Credible commitment and the cost of venture debt

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Abstract

Prior research on venture lending suggests that VC-backed companies are more likely to receive loans since VC funds can provide a credible commitment to refinance the loan, reducing the repayment risk of the lender. In this paper, we investigate the impact of this credible commitment channel on venture loan costs. Using a large sample of venture debt contracts in the period 2005-2024, we find evidence that venture debt lenders incorporate the VC fund age at the time of loan expiration, precisely when credible commitment to refinance companies matters. In particular, we find that the loan borrowing costs, proxied by the interest rate charged for that loan, increase in VC fund age at loan expiration. We further find that this relationship is especially pronounced if the fund life of invested VC funds is approaching the end. Our study thus finds the link between credible commitment and the cost of venture debt.

Keywords: Venture debt, venture capital, borrowing cost, credible commitment

JEL classifications: G24, G32

1 Introduction

While conventional wisdom in the entrepreneurial finance literature suggests that "debt and start-ups don't mix" (Ibrahim (2010)), there exists a significant venture debt (VD) industry. As a result, lending to early-stage companies has received increased attention from researchers. Several papers explore the economic reasons behind the usage of debt by early-stage companies, which initially seems to contradict this conventional wisdom. The survey paper by Ibrahim (2010) suggests that venture lending extends the runway for VC investors, acting as bridge financing, and reducing dilution.[1] More recently, Gonzalez-Uribe and Mann (2024) support this claim by showing that VD helps overcome financing needs if firms are awaiting new information, such as trial outcomes. Davis et al. (2020) suggest that VD helps align incentives within the firm.

From the perspective of lenders, providing loans to early-stage companies may involve significant risks that cannot be minimized conventionally through positive cash flows or tangible collateral, with lenders instead seeking other signals of firm quality, such as the availability of patents (Hochberg et al. (2018)).[2] More important is the role of invested VC funds in facilitating lending, both in terms of quality certification and the provision of an exit strategy for the lenders. On the one hand, Ibrahim (2010) suggests venture lenders rely on the monitoring functions of VC funds. A similar argument is provided by Buchner et al. (2023), who study non-bank private debt to later-stage companies. They find that invested VC and PE funds assume a monitoring role and thereby decrease the cost of private debt. On the other hand, Mann (1999) suggests that venture lenders rely on the implicit but credible commitment of VC funds to grow and refinance

[1] The extension could be up to 6 months of extra runway, see https://www.bloomberg.com/news/articles/2008-09-19/how-venture-debt-financing-works-and-how-to-get-itbusinessweek-business-news-stock-market-and-financial-advice.

[2] As Ibrahim (2010) points out, venture lenders are often specialized financial institutions rather than traditional banks; however, both banks and non-banks participate in venture lending.

early-stage companies (Holmstrom and Tirole (1997), Hochberg et al. (2018)). The credibility stems from the fact that venture loan satisfaction is observable when VCs repay the venture loans, and their breach is potentially punishable due to a repeat relationship between the lenders and the VCs.[3] Similarly, Ibrahim (2010) suggests that venture lenders rely on subsequent rounds of VC financing for loan repayment, rather than the firm's ability to generate cash flows.

Nevertheless, as shown by Hochberg et al. (2018), the pure existence of VC fund investments at the lending date might not be sufficient to credibly commit to refinancing at the debt maturity date. Risk minimization will only happen if VC funds commit to providing fresh capital in the next financing rounds. Since VC funds typically have a limited fund life, their presence alone might be insufficient to commit future funding. In his survey, Ibrahim (2010) suggests that VC fund life is a relevant consideration for lenders next to prior relationships with the VC and VC's general reputation. Moreover, he notes that venture lenders prefer recent VC investments to ensure more present equity is available to repay loans due to uncertainty on follow-up investments. Similarly, Hochberg et al. (2018) find that venture lending activities decrease when invested VC funds cannot convincingly commit to further financing of start-ups due to capital constraints.

Our study extends this research by investigating the relationship between credible commitment and the cost of venture debt. Specifically, we explore how the fund age of invested VC funds impacts venture lending decisions. If the maturity date of venture debt is beyond the fund life of invested VC funds (at this maturity date), those fund investments will not lower the repayment risk for the lender. Our research question is whether venture lenders consider this when making their lending decisions and adjust the cost of debt accordingly. If they do, we predict that the higher the fund life at the debt maturity date, the higher the repayment risk and, thus, the higher

[3]See also Black and Gilson (1998) for a discussion on implicit vs explicit contracting.

the cost of debt.

We test this prediction using a large sample of venture debt contracts in the period 2005-2024. Our empirical results confirm our hypothesis that venture debt lenders incorporate the VC fund age at the time of loan expiration, precisely when credible commitment to refinance companies matters. In particular, the loan borrowing costs, proxied by the interest rate charged for that loan, increase in VC fund age at loan expiration. We further find that this relationship weakens when alternative commitment signals become available, such as the reputation of invested VC funds backing the borrowers, or when the public market signals are positive.

We further test whether this relationship is especially pronounced if the VC fund age at the loan maturity date is above the VC fund investment period. While the typical life of VC funds is 10 years, most investments are made within the first half of the fund's life, with only limited additional resources available for reinvestments. We find, however, that only the last few years of the VC fund life are critically important for venture lending decisions, and lenders do not consider the threshold of 5 years as relevant.

Lastly, we investigate the impact of VC fund life on the maturity choice of venture loans. Consistent with the relevance of the credible commitment channel, we find that lenders prefer to issue loans of lower maturity if the fund life of the invested VC funds approaches the end.

Our paper makes the following contributions. First, we provide novel empirical evidence that the presence of VC funds affects the costs of venture loans through the credible commitment channel. Prior research, including Buchner et al. (2023), has highlighted the monitoring role of VC and PE investors in later-stage companies, suggesting that it decreases the cost of private debt relative to companies without such investors. Our paper highlights the role of VC funds as providers of an exit strategy, which is more relevant in venture lending, consistent with Ibrahim

(2010) and Hochberg et al. (2018). We show that the provision of an exit strategy through a credible commitment to refinance early-stage companies decreases borrowing costs.

