Venture debt as bridge financing*

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Abstract

We show that venture debt often acts as bridge financing to an equity round or acquisition. We argue that venture lenders have distinct skill sets from traditional venture capitalists (VCs) that make them the natural investors while the company awaits the resolution of important strategic uncertainty. Using novel contract-level data from BDC venture lenders, we establish that venture loans are frequently prepaid long before maturity, and that prepayment rates spike with new financing rounds or acquisitions. When financing rounds or acquisitions are induced by uncertainty resolution, as measured by the grant of a patent or the end of a clinical trial, they essentially always pay off the existing venture loan. Our explanation is consistent with narratives that venture debt "avoids dilution" and "extends the runway" between equity rounds.

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Venture debt – the use of debt by companies backed by venture capital – is a growing phenomenon, constituting 15% of aggregate venture capital investment in 2022. There is little research on venture debt, and many open questions remain about this market: Why would debt be appealing to a venture-stage company that pays no taxes, and why is that debt typically provided by a new lender instead of the company's existing investors? Is the growth of this market a product of the low interest rates that prevailed after the global financial crisis, or should we expect it to persist even in a future environment of higher rates?

Venture debt received renewed attention in March 2023 with the sudden collapse of the leading venture lender, Silicon Valley Bank (SVB), following rapid rate increases by the Federal Reserve. At first glance, SVB's failure might suggest that debt contracts are incompatible with the credit risk of startup financing. But as observers quickly realized, SVB failed due to risks facing many midsize banks at the time, and not due to the unique credit risk of its loan book. In fact, rival venture lenders organized as business development companies (BDCs) survived the year without disruption, as we demonstrate below.

Using novel contract-level data from these BDC venture lenders, we document an important role for venture debt as bridge financing to equity rounds or acquisitions. To explain this role, we propose that venture lenders offer a lower cost of capital than a traditional venture capitalist (VC), because their comparative advantage is in financing the company, not improving it. We present a model in which venture loans are optimal while awaiting new information that will dictate the company's future strategy. When that information arrives, the company obtains new financing from equity investors or an acquirer, and they in turn prioritize payoff of the loan in order to have complete control of the company. This role for venture debt helps explain why it is provided by specialist lenders, not VCs. Importantly, it does not require that the lender be a bank, nor does it require a low-rate environment.

Our model rationalizes popular claims about venture debt. Venture debt is often described as "avoiding dilution" and "extending the runway" between equity rounds. One might ask why equity issuance is dilutive only when the loan is taken out, not at other dates when equity is issued, or why the existing VCs do not skip the "runway" and provide capital themselves. Our answer is that equity rounds and acquisitions price in a premium for the investor's ability to improve the company. It would indeed be dilutive to pay this premium when it is not needed, and there is value in delaying to a future date when it is.

We highlight this investor-based explanation for bridge debt in the setting of venture capital, but it plausibly applies to private credit more broadly. On the other hand, it is distinct from prior justifications for bridge debt. For example, Kahl, Shivdasani, and Wang (2015) show that firms use commercial paper to bridge from an initial investment to a date when they can design the optimal bond package. In our setting, bridge debt is used *between* dates of significant investment. Other theories of short-term debt do not explain bridge debt, because they focus on factors that do not fluctuate greatly over a short horizon (e.g. moral hazard in Dewatripont and Tirole, 1994, and information asymmetry in Diamond, 1991).

Turning to our empirical analysis, we first observe that venture debt is quite common in practice. In the Preqin database, venture debt is between 10% and 15% of total venture capital recorded in a typical year, a share that has held steady since the financial crisis. Most loans are made between the Series A and C rounds, and approximately 15% of Series A rounds and 20% of Series B rounds are followed within two years by a venture loan to the same company. Venture debt is outside debt, not provided by the company's existing VC investors. Loans are typically made between equity rounds that exhibit growth, in terms of both dollar proceeds and syndicate size, but the loans themselves are for smaller average amounts and typically feature only one lender. Finally, when a subsequent equity round of equity financing is recorded in Preqin, it happens within less than a year on average.

These patterns already suggest a bridging role for venture debt during the company's transition between equity rounds. However, it is difficult to establish much more from standard data providers, which do not record the contract terms of the loans, nor their performance after origination. Our main contribution is to address this gap with novel data.

Five of the top venture lenders in Preqin are organized as business development companies

(BDCs). These lenders file quarterly statements with the SEC that disclose many details regarding the pricing, contract structure, and current status of each loan in their portfolio, as well as any accompanying investments in the portfolio companies, such as warrants. We hand-collect this data for each available quarter and match it to Pitchbook, compiling a picture of each borrower's lifetime before, during, and after taking out the loan.

Venture loans in this sample are straight debt, though often bundled with a small amount of warrants. Lenders work with companies backed by reputable venture capitalists, and take a senior secured position in the company's assets, importantly including any intellectual property such as patents. Loans carry spreads of five to ten percentage points above the prime rate, and many fixed fees. Although originated with a maturity of three to five years, loans are typically prepaid much sooner with proceeds from a new equity round, acquisition, or IPO. The combination of VC backing, lender seniority, steep pricing, and prepayment allows venture lending to be profitable despite the fact that many borrowers eventually fail.[1] Indeed, the lenders' common stock returned an average of 10.7% per year during 2018-2022.

Using this sample, we seek evidence of our rationale for venture debt. A key assumption of our argument is that venture lenders have fundamentally different skills from traditional venture capitalists, and in particular that they focus more on financing the company and less on improving it. Consistent with this view, we show that the professional backgrounds of employees at BDC venture lenders, as documented in their CVs shared on LinkedIn, are mainly in finance and accounting, and only rarely in founding or building companies, which is opposite to the typical pattern for venture capital GPs (e.g. Metrick and Yasuda, 2010).

Next, we connect loan payoff with borrower liquidity events, defined as an equity round, acquisition, buyout, or IPO. We observe that 6% of a loan's principal is paid off in the average quarter, but this activity is bimodal: In 62% of quarters there is no principal decrease at

[1] The importance of VC certification for venture debt has previously been documented in the empirical analysis of Hochberg, Serrano, and Ziedonis (2017), the choice experiment of de Rassenfosse and Fischer (2016), and the interviews conducted by Ibrahim (2010). We add that the VC's presence matters to the lender not only generally as a signal about borrower credit quality, but also and more specifically as a signal about the future availability of the very financing that will eventually be used to repay the loan.

all, while in 8% there is a complete payoff, with an average of eight quarters remaining to maturity at this date. The rate of payoff spikes to 25% at the date of a liquidity event, and the probability of complete payoff to 26%. These patterns are consistent with venture debt being bridge financing, and can only be documented with data on ex-post loan outcomes.

Finally, we study two clear examples of when a company might need financing while awaiting the resolution of uncertainty. The first is when the company has a pending patent application, and the second is when the company is analyzing the results of a clinical trial. In either case, the company expects important information to arrive at some uncertain future date, but needs working capital in the meantime. Under our perspective, the company should finance itself with a venture loan at this moment. Then, when the patent is approved or the trial analysis is complete, the company will again have important strategic decisions to make, and will attract new capital from equity investors or an acquirer, who will prioritize the payoff of the loan to have maximum control over the borrower.

We investigate these predictions by matching the BDC borrowers to data on patent applications and grants from the US Patent and Trademark Office (USPTO), and data on clinical trials from the National Institutes of Health (NIH). We find that sample companies' loans are timed to periods when they have pending patent applications, or clinical trials that have been completed but lack a final update. Then, when borrowers exit either of these scenarios, they experience a significant increase in the probability of a liquidity event (equity round, acquisition, buyout, or IPO), and in the payoff rate of their outstanding venture loan.

We combine these last two results into an instrumental-variables (IV) specification, where the exclusion restriction is that the grant of a patent, or the end of a clinical trial, causes loan payoff only *because* it triggers a liquidity event. This specification yields an estimate of the effect of new financing on loan payoff rates, for the "compliers" who experienced a liquidity event because of the resolution of uncertainty. Our point estimate is close to 1, meaning that compliers essentially always use the new funds to repay their loans in full. This is direct evidence that venture loans are used while borrowers await the resolution of uncertainty, and are repaid with new financing when that uncertainty is resolved.

In sum, we demonstrate a role for venture debt that can be accomplished by a non-bank intermediary, and in a high- or low-rate environment. Venture debt in our analysis is a complement to traditional venture equity, not a substitute. By economizing on the limited capital of traditional VCs, venture debt allows a greater aggregate volume of venture funding. Beyond the specific setting of venture debt, we focus on an underexplored driver of security design and financing choice that plausibly applies to many early-stage and middle-market companies: Investors have different comparative advantages in either improving the company or financing it, and provide capital at times when their skill is relatively more important.

Our findings are consistent with Ibrahim (2010), who surveys market participants and concludes that venture debt is used early in the company's life-cycle, as a cooperative decision between the company and its existing investors, and is repaid by later equity rounds. We document and quantify these patterns directly in the data, and highlight the importance of the different skill sets offered by lenders and traditional venture capitalists.

In the finance literature, Davis, Morse, and Wang (2018) emphasize a different potential benefit of venture debt, in that it can help manage entrepreneurial incentive problems. Hochberg et al. (2017) show that venture lenders rely on certification by VCs. Tykvová (2017) tests signaling models for venture debt, and de Rassenfosse and Fischer (2016) conduct a choice experiment with venture loan officers. Lerner (2001), Rhodes-Kropf and Leamon (2009), and Nanda, Sahlman, and Keller (2016) discuss the older venture leasing industry.

Beyond venture-stage companies, a growing literature studies debt financing and collateral for low-tangibility, innovative firms (e.g. Hellmann, Lindsey, and Puri, 2008, Robb and Robinson, 2012, Lim, Macias, and Moeller, 2017, Mann, 2018). A common theme in this literature is that the debt capacity of innovative firms and their intangible assets, especially intellectual property such as patents, is higher than has been historically appreciated.

Several recent papers study the recent events at Silicon Valley Bank to shed light on bank regulation and the determinants of bank stability. Examples include Jiang, Matvos, Piskorski, and Seru (2023), Metrick and Schmelzing (2023), and Cookson, Fox, Gil-Bazo, Imbet, and Schiller (2023). We deliberately study *non-bank* lenders in order to focus on the economics of venture debt, not banking. Our focus on BDC lenders also places our paper within the rapidly-growing literature on private credit and direct lending. Recent studies in this area include Block, Jang, Kaplan, and Schulze (2023), Chernenko, Erel, and Prilmeier (2022), Davydiuk, Marchuk, and Rosen (2020), Jang (2024), and Suhonen (2023).

1 Stylized facts

1.1 Data from Preqin

The first source for our empirical analysis is company-level financing data from Preqin for 2002 through 2022. Table 1 shows the top 24 providers of venture debt in Preqin in the most recent years of the sample, 2018-2022. Silicon Valley Bank originated the most loans, reflecting its historical dominance of this market. The five BDC lenders that we will study later in the paper are highlighted in the caption to the table.

Figure 1 displays the aggregate volume of venture debt originations in Preqin by year. This volume has been growing steadily since the late 2000s and in recent years has averaged over $8 billion in new loans originated per year. Figure 2 translates this fraction to dollar terms by examining the aggregate fraction of venture financing in Preqin that has come from debt. The figure plots total venture debt, divided by the sum of debt plus Angel, Seed, and Series A through K financing rounds in Preqin. This fraction grew significantly after the financial crisis and has fluctuated between 10% and 15% in the years since then.

Figure 3 performs a similar analysis at the company level. For each venture loan in Preqin, we calculate the amount of that loan divided by the company's total financing recorded to date (including the loan itself). The mean (median) value of this ratio is 20% (14%).

Figure 4 shows that venture debt borrowers are also a significant fraction of venture-backed companies in Preqin. We separate out series A, B, C, and D equity rounds in Preqin, and for each round type we calculate the fraction that are followed by a venture loan to the same company within the next two years. The figure shows that about 15% of Series A rounds, and about 20% of Series B, obtain a venture loan within the next two years.

These calculations closely match the magnitudes from other studies. For example, the interviewees in Ibrahim (2010) estimated the size of the venture debt market to be between 10% and 20% of aggregate venture capital, and Davis et al. (2018) find that runway-extending loans are used by 14% of early-stage companies in Crunchbase. The importance of venture debt thus appears to be a reliable observation across data sources and methodologies.

Figure 5 plots, for each venture debt borrower in Preqin, the equity round recorded prior to its first venture debt date. Venture loans are typically obtained between the Series A and C rounds. They essentially never happen prior to the Series A round, and are rare beyond the Series D round. This pattern suggests that venture debt helps companies progress from early to later stages, but is not a substitute for seed capital nor for long-term venture equity.

