Early-Stage Venture Financing*

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Abstract

This paper develops a theory of venture financing at the earliest stages. Ventures choose between issuing equity or a "SAFE," which gives investors the right to a number of shares to be determined by a future equity price. Our key assumption is that between two rounds of financing the market learns information that is initially private to the entrepreneur. Higher quality types prefer a SAFE over equity for the first round of financing because under the SAFE they know that their types will be revealed to the market before the determination of the number of shares they must provide to investors. Offsetting this benefit of SAFEs is a moral-hazard (debt-overhang) cost. We find initial support for the theory in a data set of 500 financing rounds.

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"Simply put, we're giving your company money now but at the terms you will negotiate with other investors later."[1]

1 Introduction

A corporation finances investment by selling claims on its future returns. The classic financing question is about the *kind* of claims a corporation should issue. The vast literature on optimal financing focuses on listed firms and the two dominant claims, debt and equity.[2] A literature has also examined optimal financing by venture capitalists in middle and later stages of ventures.[3]

This paper addresses optimal financing at an earlier stage in a firm's life cycle: its very first rounds of external financing. As Hellman and Thiele (2015) document, financing of ventures has evolved over the past two decades, with venture capital firms now focusing more on later-stage ventures, with early-stage ventures typically financed by angel investors.[4]

A theory of early-stage venture financing must start with an observation of the securities issued by the ventures. Debt financing accounts for virtually zero financing at this stage. We attribute this to three factors. Early-stage ventures are typically pre-revenue; a focus by the founder on coming up with cash to make debt payments rather than building the venture would be costly; and the maturity date in a conventional debt contract would leave the entrepreneur with a lack of flexibility in the timing of an equity issue to raise the funds necessary to repay the principal. Debt is also ill-suited to financing very risky ventures. Fewer than half of ventures initially seeking external finance eventually succeed. These costs of debt financing are evidently prohibitive for early start-ups.

In early-stage venture financing, we observe essentially only two classes of securities: equity

[1] https://www.ycombinator.com/deal (accessed March 20 2022).

[2] Myers (2003) offers a synthesis of this vast literature.

[3] See for example Cornelli and Yosha (2003), Gilson and Schizer (2003) and Schmidt (2003).

[4] Angel investors are individuals with wealth and experience who typically have had successful exits on ventures of their own.

(common or convertible preferred) and a class of securities not used at any other stage: *non-priced claims*. Non-priced claims provide for a specified dollar value of financing in exchange for a number of shares to be determined by the share price in a future round of equity financing. The simplest and increasingly popular version of these claims is called a "simple agreement for future equity," or SAFE. To take an example of the basic form of a SAFE, suppose that an investor that provides $100,000 in capital in exchange for a SAFE with a discount of 20 percent. The investor is then paid back with $125,000 worth of equity when a round of equity (of a minimum specified size) is first issued. The translation of $125,000 into shares is at the price at which the future round is issued.[5] A convertible note also provides for a number of shares determined by a future equity price, but contains a date by which equity will be allocated to the note-holders even if an equity issue has not been undertaken by that date. SAFEs were developed in late 2013 as a much simpler alternative to convertible notes, which were the established form of non-priced financing. Non-priced financing accounts for about half of the observed financing rounds in our sample from 2017–19, and indications are that SAFEs continue to grow as the most popular instrument for early financing, being described by some practitioners as ubiquitous.

A SAFE is a hybrid security with features common to equity and debt. As with equity financing, the purchaser of a SAFE ends up with shares. The price translating the investment amount into shares, however, is determined at a *future* date (the next date of an equity issue of minimum size) rather than the current date. As with debt, a contractually-specified repayment is promised by the issuer — but in the case of a SAFE, the repayment is in shares (valued at the date of the future equity issue) rather than dollars. And the repayment date of a SAFE is endogenous, being the date at which the issuer issues its first round of equity — if indeed the issuer raises any equity. Finally, a default on debt involves bankruptcy and the transfer of assets to debt-holders. The decision not to pay the liability on a SAFE, on the other hand, involves no such transfer of assets. Instead, it involves simply forgoing investment.

