivative of equation (13) with respect to f, (ii.2) follows from the derivative of equation (14) with respect to f. The shift down in the z^* curve leads to increased overall demand for funds (loan demand L and bond supply B^S). For the market to clear in equation (12), r rises giving (ii.3). For (ii.4), output falls as capital is diverted from high productivity small firms to large firms with lower productivity, and by extension Z falls also, giving (ii.5). □

C.2 Proof of Proposition 2

Proof. Part (i) and part (ii.1) and (ii.2) are as in the proof of Proposition 1. Part (ii.3) depends on whether supply of new funds exceeds demand. Because firms borrow a multiple of assets, incremental demand consists of bond issuance by newly entering firms, above a^*

and z^*, which is $\int_{a'}^{\overline{a}} \int_{z^*}^{r} \theta a \, dG(a, z)$. Parts (ii.4) and (ii.5) follow from (ii.3) and equations (18) and (19). □

C.3 Proof of Proposition 3

Proof. For part (1), note that (13) depends on $r - r_f$: if r declines by as much as r_f (i.e. when banks are unconstrained), a^* does not change. When the pass through of r_f to r is incomplete (i.e. when banks are constrained), a^* declines. This also depends on the existence of bond markets, i.e. $f < \infty$. If $f < \infty$, part (2) follows from the derivative of equation (14) with respect to r_f. The pass through of r_f to r comes from competition among banks, which gives part (3), provided that banks are not already constrained. When banks are constrained, then r cannot fall. For part (4), equation (18) is increasing in r_f (first term). Since $\theta > 1$, decreases in r further increase output by shifting entrepreneurs from self-financing into the borrowing market. Although output rises, marginal firms entering self-financing or borrowing markets have lower productivity than existing firms, which implies part (5).

For the effect of bond markets on these responses, note that when banks are constrained, the fall in r_f results in a shift in a^* which leads firms to shift away from bank borrowing and towards bond issuance. This relaxes the bank constraint and allows banks to lower r. As such, the decrease in r, increase in Y, and decrease in Y that result from a decline in r_f are decreasing in f (i.e. increasing in the size of bond markets). □

C.4 Proof of Proposition 4

Proof. Parts (1) and (2) follow from the derivatives of equations (13) and (14) with respect to θ. The increase in θ implies an increase in demand for capital among all firms, which requires either inflows or an increase in r for market clearing, yielding part (3). Part (4) comes from equation (18), where the second term is increasing in θ. Any increase in r reallocates capital from low z firms to high z firms, which increases output as well. In an unconstrained case without bond markets, the scale of all firms simply increases, which is neutral for productivity. However, with bond markets, the downward shift in z^* leads to large marginal firms entering the borrowing market, which lowers Z.

For the effect of bond markets on these responses, note that when banks are constrained, the fall in θ leads to an increase in r, which amplifies the shift in a^*. Because this relaxes the bank constraint, the increase in r is decreasing in the size of bond markets. By providing a source

of financing that relaxes bank constraints, bond markets amplify the increase in output Y, but allow lower productivity firms to remain in or enter the market, thus attenuating the increase in Z. □

C.5 Proof of Proposition 5

Proof. A a decline in ϕ when $D = \phi E$, or a decline in E requires an increase in r for market clearing, provided that not all firms can issue bonds, which gives part (3). Part (1) follows from the derivative of equation (13) with respect to r. Part (2) follows from the derivative of equation (14) with respect to r. The decline in output comes from equation (18), which gives part (4). Part (5) is implied by the increase in r, which implies an increase in the productivity of the marginal small firm in the borrowing market.

For the effect of bond markets on these responses, note that $\partial^2 a^*/\partial r \partial f < 0$. This implies that a smaller f (i.e. larger bond market) leads to a larger change in a^* results from a change in r. This relaxes bank borrowing constraints and attenuates the increase in r, which attenuates the effects on output and productivity. □