Figure 6 compares the median syndicate size, and Figure 7 the median proceeds, by stage of financing. On the one hand, venture debt is obtained at times when the company's external financing, and the number of investors, are increasing. From the Series A to Series D rounds, the median deal size increases by a factor of four, and the median syndicate from two to four investors. On the other hand, the loans themselves are not part of that trend. The median amount of a venture loan is smaller than for any of the rounds following Series A, and loans are almost never originated by more than one lender. The figures show that venture loans arrive between growth stages, yet do not themselves represent a growth stage.

Finally, we examine the time interval between venture debt and venture equity rounds. Figure 9 plots the time until the next equity round in Preqin, The mean (median) time until next financing is about 1.4 years (1.2 years) for each of the equity rounds, but only 0.94 years (0.66 years) for venture debt. For comparison, Figure 10 plots the density of the time *since* the prior financing round, again separating by round type. Here there is no great difference between venture debt and other round types. Hence, venture loans and venture equity arrive at roughly the same amount of elapsed time after the prior round, but venture debt is followed much more rapidly by another financing round.

The patterns documented in this section are consistent with the idea that venture debt is used while the company waits for the right timing for its next financing event. They suggest that venture debt is best understood not as a substitute for venture equity capital, but rather as a supporting mechanism that bridges the borrower between rounds of equity investment. In the remainder of the paper we introduce a novel dataset of contract terms and ex-post repayments, and use it to establish this interpretation more precisely.

1.2 Data from BDC venture lenders

Of the top venture lenders listed in Table 1, five are organized as business development companies (BDCs), closed-end funds that promote small-business finance and benefit from special regulatory treatment.[2] These funds are pure-play venture lenders, which makes them especially well suited for studying the economics of this market in isolation from the unique pressures facing midsize banks. To highlight this perspective, in Appendix B.1 we show that the stock prices of BDC lenders did not deteriorate around the time of SVB's failure in March 2023, and even before then had relatively low correlation with SVB's stock, which more closely resembled that of other (non-venture-lending) regional banks.

In each quarterly filing with the SEC, the BDC lenders list all loans currently outstanding to portfolio companies (at both cost and fair value), along with a wealth of data about each one including outstanding principal, remaining maturity, equity or warrants held in the same company (at both cost and fair value), and the loan's interest rate (either a fixed rate or a spread over the prime rate, LIBOR, or SOFR). This is, to our knowledge, the only publicly-available dataset on venture debt contract terms, modifications, and repayments.

We hand-collect all available data on the investment portfolio of each lender in each quarter, including both loans and any accompanying equity or warrants, through the end

[2]Three of them also appeared among the thirteen lenders that Ibrahim (2010) describes as the "core" of venture lending, and two were also in the top ten lenders reported by Tykvová (2017).

of 2022. This yields a sample of 1,079 distinct borrowers from 2005-2022. We match each borrower to any available deals in the Pitchbook database. Then, to ensure our sample is free of survivorship bias, we manually classify each borrower as either still active in December 2022, or exiting prior to that date through acquisition or liquidation. This sometimes requires searching online for information to fill in gaps in the Pitchbook record.[3]

The discussions in the filings confirm that these lenders focus on direct lending to venture-stage companies, not to the broader middle market. They also provide useful perspective on the lenders' business model. Three points will be important for us: First, lenders rely on relationships with VCs for deal flow, not only to certify borrower quality (Hochberg et al., 2017) but also as a source of future capital to repay the loan (a characteristic of private credit generally; see for example Jang, 2024). Second, loans are secured debt, not convertible, and lenders always obtain a senior claim to the borrower's assets, either through an explicit security agreement or through a negative pledge covenant. Third, loans typically come bundled with warrants. Though their amount is small,[4] their reported fair value each quarter provides ongoing insight into the borrower's financial viability, or lack thereof.

1.2.1 General stylized facts about BDC venture loans

Figure 11 plots the total loan principal outstanding for BDC lenders through the end of 2022. By the end of 2022 the aggregate principal outstanding across the five lenders was over $6 billion. Figure 13 plots the distribution of loan amounts at the end of the quarter when each borrower first enters the sample, and Figure 14 plots the distribution of interest rates prevailing for each borrower-quarter, as a spread over that quarter's prime rate.[5]

[3]Details are in Appendix B.2. Our earlier results used Preqin because it provides relatively easier access to aggregate figures. However, we find that Pitchbook has better company-level coverage of events like acquisitions, IPOs, and bankruptcies/liquidations, which will be important in the rest of our analysis.

[4]The reported fair value of warrants is only 1.4% of loan principal at the median, and 3% at the mean. These magnitudes are consistent with Ibrahim (2010), who downplays the importance of warrant coverage based on his interviews with venture lenders, calling it only "a nice bonus."

[5]Most loans in the data are priced as spreads over the prime rate, but some are also priced as spreads over LIBOR or SOFR, often with interest rate floors or caps, as well as some fixed-rate loans. To construct the figure, we calculate the prevailing rate at each loan-quarter taking all these details into account, then subtract out the then-current prime rate to construct the figure. The figure does not include fixed payments

Venture loan borrowers are risky: By the end of 2022, 118 borrowers have exited through liquidation or distressed acquisition, another 56 were acquired for amounts below the valuation in their most recent round, and 203 more were acquired without sufficient information to make this comparison. (Of the rest, 73 were acquired at a premium to their most recent valuation, and 629 are still active, of which 131 have been publicly traded at some point.)

However, venture *loans* are much less risky. They are rarely still outstanding by the time the borrower fails, and even when they are, they have a relatively small principal protected by a senior secured position in the company's assets. We classify only 4.3% of aggregate loan principal as being written off in an average year (see Appendix B.2 for details of this calculation). Even this figure overstates the true rate of loan losses, because it appears common for lenders to write off a loan at the onset of financial distress, only to realize significant recovery at a later date (which is not comprehensively disclosed in the data).

The lender typically receives warrants in the borrowing company. On average their reported fair value is about two percent of loan portfolio value. Warrants either convert to equity with a later financing round, or expire at a preset maturity (typically ten years). Our analysis will not focus heavily on warrants. However, when the lender reports warrants carried at positive value, we do interpret this as an indicator of the company's ongoing economic viability, which helps us in classifying which loan principal decreases are payoffs as opposed to writeoffs. Appendix B.2 provides further detail and validation of this approach.

1.2.2 Prepayment patterns for BDC venture loans

The most important facts that we establish with the BDC data are related to repayment and prepayment of venture loans, which could not be directly observed in Preqin.

Figure 15 plots the fraction of the lenders' aggregate investment portfolio that is repaid each quarter through scheduled payments (solid line) and early prepayments (dashed line). These rates are about 2.5% and 7.5% respectively. At the loan level, Figure 16 plots the

due at the end of the loan, which are present in about 84% of loans and are about 5% of principal on average.

distribution of quarterly loan growth or repayment, as a fraction of outstanding principal. The majority of loan-quarters exhibit no significant principal change, while in 8% of quarters there is a complete payoff, suggesting a loan half-life of approximately two years.[6]

Figures 17 and 18 show the distribution of loan maturities when the loan first appears in our data (for all loans), and in the quarter when the loan is paid off (for the 688 borrower-quarters in which we observe a complete payoff). At origination, venture loans typically carry a maturity of three to five years. At the payoff date, only about 11% matured normally (that is, have a remaining maturity of zero), while the median remaining maturity across all loans is seven quarters. While it is hard to make unconditional statements given that a large number of sample loans remain active as of the end of 2022, it seems clear that the typical ex-post maturity of a venture loan is much shorter than its specified maturity.

Finally, we examine payoff rates around events recorded in Pitchbook that could plausibly provide the capital to pay off the loan. Specifically, we examine equity rounds, acquisitions, buyouts, and listing events (including IPOs, SPAC listings, and reverse mergers). In the remainder of the paper we will refer to these as "liquidity events," a term also used by the lenders in their filings and earnings calls to describe opportunities for portfolio companies to repay loans. Figure 19 shows that, in the quarter of such an event, the average rate of loan principal payoff is 25%, far above the average rate of 10% in surrounding quarters.

The results in this section establish that venture loans are often prepaid far ahead of schedule. They also establish a connection between those prepayments and liquidity events, such as a new financing round, acquisition, buyout, or IPO. We emphasize again that this analysis is only possible using data that records ex-post loan outcomes. The next section suggests a theoretical explanation for this bridging role of venture debt. Then the remainder of the paper will focus on establishing that explanation more precisely in the data.

[6]The aggregate numbers behind Figure 15 are reported directly in the lender filings. The loan-level numbers behind Figure 16 require us to distinguish which quarterly principal decreases are loan payoffs and which are writeoffs. Our procedure for this is described in detail in Appendix B.2.

2 Model: The role of venture lenders

Our stylized facts show that venture debt often serves as a form of bridge financing in the company's early lifetime. It is not immediately obvious why there should be demand for such financing, when the company already has a relationship with a traditional venture capitalist (VC) who has provided equity capital, and is likely to do so again in the future.

We propose an explanation based on the idea that venture lenders have different skills from a VC or potential acquirer, making them the appropriate investors at certain moments in the company's development. Appendix C presents a formal model that matches the key facts we have documented. Here we describe the intuition of that model.

We consider a VC who must decide whether to continue a portfolio company to a second stage of growth, or else to stop investing and sell off the company's assets. At date 1, the company requires interim financing. At date 2, the VC will privately observe a signal about the value of continuation. Later, the VC can increase that value through costly effort.

In principle, the VC could offer the interim financing herself, but we assume that there exists another investor, the venture lender (VL), who has a lower (risk-adjusted) opportunity cost of capital. Outside the model, our justification is that the VC has limited funds, and other portfolio companies that are willing to pay a premium for her involvement. The VL by contrast focuses on financing the company rather than improving it, and is better at valuing and selling the company's assets such as IP on a standalone basis, if needed.

The VL's lower cost of capital implies that there is potentially a benefit to having the VL arrange the financing instead of the VC. However, this contracting process is complicated by the model's ex post frictions: First, the VC will have private information on the probability of the company's success. Second, the VC cannot pre-commit to exert optimal effort.

We show that the first-best outcome is achieved by arranging loan from the VL, then paying off that loan when continuation is efficient. The intuition is as follows:

If the VL provides interim financing with an equity contract, the VC's effort incentives will be diminished ex-post due to her lower ownership stake (as in Jensen and Meckling, 1976). The VC could try to improve her own incentives by repurchasing the VL's equity, but this is only an imperfect solution due to the holdup problem that would arise in bargaining over the repurchase price of the equity.

A debt contract preserves the VC's effort incentives, but leads to a risk-shifting problem. The VC now pursues continuation in some cases where this is inefficient (as in de Meza and Webb, 1987), which lowers total surplus, exposes the lender to potential losses, and forces up the required face value of debt. We assume the VC cannot address this problem by communicating her private information or committing to the efficient investment policy, but she can offer the VL strong control rights that give her veto power over the continuation.

With this veto power, the lender is willing to provide debt with face value up to the value of assets-in-place, then blocks any continuation until she is repaid. The VC's incentives are now aligned with efficiency, and she will pursue continuation if and only if that is efficient. The VL faces no risk of loss: If the VC continues the company, she first repays the loan in full, while if she does not, the company is sold for more than the face value of the loan.

To summarize, the VL is the optimal investor while the company waits on important information to arrive, and the VL optimally uses a debt contract to minimize the effect of contracting frictions. Consistent with conventional wisdom about this market, the venture loan in our model "avoids dilution" (by avoiding the need to pay the VC's higher cost of capital) and "extends the runway" (by financing the company until the next liquidity event).

One might guess that venture debt is used by relatively low-quality companies, or at times when the company's value is declining. However, our model makes little assumption about the distribution of borrower quality, other than that continuation is optimal in expectation, and can therefore nest both positive and negative scenarios. Indeed, our sample includes many companies that have gone on to successful public listings. Rather, the key feature of our model is the *uncertainty* about borrower quality at date 1, coupled with the knowledge that a signal about this quality will be revealed (to the VC) at date 2.

It may also seem counterintuitive for lenders to provide debt at a moment of *greater* uncertainty about the company's future value, and to be repaid when uncertainty is resolved. We emphasize that the initial uncertainty creates risk for the VC, but not necessarily for the VL, given that she lends a relatively small amount backed by the company's assets and coupled with strong control rights. We will show that BDC venture lenders indeed appear to face low loss rates despite the unconditional risk of their portfolio companies.

A key feature of our model is that venture lenders are different from VCs in terms of their abilities and information, with the use of a debt contract being a symptom of that difference. To corroborate this point, we collect work experience from 247 CVs shared on LinkedIn by employees of the ten biggest venture lenders in Preqin, and compare with the evidence from Metrick and Yasuda (2010) on 125 venture capital general partners (GPs). We find that the two groups have very different professional backgrounds. For example, Metrick and Yasuda report that only 14% of GPs had experience in finance, and only 2% in accounting. In contrast, 80% of our sample venture lender employees previously held positions as CFOs, financial analysts, accountants, or auditors, or previously worked at banks, fund managers, investment companies, real estate companies, or accounting firms (excluding other venture lenders). On the other hand, Metrick and Yasuda report that 37% of sample GPs were past founders of for-profit firms. In contrast, only 7.3% of venture lender employees in our sample (18 out of 247) report being the founder or co-founder of any past employer.

