# The Leveraging of Silicon Valley*

Jesse Davis, Adair Morse, Xinxin Wang

March 2018

**Abstract**

Venture debt is now observed in 28-40% of venture financings. We model and document how this early-stage leveraging can affect firm outcomes. In our model, a venture capitalist maximizes firm value through financing. An equity-holding entrepreneur chooses how much risk to take, trading off the financial benefit against his preference for continuation. By extending the runway, utilizing venture debt can reduce dilution, thereby aligning the entrepreneur's incentives with the firm's. The resultant risk-taking increases firm value, but the leverage puts the startup at greater risk of failure. Empirically, we show that early-stage ventures take on venture debt when it is optimal to delay financing: such firms face higher potential dilution and exhibit lower pre-money valuations. Consistent with this notion, such firms take eighty-two fewer days between financing events. This strategy induces higher failure rates: $125,000 more venture debt predicts 6% higher closures. However, conditional on survival, venture debt-backed firms have 7-10% higher acquisition rates. Our study highlights the role of leverage in the risking-up of early-stage startup firms. Aggregation of these tradeoffs is important for understanding venture debt's role in the real economy.

*University of North Carolina - Chapel Hill (jesse_davis@kenan-flagler.unc.edu), University of California - Berkeley (morse@haas.berkeley.edu), and University of North Carolina - Chapel Hill (xinxin_wang@kenan-flagler.unc.edu) respectively.

# 1 Introduction

Entrepreneurial ventures foster technological development, drive competition and create economic growth. However, entrepreneurs are usually liquidity-constrained, making the financing of entrepreneurial ventures through external capital an essential question in economics and finance. Although economic theory would generally predict that external debt is an unlikely vehicle for the financing of early-stage startups, the venture debt market has grown rapidly in recent years. Ibrahim (2010) estimates that venture lenders, including leader Silicon Valley Bank and specialized non-bank lenders, supply $1 - $5 billion to startups annually. In more recent work, Tykvová (2017) finds that around 28% of venture-backed companies in Dow Jones Venture Source utilize venture debt. In our large-sample analysis, we find that venture debt is often a complement to equity financing, with over 40% of all financing rounds including some amount of debt.[1]

Venture debt is generally structured as a short-term (three-year) loan, with warrants for company stock. Its role differs from the now-ubiquitous convertible note contract (the standard early-stage seed financing contract), whose primary feature is its conversion to equity at a later stage. It also does not resemble traditional debt loans in that it is a debt instrument for venture equity-backed companies that lack collaterizable assets or cash flows. Instead, venture debt is secured (with uncertainty) by future rounds of equity finance. Proponents of venture debt and the nascent, important literature on venture debt (e.g., de Rassenfosse and Fischer (2016), Hochberg et al. ((forthcoming), González-Uribe and Mann (2017)) convincingly argue that it provides growth capital to extend the runway of a startup, allowing them to achieve the next milestone while minimizing equity dilution for both the founders and equity investors. These studies overlook the impact to startups and the real economy from the fact that venture debt is still a debt product, which carries the traditional implications which arise when leveraging a firm.

In this paper, we provide theoretical foundations, supported by empirical evidence, on the use of venture debt. In the model, an entrepreneur trades off the financial benefits of risk-taking with the utility he forfeits if the firm fails. If the entrepeneur's equity is too diluted, he favors a low-risk (low-value) strategy. We show that venture debt can reduce dilution by delaying equity financing until a milestone is met and incents the entrepreneur to choose a high-risk (high-value) strategy. Empirically, we show that venture debt is utilized when expected dilution is high and when it is optimal to delay financing so that the next milestone may be reached. Furthermore, startups that take on venture debt have shorter time between financing events, higher failure

[1]See Figure 1 for a breakdown of financing round by types. Ibrahim (2010) estimates that the venture debt market is approximately 10-20% of aggregate venture capital. The difference in magnitude is the syndication of rounds by both debt and equity investors.

rates, and higher acquisition rates conditional on survival.

The optimal use of early-stage leverage suggests several major changes in our perception of startups. First, if venture debt incents entrepreneurs and firms to "risk up", the innovation economy may be facing greater uncertainty (both financial and strategic) than in previous decades. Second, if venture debt increases expected firm value, more startups may be able to receive funding (ex-ante and interim) than would otherwise. Third, the use of venture debt may be changing the allocation of both human capital and startup finance capital toward the continuation of riskier endeavors and away from the alternative use of such resources.

To establish our theoretical predictions, we consider a three-date model. At date zero, a firm owns a risky asset of uncertain quality. At date one, the asset's quality is revealed after which the firm's strategy is chosen. At date two, the cash flow is realized.[2] Before each date, the firm must raise capital to avoid closure, e.g., to pay employees.

The firm is owned by an entrepreneur and a venture capitalist; both are risk-neutral.[3] The venture capitalist chooses how and when to raise capital to maximize the expected value of the firm.[4] In particular, at date zero, she has (1) the option of raising some portion of the required financing after the asset's quality is revealed and (2) access to both equity and venture debt investors. At date one, the entrepreneur implements the firm's going-to-market strategy, which is unobservable. Specifically, the firm's strategy determines the riskiness of the distribution of the terminal cash flow. The entrepreneur chooses how much risk to take, accounting for the value of his equity claim as well as the non-pecuniary utility he derives from continuation, i.e., the firm avoiding shutdown.

This non-pecuniary utility creates a wedge between the venture capitalist's and entrepreneur's incentives.[5] Unsurprisingly, when the entrepreneur's stake is excessively diluted, he chooses the low-risk (low-value) strategy. Preferring the high-risk strategy, the venture capitalist makes her financing decisions to minimize the likelihood this occurs. We show that if the firm's unconditional quality is sufficiently high, the firm can raise the required capital cheaply in one round – the entrepreneur chooses the high-risk strategy and firm value is maximized. As unconditional quality falls, the entrepreneur's dilution increases; if it falls sufficiently, the entrepreneur chooses to scale back risk. In this case, the venture capitalist chooses to raise some portion of the needed funds after firm quality is known. We show that this is beneficial if the firm's asset is revealed to be high-quality: at that point, equity can be raised less expensively, reducing

[2]Under the assumptions of the model, this terminal cash flow need not be realized and is equivalent to an expectation of the firm's value as a going concern.

[3]The venture capitalist is an equity investor from an earlier round.

[4]This is consistent with both the survey evidence from Ibrahim (2010) and Sage (2010).

[5]This wedge utilizes the well-documented fact that while both venture capitalists and entrepreneurs seek to maximize firm value, venture capitalists' often prefer higher volatility in their investments relative to entrepreneurs (who also value continuation of their startups).

dilution (and potentially incenting the entrepreneur to take the high-risk strategy once more). On the other hand, it also creates the possibility of failure if the firm's asset is revealed to be low-quality.

Venture debt amplifies this effect. By borrowing today, the firm raises less equity at a low, unconditional value. This increases the required equity issued in the future, but this is done at a potentially high conditional value. Though it comes with increased risk of failure, we show that, in some cases, venture debt is strictly preferable from the venture capitalist's perspective.

The model generates several empirical predictions consistent with features of the venture debt market. First, all else equal, venture debt is more likely to be optimal when the entrepreneur faces high potential dilution - for instance, when the firm requires significant investments of capital. Second, we expect to see more venture debt when the benefits of risk-taking are low; such debt is necessary to incent the entrepreneur to choose the value-maximizing strategy. Third, we expect to see venture capital utilized by "mid-value" firms: those firm that firms can raise capital, but do so at great cost. Finally, we show that while the use of venture debt increases the short-term probability of firm closure it also increases the value of the firm, conditional on survival.

With these theoretical predictions in mind, we offer five, novel empirical contributions.

We begin by identifying which startups choose debt in their financing and how it. First, we show that potential dilution is a strong predictor of the decision to raise venture debt instead of venture equity. Indeed, startups with a standard deviation higher dilution from the current round are five percent more likely to issue such debt. Both entrepreneurs and investors value "skin-in-the-game" and the additional capital provided by a venture loan allows startups to achieve more progress before raising additional equity. Further, if the firm is able to reach its milestone (i.e., is "high quality" in the parlance of the model), this approach minimizes the dilution that occurs relative to securing such external capital at an earlier time.

We then provide evidence consistent with this intuition of venture debt as extending the runway. Our second contribution shows that firm quality realizations are a driver of venture capitalist preference for venture debt. We find that in early rounds, low pre-money valuations, which are indicative of missing milestones or targets, lead to an increase in the likelihood of raising debt.[6] Our third contribution finds that after early-stage startups choose venture debt, they return to the venture investor market in eighty-two fewer days, even after controlling for the amount of capital raised. This suggests that such firms are using venture debt as an extension (having failed to reach a needed milestone) and that they return to the market after more information is revealed about the firm's future prospects.

[6] In later rounds, high pre-money valuations, which are indicative of stable returns, lead to an increase in traditional debt financing.

Turning to firm level outcomes, our fourth contribution shows that leverage makes the company more risky, at least until the next milestone is met. Specifically, debt increases the probability of startup closure in the first three years. An increase in early-stage financing to include $125,000 in venture debt is associated with a 6% higher likelihood of firm closing. As expected, firms which survive the risk generated by venture debt benefit. An early debt round increases the likelihood of exiting via acquisition, conditional on not closing, by 7-10%. This fiftn contribution is consistent with the intuition that firms utilize venture debt not simply to prevent dilution but to improve firm value as well.

Our research adds to the current finance literature in several areas. First, this paper contributes to the growing literature on venture lending. The existing literature has focused on determinants of the lending decision. Hochberg et al. ((forthcoming) empirically tests the collateriability of patents as a driver of venture lending lending while de Rassenfosse and Fischer (2016) finds that backing from venture capitalists substitute for startups' cash flow in the lending decision. González-Uribe and Mann (2017) provides contract-level data on venture loans and finds that intellectual capital and warrants are important features. These results corroborate the earlier market survey work by Ibrahim (2010) who finds that venture debt provides additional runway between early-stage rounds and are repaid through future equity raises. Similarly, his research also points to the importance of intellectual property as collateral for the loan. Missing from this, however, is a consideration of the risk implications of the leveraging of venture capital funded startups. Our paper instead studies the effects of the growth of the venture debt market on startup outcomes.

Secondly, our paper contributes to the broader literature on the financing of growth startups. Empirically, Kortum and Lerner (2000), Hirukawa and Ueda (2011), Nanda and Rhodes-Kropf (2013), and Kerr et al. (2014), show the effect of different types of equity-based venture capital on firm level outcomes. This paper, on the other hand, documents a different mechanism for accessing financial markets and thus, a different set of incentives for investors and entrepreneurs. On the theoretical side, our paper highliglights a new channel through which staged financing, and in particular, venture debt, can be optimal. In contrast to the large literature which provides a role for staged financing (e.g., Bergemann and Hege (1998), Neher (1999), Casamatta (2003)), our model shows that firms may prefer staged financing in order to reduce dilution, aligning the entrepreneur's incentives with the firm.

The remainder of the paper is organized as follows. We present the model and develop testable empirical predictions in Section 2. Section 3 describes data sources and sample construction, while section 4 presents the main empirical results. Section 5 concludes the paper.