A model of the choice between SAFEs and equity must include not just the initial financing choice but also a decision on future equity financing. (A SAFE is defined only if there is a prospect of a future equity issue.) We outline the simplest of such models. A venture has investment opportunities in two periods. We start with the standard assumption of asymmetrically informed entrepreneurs at the time of the first-period investment decision, where

[5]If the share price in the future round is 12.50, for example, this means that the investor is allocated 10,000 shares.

the financing is either through the issuance of a SAFE or equity. The pivotal assumption in explaining the binary choice between a SAFE and equity is that between the two financing dates the market receives a signal of the venture's type.

The assumption on learning over time by the investors is compelling for early-stage ventures. The market's information on the venture is at a minimum at the first external financing round because the venture has typically not established proof of market acceptance of its product or even proof of concept. The entrepreneur may not have a record of previous success. And the venture has not been subject to external market valuation that new investors could draw on in formulating expectations. By the time of the next round of financing, the market has much better information.

We take the assumption of a change in asymmetry of information to the extreme, as a first step towards a richer theory. The informational asymmetry between the entrepreneur and the market is resolved completely between the dates of a first investment decision and a second investment decision. This assumption makes a SAFE similar to debt in our model in that issuing a SAFE allows the entrepreneur to avoid the costs of asymmetric information. It is well-established in the literature (reviewed below) that debt is valuable under asymmetric information because the value of debt is less sensitive to private information than is the value of equity. The literature predicts that debt is optimal under adverse selection conditions. But this prediction relies on the absence of a well-known cost of issuing debt, the *debt-overhang* distortion in the incentives for future investment decisions.

Our model characterizes the equilibrium trade-off between the adverse-selection distortion under equity and the debt-overhang distortion under SAFEs. For ventures of low quality, equity is preferred because the mis-pricing distortion involved in equity valuation is advantageous to the venture. But for high-quality ventures, SAFEs are optimal even at the cost of the incentive distortion of SAFE financing. The model thus explains SAFEs.

The trade-off between adverse-selection distortion and the debt-overhang distortion is familiar from the literature on debt and equity financing. Two differences arise between our setting of SAFEs and equity and the conventional setting of debt and equity, however. First, the incentive distortion is more severe with SAFE's than it would be with debt. In the case of debt, default is costly and involves the transfer of asset ownership to creditors. The threat of this transfer can encourage the owner to issue equity that would allow the repayment of debt (as well as additional investment). The decision to refrain from paying the contingent liability to SAFE-holders carries no such penalty. The venture is free to choose the timing of a future issue of equity and therefore of repayment of the SAFE liability. The venture is even free to avoid future financing entirely, thus escaping any liability to SAFE holders. This difference magnifies the incentive distortion under SAFE financing, compared to debt. Second, unlike debt financing, the advantages of SAFE financing emerge only under our central assumption of investors *learning over time* information that is initially private to the entrepreneur.

Links to the literature: We are unaware of any literature on our topic, the optimal mix of equity and non-priced financing for early-stage ventures. This paper, however, has a natural place in the more general literature on the theory of venture financing. Drawing on the theory of corporate capital structure, this literature has developed two themes, among others. The first is that optimal contracts are designed to minimize agency costs or moral hazard costs inherent in the relationship between startups and investors such as venture capitalists. Moral hazard includes shirking on effort because the entrepreneur shares returns with investors. Conflicts between the entrepreneur and investors around exit decisions are specific to the venture context. The contract responses to these problems include sensitivity of compensation to performance (Holmstrom, 1979; Lazear, 1986), investor liquidation rights (Diamond, 1991; Ross, 1977), contingency-control rights (Aghion and Bolton, 1992; Dewatripont and Tirole, 1994) and vesting rights (Hart and Moore, 1994).