These patterns support our view that VCs have a relative advantage over venture lenders in terms of building and improving the company. On the other hand, we assume that venture lenders have a comparative advantage at underwriting investments based on the company's assets compared to venture capitalists. Indeed, all five of our sample lenders explicitly describe the importance of evaluating the company's assets, especially intangible assets such as patents, which serve as collateral for loans either through explicit security agreements or through negative pledge covenants. Past literature has shown that intellectual property can have significant collateral value, but requires special expertise from lenders due to the complexities of valuing, foreclosing, and reselling these assets (see e.g. Mann, 2018).

Finally, our model assumes that loans are used when companies face uncertainty that will soon be resolved and will dictate the company's optimal strategy going forward. The rest of the paper seeks out direct evidence of this idea in our sample of BDC venture loans.

3 Evidence: Uncertainty resolution and payoff rates

Our argument is that venture debt is valuable when companies await the arrival of new information that will dictate later strategic decisions, and that the debt is paid off when that new information arrives. In this section, we confirm this behavior empirically, using two specific examples of the arrival of information and resolution of uncertainty.

The first example we study is when a company is waiting for a patent application to be granted. The second example is when the company is analyzing data on the primary outcomes of a completed clinical trial. In either case, potential investors or owners know that new information is coming that matters for their involvement with the company, but they do not know when it will arrive or what it will be. We argue that it is then in the best interests of all parties to delay their involvement by having the company use a venture loan at this time, then pay off the loan when the key information is revealed.

To motivate the analysis, in Table 2 we begin by examining generally how liquidity events and venture debt usage evolve around the dates of these two scenarios. We work with a quarterly panel from 2005-2022 of all companies that borrowed from BDC venture lenders, including the dates before and after they took out the loan (when their loan principal is zero). Because all sample companies borrow at some point, our analysis in this section speaks specifically to the *timing* of venture debt usage, not the unconditional probability of using venture debt at all. We match all borrowers to dates of patent applications and grants as reported by the USPTO, and to data on clinical trials available from clinicaltrials.gov.[7]

In Panel A of Table 2, we restrict to quarters in which the company has filed at least one prior patent application. We construct an indicator equal to 1 if the company had

[7]Reporting to this website has been mandatory since 2007.

pending patents one year ago, but has no pending patents today. Column 1 shows that this "resolution" indicator predicts roughly a 1% increase in the quarterly probability of the company experiencing a liquidity event (as defined earlier), after removing borrower and year fixed effects. This can be compared with a 7% unconditional quarterly probability of a liquidity event. Column 2 shows that the same indicator predicts an average decrease of $164,000 in the borrower's outstanding venture loan principal, which is about 5% of the sample median loan amount of $3m. Column 3 confirms that this result is entirely driven by higher rates of loan payoff, not lower rates of new borrowing. Overall, we find that patent approval predicts the arrival of a new liquidity event and the payoff of existing venture debt.

Panel B conducts a similar analysis for clinical trials. We restrict attention to quarters in which the company has started at least one clinical trial in the past. The outcome variables across the three columns are the same as in Panel A. The explanatory variables are indicators for whether the company, in a given quarter, starts any new trials; has any trials reach primary completion (when all data on the primary outcome have been collected for all participants); or has any trials post their last updates on the clinicaltrials.gov website. We use the third of these dates as a proxy for the final date on which important information from the trial is revealed to the company and its investors.[8]

Column 1 shows that both the beginning of a trial, and the quarter of its final update, are associated with elevated probabilities of a liquidity event (as defined earlier). Intuitively, companies often raise new equity rounds to fund a trial, and also raise new rounds (or are acquired) once the results of the trial are known. But in between these two, in the quarter in which a trial reaches primary completion (meaning data collected but results not yet analyzed), there is roughly an equal *decrease* in the probability of a liquidity event. This is

[8]Although all completed trials are legally required to post results on the website within one year of primary completion, compliance with this requirement has been poor (e.g. DeVito, Bacon, and Goldacre, 2020). Consistent with this observation, while our results include a "results first posted" field, this field is only populated in about one-quarter of trials. In contrast, the "last update posted" field is populated for every trial. When both dates are populated in the data, "last update" is never earlier than "results first posted," and the median gap between them is two quarters. Our results are qualitatively the same using either of these two dates as our timing of information resolution.

consistent with the idea that there is no value to involving a VC investor at the intermediate time of primary completion, when there is substantial uncertainty that will soon be resolved.

Column 2 shows that it is precisely at this intermediate date when the company is likely to increase its venture loan financing. In the quarter in which a trial reaches primary completion, on average the company increases its debt principal outstanding by $255,000. Conversely, in the quarter in which a trial's final updates are posted, there is an almost identical decrease in loan principal. Column 3 shows similar qualitative patterns when focusing on only the amount of loan payoff, which is relatively low at the date of primary completion, and much higher in the quarter when final updates are posted.

These results confirm that venture debt is more likely to be used at times of elevated uncertainty about the company's strategic direction. It may seem counterintuitive to use debt at such times, but we emphasize again that heightened uncertainty does not necessarily translate into large *lender* risk, given the small amount of the loan and the lender's senior position. Instead, the important feature of the times on which we focus is that there are relatively few important strategic decisions to be made. The company then seeks financing from an investor who specializes in underwriting rather than advising or managing.

We also emphasize that all our analysis includes year fixed effects, putting the focus on idiosyncratic borrower circumstances, and not on aggregate conditions such as the level of interest rates, overall venture funding volumes, or the status of private equity fundraising. While these aggregate conditions may indeed affect the market for venture loans, our point is to highlight that loans can serve a valuable purpose without respect to such factors.

With this evidence as motivation, in the remainder of this section we focus specifically on the payoff rate of existing loans, and quantify more precisely how this rate is affected by patent grants and trial updates as examples of the resolution of uncertainty. The payoff event, rather than the initial borrowing event, is the cleanest date at which to study our proposed mechanism because (according to that mechanism) it is triggered by an event with unpredictable timing, while initial borrowing may be endogenous to many other features of the borrower's environment that are difficult to quantify. Our focus on payoff rates also leverages the unique contribution of our novel data, relative to other sources such as Preqin or Pitchbook that only report the origination of a loan and not its ultimate repayment.

In Table 3 we restrict to borrower-quarters in which there is a venture loan outstanding. Panel A regresses an indicator for the company experiencing a liquidity event on the number of its patent applications that are currently pending, and company and year fixed effects as in the earlier regressions. We estimate that a one-standard-deviation decrease in the number of pending patents is associated with a 22 percentage point increase in the probability of a liquidity event in a given quarter. Column 2 shows that the same change is associated with a 12.6 percentage point increase in the fraction of loan principal being paid off in the quarter.

Panel B repeats this investigation, but with the key explanatory variable now being the company's number of ongoing trials that have reached primary completion, but have not yet posted their final update to clinicaltrials.gov. As in Panel A, this predictor is scaled by its sample standard deviation. The estimates suggest that when the number of such trials decreases by one standard deviation, the company experiences a 2.5 percentage point greater probability of a liquidity event, and pays off its loan at a 7.5 percentage point greater rate.

Although we include company fixed effects in all regressions so far, one might still be concerned about unobserved borrower heterogeneity that changes *within* the time period covered by our sample, since venture-backed companies evolve rapidly from one quarter to the next. While by definition we cannot completely control for this heterogeneity, in Columns 3 and 4 we add a control for the number of past equity rounds the company has raised as one proxy for its growth. The number of equity rounds negatively predicts the probability of a liquidity event, and has no explanatory power for the loan payoff rate. More importantly, the addition of this control does not affect the other estimates in the regressions.

We regard all these results as consistent with the interpretation that when important uncertainty is resolved, this triggers new external financing that in turn goes to pay off the venture loan. These results are consistent with our proposed mechanism for the value of venture debt, and highlight the value of data that records ex-post loan outcomes.

Aside from this qualitative narrative, the results are also revealing in terms of their magnitudes. We have interpreted them as showing that patent grants and clinical trial resolutions spur both a new liquidity event, and the payoff of an existing loan. Given that borrowers are typically small and constrained companies with little excess cash, and loans are typically paid off long before they are due, it seems plausible to assume that any increased payoff only happens *because* of the liquidity event. Granted this exclusion restriction, we can effectively divide the magnitudes of the earlier coefficients to obtain an instrumental-variables (IV) estimate of the effect of a liquidity event on the rate of loan payoff.

Table 4 implements this logic. Panel A, column 1 reports the IV estimate just described. We regress the repayment rate of outstanding loans on an indicator for a liquidity event occurring in the quarter, instrumented with the company's number of patents pending or post-completion trials, and including borrower and year fixed effects as before. We estimate that a liquidity event induced by the resolution of uncertainty predicts a 93 percentage point increase in loan payoff rate, indistinguishable from an increase to 100%.

To interpret this finding, recall that in Figure 19, a liquidity event only increased the rate of loan payoff by 15%. While significant, this effect is lower than what one would expect from our narrative, which predicts a complete payoff of the loan at such an event. The IV estimate in Table 4 helps to resolve this tension, by narrowing the focus to the events that should best fit our prediction. Formally, the estimate is specific to compliers, that is, the liquidity events that are *induced by* the resolution of uncertainty as captured by our two proxies. For these complier events, we indeed find that the loan is essentially always repaid in full. In other words, not every venture loan fits our model, but among the significant number that do, the economic magnitudes are as we would expect.

The remaining specifications in Table 4 consider various alternative approaches to this result. Column 2 of Panel A saturates the model by adding a third instrument equal to the interaction of the other two. In Panel B we replace the continuous instruments with indicators for having any pending patents, or any completed (non-final) trials. Panel B also reports results for the two instruments separately. The magnitude of the IV estimate is statistically indistinguishable across all specifications. In unreported results we also obtain similar magnitudes with various alternative approach to clustering, control variables, and sample time period. Table 4 also shows that, when we use multiple instruments, the null hypothesis of Hansen's J-test of overidentifying restrictions is never rejected.

The analysis in this section provides direct evidence that when important information is due to arrive in the near future, a company is more likely to finance itself with a venture loan. Conversely, when that information arrives, the company frequently realizes a new liquidity event, and when this happens the proceeds essentially always pay off the loan. These findings are consistent with our proposed rationale for venture debt: In many cases, it represents a deliberate choice to use an investor who is specialized for situations where the company is waiting on new information to come out, at which time the company will pay off the loan.

4 Conclusion

This paper contributes to a growing understanding of the venture debt market with novel results from multiple sources, most importantly contract-level data from BDC venture lenders. We show that venture debt frequently plays a bridging role to future equity rounds or acquisitions. We use patent applications and clinical trials to identify moments when these liquidity events are likely triggered by the arrival of new information, and find that in these situations the new financing virtually always pays off the existing venture loan.

We conclude that venture debt plays a valuable, auxiliary role for managers and investors in early-stage companies, complementing venture equity by providing flexibility in when that financing is used. These results also highlight that venture debt can be valuable even outside the context of a banking relationship, which is important to establish in the wake of the collapse of Silicon Valley Bank. Likewise, the economic role that we highlight for venture debt does not necessarily depend on particular aggregate conditions such as a low level of interest rates, and is likely to remain important in the future irrespective of these conditions.

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A Tables and figures

A.1 Preqin data

	Lender	Preqin loans, 2018-2022	Volume ($m)
1	Silicon Valley Bank	63	$1,832.30
2	Horizon Technology Finance	39	$676.00
3	Hercules Capital	22	$1,232.50
4	Oxford Finance	17	$1,160.00
5	Bridge Bank	15	$374.50
6	CIBC Innovation Banking	14	$529.50
7	Runway Growth Capital	14	$496.50
8	K2 HealthVentures	13	$507.50
9	Espresso Capital	13	$122.00
10	Credit Suisse	12	$1,335.00
11	Goldman Sachs	9	$2,710.00
12	Atalaya Capital Management	9	$1,158.00
13	TriplePoint Capital	8	$392.50
14	i80 Group	7	$857.50
15	Goldman Sachs Asset Management	7	$995.00
16	MidCap Financial	7	$467.50
17	Community Management	7	$705.00
18	Lighter Capital	6	$1.78
19	Perceptive Advisors	6	$426.50
20	Signature Bank	6	$58.50
21	J.P. Morgan	6	$515.00
22	Upper90	6	$192.50
23	Trinity Capital	6	$125.55
24	Western Technology	6	$38.58
	Total	318	$16909.71

Table 1: Top active venture lenders in Preqin as of 2022. The table lists all lenders that originated at least six venture loans in Preqin during 2018-2022, along with the total number and amount of those loans. The five BDC lenders that we study in the paper are #2 Horizon Technology Finance (HRZN); #3 Hercules Capital (HTGC), #7 Runway Growth Capital (RWAY), #13 TriplePoint Capital (TPVG), and #23 Trinity Capital (TRIN).