# 2 Model

## 2.1 Model setup

There are three dates, $t \in \{0, 1, 2\}$. A firm owns a risky asset which pays a cash flow $\gamma Y$ at the end of date two. At the start of each date, the firm must invest $X_t$; if it fails to do so for any $t$, the firm shuts down (i.e., $Y = 0$). Otherwise, $Y > 0$. For instance, such "investments" may be required to pay employees or produce for orders. The asset is initially of unknown quality. If the initial investment ($X_0$) is made, the quality of the asset is revealed. If the intermediate investment ($X_1$) is made, the firm can choose its going-to-market strategy, which determines the distribution of $\gamma$. Prior to the terminal investment ($X_2$),$\gamma$ is realized.

The firm is initially owned by (i) a risk-neutral venture capitalist and (ii) a risk-neutral entrepreneur. The firm has no debt outstanding and the venture capitalist owns a fraction $\theta$ of the firm's equity. The entrepreneur has no wealth (outside of his equity stake in the firm) and no labor income. As a result, the capital required to make each investment must be raised from (outside) risk-neutral investors.[7] The price of each claim is set such that outside investors breakeven in expectation, conditional on the information available on that date.[8]

This initial venture capitalist is responsible for all financing decisions. At each date, her objective is to maximize the expected payoff from her equity claim, $V_t$. Any equity issued by the firm is dilutive (of all existing owners) and we denote the fraction of the firm sold at each date by $\alpha_t$. To highlight the potential role of venture debt, we allow the firm to issue one-period straight debt (with face value $F$) at date zero.[9] While the firm generates no cash flows, this venture debt is backed by the promise of equity issuance in the next period. If the firm is unable to repay the debt owed at date one, the asset value goes to zero.[10]

At dates one and two the venture capitalist raises the required capital as long as it is less than the expected value of the ongoing concern. At date zero, however, she chooses both (i) how much capital to raise and (ii) how to raise it in order to maximize

$$V_0 \equiv \theta \left(1 - \alpha_0\right) \mathbb{E}\left[\prod_{j=1}^{2} \left(1 - \alpha_2\right) \gamma Y \mid p_0\right]. \tag{1}$$

We assume that the venture capitalist has two options: she can raise $X_0 + X_1$ (which we will

[7]Future equity capital could also come from the inside venture capitalist, but for ease of exposition, we focus on this setting.

[8]This is equivalent to assuming (i) competitive capital markets and (ii) a perfectly elastic supply of the risk-free asset.

[9]It is without loss of generality to assume that any capital raised at date two is via equity.

[10]This assumption is not necessary but is made for tractability - the intuition for our results holds as long as there is some liquidation cost in bankruptcy.

call “upfront” financing) or she can raise only $X_0$ and delay the financing of $X_1$ until after the firm's quality is revealed (which we will call “staged” financing). This revelation of quality is consistent with the notion of reaching (or failing to reach) certain milestones, common in start-up financing objectives. If the venture capitalist chooses staged financing, she must also choose what fraction of the initial capital to raise from equity and venture debt investors.[11]

The entrepreneur is responsible for choosing the firm's strategy, which is unobservable. In what follows, we focus on how the firm's strategy can affect the riskiness of its cash flows. For tractability, we assume

$$\gamma = \begin{cases} \tilde{\gamma} + \delta & \text{with probability } \tau \\ \tilde{\gamma} & \text{with probability } p_1 - 2\tau \\ \tilde{\gamma} - \delta & \text{with probability } (1 - p_1) + \tau \end{cases} . \tag{2}$$

The parameter $\gamma$ can be interpreted in many ways in our model, including a pricing multiple (e.g. price-to-sales), the fraction of the market obtained by the firm, even the likelihood the firm is able to successfully exit. We refer to $p_1$ as the quality of the firm - as $p_1$ increases, the expected value of the asset increases. On the other hand, an increase in $\tau$, where $\tau \in [0, \tau_h]$, captures the “riskiness” of the firm's strategy: extreme realizations of $\gamma$ (both good and bad) are more likely. [12]

While risk-neutral, we assume that the entrepreneur receives some non-pecuniary utility over continuation, i.e., if $Y > 0$. We model this simply, so that the entrepreneur chooses $\tau$ to maximize

$$A_1 \mathbb{E}\left[(1-\alpha_2)\,\gamma Y \,|\, p_1, \tau\right] - b\mathbb{P}\left[Y > 0 |\, p_1, \tau\right]. \tag{3}$$

where $A_1 \equiv (1-\theta) \prod_{j=0}^{1} (1-\alpha_j)$ is the entrepreneur's current stake in the firm and $b > 0$ parameterizes the level of continuation utility relative to his financial gains. This non-pecuniary utility is a source of potential misalignment between the entrepreneur and the venture capitalist's incentives. Further, we note that because the entrepreneur's distribution choice is unobservable it is not contractible.[13] As a result, the venture capitalist must use his financing decision, and its impact on the entrepreneur's stake in the firm, to influence the action taken by the entrepreneur.

Finally, we assume that firm quality is binary: with probability $q$ the asset is high-quality

[11] We assume that the firm cannot repurchase equity at date zero ($F \leq X_0$).

[12] An increase in $\tau$ is a mean-preserving spread with respect to the distribution of $\gamma$. On the other hand, as we detail below, such risk-taking (weakly) increases the expected value of the firm.

[13] We take as given that the entrpreneur cannot be relieved of her role – for instance, she may possess unique human capital, specific to the firm's asset.

$(p_1 = p_h)$, otherwise it is low-quality $(p_1 = p_l < p_h)$.[14] We let $p_0 \equiv qp_h + (1-q)\, p_l$ be the expected quality of the asset. To close the model, we note that, excepting $\gamma$ and $p_1$, all exogenous variables are known before date zero.

## 2.2 Optimal Issuance Policy

In what follows, we work recursively through the optimal issuance policy. At each date, we assume that the firm was able to successfully finance the previous investments; otherwise, no actions would be necessary.

### 2.2.1 Date Two

In order to raise sufficient capital for investment, the firm must sell a fraction,

$$\alpha_2 = \frac{X_2}{\gamma Y}, \tag{4}$$

of the firm's equity. In order for this to be feasible $(\alpha_2 \leq 1)$, it must be the case that

$$\gamma \geq \underline{\gamma} \equiv \frac{X_2}{Y}. \tag{5}$$

In our setting, $\underline{\gamma}$ denotes the final "milestone" the firm needs to achieve in order to successfully raise capital and realize the asset's terminal value.

### 2.2.2 Date One

**Optimal Strategy**

Knowing that his claim is worthless unless $\gamma \geq \underline{\gamma}$, the entrepreneur chooses the firm's strategy to maximize

$$A_1 \mathbb{E}\left[(1-\alpha_2)\,\gamma Y \,|\, p_1, \tau\right] - b\mathbb{P}\left[\gamma \geq \underline{\gamma} |\, p_1, \tau\right]. \tag{6}$$

To highlight how venture debt (through its impact on dilution) affects the firm's strategy, we assume that $\tilde{\gamma} - \delta < \underline{\gamma} < \tilde{\gamma}$.[15]

While the probability of successful exit is decreasing in the level of risk – $\mathbb{P}\left[\gamma \geq \underline{\gamma} |\, p_1, \tau\right] = p_1 - \tau$ – the expected value of his stake is actually increasing in $\tau$, because

[14] To ensure that all probabilities are non-negative, let $\tau_h < \frac{p_l}{2}$.

[15] If $\tilde{\gamma} - \delta \geq \underline{\gamma}$, then the manager is indifferent with respect to the choice of $\tau$: the expected value of her claim is constant and she faces no risk of failure. Similary, if $\tilde{\gamma} < \underline{\gamma}$, then the manager always chooses to maximize the firm's riskiness: both firm value and the probability of success are strictly increasing in $\tau$.

$$\mathbb{E}\left[(1-\alpha_2)\,\gamma Y\,|\,p_1,\tau\right] = \mathbb{P}\left[\gamma \geq \underline{\gamma}|\,p_1,\tau\right]\mathbb{E}\left[(1-\alpha_2)\,\gamma Y\,|\,p_1,\tau,\,\gamma \geq \tilde{\gamma}\right] \tag{7}$$

$$= p_1\left[\tilde{\gamma}Y - X_2\right] + \tau\left[\underbrace{\delta Y - (\tilde{\gamma}Y - X_2)}_{>0}\right]. \tag{8}$$

Risk-taking increases the expected value of equity because the firm faces a threshold for financing in the next period. Though the probability of hitting that threshold falls with risk, it is outweighed by the increase in the value of equity, conditional on success.[16] Thus, the entrepreneur faces a tradeoff. If the entrepreneur held no equity, he would always choose the lowest risk strategy. If he derived no utility from the firm's survival (i.e., $b = 0$), then he would always choose the riskiest strategy. This intuition is generalized in the following lemma.[17]

**Lemma 1.** *The entrepreneur optimally chooses the riskiest strategy ($\tau(A_1) = \tau_h$) if and only if*

$$A_1 \geq \frac{b}{\delta Y - (\tilde{\gamma}Y - X_2)} \equiv \bar{b}. \tag{9}$$

*Otherwise, she optimally sets $\tau(A_1) = 0$.*

Since all other parameters in (9) are primitives of the model, we abuse notation and let $\tau(A_1)$ denote the entrepreneur's optimal choice of risk. Note that the entrepreneur's cutoff for choosing which strategy to take ($\bar{b}$) does not depend upon whether the firm is high ($p_1^h$) or low ($p_1^l$) quality. On the other hand, the realization of this information can impact the size of the entrepreneur's stake, $A_1$, if the firm chooses to stage its financing. For instance, investors who learn that the firm is low-quality will demand a higher stake in the firm (in exchange for their investment), which increases the entrepreneur's dilution.

From the venture capitalist's perspective, risk-taking is always valuable, as she suffers no disutility if the firm fails to survive. In order to incent the entrepreneur to choose the risky strategy, however, requires that his stake not be too diluted. As a result, we turn our focus to the impact of the firm's financing choices on the entrepreneur's stake in the firm. There are two cases to consider: upfront financing and staged financing.

[16] The value of equity is convex in $\gamma$ - as a result, a mean-preserving spread over the distribution of $\gamma$ increases the expected value of equity.

[17] We assume that if the entrepreneur is indifferent between two levels of risk, he chooses the level which maximizes the value of the firm.

**Upfront Issuance**

If the firm has already raised the capital necessary for investment ($X_1$) as part of the initial round of financing, there is no issuance decision to be made and no further dilution occurs ($\alpha_1 = 0$). Let $A_1^0$ denote the entrepreneur's stake when there is upfront financing. We note that learning the quality of the firm at date one does not alter the entrepreneur's stake ($A_1^0$). Then, by Lemma 1, if the firm is financed upfront, the entrpreneur either (i) always takes risk ($A_1^0 \geq \bar{b}$) or (ii) never takes risk ($A_1^0 < \bar{b}$). We will return to this point when we consider the initial financing decision.[18]

**Staged Finance**

If the venture capitalist initially chose to raise only $X_0$, then she must now raise enough capital to make (i) the additional investment ($X_1$) as well as (ii) sufficient funds to repay the venture debt (if any) issued at date zero.[19] Thus,

$$\alpha_1 (p_1) = \frac{X_1 + F}{\mathbb{E}\left[(1-\alpha_2)\,\gamma Y \,|\, p_1, \tau\left(A_1\left(p_1\right)\right)\right]} \tag{12}$$

Investors, knowing that the size of the entrepreneur's stake affects how much risk she takes, account for this when valuing their investment in firm. For example, as the required financing needs ($X_1 + F$) grow, so must the fraction of the firm sold to new investors. This decreases the entrepreneur's stake ($A_1$). If $A_1$ falls sufficiently, the entrepreneur opts for the low-risk (low-value) strategy. Since the size of the entrepreneur's stake ($A_1$) is increasing in the quality of the firm, $p_1$, this intuition creates a clear link between firm quality and firm strategy, as summarized in the lemma below.