Second, we find additional empirical support for the claim raised in the survey paper by Ibrahim (2010) that VC fund life is a relevant consideration for venture lenders. Our empirical findings suggest that the sole presence of VC investments is not sufficient for risk minimization. Instead, lenders carefully examine the characteristics of invested VC funds that matter for future loan repayment. By highlighting the important role of VC fund life and its interaction with loan maturity, our evidence suggests that VC fund investments matter for loan borrowing costs. We thus find supporting evidence for Hochberg et al. (2018) who show that the disability of invested VC funds to commit further financing of start-ups decreases venture lending activities.

The remainder of the paper is organized as follows. Section 2 presents the institutional details relevant to the venture debt process and discusses our hypotheses. Section 3 presents the sample and the corresponding summary statistics. In Section 4, we empirically investigate the link between borrowing costs and VC fund age at loan maturity, and Section 5 concludes.

2 Institutional details & hypothesis development

2.1 Venture debt process

Venture debt (VD) serves as a financing channel for VC-backed companies that lack assets and cash flows to secure senior debts. It supports early-stage companies that are proving their business models, or later-stage companies that are expanding their market share or edging the stage of positive free cash flows. VD typically spans short to medium terms, and it is offered by specialized

banks (commercial banks, investment banks, or merchant banks) or non-bank lenders (Business Development Companies (BDCs), VC debt funds) with the aim of facilitating growth and covering capital expenditures.

In recent years, VD has experienced significant growth because lenders are able to offer a relatively inexpensive and nondilutive source of capital. According to Pitchbook, the amount of VD has increased more than three times over the past decade, rising from $8.1 billion in 2013 to $33.5 billion in 2022.[4]

Lenders in VD transactions often assess the creditworthiness of a borrower based on different criteria. They may examine whether the borrower is backed by reputable VCs, is operated under recurring or subscription-based revenue models, shows clear signs of positive cash flows, maintains a diversified customer base with minimal turnover, or has collateral, including intellectual property. Note that VC-backed companies often experience negative cash flows because they are in the early stage and spend a significant amount of cash on R&D and infrastructure development. Hence, VD lenders need to use different metrics to assess the company's ability to repay, such as the potential funds raised from VC funds in subsequent rounds. This approach is different from the approach used by traditional lenders, in which lenders rely on operating cash flows to assess repayment capability (Carey and Hrycay (2001)).

However, VC funds often allocate capital to companies at different stages. Due to their typical lifetime of 10 years, they usually invest in the first 5 years and start divesting their investments from year 6. The borrower's ability to receive another financing round from VC funds, therefore, depends on the horizon of the funds. This effectively serves as an indicator of the borrower's future

[4] https://pitchbook.com/news/reports/q1-2023-pitchbook-analyst-note-venture-debt-as-the-market-turns

potential to meet their repayment obligation.

2.2 Hypothesis development

Venture debt providers must secure themselves from the risk of not being paid out. Thus, their lending decision and the required interest rate will depend on the signals they receive about this repayment risk. Hochberg et al. (2018) find that venture lenders rely not only on firm quality (in the form of patent collaterals) but also on the credible commitment of VC funds to refinance and grow early-stage companies. Similarly, Buchner et al. (2023) show that backing by VC and PE funds decreases the cost of venture debt.

However, the pure existence of VC fund investments in the firm at the lending date might not be sufficient to credibly commit to refinancing at the debt maturity date. Instead, venture lenders need to consider the fund life of invested VC funds at the debt maturity date. As mentioned above, VC funds are typically organized as limited partnerships with a fund life of 10 years. Therefore, if the maturity date of venture debt is beyond the fund life of invested VC funds (at this maturity date), those fund investments will not lower the repayment risk for the lender. We hypothesize that venture lenders consider this when making their lending decisions and adjust the cost of debt accordingly. The higher the fund life at the debt maturity date, the higher the repayment risk and, thus, the higher the cost of debt.[5]

H1 (Fund life): When lending to a VC-backed enterprise, lenders consider the fund life of invested VC funds. We expect that the cost of venture debt will increase in VC fund age at the loan maturity date.

[5]We expect this relation to hold if the VC fund age at the debt maturity date is below 10 years. If the VC fund's age is beyond 10 years, the lenders will not consider these VC funds relevant to their lending decisions, as those funds will not affect the repayment to the lenders.

While the typical life of VC funds is 10 years, GPs are usually required to make investments within the first half of the fund's life. During this investment period, VC funds usually make the bulk of their investments and only keep additional resources for potential reinvestments in the remaining fund life. If the VC fund life matters for venture lending decisions, lenders will likely see a higher likelihood of debt repayment if the debt maturity date lies within the investment period. Therefore, the cost of venture debt should be lower if the maturity date lies within the investment period of invested VC funds.

H2 (Investment period): Since the contractual framework of VC funds requires the majority of investments to happen within the investment period, we expect that the cost of venture debt will particularly increase in VC fund age at the loan maturity date if this fund age is above the investment period.

3 Sample characteristics

3.1 Data

We use debt-lender data from Pitchbook to test the hypotheses above. The dataset covers detailed information on thousands of lenders, borrowers, and debt deals, such as maturity date, spread and interest rates, and deal amount. It has been used increasingly in private credit studies (e.g., Gonzalez-Uribe and Mann (2024), Jang and Kim (2025), Aldasoro and Doerr (2025), Cai and Haque (2024). We start with the sample of debt deals arranged at the lender-deal level. Because we focus on regular borrowings, we exclude all debt deals that are associated with buy-out/LBO. We then retain 238, 307 lender-deal observations from 2005 to 2024 after requiring the

information on debt amount and interest rate. Other miscellaneous deals related to bankruptcy (admin/reorganization), bankruptcy (liquidation), investor buyout by management, IPO, merger of equals, merger/acquisition, PIPE, reverse merger, and spin-off deals are also removed. We require that all borrowers are U.S. companies, as the majority of debt deals are made to U.S. borrowers. After applying this filter, we obtain 230,215 observations at the lender-deal level. We then aggregate information at the facility level as loan spread and other deal-level information are unchanged at this level, resulting in a sample of 96,633 loan facilities.