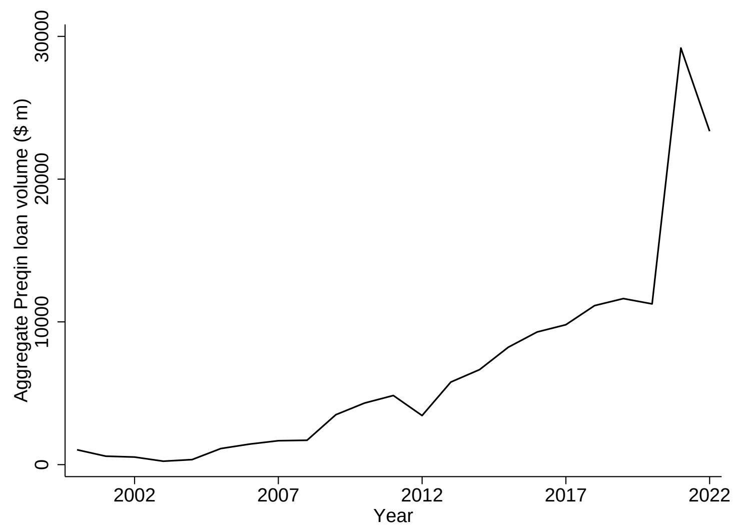

Figure 1: Aggregate volume of venture lending in Preqin per year.

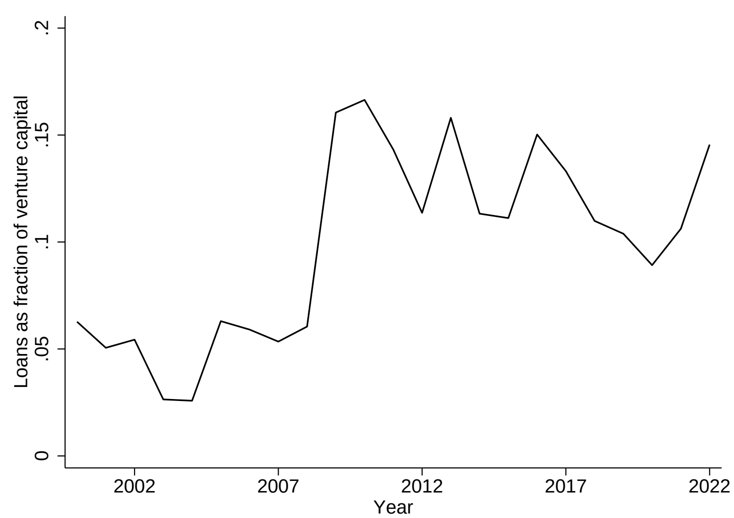

Figure 2: Venture debt divided by total venture capital financing in Preqin. The denominator is venture debt plus Angel, Seed, and Series A through K financing from Preqin.

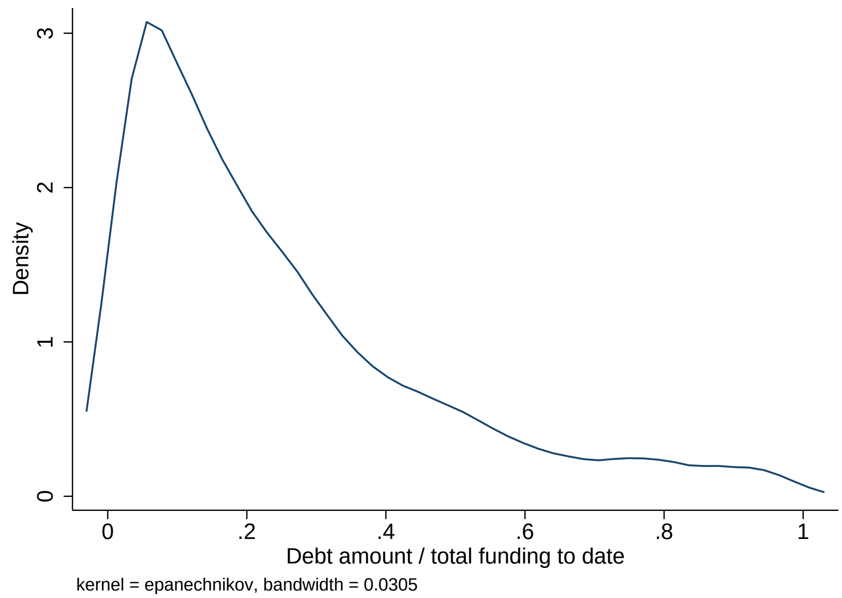

Figure 3: Distribution of the ratio of venture loan size to total venture capital financing recorded to date in Preqin for the borrowing company (including the loan itself). The mean (median) ratio is 25% (18%).

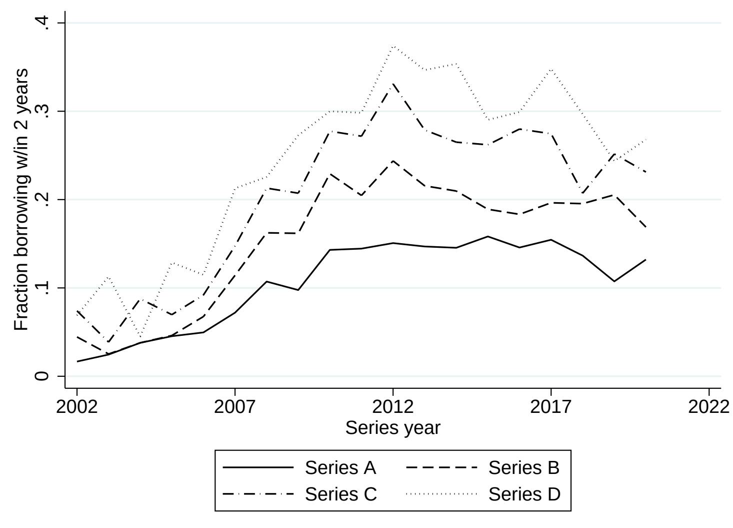

Figure 4: Fraction of venture-backed equity rounds in Preqin from 2000–2020 that are followed by a venture debt round to the same company within the next two years.

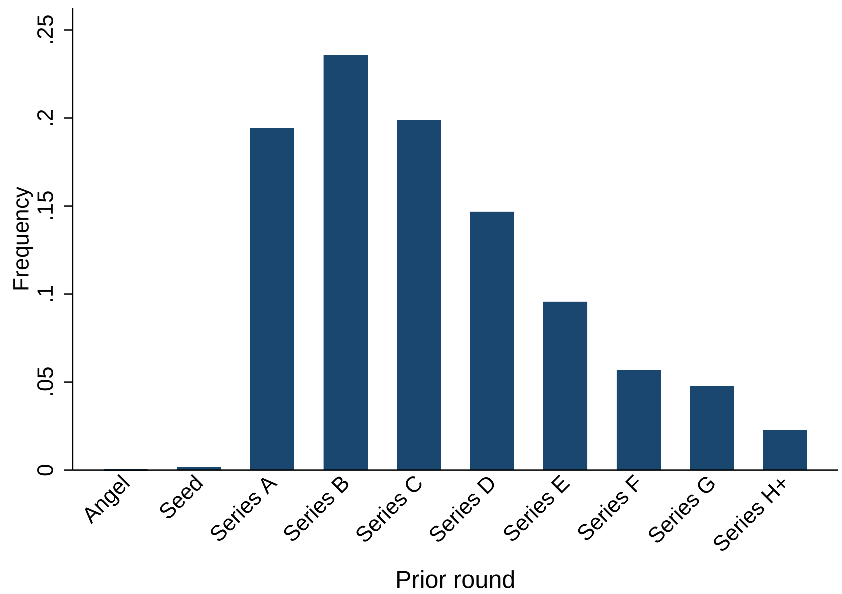

Figure 5: Most recent stage of financing observed before venture loans in Preqin. Excludes rounds whose most recent stage was not one of those listed.

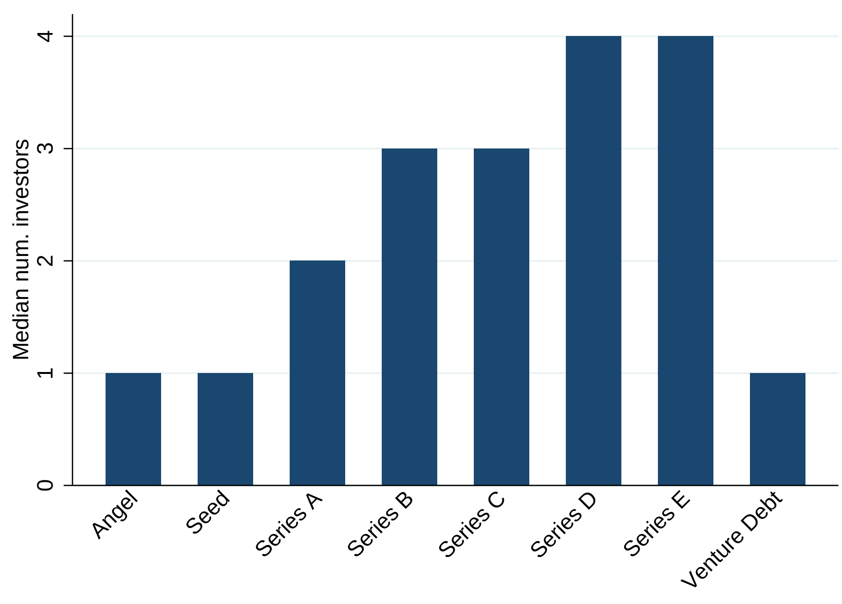

Figure 6: Syndicate size of Preqin venture rounds by stage

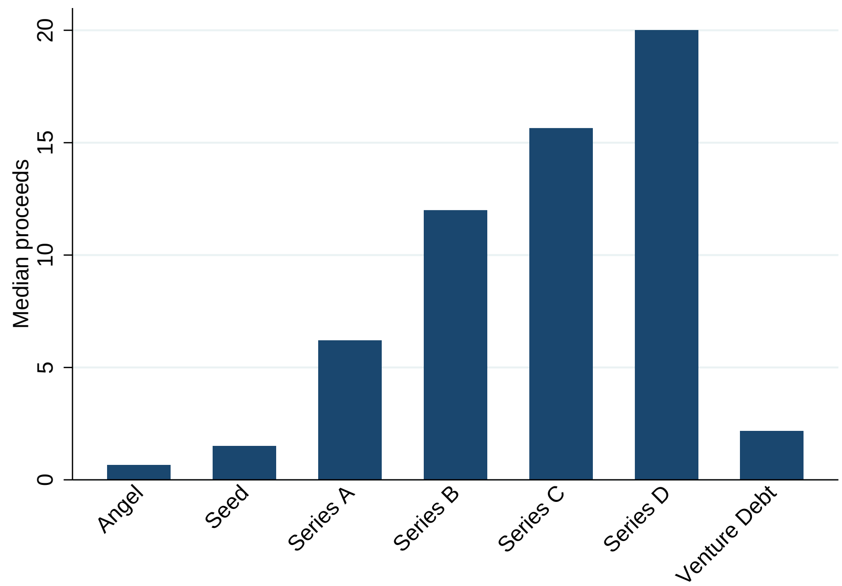

Figure 7: Proceeds of Preqin venture rounds by stage.

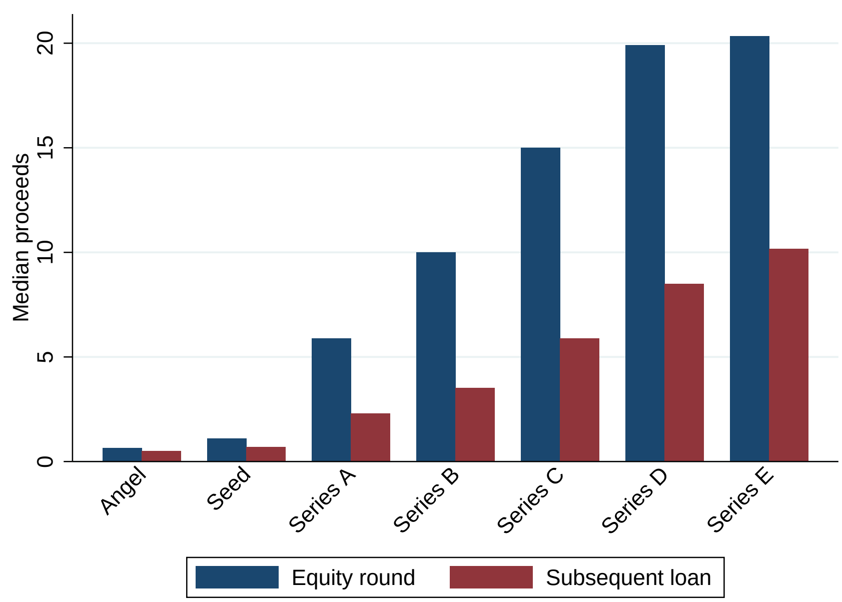

Figure 8: Comparison of equity and loan amounts by stage. In contrast to Figure 7, the blue bars restrict to equity rounds that are followed by venture debt.