**Lemma 2.** *With staged financing, there exists a threshold $p_e$ such that if $p_1 \geq p_e$, the entrepreneur picks the high-risk strategy, i.e. $\tau\left(A_1(p_1)\right) = \tau_h$; otherwise, he opts for the low-risk*

[18] The realization of the firm's quality ($p_1$) does impact whether or not it is optimal to (i) invest $X_1$ and move on to the next stage or (ii) distribute $X_1$ to the firm's equityholders.The venture capitalist closes down the firm and returns $X_1$ if she fails to breaks even, i.e., if

$$\mathbb{E}\left[(1-\alpha_2)\,\gamma Y \,|\, p_1, \tau\left(A_1^0\right)\right] - X_1 < 0. \tag{10}$$

The entrepreneur would choose to invest (and keep the firm as a going concern) as long as

$$\mathbb{E}\left[(1-\alpha_2)\,\gamma Y \,|\, p_1, \tau\left(A_1^0\right)\right] - X_1 \geq -\left(\frac{b\left[p_1 - \tau\left(A_1^0\right)\right]}{A_1^0}\right). \tag{11}$$

Equation (11) says that the entrepreneur is willing to invest in a negative NPV project as long as the non-pecuniary benefit of survival is sufficiently high. There is a literature which explores how this impacts start-up financing. We abstract away from this conflict to highlight a new channel through which staged finance (and particularly, venture debt) is optimal.

[19] Recall that we are restricting the firm to equity issuance at date one.

*strategy, i.e.,* $\tau(A_1(p_1)) = 0$.

Thus, unlike with upfront financing, when the firm chooses to stage its capital raising, the realized quality of the firm can alter the firm's strategy (and therefore, its expected value).

In order for the firm to successfully raise capital at date one, it must be the case that $\alpha_1(p_1) \leq 1$. If this treshold were reached, the entrepreneur would be fully diluted and so chooses the low-risk strategy, implying that[20]

$$p_1 \geq \frac{X_1 + F}{[\tilde{\gamma}Y - X_2]} \equiv \overline{p} \tag{13}$$

As at date two, this should be interpreted as a "milestone" the firm must reach in order to successfully issue equity at date one. Equation (13) highlights one potential cost of debt - its issuance at date zero may preclude the entrepreneur from receiving financing at date one. Finally, as we show in the proof of Lemma 2, it is not necessarily the case that $p_e \geq \overline{p}$: engaging in the risky strategy may be necessary to secure financing (due to the increase in expected value the risky strategy generates).

### 2.2.3 Date Zero

If the venture capitalist chooses upfront financing, then investors breakeven in expectation if

$$\alpha_0 = \frac{X_0 + X_1}{\mathbb{E}\left[(1-\alpha_2)\,\gamma Y || \alpha_0\right]}. \tag{14}$$

Then, with upfront financing, the entrepreneur chooses the risky strategy (regardless of asset quality) as long as $A_0^1 = (1-\theta)(1-\alpha_0) \geq \bar{b}$, i.e.,

$$\frac{X_0 + X_1}{p_0\left[\tilde{\gamma}Y - X_2\right] + \tau_h\left[\delta Y - (\tilde{\gamma}Y - X_2)\right]} \leq 1 - \frac{b}{(1-\theta)\left[\delta Y - (\tilde{\gamma}Y - X_2)\right]}. \tag{15}$$

and the firm is able to obtain upfront financing as long as $\alpha_0 \leq 1$, i.e.

$$\frac{X_0 + X_1}{p_0\left[\tilde{\gamma}Y - X_2\right]} \leq 1 \tag{16}$$

To make clear our theoretical predictions, we will make use of this observation and utilize the following definitions:

[20] In order for the entrepreneur to choose the risky strategy he must still own some fraction of the firm's equity.

- A **low-value** firm cannot obtain upfront financing.
- A **mid-value** firm can obtain upfront financing but pursues the low-risk strategy.
- A **high-value** firm can obtain upfront financing and pursues the high-risk strategy.

Moreover, as the following proposition makes clear, upfront financing is always preferable to staged financing when (15) holds.

**Proposition 1.** *A high-value firm raises the capital required to reach the next stage in one round, i.e., utilizes upfront financing.*

If staged financing induces the entrepreneur to choose the high-risk strategy, regardless of asset quality, then the venture capitalist is indifferent between the two types of financing.[21] For example, if the initial investment in the firm ($X_0$) is low, staged financing performs as well as upfront financing. However, this will not always be the case. By delaying some portion of the capital raise until date one, the venture capitalist runs the risk that the asset is revealed to be low-quality. In that state of the world, the entrepreneur is more diluted than if the capital had simply been raised upfront. If the required investment increases sufficiently, the entrepreneur will be so diluted in the low-quality state that he will opt for the low-risk strategy. This lowers the venture capitalist's expected return with staged financing making upfront financing preferable.

**Proposition 2.** *A low-value firm always prefers staged financing. A mid-value firm prefers to utilize staged financing as long as*
*(1) capital can be raised when the asset is revealed to be low-quality ($p_l \geq \bar{p}$) or*
*(2) the high-quality asset is sufficiently valuable ($p_h \geq \underline{p_h}$) and the low-quality asset is not too valuable ($p_l \leq \overline{p_l}$), where $\underline{p_h}$, $\overline{p_l}$ are defined in the proof.*

Suppose the entrepreneur chooses the low-risk strategy with upfront financing – the firm is mid-value. Then, as argued above, the entrepreneur whose asset is revealed to be low-quality will do the same with staged financing. But what happens if the asset is revealed to be high-quality? In this case, staged financing *reduces dilution* relative to upfront financing — investors are willing to pay more for any equity issued when they know the asset is high-quality. If the information revealed about the asset is good (i.e., if $p_h \geq p_e$), the entrepreneur will choose the high-risk strategy, making staged financing strictly preferable. Moreover, if the information revealed about the asset is sufficiently good (i.e., if $p_h \geq \underline{p_h}$) and the value of financing a

[21]In both cases, the venture capitalist earns $\theta \left[ q V_h^{\tau_h} + (1-q) V_l^{\tau_h} - X_0 - X_1 \right]$: capital structure does not matter (i.e., Modigliani-Miller holds).

low-quality asset isn't too high (i.e., if $p_l \leq \overline{p_l}$), then the venture capitalist will choose staged financing even if the firm must shut down once the asset is revealed to be low-quality.

Finally, with a low-value firm, the venture capitalist cannot obtain upfront financing – the firm's unconditional value is negative. Of course, with staged financing, the firm will also surely shut down at date one if the asset is revealed to be low-quality. On the other hand, investing in a firm revealed to be high-quality can be profitable at date one. Knowing this, investors at date zero may finance the firm in the hopes that this comes to pass. Even with a low-value firm, it is possible that the entrepreneur will choose the high-risk strategy when date one financing is extended; in fact, such financing may only be feasible when this choice is made (when $\overline{p} \geq p_e$, as discussed above).

**Proposition 3.** *If the firm can obtain financing at date one, a mid-value firm prefers venture debt, sometimes strictly.*

The value of staged financing is that it can reduce dilution when the asset is revealed to be high-quality. In our setting, venture debt amplifies this effect. By borrowing at date zero, the firm raises (1) less equity when the firm is valued unconditionally (date zero) and (2) more equity when the firm is revealed to be high quality (date one). As the proposition makes clear, in some cases this amplification is necessary: relying on equity only can leave the entrepreneur with too little incentive to take risk. As the proof of proposition 3 argues, venture debt is more likely to be necessary at such a mid-value firm when

1. required investment ($X_0$, $X_1$) and initial dilution ($1-\theta$) increase, and
2. gains from risk-taking ($\delta$, $\tau_h$) and unconditional asset quality ($p_0$) decrease.

All else equal, such changes make it more likely that the entrepreneur will choose the low-risk strategy, making venture debt a valuable antidote. We end this section by summarizing the implications of venture debt for firm outcomes.

**Corollary 1.** *The optimal use of venture debt increases the expected value of the firm,*
*(1) increases the probability of short-term failure,*
*(2) increases the firm's expected value, conditional on survival, and*
*(3) decreases the firm's dilution if the asset is revealed to be high-quality.*

With these predictions in mind, we turn now to a description of the data analyzed.

# 3 Data and Descriptive Findings

Our data is collected from CrunchBase, a crowd-sourced database that tracks start-ups.[22] CrunchBase, which investors and analysts alike consider the most comprehensive dataset of early-stage start-up activity, describes itself as "the leading platform to discover innovative companies and the people behind them." CrunchBase was founded in 2005 but include backfill data from the mid-1900s. To address concerns of backfill bias, we limit the sample from 2000 onwards.

The start-up firm characteristics of interest from CrunchBase include: the entrepreneur(s), high-leveled employees, founding date, current status (ongoing, inactive), and exit outcomes (IPO, acquired, closed). We also have round level data on each financing event. The round level characteristics include: date of closing, investors name and type (debt, equity, angel, etc.), investment amount, and stage of financing (Series A, B, C, D). For a subset of the rounds, we also have data on pre-money valuations.

CrunchBase has many advantages over traditional finance databases such as VentureOne. One distinct benefit necessary in our context is that CrunchBase collects and aggregates all relevant startup data from the greater Web. If a startup receives Bloomberg press coverage regarding a C-suite employee change, CrunchBase will incorporate this information automatically. Additionally, CrunchBase will timestamp the event. Given that many startups rarely (and potentially endogenously) self-report closures, this provides us with a way to distinguish inactive firms from ongoing firms. We classify any firm that has no "updates" within the last two years as inactive.

The second benefit that is useful for our analysis is the availability of detailed investor information. Many financing rounds are syndicated, meaning the round has more than one investor. While CrunchBase classifies these syndicated rounds as venture, this greatly understates the use of venture debt in early-stage financing. Instead of classifying rounds as fully debt or equity, we look at the type of investors and sort investors into debt or equity investors based on their past portfolio investments. We call any round that has a known debt investor to be a syndicated debt round. We check that this is accurate through qualitative assessments and google searches.

The limitation of our data is that we do not have contract-level data on the loans meaning we don't have information on the interest rates or associated warrants. However, we take comfort in knowing that the contracts of venture loans are relatively standard across firms.[23]

The main dataset includes 61,667 firms and 135,069 financing rounds during the period

[22] https://www.crunchbase.com/\#/home/index and http://techcrunch.com/ CrunchBase. For more information on the use of this dataset, refer to Wang (2017).

[23] Cite needed.