We then attempt to create a sample of VC debts. First, we need to identify all VC funds investing in a borrower prior to a particular debt deal, we first use the full sample of completed VC financing rounds from Pitchbook data. We require that financing rounds are in the late, early, and seed stages. We drop observations with missing round number information. To identify VC funds investing in each round, we merge the sample of VC deals with the deal-investor-relation file and obtain VC and fund details. There is a total of 217,037 observations at the fund-deal level after we apply this filter.

For each observation at the facility level, we search for all VC funds invested in the borrower prior to the debt deal date. As a result, we obtain 29,399 observations at the VC fund-facility level of which 8,587 observations have VC fund age equal to or less than 10 years. We apply this restriction because the borrowers are less likely to get another round of financing from the same VC fund. Note that the duration of VC funds is often 10 years, with some possible small extensions. After removing observations with missing information of variables needed to carry out baseline analyses. Our final sample has 7,105 transactions at the VC-fund-facility level. Table 1 summarizes main steps of our data collection procedure.

We then measure fund horizon as the number of years between the fund's vintage year and the

debt maturity year. We measure the fund horizon at the maturity date, as lenders are concerned about borrowers' ability to meet their debt obligations at this moment.

3.2 Summary statistics

Table 2 presents summary statistics for the variables used in our main analysis. Overall, our sample includes 7,105 loans issued to companies that received financing from VC funds, which are less than 10 years of age at the loan maturity date. Loans in the sample are predominantly non-syndicated (i.e., loans are provided by a single lender). Only 11% of the sample are syndicated loans which is significantly lower than the ratio of syndicated deals using the DealScan database at 77% in Cortés et al. (2020)'s study. The average maturity of the sample loans is 3.36 years, with 20% of the loans having 4 years and more in maturity.

As borrowers in private debt contracts are companies that are private, young, and informationally opaque, it is not surprising that financial data on borrower characteristics, that are commonly used in the lending literature to public firms, such as total assets, ROA, interest coverage, tangibility, etc., are not available for venture debt borrowers.

Regarding the characteristics of VC investors, the average assets under management (AUM) and the average age of the VC firms that invest in the borrowers of the venture debt are $10,773.2 million, and 17.27 years. Meanwhile, the average VC fund age is 7.18 years with a significant proportion of loan deals (45.4%) associated with VC fund life greater 5 and equal or less than 8 years.

The average loan spread is 7.67% with a large standard deviation of 3.18%. 25% of loan deals have a loan spread of more than 10.5%. The average loan size is $38.88 thousand. The majority

(96%) of the loan deals have at least one private lender.

Appendix Tables A.2 and A.3 display the distribution of the considered loans by year and industry, respectively. The majority of the loans have been issued in the post-2019 period.[6] The borrowers operate in a variety of industries, with over 40% operating in the information technology sector and 20% operating in the healthcare and consumer products sectors.

4 Empirical results

4.1 H1: VC fund life at debt maturity and borrowing costs

H1 suggests that VD lenders incorporate the fund life of invested VC funds into their lending decisions. In particular, this should be reflected in the cost of borrowing, with the cost of borrowing increasing in VC fund life. We approach this by directly testing the relationship between VC fund age at the loan maturity date and the interest rate charged for the loan. Because multiple VC funds may syndicate in a financing round, we treat each VC-fund-VD-facility pair as a unit of observation.

We begin by plotting the fund age at loan maturity against the loan spread. Figure 1 presents the plots. In Panel A, we group the loan data into 10 bins based on fund age at the loan maturity date, in Panel B, we group them into 5 bins, and in Panel C, we consider only floating-rate loans that use the prime rate as the base rate. Consistent with our predictions, visual observations reveal a positive relationship between fund age at loan maturity and the loan spread.

[6]Note that our sample covers Pitchbook loans up until June 2024.

Next, we want to formally estimate this relationship using the following OLS regression model:

$$Log(Spread) = \alpha + \beta \times Fund\ age + \lambda' X + FEs(Year, Security, Loan\ type) + \varepsilon \tag{1}$$

where $Log(Spread)$ is the logarithm of the spread of the VD facility. The main independent variable, $Fund\ age$, is the number of years between the VC fund's vintage year and the loan maturity date. In other words, it illustrates the age of the invested VC fund at the loan maturity date. X represents a vector of controls, including VC fund, debt facility, and borrower characteristics. VC fund characteristics include assets under management and VC fund age at loan initiation. Debt facility characteristics include the facility amount and indicators for syndicated loans and participation of private lenders. In addition, we control for the age of the borrower. We further include a variety of fixed effects, including industry-, year-, security- (first lien, second lien, secured, unsecured, and other), and loan type-fixed effects (loan, bridge, revolving credit line, and other).

Table 3 displays our baseline results. In accordance with H1, lenders to VC-backed enterprises incorporate the VC fund age into their lending decisions. Column (1) displays a positive correlation between the average VC fund age at the loan maturity date and the interest rate spread. Put differently, the higher the VC fund age at the loan maturity date, the higher the interest rate charged for the loan. Column (2) confirms that this result holds when controlling for the type of interest rate (floating vs. fixed).

We note that loans with different maturities may have different interest rates for other reasons. For instance, a lender would want to charge the same borrower a different rate on a 5-year loan relative to a 10-year loan. This can happen due to various reasons, including inflation expectations.

Thus, if we compare loan maturities at different VC fund horizons, we might in fact account for differences in maturities that are not related to the VC fund horizon. Such a case would confound our results. To account for this issue, we split our loans into maturity bins, where loans with similar maturities are clustered together. This allows us to compare loans with the same maturities but different VC fund ages at expiration. Column (3) suggests that our results remain robust after controlling for maturity differences. Overall, our baseline results suggest that an increase in the VC fund age by one year translates to an average increase in the interest rate between 0.6 and 0.8%.