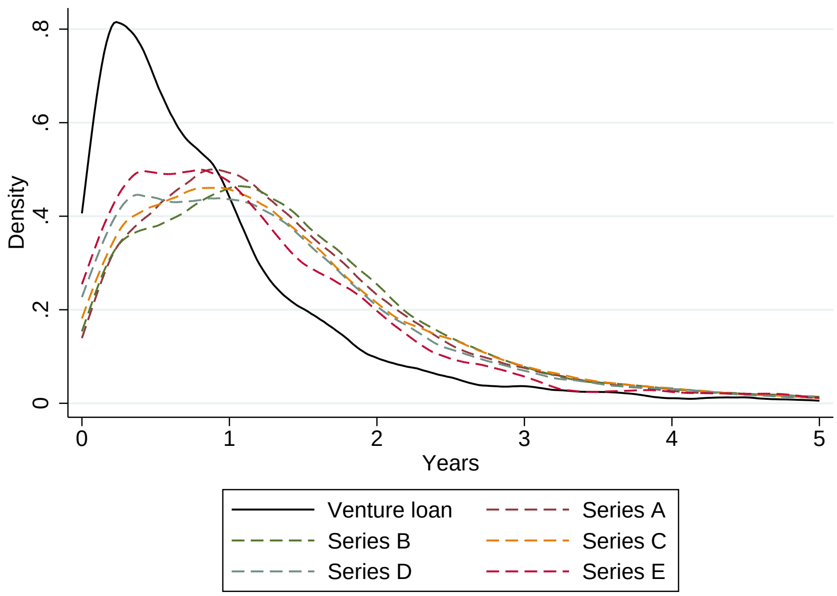

Figure 9: Years until next round in Preqin, by current round type.

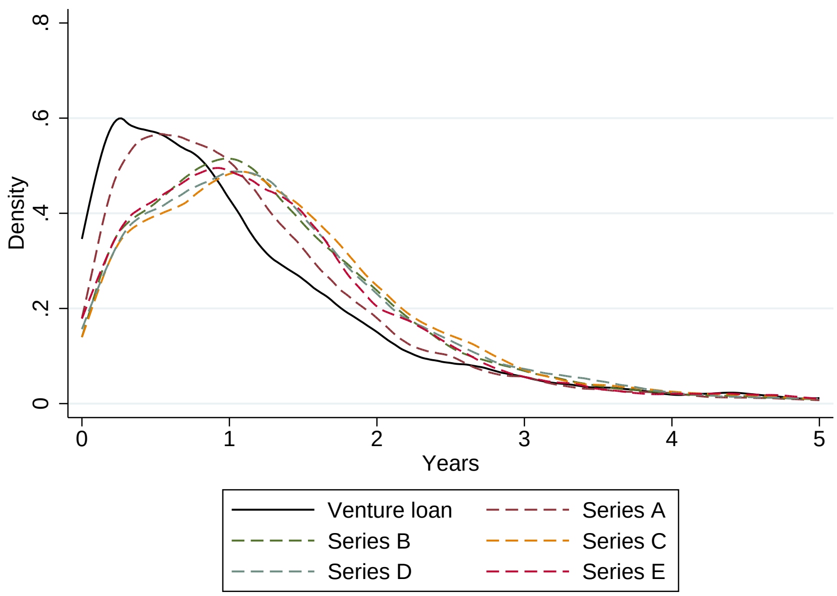

Figure 10: Years since prior round in Preqin, by current round type.

A.2 BDC data

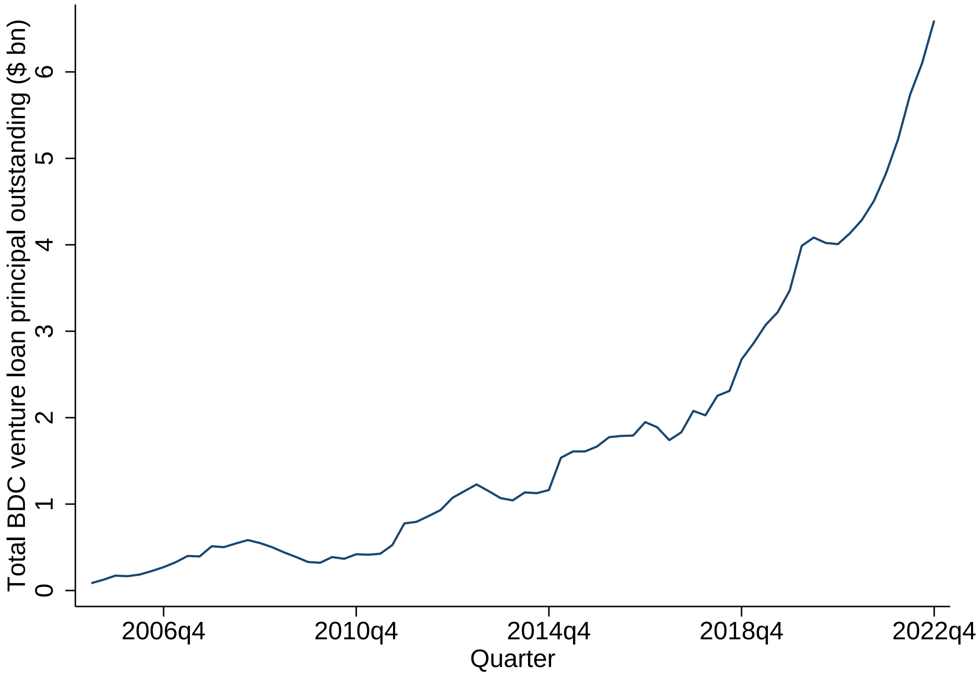

Figure 11: Volume of venture loan principal outstanding from BDCs, combined.

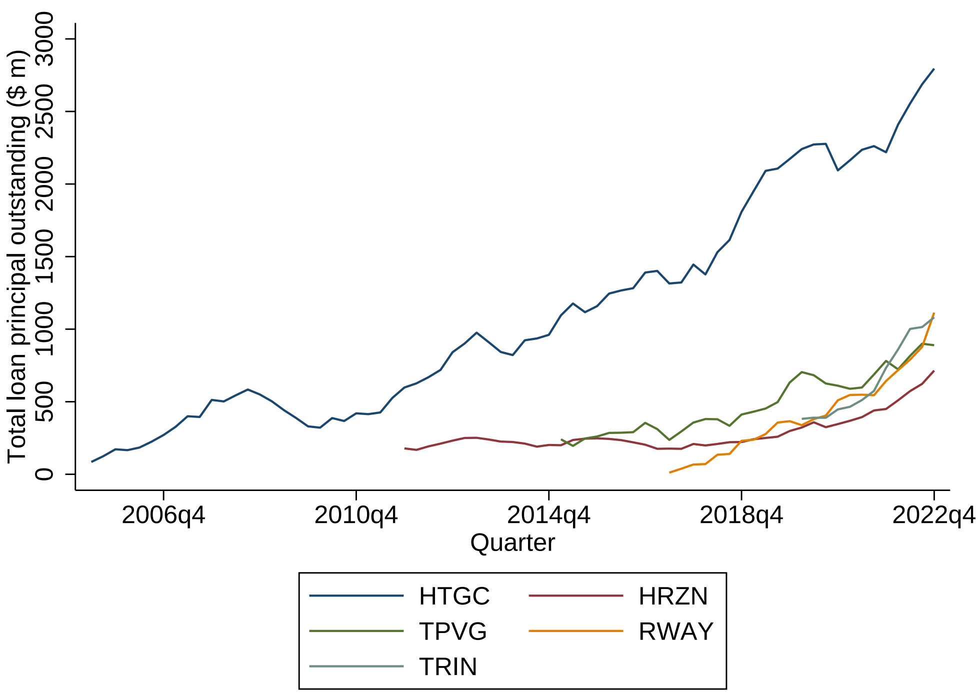

Figure 12: Volume of venture loan principal outstanding from BDCs, separately.

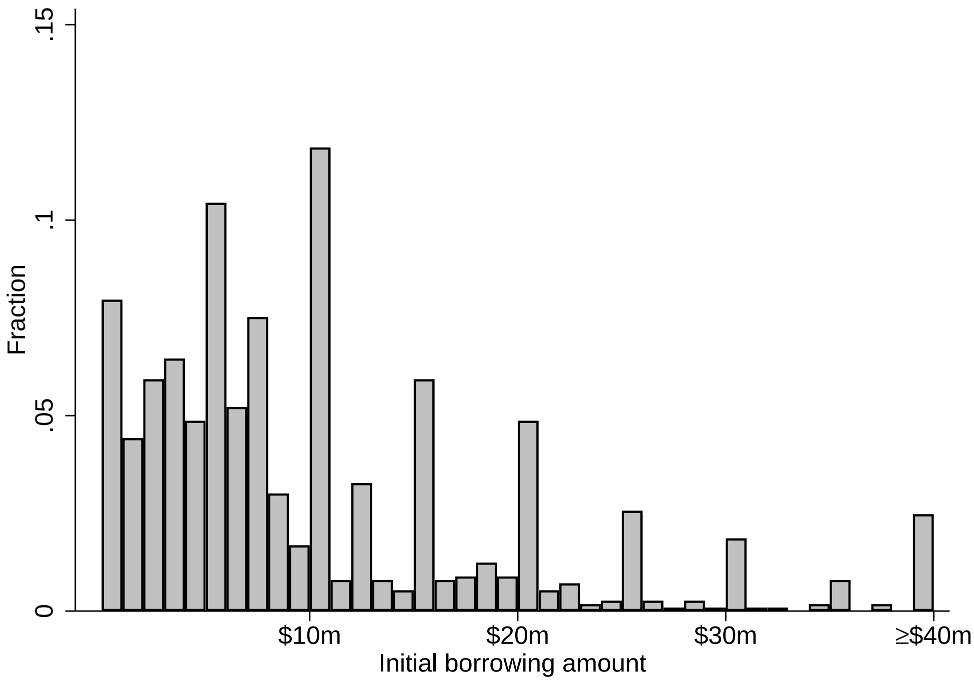

Figure 13: Distribution of principal amounts when BDC loans first enter the data.

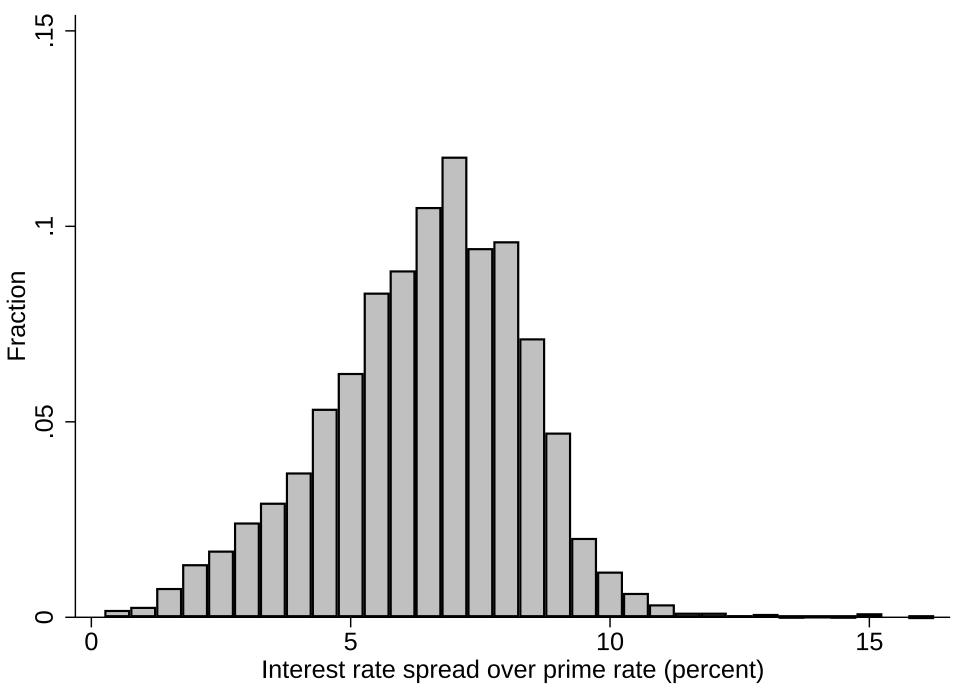

Figure 14: We calculate the interest rate for each loan in each quarter, taking into account its base rate (Prime, LIBOR, or SOFR) and any rate ceilings and floors, then subtract out that quarter's prime rate. We do not include end-of-term payments or prepayment fees.