2000-2017. Table 1 presents the company-level summary statistics.[24] A startup in our sample has on average two rounds of financing, with the first round occurring approximately three year after startup founding and 40% of all rounds involving some debt financing. The total amount of investment received during a startups lifetime is $16.6 million of which $2 million is from early debt rounds. Consistent with industry-level estimates of exit rates, 1.7% of startups go through an initial public offering (IPO), 12.4% are acquired, and 62.9% of the firms are closed/inactive.

Table 2 presents the round-level summary statistics broken down by Series. The Series show in the different panels is the actual round (for equity rounds or equity-debt syndicate rounds) or the would-be round for debt financing had the firm issued a equity round. Dilution Proxy is Current Investment divided by the sum of current + the immediate prior investment round. The pre-money valuation, which is sparsely reported in CrunchBase, is the valuation accruing to founders and prior investors as implied by the valuation of the current investment. Burn Rate Duration is the number of days forward until the next financing.

# 4 Empirical Analysis

First, we examine the decision of a startup to take on venture debt. Proposition 3 of the model states that venture debt is more likely to be necessary when

1. the required investment and initial dilution increases, and
2. the gains from risk-taking and the unconditional quality decreases.

In table 3, we present the results of a logit regression and the marginal effects of the round-level characteristics on the choice of debt versus equity. Each column subsamples only to estimate rounds for Series A, Series B, or Series C/D in order to both control for a startup's milestones and to show how the coefficients change across a startup's lifecycle. In columns 1-3, we find that the decision to take on debt does increases as dilution increases just as the model predicts. Furthermore, the coefficient increases in magnitude and statistical significance as the startup moves further along in financing rounds. In column 4, we find that a lower Series A pre-money valuation leads to an increase in the probability that a startup takes on debt instead of equity. However, the coefficient flips in the later Series C round (column 6). These results suggest that in earlier rounds, when uncertainty is higher, the inability to reach certain milestones leads to venture debt. On the other hand, venture debt is functioning like it's traditional counterpart in later rounds when the startup has more consistent cash flows.

[24] All tables are found in the Appendix.

Next, we look at the effect of venture debt on firm outcomes. In table 4, we regress burn rate, defined as the realized time until the next round in days, on a dummy variable for whether the current round is financed via debt or equity. We control for the amount of current investment since a higher investment amount should by definition provide a longer runway for the firm. We find that in early rounds (Series A), taking on debt decreases the amount of time between financing events, consistent the idea that debt repayment requires new financings sooner due to a higher burn rate. Put differently, debt is extending the runway of a firm by providing capital when the burn rate is higher.

In tables 5 and 6, we focus our attention on corollary 1 of the model, restated below.

**Corollary 2.** *The optimal use of venture debt increases the expected value of the firm,*

*(1) increases the probability of short-term failure,*

*(2) increases the firm's expected value, conditional on survival, and*

*(3) decreases the firm's dilution if the asset is revealed to be high-quality.*

In table 5, the dependent variable is an indicator for the startup closing. The estimation is logit, reporting the marginal effects effect for a change in the probability of closing. The variables of interest are the total money raised by the startup (Log Total Investment), the total money raised in a debt or debt syndicated round, and the total money raised in a debt or debt syndicated round prior to a Series B equity round. Focusing on column 1, the coefficient on Log Total Investment is negative and statistically significant at the 1% level. Consistent with our intuition, this implies that raising more capital leads to a lower probability of startup failure. The coefficient on Log Debt Investment is also negative and statistically significant, suggesting that debt extends the runway, thus delaying creative destruction in preference for risk. In column 2, we disaggregate debt investment into debt investment before and after Series B. Interestingly, the coefficient on Log Debt Investment remains negative and statistically significant, but the coefficient on Log Debt Investment Prior to Series B is positive and significant. A 10% increase in the amount of early-stage debt investment increases the probability of closure by 6%. The results are consistent with the model's predictions - while the optimal use of debt increases the firms' expected value and extends the runway, it also increases the probability of short-term failure. Venture debt provides a lever for the VC to induce risk-taking.

In table 6, we show the effect of debt on other exit outcomes (IPO, Acquisition, Ongoing), conditional on not closing. The estimation is multinomial logit, and thus each estimation has two columns, reporting the marginal effects effect for increasing the probability of exit for outcomes Acquisition or IPO relative to the probability of exit in the offset category of Ongoing. The independent variable of interest, Debt Round, is the choice of venture debt versus venture equity for each round. We also control for the current opportunity set by controlling for the log of the money raised in the current investment round. Financing round year fixed effects are included. Each numbered set of two columns subsamples only to estimate exit outcomes as of Series A rounds (column 1), Series B (column 2), or Series C/D (column 3). Across all series, a debt round increases the likelihood of exiting via acquisition relative to ongoing by 7-10%. Conversely, across all series, a debt round decreases the likelihood of an IPO exit relative to ongoing by 1-4%. While these two results seem contradictory at first glance, it is easily acknowledged and reconciled in the model. The highest-quality firms raises the capital required to reach the next milestone in one round, i.e., utilizes upfront financing, and has less use for debt financing. These are exactly the firms that have the highest expected value and the most likely to go through an initial public offering. On the other hand, venture debt amplifies the value of staged financing for mid-value firms. Venture debt thus increases the probability of a positive outcome (acquisition) for these firms.

In sum, our empirical results indicate that the startup landscape is fundamentally altered by the introduction of venture debt. Firms that take on leverage experience more downside (closures) along with more upside (acquisitions).

# 5 Conclusions

Our results demonstrate that the introduction of venture debt has potentially dramatic implications for early-stage firms. While such issuance may increase firm value and allow firms to obtain otherwise unavailable financing, it can carry with it significantly more risk, both strategic and financial. We find empirical evidence consistent with our theoretical predictions and, in particular, the role venture debt plays in extending the firm's runway. Given the recent growth in the venture debt market, and its prevalence across the innovation economy, we hope to build on this research to study its implications for the real economy.

## References


Bergemann, D., Hege, U., 1998. Venture capital financing, moral hazard, and learning. Journal of Banking & Finance 22, 703–735. 1

Casamatta, C., 2003. Financing and advising: Optimal financial contracts with venture capitalists. Journal of Finance 58 (5), 2059–2085. 1

Cornelli, F., Yosha, O., 2003. Stage financing and the role of convertible securities. Review of Economic Studies 70, 1–32.

Dahiya, S., Ray, K., 2012. Staged investments in entrepreneurial financing. Journal of Corporate Finance 18, 1193–1216.

de Rassenfosse, G., Fischer, T., 2016. Venture debt financing: Determinants of the lending decision. Strategic Entrepreneurship Journal 10, 235–256. 1

González-Uribe, J., Mann, W., 2017. New evidence on venture loans. Working Paper. 1

Hirukawa, M., Ueda, M., 2011. Venture capital and innovation: Which is first? Pacific Economic Review 16 (4), 421–465. 1

Hochberg, Y., Serrano, C., Ziedonis, R., (forthcoming). Patent collateral, investor commitment, and the market for venture lending. Jounrnal of Financial Economics. 1

Ibrahim, D., 2010. Debt as venture capital. The University of Illinois Law Review, 1169–1210. 1, 1, 4

Kerr, W., Lerner, J., Schoar, A., 2014. The consequences of entrepreneurial finance. Review of Financial Studies 27, 20–55. 1

Kortum, S., Lerner, J., 2000. Assessing the impact of venture capital on innovation. Rand Journal of Economics 31, 674–692. 1

Modigliani, F., Miller, M., 1958. The cost of capital, corporation finance and the theory of investment. American Economic Review 48 (3), 261–297.

Nanda, R., Rhodes-Kropf, M., 2013. Investment cycles and startup innovation. Journal of Financial Economics 110 (2), 403–418. 1

Nanda, R., Sahlman, W., Keller, N., 2016. Western technology investment. HBS No. 817-019.

Neher, D., 1999. Staged financing: An agency perspective. Review of Economic Studies 66, 255–274. 1

Repullo, R., Suarez, J., 2004. Venture capital finance: A security design approach. Review of Finance 8, 75–108.

Sage, S., 2010. The rise of venture debt in europe. Tech. rep., Winston & Strawn. 4

Tykvová, T., 2017. When and why do venture capital-backed companies obtain venture lending? Journal of Financial and Quantitative Analysis 52 (3), 1049–1080. 1

Wang, S., Zhou, H., 2004. Staged financing in venture capital: Moral hazard and risks. Journal of Corporate Finance 10, 131–155.

# A Proofs

## Proof of Lemma 1

First, we confirm (7):

$$\mathbb{E}\left[(1-\alpha_2)\,\gamma Y \mid p_1,\tau\right] = \tau\left[\left(1-\frac{X_2}{(\tilde{\gamma}+\delta)\,Y}\right)(\tilde{\gamma}+\delta)\,Y\right] \tag{17}$$

$$+\,(p_1-2\tau)\left[\left(1-\frac{X_2}{(\tilde{\gamma})\,Y}\right)(\tilde{\gamma})\,Y\right] \tag{18}$$

$$= p_1\left[\tilde{\gamma}Y - X_2\right] + \tau\left[\delta Y - (\tilde{\gamma}Y - X_2)\right] \tag{19}$$

Note that the last term in brackets is positive as long as

$$\delta Y > (\tilde{\gamma}Y - X_2) \tag{20}$$

$$\frac{X_2}{Y} > \tilde{\gamma} - \delta \tag{21}$$

which is true by assumption - the firm cannot get financing at date two if $\gamma = \tilde{\gamma} - \delta$. Rewriting the entrepreneur's objective function yields

$$A_1\left(p_1\left[\tilde{\gamma}Y - X_2\right] + \tau\left[\delta Y - (\tilde{\gamma}Y - X_2)\right]\right) + b\,(p_1 - \tau) \tag{22}$$

This is linear in $\tau$, implying a corner solution: $\tau* \in \{0,\, \tau_h\}$. The entrepreneur's utility is weakly increasing in $\tau$ as long as

$$A_1\left[\delta Y - (\tilde{\gamma}Y - X_2)\right] - b \geq 0 \tag{23}$$

which completes our proof. □

## Proof of Lemma 2

Rewriting (9), the entrepreneur chooses the risky strategy as long as

$$\alpha_1(p_1) \leq 1 - \left[\frac{\bar{b}}{(1-\alpha_0)\,(1-\theta)}\right] \tag{24}$$

$$\frac{X_1 + F}{1 - \left[\frac{\bar{b}}{(1-\alpha_0)(1-\theta)}\right]} \leq \mathbb{E}\left[(1-\alpha_2)\,\gamma Y \mid p_1, \tau\,(A_1\,(p_1))\right] \tag{25}$$

$$\frac{\frac{X_1+F}{1-\left[\frac{\bar{b}}{(1-\alpha_0)(1-\theta)}\right]}-\tau_h\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]}{\left[\tilde{\gamma}Y-X_2\right]}\equiv p_e\leq p_1 \tag{26}$$

This threshold exceeds $\bar{p}$ as long as

$$\frac{X_1+F}{\left[\tilde{\gamma}Y-X_2\right]}\leq\frac{\frac{X_1+F}{1-\left[\frac{\bar{b}}{(1-\alpha_0)(1-\theta)}\right]}-\tau\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]}{\left[\tilde{\gamma}Y-X_2\right]} \tag{27}$$

$$\tau_h\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]\leq\frac{X_1+F}{1-\left[\frac{\bar{b}}{(1-\alpha_0)(1-\theta)}\right]}-(X_1+F) \tag{28}$$

$$\frac{\tau_h\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]}{\left[\frac{\left[\frac{b}{(1-\alpha_0)(1-\theta)}\right]}{\delta Y-(\tilde{\gamma}Y-X_2)-\left[\frac{b}{(1-\alpha_0)(1-\theta)}\right]}\right]}\leq(X_1+F) \tag{29}$$

This completes the proof. □

## Proof of Proposition 1

First, we establish the following lemma regarding the impact of financing.