To further verify the robustness of our baseline regression, we include additional controls for the characteristics of the VC funds involved. In particular, we control for VC fund size and prior successful exits by the VC fund, both through IPOs and M&A. We also control for the total VC capital raised by the borrower prior to the loan date. Table 4 suggests that results are largely robust to the inclusion of these additional controls.

4.1.1 The impact of alternative commitment signals

The results so far support the hypothesis that VD lenders consider the characteristics of the credible commitment, in particular the age of the invested VC funds, when making lending decisions. We want to test the circumstances under which this relationship holds. In particular, we predict that this relationship is stronger when lenders have fewer alternative signals of the VC fund commitment.

First, we focus on the market sentiment, particularly, deal valuations. If positive market sentiment serves as a signal of further VC investments, for instance, due to higher availability of funds from investors, then the reliance on the fund age of the invested VC funds should be less

pronounced. We formally test this in Table 5, where we include interactions with proxies for market sentiment. We follow Gompers et al. (2008) and construct two proxies for the private market sentiment. In column (1), we include the yearly industry median of valuation-sale multiples of IPO and M&A deals, whereas in column (2), we include this for all deals listed in Pitchbook. In both cases, the coefficients of the interactions are negative and statistically significant at the 1% level. The results confirm our prediction that the age of the VC fund matters, especially in low-sentiment markets, whereas in high-sentiment markets, VD lenders rely less on this characteristic. The positive and statistically significant coefficient of *Industry exit valuation-sale multiple* is consistent with Gompers et al. (2008)'s findings that when there are positive market signals, VC firms tend to increase their investments as they rationally react to attractive investment opportunities.

Second, we focus on VC firm's reputation and experience. Similarly, if reputable and experienced VCs are better at signaling further investments, then the reliance on the fund age of the invested VC funds should be less pronounced. Table 6 presents the results of the test using alternative measurements of VC reputation and investment experience used in the literature (Hochberg et al., 2007, Atanasov et al., 2012, Li et al., 2025). In column (1), we include the number of past exits by the VC, including IPO and M&A. In column (2), we only consider IPOs, in column (3) we include the number of investments made by the VC, and in column (4) we include the VC's age at the time of the investment into the borrower. The results largely confirm our prior findings that the age of the VC fund matters for VD lending decisions if fewer alternative signals are available.

4.2 H2: Exploring the effect within the investment period

Our second hypothesis suggests that VC fund age at the loan maturity date should impact the lending decision precisely in those situations where the age of the fund is above the investment period. As a reminder, the contractual setting requires VC funds to make the majority of investments within the first five years, leaving only limited funds for investment activities beyond this period. If the VC fund age at the loan maturity date is above the investment period, those funds will not significantly lower the repayment risk for the lender. We test whether lenders consider this when providing credit to venture-backed companies by adjusting the above regression. In particular, we replace *Fund age* with a dummy variable equal to 1 if the VC fund age at the loan maturity date is above 5 years, 0 otherwise. Thus, we estimate whether the impact on the loan interest rate is especially pronounced if the fund age is above 5 years.

Columns (1) to (3) of Table 7 display the results. The coefficient on the dummy variable is positive but not statistically significant in any of the specifications. This result is not consistent with the hypothesis that the investment period cutoff of 5 years serves as the decision factor in the choice of the interest rate. We further test whether VD lenders consider a different threshold than 5 years. In columns (4) to (6), we therefore introduce a dummy variable equal to 1 if the VC fund age at the loan maturity date is between 5 and 8 years, and a further one equal to 1 if the VC fund age at the loan maturity date is above 8 years. Interestingly, we observe that the coefficients are statistically significant if the VC fund age at the loan maturity date is above 8 years. These results suggest that VD lenders do consider the fund age of the invested VC fund; however, the repayment risk only matters if invested VC funds are close to expiration.

4.3 VC fund age and probability of next VC round

To shed further light on the role of VC fund age in the VD lending decision, we want to analyse whether the VC fund age indeed predicts next round refinancing of the borrower (by already invested VC funds). If higher VC fund age indicates lower ability of the VC fund to invest in the next round, we hypothesize that the probability of refinancing decreases with higher fund age.

To test this hypothesis, we collect a full sample of VC funds' investments from Pitchbook data. First, we select all venture capital deals that are completed. We only keep VC investments in seed, early, or later stage to U.S. companies between 2005 and 2024. We then identify all VC funds participate in each financing round. After removing all observation with missing information of variables needed to conduct analyses, i.e., fund size, fund age, and total invested equity, the sample contains 118,517 observations at the VC-fund-round level.

Formally, we perform an ex post probit analysis where the dependent variable is *Next financing round*, a dummy variable equal to one if the focal firm obtains funding in the next financing round from the same VC fund, and zero otherwise. As independent variables, we again include a dummy variable equal to 1 if the VC fund age at the loan maturity date is between 5 and 8 years, *Fund age 58*, and a further one equal to 1 if the VC fund age at the loan maturity date is above 8 years, *Fund age 810*. In addition, we control for *Log(VC fund size)* which is the natural logarithm of the VC fund's size. *Log(Funding raised to current VC deal date)* is the natural logarithm of one plus the total funding raised up to the present VC financing round. We also include year and industry fixed effects in the probit regression models.

Table 8 presents the estimation results. In column (1), we consider all financing rounds by all VC firms and treat each VC fund in a financing round as a separate observation. In column

(2), we keep all financing rounds but focus only on the lead VC of each round. In column (3), our sample includes first financing rounds only while keeping all VC funds participating in the rounds, and in column (4), we limit the sample to first financing rounds and focus on lead VCs. The results suggest that the VC fund age is indeed negatively related to the probability of next round refinancing. Particularly, the coefficients of *Fund age 58* and *Fund age 810* are all negative and statistically significant in all specifications. The large marginal effects also imply that the negative effects are economically significant. We also observe that the coefficients of *Fund age 810* are larger than those of *Fund age 58*, suggesting that the effects are even larger when VC funds approach maturity.