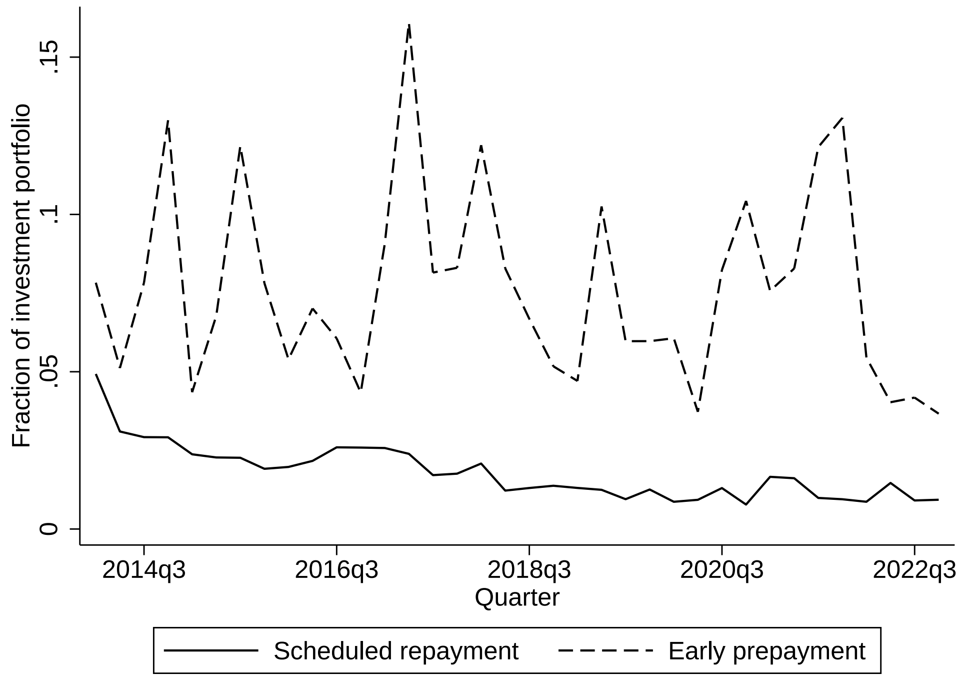

Figure 15: Aggregate principal payments as a fraction of portfolio value for BDC lenders.

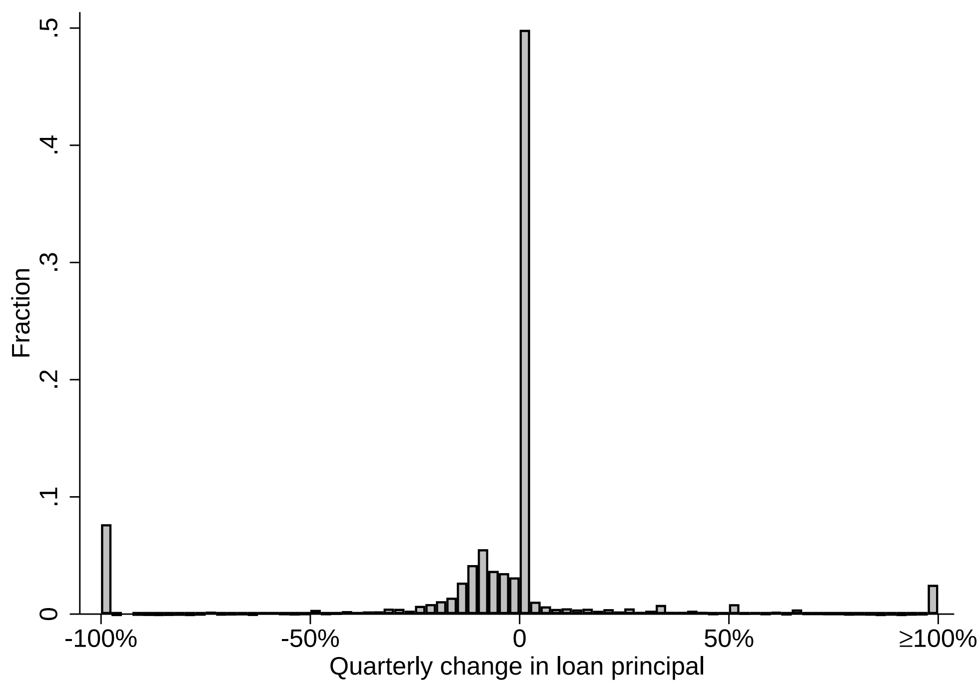

Figure 16: Distribution of borrower-quarter payoffs and increases of loan principal. We remove any principal decreases that appear to be writeoffs, as described Appendix B.2.

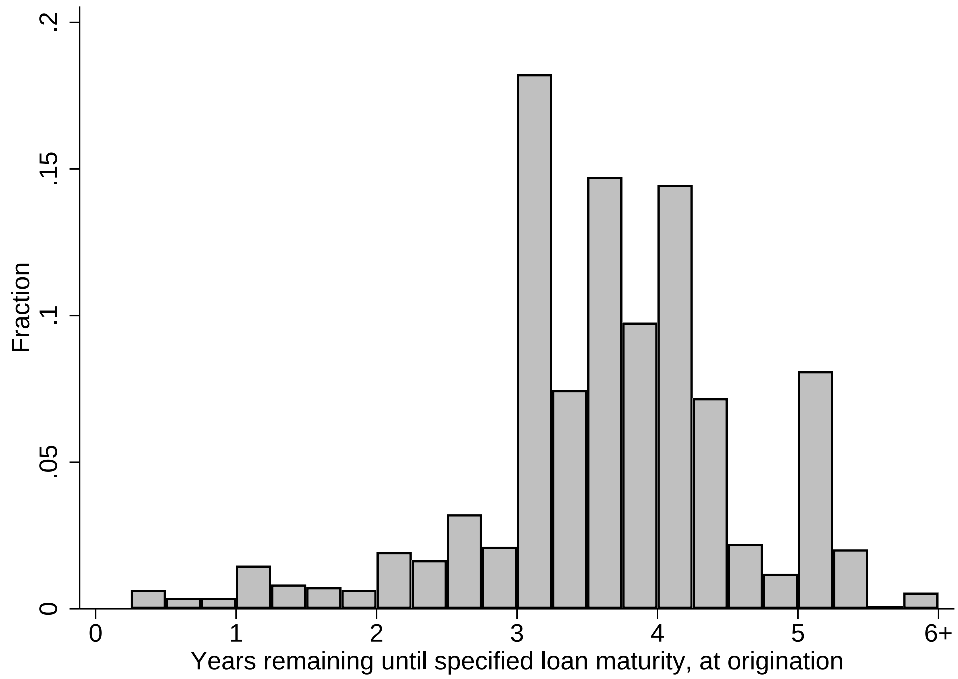

Figure 17: Distribution of maturities when BDC loans first enter the data.

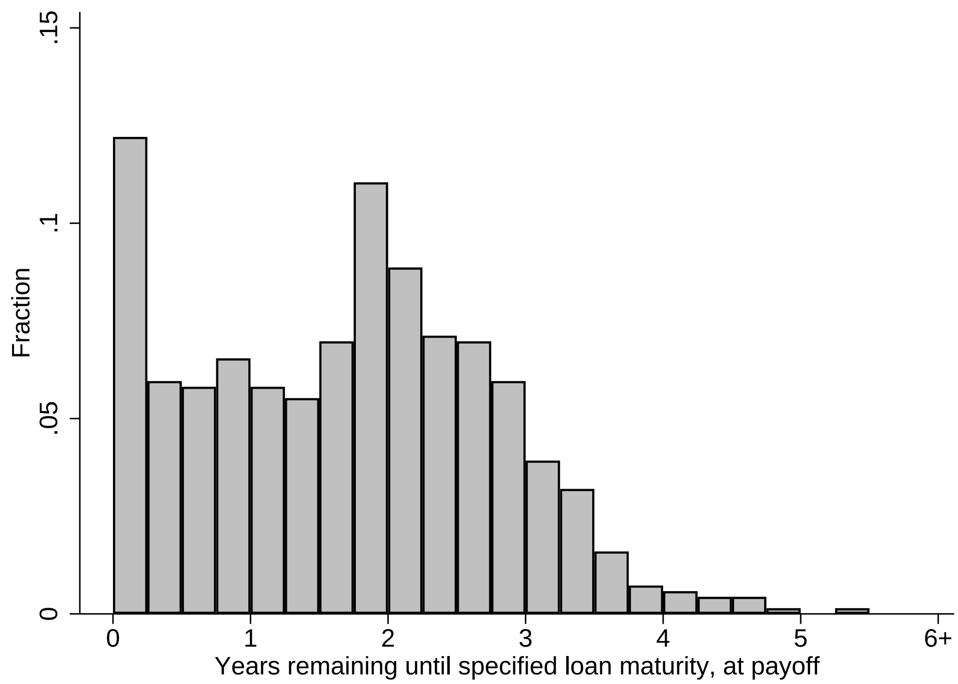

Figure 18: Distribution of remaining maturities when BDC loans are paid off.

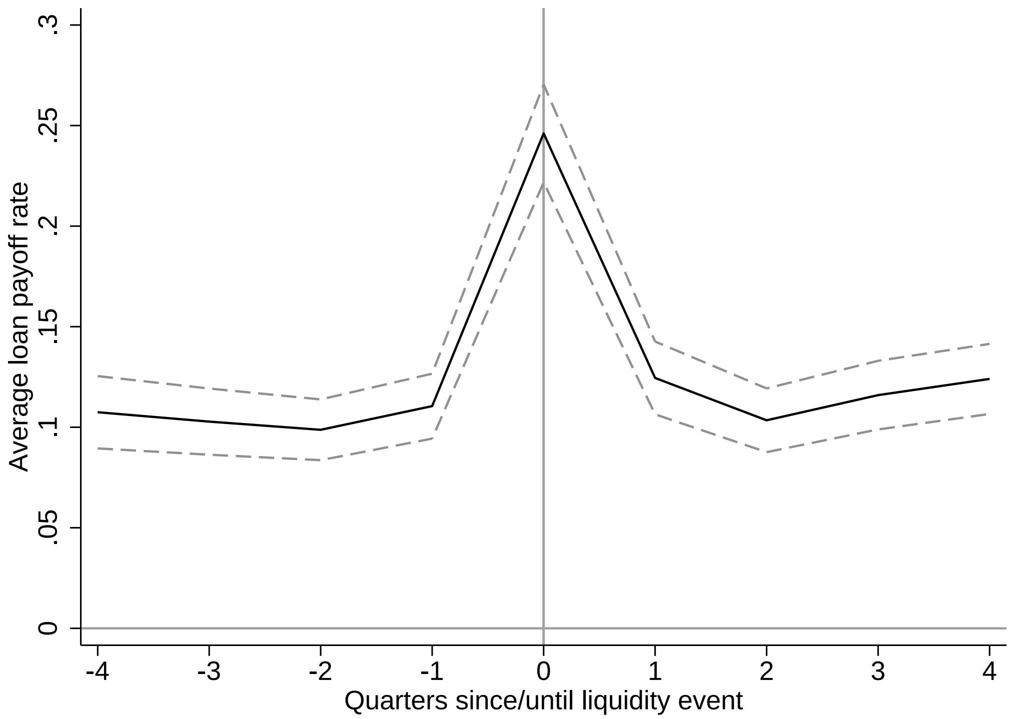

Figure 19: The horizontal axis plots the number of quarters since or until a liquidity event, defined as an equity round, acquisition, buyout, or IPO recorded in Pitchbook. The solid line plots the average payoff rate of outstanding venture loans in that quarter as a fraction of principal. The dashed lines are two standard errors of the mean above and below this average.

	(1) Liquidity event	(2) Principal change	(3) Payoff amt
Patents no longer pending	0.00903**	-164.1**	159.7***
	(0.00368)	(67.50)	(31.94)
Obs.	35815	35815	35815
R^2	0.0102	0.000834	0.00220
Fixed Effect	Company, Year	Company, Year	Company, Year

Panel A

	(1) Liquidity event	(2) Principal change	(3) Payoff amt
Any trial starts	0.0166**	-76.30	-29.63
	(0.00489)	(42.13)	(58.68)
Any primary completions	-0.0182**	255.2***	-99.59***
	(0.00542)	(12.85)	(15.00)
Any final updates	0.0144**	-255.1**	220.3**
	(0.00379)	(93.76)	(66.83)
Obs.	7844	7844	7844
R^2	0.00852	0.00224	0.00414
Fixed Effect	Company, Year	Company, Year	Company, Year

Panel B

Table 2: The sample is a quarterly panel of companies that have ever taken out a loan from our BDC lenders. In Panel A, the sample is restricted to quarters in which the company has filed at least one prior patent application, and the key explanatory variable is an indicator equal to 1 if the company had pending patents one year ago, and has no pending patents now. In Panel B, the sample is restricted to quarters in which the company has started at least one clinical trial in the past, and the key explanatory variables are indicators for any of the company's trials starting in this quarter, reaching primary completion in this quarter, or posting their final update in this quarter. In each panel, the outcome in the first column is an indicator for a liquidity event being recorded in Pitchbook this quarter (equity round, buyout, acquisition, or public offering). In the second column the outcome variable is the change in venture loan principal outstanding through either new borrowing or repayment of principal. In the third column the outcome variable is the amount of principal repayment (zero if there was no repayment or if the principal increased). In each specification, fixed effects are included for both company and year, and standard errors are clustered by the company's industry listed in Pitchbook.