**Lemma 3.** *Holding fixed the entrepreneur's choice of strategy, the venture capitalist is indifferent between stage financing and upfront financing.*

*Proof.* To see this, note that with upfront financing she earns in expectation,

$$\theta\left(1-\frac{X_0+X_1}{\mathbb{E}\left[(1-\alpha_2)\,\gamma Y||\alpha_0\right]}\right)\mathbb{E}\left[(1-\alpha_2)\,\gamma Y||\alpha_0\right]= \tag{30}$$

$$\theta\left(\psi-X_0-X_1\right) \tag{31}$$

, where $\psi\equiv p_0\left[\tilde{\gamma}Y-X_2\right]+\tau\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]$. By the same logic, if the low-risk strategy is chosen, she earns $\theta\left(\psi_0-X_0-X_1\right)$, where $\psi_0\equiv p_0\left[\tilde{\gamma}Y-X_2\right]$. To simplify our notation, let $V_s^\tau\equiv\mathbb{E}\left[(1-\alpha_2)\,\gamma Y|p_s,\,\tau\right]=p_s\left[\tilde{\gamma}Y-X_2\right]+\tau\left[\delta Y-(\tilde{\gamma}Y-X_2)\right]$ denote the expected value of the (diluted) equity claim, conditional on the asset quality and the entrepreneur's choice of strategy. If stage financing incents the high-risk strategy regardless of asset quality, the venture capitalist's expected earnings are

$$\theta\left(1-\frac{X_0-F}{\mathbb{E}\left[(1-\alpha_1)\,(1-\alpha_2)\,\gamma Y|\alpha_0\right]}\right)\mathbb{E}\left[(1-\alpha_1)\,(1-\alpha_2)\,\gamma Y|\alpha_0\right]\text{where} \tag{32}$$

$$\mathbb{E}\left[(1-\alpha_1)(1-\alpha_2)\gamma Y|\alpha_0\right] = \left(q\left(1-\alpha_1(p_h)\right)V_h^{\tau_h} + (1-q)\left(1-\alpha_1(p_l)\right)V_l^{\tau_h}\right) \tag{33}$$

$$= \psi - (X_1 + F) \quad \Longrightarrow \tag{34}$$

$$\theta\left(1 - \frac{X_0 - F}{\mathbb{E}\left[(1-\alpha_1)(1-\alpha_2)\gamma Y|\alpha_0\right]}\right)\mathbb{E}\left[(1-\alpha_1)(1-\alpha_2)\gamma Y|\alpha_0\right] = \theta\left(\psi - X_0 - X_1\right). \tag{35}$$

Again, by the same logic, if stage financing incents the low-risk strategy, her expected earnings-financing are just $\theta(\psi_0 - X_0 - X_1)$. Thus, the only effect capital structure has on the expected value of the firm is through its effect on the entrepreneur's choice of strategy. doesn't matter as long as the entrepreneur takes the same action. □

With this established, we can complete the proof. Suppose that $p_e \geq \overline{p}$. Then the entrepreneur chooses the risky strategy, regardless of asset quality, as long as[25]

$$\left(1 - \frac{X_1 + F}{V_l^{\tau_h}}\right)\left(1 - \frac{X_0 - F}{q\left(V_h^{\tau_h} - (X_1 + F)\right) + (1-q)\left(V_l^{\tau_h} - (X_1 + F)\right)}\right) \geq \frac{\bar{b}}{1-\theta}. \tag{36}$$

If both (15) and (36) hold, the venture capitalist is indifferent between staged and upfront financing, by Lemma 3. To show that this will not always be the case, we can rewrite the left-hand side of (36) as

$$1 - \frac{(X_1 + F)\left[\psi - (X_1 + F)\right] + \left(V_l^{\tau_h} - (X_1 + F)\right)(X_0 - F)}{\left[\psi - (X_1 + F)\right]V_l^{\tau_h}}. \tag{37}$$

Second, with a little algebra it can be shown that

$$\frac{(X_1 + F)\left[\psi - (X_1 + F)\right] + \left(V_l^{\tau_h} - (X_1 + F)\right)(X_0 - F)}{\left[\psi - (X_1 + F)\right]V_l^{\tau_h}} > \frac{X_0 + X_1}{\psi} \quad \Longleftrightarrow \tag{38}$$

$$[X_0]\left(\left(\psi - V_l^{\tau_h}\right)(X_1 + F)\right) - [X_1]\left[\psi - (X_1 + F)\right]\left(\psi - V_l^{\tau_h}\right) < \psi F\left[\psi - V_l^{\tau_h}\right] \Longleftrightarrow \tag{39}$$

$$X_0 + X_1 < \psi \tag{40}$$

where the last inequality obviously holds because the firm is able to obtain financing upfront. Note that when we move from the second to the third inequality the sign stays the same because $\psi > V_l^{\tau_h}$. On the other hand, As a result, there exist parameters such that (15) holds but (36) does not.[26] Under those conditions, if the firm uses staged financing and the asset is low quality,

[25] There is less dilution at date one if the asset is revealed to be high-quality and so we focus on the incentive to take risk in the low-quality state.

[26] Using similar steps, it is straightforward to show that, under staged financing, a high-value firm always chooses the high-risk strategy when the asset is high-quality.

the entrepreneur chooses the low-risk strategy, which lowers the expected value of the venture capitalist's claim. Thus, she strictly prefers upfront financing under these conditions by Lemma 3.

To complete the proof, we consider the case when $p_e < \bar{p}$. If (36) does not hold, then $p_l < \bar{p}$, and so the entrepreneur cannot even finance the investment if the asset is low-quality. Further, by continuity of the diluted equity stake, parameter values exist such the investment cannot be financed in the low-state (even though (36) is not violated). Thus, by the same logic, upfront financing remains preferable when $p_e < \bar{p}$, sometimes strictly. $\square$

## Proof of Proposition 2

Suppose the firm is mid-value. If the entrepreneur chooses staged financing (and can finance the firm when it is revealed to be low-quality), then he chooses the high-risk strategy when the asset is high-quality as long as

$$\left(1 - \frac{X_1 + F}{V_h^{\tau_h}}\right)\left(1 - \frac{X_0 - F}{q\left(V_h^{\tau_h} - (X_1 + F)\right) + (1-q)\left(V_l^0 - (X_1 + F)\right)}\right) \geq \frac{\bar{b}}{1-\theta}. \tag{41}$$

Let $\psi_0 \equiv p_0\left[\tilde{\gamma}Y - X_2\right]$ and $\psi_1 \equiv p_0\left[\tilde{\gamma}Y - X_2\right] + q\tau\left[\delta Y - (\tilde{\gamma}Y - X_2)\right]$. Note that $\psi_1$ is the unconditional expetation of the diulted cash flow at date one - by the above proof, it is easy to show that the entrepreneur cannot choose the high-risk strategy if the asset is low-quality in this setting. On the other hand, following steps similar to those found in the proof of Proposition 1, we can show that

$$\frac{(X_1 + F)\left[\psi_1 - (X_1 + F)\right] + \left(V_h^{\tau_h} - (X_1 + F)\right)(X_0 - F)}{\left[\psi_1 - (X_1 + F)\right] V_h^{\tau_h}} < \frac{X_0 + X_1}{\psi_1} \tag{42}$$

as long as $X_0 + X_1 < \psi_1$. But of course this holds because the entrepreneur can successfully engage in upfront financing, i.e., $X_0 + X_1 < \psi_0 < \psi_1$. Thus, if the firm receives financing (even when the asset is low-quality), staged financing creates the possibility of (41) holding, in which case the entrepreneur chooses the high-risk strategy when the asset is high-quality. Thus, the venture capitalist prefers staged financing, sometimes strictly, by Lemma 3.

If the entrepreneur chooses staged financing and cannot finance the firm when it revealed to be low-quality, he defaults some portion of the time. Knowing this, he chooses the high-risk strategy when the asset is high-quality as long as

$$\left(1 - \frac{X_1 + F}{V_h^{\tau_h}}\right)\left(1 - \frac{X_0 - qF}{q\left(V_h^{\tau_h} - (X_1 + F)\right)}\right) \geq \frac{\bar{b}}{1-\theta}. \tag{43}$$

If this doesn't hold, then the venture capitalist strictly prefers upfront financing by Lemma 3. First, we show that it is feasible for (43) to hold even though (15) does not.

$$\left(1 - \frac{X_1 + F}{V_h^{\tau_h}}\right)\left(1 - \frac{X_0 - qF}{q\left(V_h^{\tau_h} - (X_1 + F)\right)}\right) = 1 - \frac{qX_1 + X_0}{qV_h^{\tau_h}} \tag{44}$$

Then it is possible for the entrepreneur to choose the high-risk strategy (with staged financing) as long as

$$\frac{qX_1 + X_0}{qV_h^{\tau_h}} < \frac{X_0 + X_1}{\psi} \quad \Longleftrightarrow \tag{45}$$

$$X_0 V_l^{\tau_h} < qX_1 \left(p_h - p_L\right)\left[\tilde{\gamma} Y - X_2\right] \tag{46}$$

It is clear this holds if $X_0 = 0$, for example. Second, the venture capitalist would prefers staged financing over upfront financing as long as:

$$\theta\left(\psi_0 - X_0 - X_1\right) < \theta\left(q\left[V_h^{\tau_h} - (X_1 + F)\right] - (X_0 - qF)\right) \Longleftrightarrow \tag{47}$$

$$(1 - q)\left(V_l^0 - X_1\right) < q\left(\tau_h\left[\delta Y - (\tilde{\gamma} Y - X_2)\right]\right). \tag{48}$$

which clearly holds if $X_1 = V_l^0$. Under these assumptions, the venture capitalist can still raise capital because $X_0 + X_1 = V_l^0 < (1-q)V_l^0 + qV_h^0$. Thus, conditions exist under which the venture capitalist prefers staged financing to upfront financing, even though she cannot raise capital with a low-quality asset.