The coefficients of other control variables are also consistent with the literature. Specifically, the coefficient of *Log(VC fund size)* is positive and statistically significant in all specifications, indicating that larger VC funds are more likely to participate in the subsequent financing round. Similarly, the larger the amount of funding raised by the focal firm, the more likely that it continues receive funding from the same VC fund because it builds up trust from prior financing rounds. The coefficient of *Log(Funding raised to current VC deal date)* is positive and statistically significant in all models.

4.4 VC fund age and loan maturity

Lastly, we want to analyse the impact of VC fund age on characteristics of the VD lending agreement other than the costs of borrowing. Specifically, we ask whether VD lenders time the loan repayment date in accordance with their expectations of the credible commitment of the VC fund. We hypothesize that lenders will choose the maturity date of the loan so that it will still be

within the life period of the invested VC fund.

Figure 2 illustrates the relationship between the fund age at the loan initiation date and loan maturity. We can clearly observe that the loan maturity gradually decreases after the average VC fund life has reached the investment period of 5 years. We formally confirm this relationship in Table 9, where we regress the loan maturity on the average VC fund life at contract initiation. The coefficient of interest is negative and statistically significant at the 1% level, confirming the visual observation.

5 Conclusion

Prior research on lending to VC-backed companies (e.g., Hochberg et al. (2018) and Buchner et al. (2023)) has established that creditors rely on the credible commitment of VC funds to refinance companies. Nevertheless, the precise channel of this credible commitment has not been well researched since the pure existence of VC fund investments at the lending date might not be sufficient to credibly commit to refinancing at the debt maturity date.

In this paper, we explore how venture lenders take into consideration the ability of invested VC funds to refinance companies. In particular, we explore the role of the fund age of invested VC funds. Using a large sample of venture debt contracts in the period 2005-2024, we find evidence that venture debt lenders incorporate the VC fund age at the time of loan expiration, precisely when credible commitment to refinance companies matters. In particular, we find that the loan borrowing costs, proxied by the interest rate charged for that loan, increase in VC fund age at loan expiration. We also find that this effect is especially pronounced during the last years of the VC fund's life. Additionally, we find that borrowers issue loans of shorter maturity when the fund life

of invested VC funds approaches the end. Our paper thus contributes to a better understanding of the credible commitment channel in venture lending.

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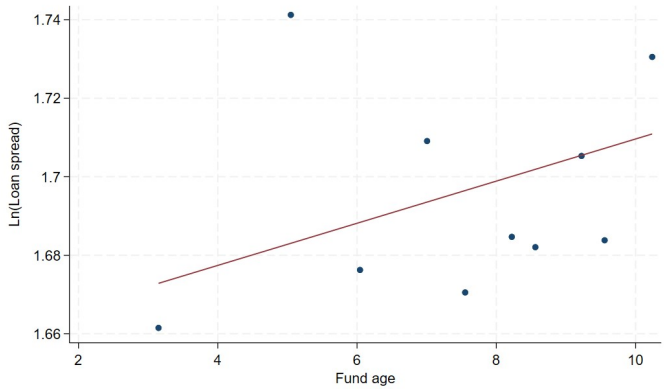
6 Figures & Tables

Figure 1: **Fund age at loan maturity and loan spread**

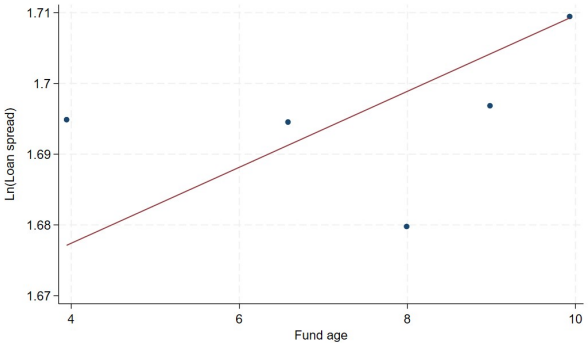
This figure displays the relationship between fund age at loan maturity and loan spread. Ln(Loan spread) is the natural logarithm of the loan spread over the reference rate. **Fund age** is the number of years between the VC fund's vintage year and the maturity date.

Panel A uses all loan data grouped into 10 bins. Panel B uses all loan data grouped into 5 bins. Panel C focuses on floating-rate loans that use the prime rate as their base rate, grouped into 5 bins.

Panel A. All loan data grouped into 10 bins



Panel B. All loan data grouped into 5 bins



Panel C. Floating rate loans using the prime rate as the base rate, grouped into 5 bins

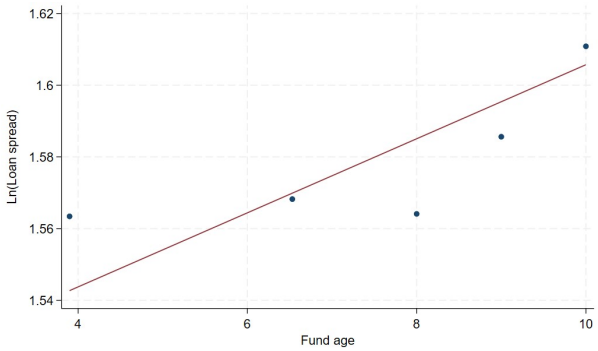


Figure 2: **Fund age at loan date and maturity of loan contract**

This figure displays the relationship between fund age at the loan initiation date and loan maturity. *Years from vintage* is the number of years from the fund's vintage to the loan date. *Loan maturity* is the maturity of the loan contract, measured in years.