	(1) Liquidity event	(2) Payoff rate	(3) Liquidity event	(4) Payoff rate
Pending patents	-0.218***	-0.128**	-0.164**	-0.131**
	(0.0596)	(0.0529)	(0.0834)	(0.0514)
# equity rounds			-0.166***	0.00729
			(0.0222)	(0.00734)
Obs.	8804	8804	8804	8804
R^2	0.00302	0.0581	0.0580	0.0583
Fixed Effect	Company, Year	Company, Year	Company, Year	Company, Year

Standard errors in parentheses

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

Panel A

	(1) Liquidity event	(2) Payoff rate	(3) Liquidity event	(4) Payoff rate
Completed trials	-0.0254***	-0.0752***	-0.0187**	-0.0755***
	(0.00423)	(0.0145)	(0.00781)	(0.0143)
# equity rounds			-0.166***	0.00730
			(0.0221)	(0.00770)
Obs.	8804	8804	8804	8804
R^2	0.00227	0.0600	0.0576	0.0601
Fixed Effect	Company, Year	Company, Year	Company, Year	Company, Year

Standard errors in parentheses

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

Panel B

Table 3: The sample is a quarterly panel of companies with a venture loan currently outstanding from a BDC lender. In Panel A, the key explanatory variable is the company's current number of pending patents as of the given quarter. In Panel B, it is the number of the company's clinical trials that have reached primary completion (meaning all data has been collected on the primary outcome of the trial), but have not yet posted their last update to the clinicaltrials.gov website as of the given quarter. Both of these variables are scaled by their sample standard deviation for ease of interpretation. Columns 3 and 4 of each panel also control for the number of equity rounds that the company has raised prior to the quarter, as reported in Pitchbook. In each panel, the outcome variables in Columns 1 and 3 are an indicator for the company experiencing a liquidity event in the current quarter (equity round, acquisition, buyout, or public offering reported in Pitchbook). The outcome variables in Columns 2 and 4 are the fraction of venture loan principal paid off during the given quarter. In each specification, fixed effects are included for both company and year, and standard errors are clustered by the company's industry listed in Pitchbook.

	(1) Payoff rate	(2) Payoff rate	(3) Payoff rate
Liquidity event	0.925***	0.924***	0.948**
	(0.330)	(0.316)	(0.376)
# equity rounds			0.164***
			(0.0616)
Obs.	8804	8804	8804
Fixed Effect	Company, Year	Company, Year	Company, Year
Instruments	# pending patents, # completed trials	# pending patents, # completed trials, interaction	# pending patents, # completed trials, interaction
J test p-value	0.1042	0.2624	0.1622

Standard errors in parentheses

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

Panel A

	(1) Payoff rate	(2) Payoff rate	(3) Payoff rate
Liquidity event	1.164***	0.999*	1.240***
	(0.308)	(0.559)	(0.326)
Obs.	8804	8804	8804
Fixed Effect	Company, Year	Company, Year	Company, Year
Instruments	Any pending patents, any completed trials, interaction	Any pending patents	Any completed trials
J test p-value	0.5572		

Standard errors in parentheses

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

Panel B

Table 4: The table reports IV regressions of the effect of a liquidity event on the payoff rate of a venture loan, building on the results in Table 3. In each column, the outcome variable is the fraction of venture loan principal paid off in the current quarter, and the key explanatory variable is an indicator for the company experiencing a liquidity event. In Column 1 of Panel A, the instruments are the key explanatory variables from Table 3 (the company's current number of pending patents, and its current number of clinical trials that have reached primary completion but not yet posted final results). Column 2 adds the interaction of these two as an instrument. Column 3 of Panel A additionally controls for the number of equity rounds the company has recorded in Pitchbook prior to the current quarter. In Panel B, the instruments are indicators (rather than counts) of having any pending patents, or any trials past primary completion and before final update. In each specification, we include fixed effects for company and year, and standard errors are clustered by the company's industry listed in Pitchbook. The bottom row of each panel lists the p-value corresponding with Hansen's J statistic for the test of the model's overidentifying restrictions.

B Further information on BDC data

B.1 Comparing BDC venture lenders with Silicon Valley Bank

This section compares the stock prices of the BDCs we study in the paper with that of Silicon Valley Bank prior to its collapse. Our main point is that SVB was economically quite distinct from the other lenders, likely reflecting its unique status as a bank that also took borrowers' deposits, in contrast to the BDCs, which are all pure-play venture lenders.

Figure 20 demonstrates that there was no noticeable deterioration in the stock price of our BDC lenders during 2023, even as SVB collapsed and many other banks came under severe stress. In Table 5 we study the pairwise correlations of the daily returns of all six stocks (SVB and our five BDC lenders) during 2018-2023. Panel A focuses on raw returns, and Panel B on market-adjusted returns. In both panels, the five pure-play venture lenders have strong correlations with each other but notably lower correlation with SIVB. In Panel B, the market-adjusted returns of SIVB have almost no correlation with the other five, which continue to be strongly connected to each other. These findings emphasize that SVB's performance was as much defined by its identity a bank as by its venture lending business, and that this performance is not indicative of the venture debt industry overall.

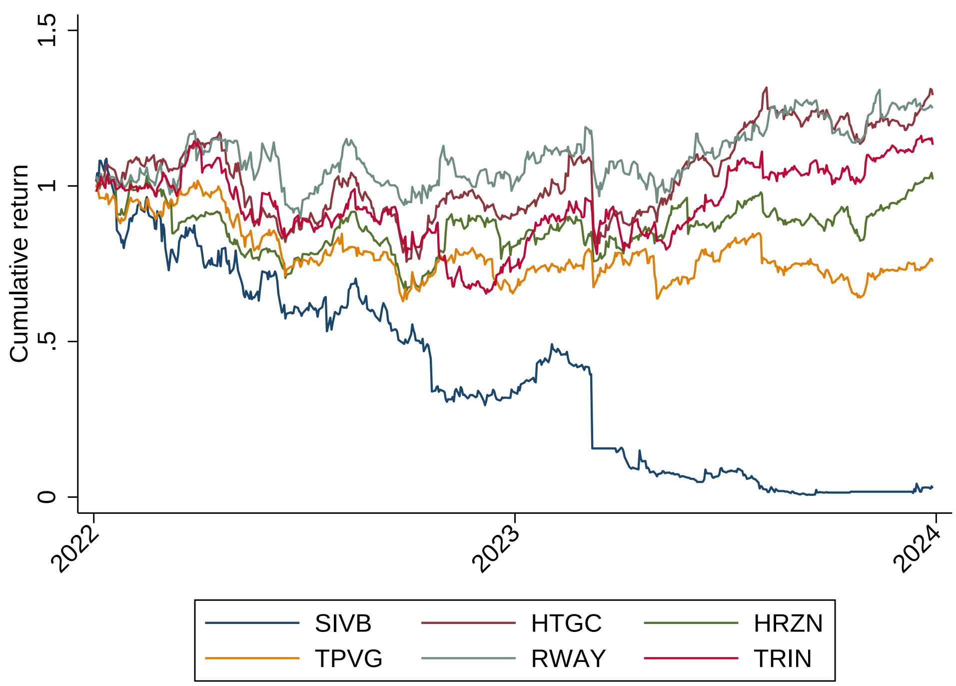

Figure 20: Comparison of stock returns 2022-2023 for SVB Financial Group (SIVB) and the five BDC venture lenders in our study.

	SIVB	HTGC	HRZN	TPVG	RWAY	TRIN
SIVB	1.00					
HTGC	0.44***	1.00				
HRZN	0.33***	0.66***	1.00			
TPVG	0.26***	0.52***	0.59***	1.00		
RWAY	0.25***	0.37***	0.34***	0.34***	1.00	
TRIN	0.25***	0.39***	0.30***	0.35***	0.26***	1.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A. Raw returns

	SIVB	HTGC	HRZN	TPVG	RWAY	TRIN
SIVB	1.00					
HTGC	0.07**	1.00				
HRZN	-0.02	0.53***	1.00			
TPVG	0.11***	0.46***	0.54***	1.00		
RWAY	0.01	0.20***	0.19***	0.18**	1.00	
TRIN	0.01	0.23***	0.14**	0.19***	0.13*	1.00

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Market-adjusted returns

Table 5: This table reports pairwise correlation matrices of raw returns (panel A) and market-adjusted returns (panel B), for SVB and the five BDC venture lenders in our sample, using daily data for the years 2018 to 2022.

B.2 Classifying BDC borrower outcomes and loan writeoffs

This section details how we classify the survival or exit status of the borrowers from BDC lenders, and how we classify observed decreases in loan principal as either payoffs or writeoffs.

To classify exit status, we start with the data from Pitchbook. This data records extensive information on each borrower, covering not only financing events but also mergers, acquisitions, IPOs and other listing events, and events of bankruptcy filing or liquidation.

However, Pitchbook's coverage is not always complete. To avoid survivorship bias, we manually fill in for each borrower a record of its final status. First, we search online for any records of liquidation or distress for each company, and fill any events or dates that were missing from Pitchbook. Next, we check for each company whether it has an active website as of 2023, or if we can find any other clear evidence through online search that the company existed at the end of 2022 (such as a new financing round or press release during 2023).

Whenever a company's final observation in our data is an acquisition, we check whether it appeared to be a distressed acquisition. We define this category broadly to include any instances in which the borrower had already entered bankruptcy or announced plans to do so, had formally announced plans to shut down or liquidate, or described the acquisition as a sale of all assets or an assignment for the benefit of creditors.

We then classify each of the 1,079 borrowers into one of four outcomes: Still active at the end of 2022 (629), exited through a liquidation or distressed acquisition (118), or exited through a non-distressed acquisition (332). Of the last category, 73 acquisitions were for more than the company's most recent valuation, 56 were less, and for 203 we do not know.

This classification highlights that portfolio companies are indeed risky, with 11% having exited through liquidation or a distressed acquisition, likely resulting in little or no recovery value for equity investors. At least 5% more were acquired for less than their prior valuation, which presumably imposed losses on equity, and this fraction may be as high as 24% taking into account the acquisitions with missing deal information. Failure rates would be even higher if we knew the eventual outcomes for companies that remain active today.

As we argue in the paper, risk is potentially much lower from the *lender's* perspective, as failure often happens after the loan is paid off. Indeed, lenders report realized investment losses of only about $100m in an average year, about two percent of total portfolio value. However, this percentage is only an approximation of lenders' true loan losses.[9] To arrive at a clearer perspective on credit risk, we next quantify writeoffs of principal at the loan level.

As described in the paper, we track each loan's principal during each quarter after origination. In most quarters, principal either stays flat or decreases sharply (often to zero). A principal decrease usually represents a payoff of the loan, but sometimes reflects the writeoff of an amount that the lender does not expect to recover. Lenders do not clearly distinguish the two cases in their filings, but we can do so with a high degree of confidence. The rest of this section explains our approach to this.

We first observe that the loans in our sample are always in a senior secured position, meaning that principal writeoffs should only happen when the company is in serious finan-

[9] On the one hand, it represents realized losses on the entire investment portfolio, and hence *overstates* losses on loans specifically, to the extent that it includes writeoffs of equity and warrants On the other hand, two BDC lenders only report net losses, not gross, and so we *understate* their loan losses to the extent these losses are offset by gains on the sale of other investments.

cial distress. Conversely, if a company is seriously distressed, they are very unlikely to be prepaying their loan. This means that we can separate principal payoffs and writeoffs based on the borrower's circumstances at the time.

By combining our various data sources, we have a rich perspective on these circumstances. First, the Pitchbook data augmented with our manual searches reveal if the borrower was acquired, received new funding, or entered distress or liquidation around the date of a principal decrease. Second, lenders must calculate and report each quarter the fair valuation of each loan, and of the equity or warrants that they typically also hold. If these valuations are not impaired, and especially if equity or warrants are carried at positive value, then it seems very unlikely that the lender would simultaneously write off loan principal.

With all these observations in mind, we identify each borrower-quarter in which the outstanding principal of a loan decreases by more than 20% (the vast majority are decreases by 100%). We then classify these events into payoffs or writeoffs as follows:

First, we classify a principal decrease in a given quarter as a payoff in the following cases:

- the lender continued to carry warrants or equity in the company with positive reported value after the given quarter;
- the company was acquired for more than the principal amount in the same quarter;
- the company was acquired for an undisclosed amount, but the lender's reported fair of the loan never fell significantly below its principal value; or,
- the company obtained later financing, or is clearly still active at the end of 2022, with no record of financial distress between the principal decrease date and that later date.