The second area of the literature on the theory of venture financing that is relevant for this paper is the nature of adverse selection associated with various financing instruments when venture quality (or type) cannot be observed. A concept particularly relevant for our context is the "lemons problem" of equity financing. Lower quality ventures are more willing to share in the returns to their assets via equity financing because this sharing is less costly to them. This idea has been explored by DeMeza and Webb (1987 and 1992) and follows closely from Akerlof's original lemons market paper (Akerlof, 1970).[6]

Our paper is linked to both of these themes. The adverse selection or "mis-pricing" property of equity finance is our starting point. But where we depart from the literature is in developing a mitigation to the problem that relies on the *reduction over time* in the asymmetric information that is initially private to entrepreneurs. As we have discussed, this assumption is particularly compelling for early-stage ventures. Our paper is related to the literature on moral hazard or agency costs. A moral-hazard or debt-overhang cost is balanced against the cost of adverse selection in our theory of early stage financing. Once our assumption of learn-

[6]Another selection effect is that debt contracts will attract ventures of higher risk (Stiglitz and Weiss, 1981; Cumming and Johan, 2009). This has less relevance for our context of early stage financing because of the negligible role of debt financing.

ing over time is accepted, our theory is then closest to the literature on debt as a response to adverse selection. Debt is a natural response because it is less sensitive to private information than the value of equity (Myers and Majluf, 1984, Nachman and Noe, 1994; DeMarzo, 2005). Finally, the literature on the theory of venture financing is focused on venture capital firms rather than angel financing provided at an earlier stage. Hellman and Thiele (2015) is an important exception, but focuses on the interaction between early angel financing and later venture capital financing, rather than on the forms of financing.

In Section 2 of this paper, we provide a brief background on venture financing. We develop the simplest model of the financing choice between a SAFE and equity in Section 3. In Section 4 we test two broad implications of the theory with a small but new data set. We ask whether SAFEs are used where the theory (broadly interpreted) predicts they should be used. Section 5 sets out some extensions and open questions in the economics of early-stage financing. Section 6 summarizes our conclusions.

2 Background

To set the context for this paper, we offer here a brief factual background of the stages of venture financing, the parties involved in financing, and the financial instruments relied upon.

Financing stages of a venture: The various stages of financing for a start-up are the following.

- **Financing by friends and family:** initial, quasi-internal financing provided by friends and family of the founders as well as by the founders themselves.
- **Pre-seed financing:** the first external financing, in amounts too small to be considered seed capital. In the sample that we will analyze, the average size of this round is 250 thousand dollars. This financing helps the venture to get established and ready for the seed round financing.
- **Seed financing:** the first substantial investment round of financing — in our sample a seed round raises on average two million dollars. Seed financing is intended to finance initial R&D or product development. Providers of seed capital need to understand the value proposition of the venture, i.e., the problem that the venture's product is attempting to solve, and how. Seed capital often enables the firm to invest in "proof of concept," "proof of market acceptance," and even generation of initial revenue.

- **Series A financing:** Once the venture has demonstrated clear promise and perhaps initial revenue, financing takes place in much larger amounts to develop the business (11 million on average in our sample). This almost invariably involves venture capital firms as investors and is usually the first financing obtained from venture capitalists.
- **Series B, C, etc. financing**: Further rounds of substantial VC financing.
- **Bridge financing:** refers to small rounds of financing to carry the venture to the next infusion of cash via a larger financing round - often planned for a short and relatively specific time period.

Of course, some of these stages are skipped by some ventures. And we should keep in mind that many ventures entering the beginning of this set of stages fail before making it to the final stages.

Sources of capital: In the 1990s capital for startups was supplied almost entirely by venture capital firms. Financing was mainly restricted to larger rounds, with pre-seed financing less common for example. Since the 1990s, the emergence of angel financing has grown to be a substantial fraction of startup financing.

Angel investors, like venture capital firms, provide "smart money," i.e., advice as well as financial capital. But angel investors specialize in early stage financing (pre-seed and seed financing), with VC's providing mainly later-stage financing. Each angel invests much smaller amounts that a venture capital firm: an angel investment of 20 to 40 thousand dollars would be typical, whereas VC's provide millions or tens of millions of dollars in a round of investment. The early stage rounds are typically financed by multiple angels or angel groups, whereas later VC rounds are most often financed by a single VC firm.[7]