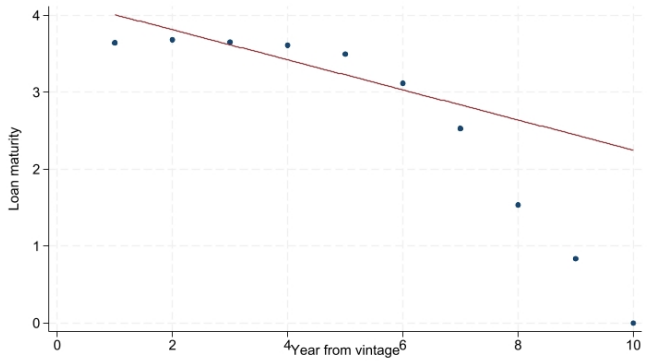


Table 1: **Sample construction**

No	**Data steps**	**Observations**	**Observation unit**
1	Select all lender-deal observations after removing observations with missing values of debt amount and interest rate and excluding deals associated with LBO	238,307	lender-deal
2	Remove all miscellaneous deals and non-US borrowers	230,215	lender-deal
3	Aggregate information at the facility level	96,633	facility
4	Select VC debts at the VC-fund-facility level	29,399	VC-fund-facility
5	Select observations where the VC fund age at maturity equal to or less than 10 years	8,578	VC-fund-facility
6	Remove observations with missing information of variables in baseline analyses	7,105	VC-fund-facility

Table 2: **Descriptive statistics**

This table presents summary statistics of loan, borrower, lender, and investor characteristics . We use a sample of venture debt deals in the period 2005-6/2024. All variables are defined in Table A.1

Variables	**Observations**	**Mean**	**SD**	**P25**	**P50**	**P75**
Fund age	7,105	7.180	2.171	6	8	9
Fund age 58	7,105	0.454	0.498	0	0	1
Fund age 810	7,105	0.325	0.468	0	0	1
Ln(VC age)	7,105	2.619	0.758	2.079	2.565	3.135
Ln(AUM)	7,105	7.108	2.141	5.704	7.049	8.412
Syndicated	7,105	0.111	0.314	0	0	0
Private lender	7,105	0.960	0.195	1	1	1
Ln(Loan size)	7,105	1.664	1.686	0.793	1.609	2.397
Ln(Company age)	7,105	2.058	0.481	1.792	2.079	2.398
Loan spread	7,105	7.665	3.183	5	7.25	10.5
AUM	7,105	10773.2	36495.9	300.0	1152.0	4500.0
Loan amount	7,105	38.876	164.484	2.210	5.000	10.987
Company age	7,105	7.756	4.254	5	7	10
VC age	7,105	17.272	15.007	7	12	22
Loan maturity	7,105	3.359	1.191	2.921	3.258	4.003
Ln(Raised to date)	7,028	4.740	1.444	3.933	4.723	5.491

Table 3: **VC fund age at loan maturity and loan spread**

This table presents the results of the OLS regressions of the determinants of venture borrowing costs. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable is *Ln(Loan spread)*, which is the natural logarithm of the loan spread over the reference rate. The main independent variable is *Fund age*, which is the the number of years between the VC fund's vintage year and the maturity date. All other variables are defined in Table A.1. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, 10% levels, respectively.

Variables	**(1)**	**(2)**	**(3)**
Fund age	0.008***	0.006***	0.007***
	(0.003)	(0.002)	(0.003)
Ln(VC age)	-0.013	-0.011	-0.013
	(0.008)	(0.007)	(0.008)
Ln(AUM)	-0.004	0.000	-0.002
	(0.003)	(0.002)	(0.003)
Syndicated	0.069***	-0.023	0.065***
	(0.016)	(0.017)	(0.017)
Private lender	0.514***	0.548***	0.492***
	(0.043)	(0.044)	(0.044)
Ln(Loan size)	-0.041***	-0.009**	-0.040***
	(0.004)	(0.004)	(0.004)
Ln(Company age)	-0.107***	-0.078***	-0.103***
	(0.012)	(0.011)	(0.012)
Constant	1.713***	1.559***	1.722***
	(0.056)	(0.054)	(0.057)
Observations	7,105	7,105	7,105
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Security FE	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes
Rate float FE		Yes	
5-bin Maturity FE			Yes
Adjusted R-squared	0.325	0.489	0.338

Table 4: **Robustness of the baseline regression**

This table reports the results of our robustness checks. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable in all models is *Ln(Loan spread)*, which is the natural logarithm of the loan spread over the reference rate. The main independent variable is *Fund age*, which is the the number of years between the VC fund's vintage year and the maturity date. Compared with the baseline regressions, we add *Ln(Fund size)*, *Ln(Raised to date)*, and *VC's exits* as additional control variables. *Ln(Fund size)* is the natural logarithm of the fund size. *Ln(Raised to date)* is the natural logarithm of the total capital raised prior to the loan date. *VC's exits* is the natural logarithm of one plus the VC firm's number of exits (IPOs/M&As). All other variables are defined in Table A.1. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, 10% levels, respectively.

Variables	**(1)**	**(2)**	**(3)**
Fund age	0.006**	0.005**	0.005*
	(0.003)	(0.002)	(0.003)
Ln(Fund size)	-0.002	0.002	0.000
	(0.005)	(0.004)	(0.005)
Ln(Raised to date)	-0.036***	-0.007	-0.030***
	(0.006)	(0.005)	(0.006)
VC's exits	0.006	0.013***	0.008
	(0.005)	(0.005)	(0.005)
Ln(VC age)	-0.026**	-0.033***	-0.028**
	(0.011)	(0.010)	(0.011)
Ln(AUM)	-0.003	-0.004	-0.004
	(0.004)	(0.003)	(0.004)
Syndicated	0.093***	-0.015	0.081***
	(0.017)	(0.019)	(0.018)
Private lender	0.512***	0.532***	0.482***
	(0.044)	(0.043)	(0.045)
Ln(Loan size)	-0.031***	-0.009**	-0.033***
	(0.004)	(0.004)	(0.004)
Ln(Company age)	-0.066***	-0.050***	-0.067***
	(0.014)	(0.012)	(0.014)
Constant	1.821***	1.598***	1.830***
	(0.059)	(0.055)	(0.059)
Observations	7,105	7,105	7,105
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Security FE	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes
Rate float FE		Yes	
5-bin Maturity FE			Yes
Adjusted R-squared	0.325	0.489	0.338

Table 5: **VC fund age at loan maturity and loan spread - The role of market condition**

This table presents the results of estimating the mediating effect of private market sentiment on the relation between the VC fund age at loan maturity and loan spread. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable is *Ln(Loan spread)*, which is the natural logarithm of the loan spread over the reference rate. The main independent variable is *Fund age*, which is the the number of years between the VC fund's vintage year and the maturity date. *Industry exit valuation-sale multiple* is the yearly industry median of valuation-sale multiples of all IPO or M&A exits listed in the Pitchbook database. *All industry valuation-sale multiple* is the yearly industry median of valuation-sale multiples of all deals listed in Pitchbook database. All other variables are defined in Table A.1. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, or 10% levels, respectively.