On the other hand, we code the principal decrease as a writeoff if the lender had no equity or warrants carried at positive value at the time, and any of the following are true:

- the borrower previously shut down or liquidated;
- the borrower had ever previously entered bankruptcy or liquidation proceedings;
- the borrower enters bankruptcy or liquidation proceedings within a year after the current quarter, with no equity financing events before then;
- the borrower was acquired within a quarter of the decrease for less than the outstanding loan principal, or was acquired for an undisclosed amount while the lender carried the loan at far below fair value around the same time.

Our approach is deliberately conservative, and if anything should over-classify events as writeoffs as opposed to payoffs. Furthermore, we note that a writeoff of a given amount still does not imply that the lender realized a loss of that amount. In fact, the lender filings anecdotally describe realizing significant recovery value on many loans even after writing off their principal. Instead, our inferred writeoffs can be viewed as the loan principal that was deemed *at risk* of a loss, which risk should be negligible for all remaining principal.

Figure 21 compares the aggregate amount of the writeoffs we infer each year, with the aggregate amount of losses that lenders report on their investment portfolio each year. This comparison is the closest we can get to a validation of our approach (although the two figures are still not exactly comparable for reasons already mentioned). The two series are similar in magnitude, with a high degree of correlation, though (as expected) our writeoff number is typically larger than the lender's reported loss number. We also check that in any anecdotal cases where a lender explicitly mentions a writeoff or realized loss on a loan to a given company, our procedure correctly identifies a corresponding writeoff of loan principal.

As another validation exercise, in Table 6 we check our interpretation of lender reported debt and warrant values, by examining how these values predict formal bankruptcy filings. The outcome in all columns is an indicator for the borrower filing for bankruptcy in the current quarter or the next quarter. The first row shows that bankruptcy filing is less likely when the lender carries warrants in the borrower at positive value. The second row shows that filing is also less likely when debt is valued at a higher proportion of principal. Finally, the third row shows that the predictive power of this debt valuation ratio is only present when the lender does not report any warrants outstanding, consistent with our interpretation that the borrower is financial solvent whenever warrants are reported at positive value.

In the main paper, all our analysis of loan payoffs refers to principal decreases that have been classified as payoffs, not writeoffs, following the approach described in this section.

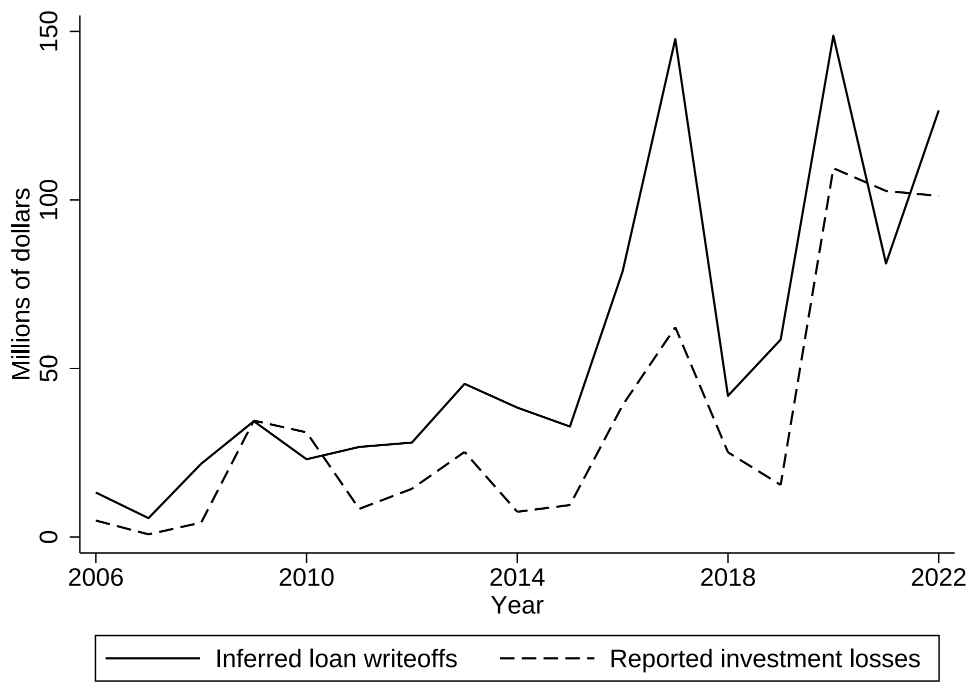

Figure 21: Comparison of BDC lender reported investment losses with inferred loan writeoffs.

	(1) Bankruptcy	(2) Bankruptcy	(3) Bankruptcy	(4) Bankruptcy
Warrants	-0.0864***	-0.104***	-0.0134***	-0.0142**
	(0.0278)	(0.0347)	(0.00355)	(0.00632)
Debt value ratio	-0.0975***	-0.0872***		
	(0.0232)	(0.0283)		
Warrants × Debt value ratio	0.0778***	0.0832**		
	(0.0282)	(0.0350)		
Δ_4 Debt value ratio			-0.139***	-0.0986***
			(0.0323)	(0.0306)
Warrants × Δ_4 Debt value ratio			0.136***	0.112***
			(0.0329)	(0.0327)
Obs.	9570	9570	5473	5473
R^2	0.0396	0.0348	0.0588	0.0390
Fixed Effect	Year	Year, Borrower	Year	Year, Borrower

Standard errors in parentheses

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

Table 6: *Bankruptcy* is an indicator for a borrower filing for bankruptcy protection in the current or next quarter. *Warrants* is an indicator for the lender carrying any warrants at positive value in the current quarter. *Debt value ratio* is the ratio of the borrower's total fair value of debt, divided by its total outstanding debt principal, as reported by the lender in the current quarter. Δ_4*Debt value ratio* is the change in this ratio over the last four quarters. Standard errors are clustered by borrower.

C Model

C.1 Setup

The game has two players, a venture capitalist (VC) and a venture lender (VL). Initially, the VC has a portfolio company with assets in place worth A. We assume the VC controls the company, ignoring any agency problem between the VC and manager. The VL operates in a competitive market and breaks even on any financing provided.

The timeline of the game is as follows:

- At date 1, the company needs interim financing $I \leq A$. The VC can either:
  - deny the financing, in which case the assets are sold and the VC receives A;
  - provide it herself, which costs an additional $I \times r_{VC} > 0$, reflecting that she has a higher cost of capital than the VL (whose discount rate we normalize to zero).
  - request financing from the VL using either a debt or equity contract.
- At date 2, the company's success probability π is drawn from some distribution with full support on $[0, 1]$. The distribution of π is common knowledge, but the realization of π is observed only by the VC. This is the only asymmetric information in the model.
- At date 3, the VC decides whether to repay the VL, and then whether to continue to the next stage of the company's development. Then the VL can veto continuation if she was not repaid. If continuation happens, the game proceeds to date 4 and the value of assets changes as described below. Otherwise assets remains at value A.
- At date 4, if the company was continued, the status of the next stage is revealed to be H with probability π and L with probability $1 - \pi$. In state L the asset value falls to $A_L < I$. If the state is H, then the VC chooses an effort level subject to a convex cost of effort $c(e) = e^2$. The value of assets in place becomes $A_H e$, where $A_H > A$.
- At date 5, the firm is liquidated for the value of its assets in place, and all payoffs are realized according to the contracts that were signed by the VC and VL.

C.2 Assumptions

We make two key assumptions on the model parameters:

1. We assume that it is efficient in expectation to provide the interim financing:

$$I < \mathbb{E}\left[\max\left\{0, \pi\left(\frac{1}{4}A_H^2\right) + (1-\pi)A_L - A\right\}\right]$$

   The left hand side is the amount of the financing. The right hand side is the expected increase in asset value from providing this financing, assuming that projects will not be continued when continuation would be inefficient. The value $\frac{1}{4}A_H^2$ is the maximum payoff that can be achieved in state H taking into account the VC's cost of effort.

2. We assume that $\frac{1}{4}A_H^2 > A$, which implies that continuation to the second stage is efficient for at least some realizations of π, again taking into account the effort cost.

C.3 Solution

We compare the VC's payoffs across her choices at date 1: request debt, request equity, provide financing herself, or deny financing. We will conclude that among her options, the VC strictly prefers to use debt with face value I, then repay that debt if continuation occurs.

Case 1a: VC requests debt with face value I. We solve backwards:

- First consider the VC's effort decision at the second stage, in the case that there is a loan in place that has not been paid off, and the state turned out to be H. The VC's problem at this date is $\max_e A_H e - I - e^2$, which is solved by setting $e = \frac{1}{2}A_H$. Moving back to the VC's decision about whether to pursue the second stage, she will do so if $\pi\left(\frac{1}{4}A_H^2 - I\right) > A - I$. Assumption 2 guarantees this is satisfied for some π. Now consider the lender's decision. By blocking continuation, the lender guarantees herself a payoff of I, while any any continuation creates the possibility of her bearing losses since $A_L < I$. Hence the lender, unable to observe π, will block *all* continuations.

- Now consider whether, for some realizations of π, the VC would pay off the loan in order to be able to continue the project. The VC's problem in state H after the loan was paid off has the same solution as before, $e = \frac{1}{2}A_H$ with expected payoff $\frac{1}{4}A_H^2$. The VC will continue the project after paying off the loan if $\pi\left(\frac{1}{4}A_H^2\right) + (1-\pi)A_L > A$. And in exactly these same cases the VC will choose to pay off the loan rather than allow the firm's assets to be liquidated, because $\pi\left(\frac{1}{4}A_H^2\right) + (1-\pi)A_L - I > A - I$. Again, the assumption $A_H^2 > 4A$ guarantees that some projects will satisfy this condition.

- Hence, if the VL provides interim financing using debt with face value I, then the VC pays off the loan and continues the firm whenever this is efficient, and otherwise allows the firm to be liquidated, with most of the proceeds going to the VL.

- Note that the VC's decisions in this case maximize total surplus, while offering the VL exactly her reservation value and thus keeping all surplus for the VC. Hence any other choice will be strictly inferior for the VC if it results in any inefficient actions.

Case 1b: VC requests debt with face value $F > I$. This can only be consistent with equilibrium if the lender will allow continuation, bearing losses in some states. As the face value F increases, the risk-shifting problem becomes worse and the VC invests in a broader range of inefficient projects rather than liquidating for certain value A. In order to offset these losses and deliver I to the lender in expectation, the VC must pay more to the lender in states where surplus is created, and this must leave him strictly worse off than in Case 1.

Case 2: VC requests equity. In exchange for providing upfront financing of I at date 1, the VL receives a promised fraction α of future cash flows. Again we solve backwards:

- If the VC does not repurchase equity, her effort problem in state H is now $\max_e (1-\alpha)A_H e - e^2$, yielding solution $e = \frac{1}{2}(1-\alpha)A_H$ and payoff of $\frac{1}{4}(1-\alpha)^2 A_H^2$. The VC then continues a company if $\pi \times \frac{1}{4}(1-\alpha)^2 A_H^2 + (1-\pi) \times (1-\alpha)A_L > A$. There are efficiency losses due to projects that are not continued, and due to lower ex post effort.

- At the other extreme, if the VC repurchases *all* of the VL's equity, then she makes efficient decisions afterward regarding both effort and continuation. Whether this repurchase is an optimal decision for the VC depends on the cost of doing so, which in turn depends on the bargaining problem between her and the VL at date 2.

- We focus on equilibria in which the VC either repurchases all or none of the VL's equity, based on a cutoff value of π. Such an equilibrium is described by a triple (α, π^*, P), where α is the VL's equity stake, π^* is the value above which the VC repurchases, and P is the price that the VC must pay. In such an equilibrium, the VC repurchases if $\pi > \pi^*_{\text{eqm}} = \frac{(P/\alpha)-A_L}{\frac{1}{4}A_H^2(2-\alpha)-\alpha A_L}$, while continuation is efficient if $\pi > \pi^*_{\text{eff}} = \frac{A-A_L}{\frac{1}{4}A_H^2-A_L}$.

- We must have $\alpha > 0$ for the VL to provide interim financing at all. Any bargaining game will generate $P > \alpha A$, because αA is the minimum payoff that the VL can anticipate from her equity stake if she rejects an offer from the VC to repurchase it (knowing that the VC will not offer unless continuation is expected to grow the value of the company's assets). These observations imply that $\pi^*_{\text{eqm}} > \pi^*_{\text{eff}}$.

- Thus, when the VL uses equity, there will be projects for which continuation is efficient, but either continuation does not happen or the VC exerts suboptimal effort. This must result in less payoff to the VC compared to the case of using a loan, since that case featured maximum total payoff to the two parties combined with minimum payoff to the VL. We conclude that the VC prefers a loan rather than equity from the VL.

Case 3: VC provides interim financing. We showed that the VC generates maximum surplus, and obtains all of that surplus, by using a venture loan. She would do strictly worse providing the financing herself, due to her higher cost of capital $r_{VC} > 0$.

Case 4: VC refuses interim financing. In this case the VC receives payoff of A. This is less than the expected payoff from using a venture loan by Assumption 1.