Financing instruments: Financing of ventures almost always takes one of the following forms: common equity, convertible preferred equity, SAFEs and convertible notes. The first two of these are *priced* rounds in which the share price is set in the financing contract. Convertible preferred equity is unrelated to the familiar convertible preferred equity issued by a seasoned corporation. The latter is preferred equity, i.e. claims with priority over dividends, for which the holder has the option to convert to common equity after a specified date; the exercise of the conversion option depends on the evolution of the share price. Convertible preferred equity for a venture, on the other hand, converts to common not at the option of the investor but in the event of exit via either an acquisition or an IPO. (And priority

[7]The specialization of VC firms in later financing rounds is not complete. Y-Combinator is a venture fund, for example, that invests extensively in seed financing rounds. See https://www.ycombinator.com.

over dividends is less important because startups rarely issue dividends.) For ventures, convertible preferred equity is close to common equity in its payoffs: in the events that the venture fails, or has a successful exit without the exit involving a down round, the payoffs to common and preferred are essentially identical.[8] Only in intermediate cases, is the payoff to preferred equity higher than the payoff to common equity.[9] The similarity of common and preferred is reflected in the standard term sheets for preferred or common financing rounds: the relationship between two terms provided on the term sheets, the (assumed or negotiated) pre-money value of the venture and the price of the shares is independent of whether the shares are common or preferred.[10] Whereas straight preferred is a debt-like instrument, a venture's convertible preferred is clearly a common-equity-like instrument.

As additional background, the 2020 Halo Report on Angel Financing (p.10) reports that for a large sample of angel-financing rounds in the U.S., of those *seed* rounds financed by equity, 30 percent were common equity. Common equity is much more important than this in *pre-seed* financing rounds, accounting for almost all equity financing.[11] Common equity, in short, makes up a substantial proportion of early-stage financing.

The two non-priced instruments are also similar to one another. A convertible note converts to equity at the option of the holder, at a future date at which equity is raised or at a specified termination date of the note. The note includes interest payments that accumulate and are paid at the conversion date. Both the principal and accumulated interest are paid in shares at the conversion date, at a rate determined by the share price at the future round.[12] SAFEs, as the name suggests, were developed as a much simpler form of non-priced financing. (The SAFE was developed in 2013 by Carolyn Levy, a partner at Y-Combinator, one of the largest platforms for early stage financing.[13]) A SAFE is converted to common equity at the date of the next (often, the first) substantial issue of equity. The date of issue and SAFE conversion

[8] In the case of exit via cash acquisition or IPO, preferred shares convert to common at a pre-specified ratio (usually 1).

[9] The main such intermediate case is where the exit share price is less than the price paid by preferred shareholders; in this case, the preferred shareholders have the right to the amount they invested (or, in a minority of cases, a multiple of this amount).

[10] For example, if a venture with a pre-money value of 8 million dollars raises 2 million dollars in shares, the price of the share is set at the value that gives the new shareholders 20 percent of the post-money value (10 million dollars) of the venture — independent of whether the shares are common or convertible preferred.

[11] Data on pre-seed financing are non-existent, but at the Creative Destruction Lab (CDL), a large platform bringing together ventures and angels, close to 100% of equity rounds for pre-seed financing are common equity. The use of the more complicated instrument, preferred equity, would be surprising and attract concern (communication with Paul Cubbon, a director of CDL.)

[12] If the maturity date is reached without a new equity issue, the note is typically renegotiated.

[13] Y-Combinator has funded more than 3,000 startups since 2005.

(and whether to issue at all) is entirely at the discretion of the venture. While the data show that convertible notes have been more common than SAFEs, SAFEs are increasing in popularity.[14]

We have described only the essence of each type of instrument. Because non-priced financing may be less familiar to readers, we offer in Appendix 1 a more detailed review of the features of SAFEs and convertible notes.

In aggregating common and preferred equity as well as SAFEs and convertible notes, we are not suggesting that the two types of equity are virtually identical, or that SAFEs and convertible notes are nearly identical. Rather we suggest that the two pairs of instruments are each close enough that we can frame the financing problem as having two steps: whether to use equity or a non-priced instrument; and then which of the two types of equity instruments or which of the two types of non-priced financing instruments to use. We study the first of these decisions in this paper, but recognize that both steps are important. We adopt the simplest form from each class of financing, common equity and SAFEs, to capture the trade-off that we argue is important for the binary choice between priced and non-priced financing.