Variables	**(1)**	**(2)**
Fund age	0.028***	0.027***
	(0.005)	(0.004)
Industry exit valuation-sale multiple	0.022***	
	(0.007)	
Fund age * Industry exit valuation-sale multiple	-0.005***	
	(0.001)	
All industry valuation-sale multiple		0.000
		(0.004)
Fund age * All industry valuation-sale multiple		-0.002***
		(0.000)
Ln(VC age)	-0.012	-0.011
	(0.008)	(0.008)
Ln(AUM)	-0.004	-0.004
	(0.003)	(0.003)
Syndicated	0.075***	0.075***
	(0.016)	(0.016)
Private lender	0.511***	0.505***
	(0.043)	(0.043)
Ln(Loan size)	-0.041***	-0.039***
	(0.004)	(0.004)
Ln(Company age)	-0.105***	-0.109***
	(0.012)	(0.012)
Constant	1.620***	1.723***
	(0.064)	(0.067)
Observations	7,105	7,105
R-squared	0.332	0.336
Industry FE	Yes	Yes
Year FE	Yes	Yes
Security FE	Yes	Yes
Loan type FE	Yes	Yes
Adjusted R-squared	0.328	0.332

Table 6: **VC fund age at loan maturity and loan spread - The role of VC firms' reputation**

This table presents the results of estimating the mediating effect of the VC firm's reputation on the relation between the VC fund age at loan maturity and loan spread. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable is *Ln(Loan spread)*, which is the logarithm of the interest rate charged on the loan. The main independent variable is *Fund age*, which is the the number of years between the VC fund's vintage year and the maturity date. *VC's exits* is the natural logarithm of one plus the VC firm's number of exits (IPO/M&A) prior to the loan date. *VC's IPO exits* is the natural logarithm of one plus the VC firm's number of IPO exits prior to the loan date. *VC's past deals* is the natural logarithm of one plus the VC firm's number of investments prior to the loan date. *Ln(VC age)* is the natural logarithm of one plus the number of years between the VC's founding year and the transaction year. All other variables are defined in Table A.1. The regressions include a variety of fixed effects. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, or 10% levels, respectively.

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Fund age	0.021***	0.016***	0.016*	0.034***
	(0.006)	(0.004)	(0.009)	(0.009)
VC's exits	0.038***			
	(0.013)			
Fund age * VC's exits	-0.004***			
	(0.002)			
VC's IPO exits		0.050***		
		(0.015)		
Fund age * VC's IPO exits		-0.005***		
		(0.002)		
VC's past deals			0.026**	
			(0.013)	
Fund age * VC's past deals			-0.002	
			(0.002)	
Fund age * Ln(VC age)				-0.010***
				(0.003)
Control	Yes	Yes	Yes	Yes
Observations	7,105	7,105	7,105	7,105
R-squared	0.330	0.330	0.330	0.330
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Security FE	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes
Adjusted R-squared	0.326	0.326	0.325	0.326

Table 7: **Exploring the effect within the investment period**

This table presents the results of the OLS regressions of the determinants of venture borrowing costs. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable is *Ln(Loan spread)*, which is the natural logarithm of the loan spread over the reference rate. The main independent variable in the first 3 columns is *Fund age 5*, which is a dummy variable equal to 1 if the average fund age of invested VC funds at loan maturity is above 5 years, 0 otherwise. In the last 3 columns, the main independent variables are *Fund age 58* and *Fund age 810*. *Fund age 58* is a dummy variable equal to one if the fund age at the loan maturity date is greater than 5 and smaller than or equal to 8. *Fund age 810* is a dummy variable equal to one if the fund age at the loan maturity date is greater than 8 and smaller than or equal to 10. All other variables are defined in Table A.1. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, 10% levels, respectively.

Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Fund age 5	0.018	0.011	0.013			
	(0.012)	(0.011)	(0.012)			
Fund age 58				0.010	0.003	0.006
				(0.013)	(0.011)	(0.013)
Fund age 810				0.032**	0.023*	0.028*
				(0.015)	(0.013)	(0.015)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,105	7,105	7,105	7,105	7,105	7,105
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Security FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan type FE	Yes	Yes	Yes	Yes	Yes	Yes
Rate float FE		Yes			Yes	
5-bin Maturity FE			Yes			Yes
Adjusted R-squared	0.324	0.489	0.335	0.324	0.489	0.336

Table 8: **VC fund age and the next round likelihood by the same VC fund**

This table presents the results of the probit regressions of next round likelihood on VC fund age. We use a sample of 118,517 VC funds' investments during the period 2005-6/2024. The dependent variable is *Next financing round*, a dummy variable that equals one if the focal firm obtains funding in the next financing round from the same VC fund, and zero otherwise. The main independent variables are *Fund age 58* and *Fund age 810*, where *Fund age 58* is a dummy variable equal to one if the fund age at the loan maturity date is greater than 5 and smaller than or equal to 8; *Fund age 810* is a dummy variable equal to one if the fund age at the loan maturity date is greater than 8 and smaller than or equal to 10. All other variables are defined in Table A.1. *Log(VC fund size)* is the natural logarithm of the VC fund's size. *Log(Funding raised to current VC deal date)* is the natural logarithm of one plus the total funding raised up to the present VC financing round. Standard errors are reported in brackets are cluster at the VC financing year. Marginal effects are in square brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, 10% levels, respectively.