Now, we formally establish the tresholds such that staged financing is preferable. First, we note that

$$1 - \frac{qX_1 + X_0}{qV_h^{\tau_h}} \geq \frac{\bar{b}}{1 - \theta} \Longleftrightarrow \tag{49}$$

$$p_h \geq \frac{\frac{qX_1 + X_0}{q\left(1 - \frac{\bar{b}}{1-\theta}\right)} - \tau_h\left[\delta Y - (\tilde{\gamma} Y - X_2)\right]}{\left[\tilde{\gamma} Y - X_2\right]} \equiv \underline{p_h} \tag{50}$$

Second, we show that if this holds, there exists an upper bound on $p_l$ such that the venture capitalist prefers staged financing to upfront financing:

$$\theta\left(\psi_0 - X_0 - X_1\right) \leq \theta\left(q\left[V_h^{\tau_h} - (X_1 + F)\right] - (X_0 - qF)\right) \Longleftrightarrow \tag{51}$$

$$p_l \leq \frac{X_1(1-q) + q\tau_h\left[\delta Y - (\tilde{\gamma} Y - X_2)\right]}{(1-q)\left[\tilde{\gamma} Y - X_2\right]} \equiv \overline{p_l} \tag{52}$$

Finally, we show that the low-value firm prefers staged financing, sometimes strictly. In this case, we need to establish that it is possible for the firm to raise capital in the high-quality state, even though $X_0 + X_1 > \psi_0$. The venture capitalist can raise capital at date one if the firm is revealed to be high-quality as long as $p_h\left[\tilde{\gamma}Y - X_2\right] \geq X_1 + F$ and at date zero as long as $\alpha_0 \leq 1$, i.e.

$$X_0 - qF \leq \mathbb{E}\left[\left(1-\alpha_1\right)\left(1-\alpha_2\right)\gamma Y|\alpha_0\right] \tag{53}$$

$$X_0 - qF \leq q\left[p_h\left[\tilde{\gamma}Y - X_2\right] - \left(X_1 + F\right)\right] \tag{54}$$

$$X_0 \leq q\left[p_h\left[\tilde{\gamma}Y - X_2\right] - X_1\right] \tag{55}$$

Suppose that $X_0 = F = 0$ and let $X_1 = p_h\left[\tilde{\gamma}Y - X_2\right]$. Then the entrepreneur can raise the capital necessary if the asset turns out to be high-quality. Moreover, it is still the case that $X_1 = p_h\left[\tilde{\gamma}Y - X_2\right] > p_0\left[\tilde{\gamma}Y - X_2\right] = \psi_0$. $\square$

## Proof of Proposition 3

We will start by focusing on the setting in which the firm is mid-value and the firm can raise capital in the low-state. Let

$$\left(1 - \frac{X_1 + F}{V_h^{\tau_h}}\right)\left(1 - \frac{X_0 - F}{\psi_1 - \left(X_1 + F\right)}\right) \equiv \chi. \tag{56}$$

Then, we want to show that issuing venture debt can induce the entrepreneur to choose the high-risk strategy when staged equity financing was insufficient to get (9) to hold. Specifically, we want to show that $\frac{\partial \chi}{\partial F} > 0$.

$$\frac{\partial \chi}{\partial F} = -\left(1 - \frac{X_0 - F}{\psi_1 - \left(X_1 + F\right)}\right)\left(\frac{1}{V_h^{\tau_h}}\right) - \left(1 - \frac{X_1 + F}{V_h^{\tau_h}}\right)\left(\frac{-\left(\psi_1 - \left(X_1 + F\right)\right) + X_0 - F}{\left(\psi_1 - \left(X_1 + F\right)\right)^2}\right) \tag{57}$$

$$= \left(\frac{-1}{V_h^{\tau_h}}\right)\left[\left(1 - \frac{X_0 - F}{\psi_1 - \left(X_1 + F\right)}\right) + \left(V_h^{\tau_h} - \left(X_1 + F\right)\right)\left(\frac{X_1 + X_0 - \psi_1}{\left(\psi_1 - \left(X_1 + F\right)\right)^2}\right)\right] \tag{58}$$

We want to show that the term in brackets is less than zero, that is

$$\left(1 - \frac{X_0 - F}{\psi_1 - \left(X_1 + F\right)}\right) < \left(V_h^{\tau_h} - \left(X_1 + F\right)\right)\left(\frac{\psi_1 - \left(X_0 + X_1\right)}{\left(\psi_1 - \left(X_1 + F\right)\right)^2}\right) \tag{59}$$

$$\left(\frac{\psi_1 - \left(X_1 + X_0\right)}{\psi_1 - \left(X_1 + F\right)}\right) < \left(V_h^{\tau_h} - \left(X_1 + F\right)\right)\left(\frac{\psi_1 - \left(X_0 + X_1\right)}{\left(\psi_1 - \left(X_1 + F\right)\right)^2}\right) \tag{60}$$

Note that $\psi_1 > \psi_0 > X_1 + X_0$ (upfront financing is feasible) and $\psi_1 > p_l\left[\tilde{\gamma}Y - X_2\right] > X_1 + F$ (date one financing with a low-quality asset is feasible). Thus, we can rewrite the inequality above,

$$1 < \left(\frac{V_h^{\tau_h} - (X_1 + F)}{\psi_1 - (X_1 + F)}\right), \tag{61}$$

which of course holds because $\psi_1 = qV_h^{\tau_h} + (1-q)V_l^0 < V_h^{\tau_h}$ and both are greater than $X_1 + F$ (date one financing with the high-quality asset is feasible). Thus, $\frac{\partial \chi}{\partial F} > 0$.

On the flip side, issuing venture debt makes it less likely that the firm can obtain financing if it owns a low-quality asset. If financing fails with a low-quality asset, then we are in the second case of proposition 2; here, venture debt does not slacken the incentive compatibility constraint and so if low-quality financing fails, no venture debt is utilized.[27]

Finally, to establish under what conditions we are more likely to observe venture debt, it is straightforward to see that $\frac{\partial \chi}{\partial X_0}, \frac{\partial \chi}{\partial X_1}, \frac{\partial \chi}{\partial X_2} < 0$, whereas $\frac{\partial \chi}{\partial \delta}, \frac{\partial \chi}{\partial Y}, \frac{\partial \chi}{\partial \tau_h}, \frac{\partial \chi}{\partial \tilde{\gamma}}, \frac{\partial \chi}{\partial p_0} > 0$. On the other side, $\bar{b}$ is always decreasing in $\delta$ (consistent with the partial effects on $\chi$), but can increase in $Y$, $\tilde{\gamma}$, $X_2$. □

## Proof of Corollary 1

The optimal use of venture debt increases the expected value of the firm because it induces the entrepreneur to take risk if the asset is revealed to be high-quality. At date two, this (1) increases the likelihood of failure (unable to raise funds) and (2) increases the expected value of the firm, conditional on successfully raising capital. The value of venture debt is that it decreases dilution if the asset is revealed to be high-quality. □

[27]This will not necessarily hold under more general assumptions about the distribution of $p_1$.

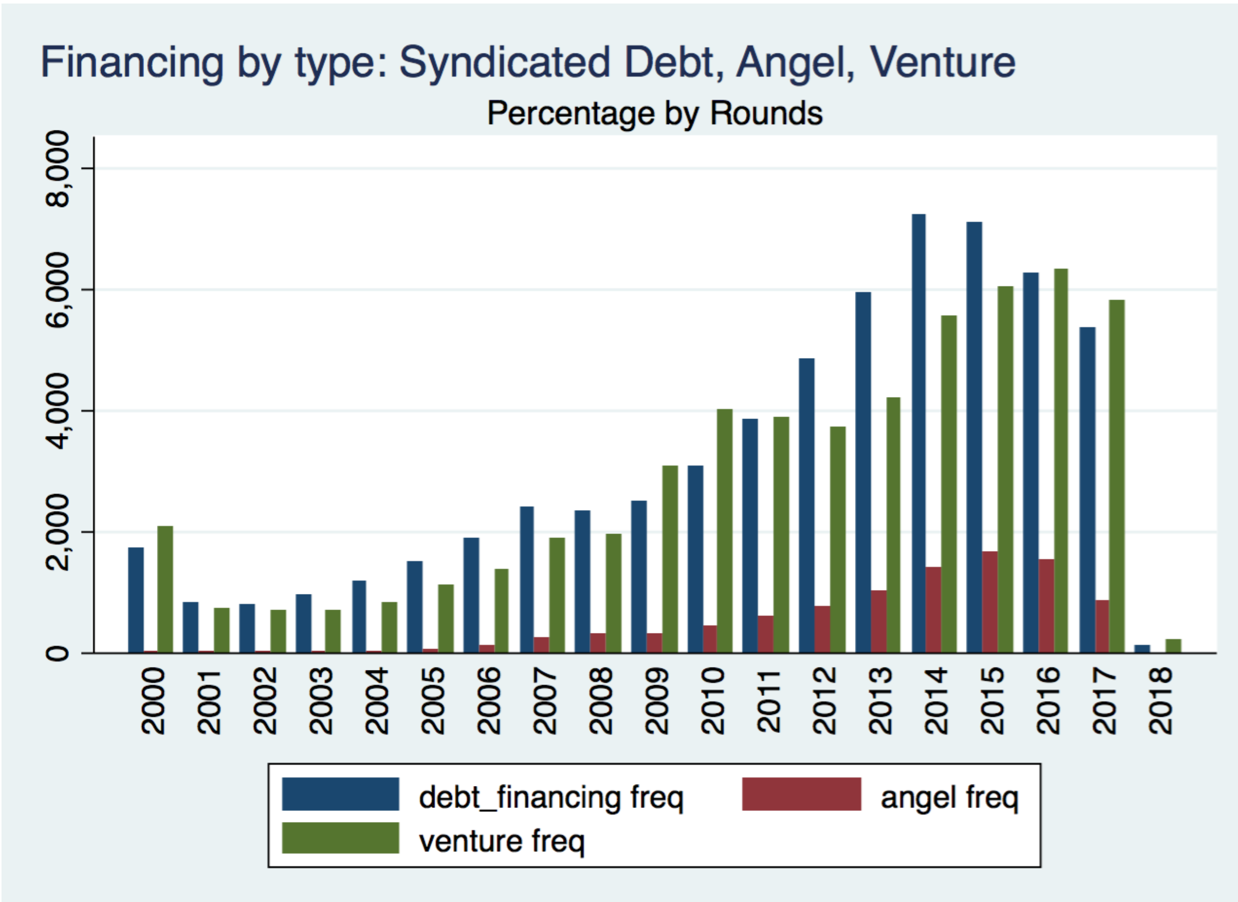


**Figure 1: Type of Financing Rounds by Funding Year**

Depicted are the frequency of financing rounds by type {venture debt, venture equity, angel financing} based on year of funding round..

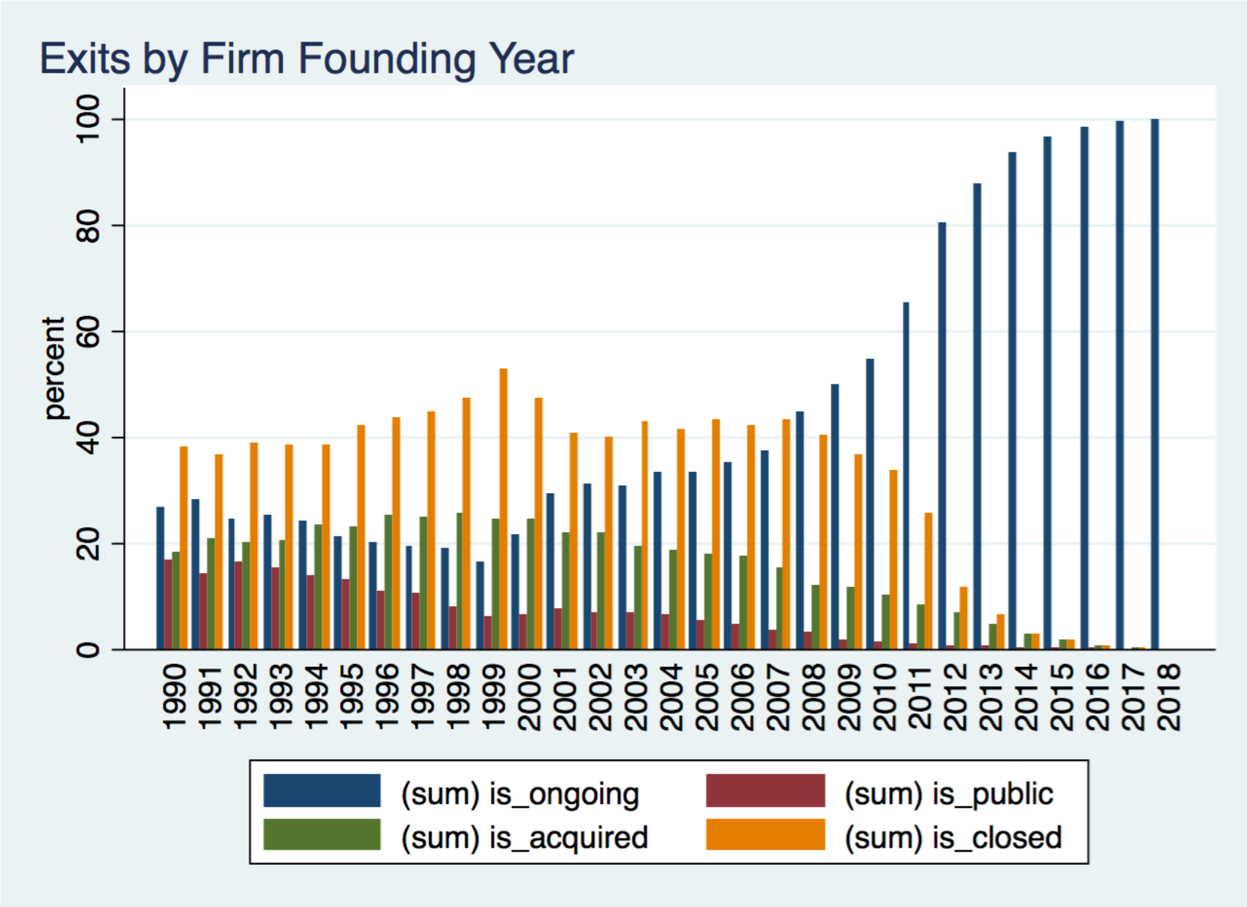


**Figure 2: Exits by Firm Founding Year**

Depicted are the firm exits {Ongoing, Acquisition, IPO, and Closing} as a percent of firms starting in the year on the x-axis.

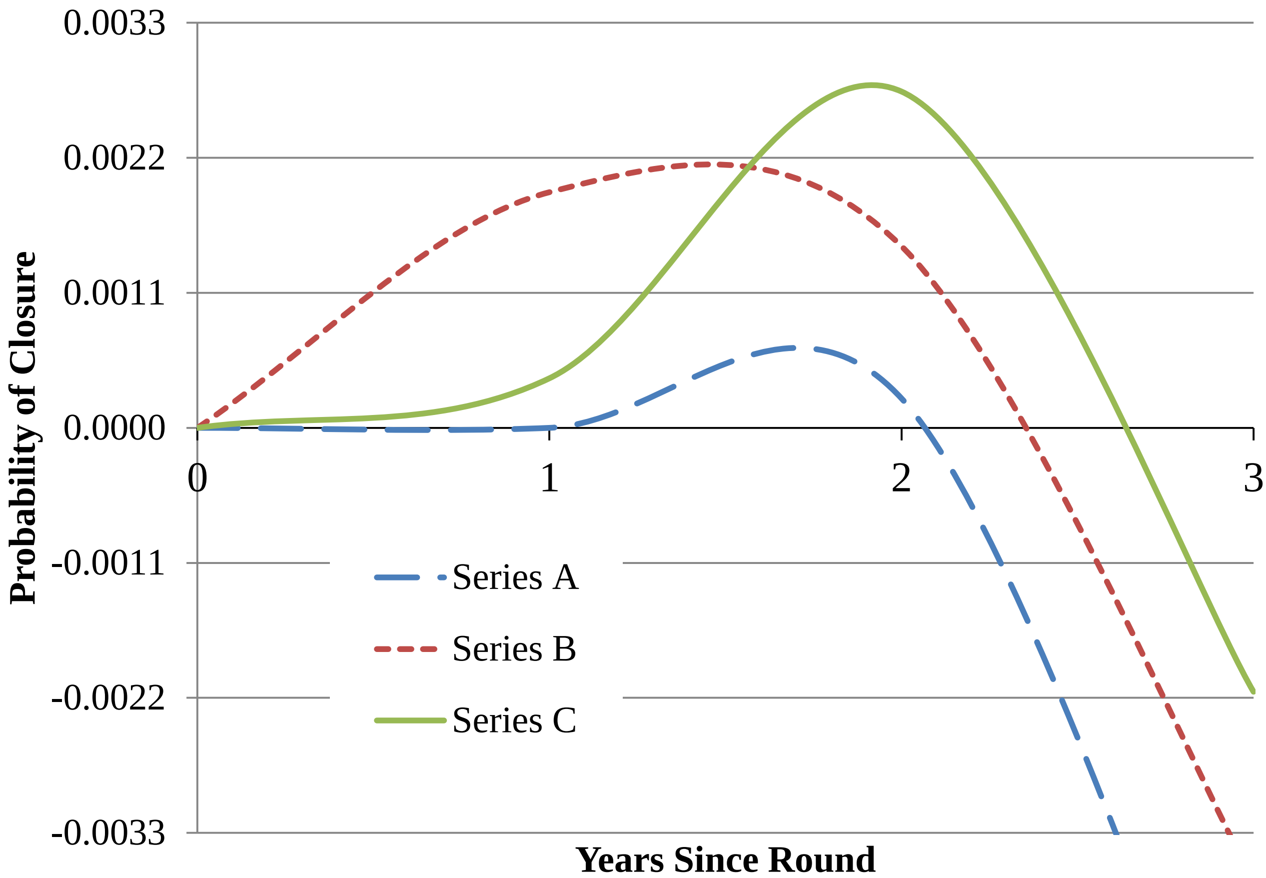


**Figure 3: The Effect of a Round Involving Debt on Future Closure**

Depicted are the Debt Round indicator mearginal effects from fifteen logit estimations of the probability that the startup closes within the x-axis time frame as a function of whether the round is a Debt Round, the log investment size of the round, and round year fixed effects. The estimation table is provided as Appendix Table 1.

## Table 1: Company-Level Summary Statistics of Financing and Exit

Reported are summary statistics at the startup company level (1 observation per company). The number of rounds is the count of investment rounds in Crunchabse. The Percent of Rounds that are Debt [Early Debt] are the percent of the Number of Rounds that are debt rounds or debt syndicated with equity. Total Investment is the dollar value of investments. Total Debt ROund Investmens include the sums of debt rounds and debt syndicated rounds. Within the exit breakdowns, the Closed/Inactive firms includes all firms marked as closed plus those who have experience no update in the last two years.

| | Mean | St. Dev. | 25th %ile | Median | 75th %ile |
|---|---|---|---|---|---|
| Number of Rounds | 2.00 | 1.56 | 1 | 1 | 2 |
| Percent of Rounds that are Debt | 40.3% | 49.1% | 0 | 0 | 1 |
| Percent of Rounds that are Early Debt | 20.8% | 40.6% | 0 | 0 | 0 |
| Total Investment | 16,600,000 | 77,400,000 | 330,000 | 1,980,000 | 10,000,000 |
| Log Total Investment | 14.65 | 1.99 | 12.97 | 14.55 | 16.13 |
| Total Debt Round Investment | 10,200,000 | 60,600,000 | 0 | 0 | 2500000 |
| Log Total Debt Round Investment | 13.06 | 2.28 | 11.51 | 11.51 | 14.77 |
| Total Early Debt Round Investment | 1,993,187 | 19,800,000 | 0 | 0 | 0 |
| Log Total Early Debt Round Investment | 12.22 | 1.57 | 11.51 | 11.51 | 11.51 |
| Year of First Financing | 2011.9 | 4.29 | 2010 | 2013 | 2015 |
| Exit Distribution | | | | | |
| Closed/Inactive | 62.9% | | 0 | 1 | 1 |
| Ongoing | 22.9% | | 0 | 0 | 0 |
| Acquired | 12.4% | | 0 | 0 | 0 |
| IPO | 1.7% | | 0 | 0 | 0 |
| | | | | | |
| Observations | 61,667 | | | | |

## Table 2: Financing Rounds Summary Statistics

Reported are means and standard deviations of round financing-level data. The Series show in the different panels is the actual round (for equity rounds or equity-debt syndicate rounds) or the would-be round for debt financing had the firm issued a equity round. Current Round Investment is the dollar value of the investment. Dilution Proxy is Current Investment divded by the sum of current + the immediate prior investment round. . The pre-money valuation, which is sparsely reported in Crunchbase, is the valuation accruing to founders and prior investors as implied by the valuation of the current investment. Burn Rate Duration is the number of days forward until the next financing. The final colum test for the difference in means of the Equity veruss Debt rounds within the Series.