Variables	**(1)** All rounds & All VCs	**(2)** All rounds & Lead VC	**(3)** First round & All VCs	**(4)** First round & Lead VC
Fund age 58	-0.062***	-0.016	-0.095***	-0.098**
	(0.014)	(0.032)	(0.031)	(0.050)
(Marginal effect)	[-0.022***]	[-0.006***]	[-0.034***]	[-0.035**]
Fund age 810	-0.230***	-0.179**	-0.244***	-0.321***
	(0.036)	(0.079)	(0.062)	(0.114)
(Marginal effect)	[-0.082***]	[-0.064**]	[-0.085***]	[-0.113***]
Log(VC fund size)	0.016***	0.057***	0.033***	0.091***
	(0.003)	(0.006)	(0.005)	(0.010)
Log(Funding raised to current VC deal date)	0.097***	0.055***	0.204***	0.109***
	(0.015)	(0.018)	(0.020)	(0.031)
Observations	118,517	23,737	35,817	7,611
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Pseudo R-squared	0.086	0.095	0.100	0.101

Table 9: **VC fund age at loan initiation and loan maturity**

This table presents the results of the OLS regression of loan maturity on VC fund age at loan initiation. We use a sample of venture debt deals in the period 2005-6/2024. The dependent variable is *Loan maturity*, which is the maturity of the loan contract, measured in years. The main independent variable is *Years from vintage*, which is the average fund life of invested VC funds at loan initiation, calculated as the number of years from VC funds' vintage to loan date. All other variables are defined in Table A.1. Standard errors are robust to heteroskedasticity and are reported in brackets. Superscripts ***, **, or * indicate significance at the 1%, 5%, or 10% levels, respectively.

Variables	**(1)**
Years from vintage	-0.173***
	(0.008)
Ln(VC age)	0.088***
	(0.020)
Ln(AUM)	-0.030***
	(0.007)
Syndicated	0.495***
	(0.061)
Private lender	0.107
	(0.095)
Ln(Loan size)	0.168***
	(0.011)
Ln(Company age)	0.136***
	(0.033)
Constant	3.379***
	(0.126)
Observations	6,605
Industry FE	Yes
Year FE	Yes
Security FE	Yes
Loan type FE	Yes
Adjusted R-squared	0.329

Table A.1: **Variable descriptions**

This table presents the definitions of the variables used in this study.

Variable name	Definition
Facility characterstics	
Ln(Loan spread)	Natural logarithm of the loan spread over the reference rate
Ln(Loan size)	Natural logarithm of the facility's amount
Loan maturity	Maturity of the loan contract, measured in years
Lender characterstics	
Ln(Lender's age)	Average lenders' age, where the age of each lender is calculated as the natural logarithm of one plus the number of years between the lender's founding year and the debt transaction year
Private lender	Dummy variable equal to one if at least one private lender participates in the facility, and zero otherwise
Syndicated	Dummy variable equal to one if the number of lenders in the facility is greater than one, and zero otherwise
Ln(lenders)	Natural logarithm of the number of lenders
Borrower characterstics	
Ln(Company age)	Natural logarithm of one plus the number of years between the company's founding year and transaction year
Ln(Raised to date)	Natural logarithm of total capital raised by the borrower prior to the loan date
Next financing round	Dummy variable equal to one if the focal firm obtains funding in the next financing round from the same VC fund, and zero otherwise
VC fund age	
Fund age	Number of years between the VC fund's vintage year and the maturity date
Years from vintage	Number of years from the fund's vintage to the loan date
Ln(VC age)	Natural logarithm of the number of years between the VC's founding year and the debt transaction year
Fund age 5	Dummy variable equal to one if the fund age at the maturity date is greater than 5, and zero otherwise
Fund age 58	Dummy variable equal to one if the fund age at the maturity date is greater than 5 and smaller than or equal to 8, and zero otherwise
Fund age 810	Dummy variable equal to one if the fund age at the maturity date is greater than 8 and smaller than or equal to 10, and zero otherwise
VC fund characteristics	
Ln(Fund size)	Natural logarithm of VC fund's size
VC's IPO exits	Natural logarithm of one plus the VC firm's number of IPO exits prior to the loan date
VC's exits	Natural logarithm of one plus the VC firm's number of exits (IPO/M&As) prior to the loan date
VC's past deals	Natural logarithm of one plus the VC firm's number of investments prior to the loan date
Ln(AUM)	Natural logarithm of VC firm's asset under management (in $ million)
Industry characteristics	
Industry exit valuation-sale multiple	Yearly industry median of valuation-sale multiples of all IPO or M&A exits listed in Pitchbook
All industry valuation-sale multiple	Yearly industry median of valuation-sale multiples of all deals listed in Pitchbook

Table A.2: **Distribution of observations by year**

This table presents the distribution of sample variables by year. We use a sample of venture debt deals in the period 2005-6/2024.

Year	**Freq.**	**Percent**	**Cumulative**
2005	75	1.06	1.06
2006	120	1.69	2.74
2007	130	1.83	4.57
2008	23	0.32	4.90
2009	13	0.18	5.08
2010	207	2.91	7.99
2011	189	2.66	10.65
2012	250	3.52	14.17
2013	170	2.39	16.57
2014	286	4.03	20.59
2015	349	4.91	25.50
2016	296	4.17	29.67
2017	189	2.66	32.33
2018	472	6.64	38.97
2019	1,070	15.06	54.03
2020	799	11.25	65.28
2021	875	12.32	77.59
2022	1,034	14.55	92.15
2023	466	6.56	98.71
2024	92	1.29	100.00
Total	**7,105**	**100.00**	

Table A.3: **Distribution of observations by industry**

This table presents the distribution of sample variables by industry. We use a sample of venture debt deals in the period 2005-6/2024.

Industry	**Freq.**	**Percent**	**Cumulative**
Business Products and Services (B2B)	647	9.11	9.11
Consumer Products and Services (B2C)	1,637	23.04	32.15
Energy	94	1.32	33.47
Financial Services	370	5.21	38.68
Healthcare	1,435	20.20	58.87
Information Technology	2,877	40.49	99.37
Materials and Resources	45	0.63	100.00
Total	**7,105**	**100.00**	