| | Seed/Series A | | | | | | |
|---|---|---|---|---|---|---|---|
| | Equity Rounds | | | Debt or Debt Syndicate | | | Mean |
| | Mean | SD | Obs. | Mean | SD | Obs. | Different |
| Current Round Investment | 2,343,715 | 15,300,000 | 47,512 | 9,335,287 | 41,300,000 | 13,605 | *** |
| Log Current Investment | 13.16 | 1.73 | 47,512 | 15.02 | 1.51 | 13,605 | *** |
| Dilution Proxy | 0.574 | 0.247 | 13,444 | 0.624 | 0.250 | 7,411 | *** |
| Pre-Money Valuation | 17,800,000 | 196,000,000 | 4,810 | 213,000,000 | 1,020,000,000 | 421 | * |
| Days to Next Financing | 14.58 | 1.48 | 4,810 | 15.85 | 2.16 | 421 | *** |
| Burn Rate Duration (days) | 475 | 438 | 25,521 | 479 | 391 | 9,333 | *** |
| Financing Year | 2013.1 | 3.5 | 62,895 | 2011.6 | 4.6 | 15,824 | |
| | Series B | | | | | | |
| | Equity Rounds | | | Debt or Debt Syndicate | | | Mean |
| | Mean | SD | Obs. | Mean | SD | Obs. | Different |
| Current Round Investment | 10,600,000 | 33,200,000 | 7,069 | 15,900,000 | 40,900,000 | 9,324 | *** |
| Log Current Investment | 15.30 | 1.40 | 7,069 | 15.77 | 1.48 | 9,324 | *** |
| Dilution Proxy | 0.510 | 0.238 | 5,505 | 0.556 | 0.232 | 7,920 | *** |
| Pre-Money Valuation | 225,000,000 | 729,000,000 | 237 | 290,000,000 | 1,150,000,000 | 306 | |
| Log Pre-Money | 17.11 | 2.00 | 237 | 17.28 | 2.27 | 306 | |
| Days to Next Financing | 541 | 507 | 4,246 | 540 | 446 | 6,167 | |
| Financing Year | 2011.5 | 4.9 | 8,470 | 2010.6 | 5.1 | 10,228 | *** |
| | Series C | | | | | | |
| | Equity Rounds | | | Debt or Debt Syndicate | | | Mean |
| | Mean | SD | Obs. | Mean | SD | Obs. | Different |
| Current Round Investment | 13,600,000 | 35,400,000 | 3,500 | 21,600,000 | 37,700,000 | 5,422 | *** |
| Log Current Investment | 15.46 | 1.47 | 3,500 | 16.11 | 1.49 | 5,422 | *** |
| Dilution Proxy | 0.382 | 0.233 | 3,113 | 0.432 | 0.219 | 5,010 | *** |
| Pre-Money Valuation | 454,000,000 | 1,320,000,000 | 117 | 462,000,000 | 847,000,000 | 206 | |
| Log Pre-Money | 17.97 | 2.14 | 117 | 18.59 | 2.09 | 206 | ** |
| Days to Next Financing | 498 | 485 | 2,202 | 528 | 450 | 3,477 | ** |
| Financing Year | 2011.5 | 4.7 | 4,182 | 2010.6 | 4.9 | 5,848 | *** |
| | Series D | | | | | | |
| | Equity Rounds | | | Debt or Debt Syndicate | | | Mean |
| | Mean | SD | Obs. | Mean | SD | Obs. | Different |
| Current Round Investment | 18,800,000 | 51,700,000 | 1,900 | 26,600,000 | 52,500,000 | 2,657 | *** |
| Log Current Investment | 15.56 | 1.59 | 1,900 | 16.18 | 1.57 | 2,657 | *** |
| Dilution Proxy | 0.299 | 0.220 | 1,813 | 0.335 | 0.203 | 2,577 | *** |
| Pre-Money Valuation | 637,000,000 | 811,000,000 | 72 | 831,000,000 | 1,160,000,000 | 142 | |
| Log Pre-Money | 18.94 | 2.12 | 72 | 19.51 | 1.98 | 142 | * |
| Burn Rate Duration (days) | 454 | 449 | 1,167 | 507 | 467 | 1,741 | *** |
| Financing Year | 2012 | 4.3 | 2,193 | 2011 | 4.4 | 2,901 | *** |

## Table 3: Choice of Debt Versus Equity

The dependent variable is the choice of venture debt versus venture equity for each round of financing. The estimation is via logit, and the marginal effects are reported. Each column subsamples only to estimate rounds for Series A (cols 1-3), Series B (4-6), or Series C or D (7-9). The series letter is the actual round (for equity rounds or equity-debt syndicate rounds) or the would-be round for debt financing had the firm issued a equity round. The second and third columns under each Series (colums 2,3,5,6,8, and 9) are limited to those where a pre-money valuation is available. The other independent variable of interest is a proxy for dilution in this round; namely, current investment divided by the current + prior investments. Financing year fixed effects are included. Errors are clustered by company. ***, **, and * denote significance at standard 1%, 5% and 10% levels.

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent Variable: | Choice of Debt verus Equity | | | | | |
| Model: | Marginal Effects Shown from Logit Estimation | | | | | |
| Subsample: | Series A | Series B | Series C/D | Series A | Series B | Series C/D |
| Dilution Proxy: Current Investment / ( Prior + Current Investment) | 0.0468** | 0.186*** | 0.216*** | | | |
| | [0.0186] | [0.0187] | [0.0217] | | | |
| Log PreMoney Valuation | | | | -0.0190** | 0.0114 | 0.0396*** |
| | | | | [0.00958] | [0.0102] | [0.0111] |
| Financing Year F.E. | Y | Y | Y | Y | Y | Y |
| Observations | 12,414 | 13,413 | 12,587 | 967 | 540 | 530 |
| Pseudo R-squared | 0.0139 | 0.0106 | 0.0132 | 0.0612 | 0.0522 | 0.0687 |

## Table 4: Time between Financing Rounds

The dependent variable is the log the number of days from the financing round indicated in the column until the next financing round, with the unit of observation being a round of finance. The series letter (A, B, C or D) is the actual round (for equity rounds or equity-debt syndicate rounds) or the would-be round for debt financing had the firm issued a equity round. The independent variable of interest, Debt Round, is the choice of venture debt (alone or syndicated) versus venture equity for each round. The other independent variable is the log of the money raised in the current investment round. Round year fixed effects are included. Errors are clustered by company. ***, **, and * reflect significance at standard 1%, 5% and 10% levels.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Dependent Variable: | Log of Days to Next Finance Round | | | |
| Subsample: | Series A | Series B | Series C | Series D |
| Debt Round | -0.165*** | -0.0367* | -0.028 | 0.00198 |
| | [0.0152] | [0.0209] | [0.0291] | [0.0415] |
| Log Current Investment | 0.105*** | 0.116*** | 0.108*** | 0.111*** |
| | [0.00643] | [0.00865] | [0.0103] | [0.0133] |
| Financing Year F.E. | Y | Y | Y | Y |
| Observations | 14,201 | 9,238 | 5,138 | 2,685 |
| R-squared | 0.107 | 0.124 | 0.119 | 0.128 |

**Table 5: Closing as a Function of the Total Debt Financing Round Invesment Dollars**

The dependent variable is an indicator for the startup closing. The unit of observation is a startup firm; -- one observation per firm. The estimation is logit, reporting the marginal effects effect for a change in the probability of closing. The independent variables capture the total money raised by the startup (Log Total Investment), the total money raised in a debt or debt syndicated round, and the total money raised in a debt or debt syndicated round prior to a Series B equity round. A debt syndicate round is one in which debt and equity are together included in the financing package. We cannot disentangle the relative amounts. Included are fixed effects for the first financing roung year and the count of total investment roungs. ***, **, and * reflect significance at standard 1%, 5% and 10% levels with robust standard errors.

| | (1) | (2) |
|---|---|---|
| Dependent Variable: | Closed | Closed |
| Log Total Investment | -0.0252*** | -0.0251*** |
| | [0.00130] | [0.00130] |
| Log Debt (or Debt Syndicate) Investment Prior | -0.00940*** | -0.0124*** |
| | [0.00101] | [0.00122] |
| Log Debt (or Debt Syndicate) Investment Prior to Series B | | 0.00631*** |
| | | [0.00140] |
| Fixed Effects: | | |
| First Financing Round Year | Y | Y |
| Count of Investment Rounds | Y | Y |
| Observations | 61,663 | 61,663 |
| Pseudo R-squared | 0.179 | 0.179 |

**Table 6 : Exit Outcomes from Rounds, Conditional on not Closing**

The dependent variable is the exit outcome {IPO, Acquisition, Ongoing} of the startup conditional on it not closing before 2018. The unit of observation is a round of finance. The estimation is multinomial logit, and thus each estimation has two columns, reporting the marginal effects effect for increasing the probability of exit for outcomes Acquisiton or IPO relative to the probability of exit in the offset category of Ongoing. Each numbered set of two columns subsamples only to estimate exit outcomes as of Series A rounds (column 1), Series B (column 2), or Series C/D (column 3). The independent variable of interest, Debt Round, is the choice of venture debt versus venture equity for each round. The other independent variable is the log of the money raised in the current investment round. Financing round year fixed effects are included. Errors are clustered by company. ***, **, and * reflect significance at standard 1%, 5% and 10% levels.

| | (1) | | (2) | | (3) | |
|---|---|---|---|---|---|---|
| Dependent Variable: | Exit Outcome | | | | | |
| Offset: | All probabilities are compared to the category "Ongoing" | | | | | |
| Subsample: | Series A | | Series B | | Series C/D | |
| | Acquisition | IPO | Acquisition | IPO | Acquisition | IPO |
| Debt Round | 0.0973*** | -0.00712** | 0.0883*** | -0.0280*** | 0.0704*** | -0.0424*** |
| | [0.00830] | [0.00346] | [0.0108] | [0.00489] | [0.0148] | [0.00571] |
| Log Current Investment | -0.0124** | 0.0331*** | -0.0161** | 0.0437*** | -0.00466 | 0.0493*** |
| | [0.00497] | [0.00261] | [0.00694] | [0.00467] | [0.0105] | [0.00493] |
| First Year Financing F.E | | Y | | Y | | Y |
| Count of Investment Rounds F.E. | | Y | | Y | | Y |
| Observations | | 10,733 | | 7,804 | | 7,393 |
| Observation Breakdown | 4785 | 729 | 3970 | 703 | 2544 | 580 |
| Percentage | 44.6% | 6.8% | 50.9% | 9.0% | 34.4% | 7.8% |
| Pseudo R-squared | | 0.285 | | 0.186 | | 0.138 |

## Appendix Table 1: Years to Closing

The dependent variable is an indicator for the startup closing within the column years from the financing round to the years indicated in the columns. Panel A starts at Series A rounds; panel B, at Series B; and panel C, at Series C. The unit of observation is a round of finance. The estimation is logit, reporting the marginal effects effect for a change in the probability of closing. We exclude later rounds because of the shortness of horizon for estimation. The independent variable of interest, Debt Round, is the choice of venture debt versus venture equity for each round. The other independent variable is the log of the money raised in the current investment round. Round year fixed effects are included. Errors are clustered by company. ***, **, and * reflect significance at standard 1%, 5% and 10% levels.

| | | | | | |
|---|---|---|---|---|---|
| **Panel A: Observations forward from Rounds at Series A** | | | | | |
| Dependent Variable: | Startup Closes in Period from the Financing Round up to the Years (below): | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| Debt Round | 0.00154*** | 0.000249 | -0.00625*** | -0.00718*** | -0.00494*** |
| | [0.000589] | [0.000839] | [0.00196] | [0.00196] | [0.00143] |
| Log Current Investment | 0.00000275 | 0.0000167 | -0.00307*** | -0.00392*** | -0.00335*** |
| | [0.000191] | [0.000290] | [0.000689] | [0.000737] | [0.000676] |
| Observations | 23,346 | 22,338 | 19,818 | 15,953 | 13,875 |
| **Panel B: Observations forward from Rounds at Series B** | | | | | |
| | Startup Closes in Period from the Financing Round up to the Years (below): | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| Debt Round | 0.00192** | 0.00148 | -0.00369** | -0.00441*** | -0.00566** |
| | [0.000788] | [0.00116] | [0.00158] | [0.00149] | [0.00234] |
| Log Current Investment | -0.000315 | -0.000355 | -0.00305*** | -0.00267*** | -0.00355*** |
| | [0.000257] | [0.000351] | [0.000574] | [0.000601] | [0.000865] |
| Observations | 15,237 | 13,842 | 12,958 | 11,285 | 8,220 |
| **Panel C: Observations forward from Rounds at Series C** | | | | | |
| | Startup Closes in Period from the Financing Round up to the Years (below): | | | | |
| | 1 | 2 | 3 | 4 | 5 |
| Debt Round | 0.000404 | 0.00274 | -0.00215 | 0.000612 | -0.00449 |
| | [0.00115] | [0.00169] | [0.00324] | [0.00444] | [0.00352] |
| Log Current Investment | -0.000453 | -0.000809 | -0.00316*** | -0.00500*** | -0.00430*** |
| | [0.000377] | [0.000506] | [0.00101] | [0.00147] | [0.00124] |
| Observations | 7,573 | 6,675 | 5,514 | 4,244 | 4,442 |