3 SAFEs versus Equity financing

3.1 Model

SAFEs appeared as a method of financing only in 2013. This would be an awkward fact for an optimal design approach to the theory of financing choices for ventures. Innovation in methods of financing does not sit well with an assumption that parties always adopt the optimal financing contract. We take instead an approach that is common in models of capital structure or optimal financing in the literature. We accept the instruments that we actually observe as feasible, and consider the optimal choice among the instruments in rounds of financing.[15] In contrast to theories of optimal capital structure, the choice is binary: at virtually all financing rounds, ventures offer only one financing instrument.

We consider a three period model, with two parties: an entrepreneur and a perfect capital

[14]The standard financing offered by Y-Combinator to a startup that they have decided to fund is 500,000 in SAFEs (https://www.ycombinator.com/deal, accessed March 20, 2022.)

[15]As discussed in Section 2, we consider the simplest form of equity, common equity, and the simplest form of non-priced financing, a SAFE.

market. The entrepreneur enters period 1 with assets in place. The entrepreneur faces opportunities to invest k_1 in period 1 and k_2 in period 2. We assume that investment in k_1 simply serves to make investment in k_2 possible. (The interpretation is that k_1 is the development of a prototype or other proof-of-concept investment, with k_2 being the seed investment that funds development of the venture if the prototype is successful.) Entrepreneurs are of various types, indexed by θ, which is distributed according to a smooth distribution function F. Both the entrepreneur and the capital market are risk-neutral and interest rates are zero.

The value of the assets in place depends on the entrepreneur's type, θ; in fact this value is equal to θ. The assets in place can be interpreted as a preliminary version of the venture's essential product or service, for example. The expected return on investment k_2 as of period 2 depends on the realization (in period 2) of another random variable, a, which represents the success of the prototype. The variable a is distributed according to G. If investment in k_2 is undertaken, the gross value of the total assets, which is realized in period 3, is

$$V = \theta + ak_2 + \epsilon. \tag{1}$$

Here ϵ is a random variable with mean 0. If investment is not undertaken in period 2 — either because the *option* to invest in period 2 is not "purchased" via the investment k_1 in period 1 or because the option to invest k_2 is not exercised — the gross return is given by

$$V = \theta + \epsilon. \tag{2}$$

In summary, the realized gross value can be written $V = \theta + aI_2 + \epsilon$, where $I_2 \in \{0, k_2\}$ is the investment in period 2. The support of F is $[\underline{\theta}, \infty)$ and the support of G is $[\underline{a}, \infty)$.[16]

In period 1, the entrepreneur's type, θ, is private information. The market knows only the distribution F of θ. The value of a is unknown to *both* the entrepreneur and the market in period 1, but both know the distribution G of a. In period 2, θ is revealed to the market and

[16] A more plausible specification would have future investment returns, not just the value of assets in place, depend on the venture's type. We show in an online appendix that our essential results extend to this alternative, providing the sensitivity of future returns to type is less than the sensitivity of the value of assets in place to type. Specifically, we adopt the following alternative value function in the extension:

$$V = \theta k_0 + ah(\theta)k_2 + \epsilon$$

where $h(\theta)$ is a function with an elasticity, $\partial \ln (h(\theta)) / \partial \ln(\theta)$ bounded by some $m < 1$. The sensitivity of the value of assets in place to θ has an elasticity of 1; the sensitivity of future returns to θ has an elasticity less than 1. Our essential results hold with this alternative value function, although single crossing properties are not satisfied in general.

Period	$t = 1$	$t = 2$	$t = 3$
Actions	• Invest in k_1 or not • Finance: SAFE or Equity	If invested in k_1: • invest in k_2 or not	
Information	• θ private information • a is unknown	• θ revealed • a publicly observed	
Payoffs			V is realized

Table 1: Timing in the Model.

the realization of a is observed by all parties before the investment decision in that period.

The first-period investment may be financed with equity or with a SAFE. A SAFE is defined as the provision by investors of k_1 in exchange for a share of equity in period 2 — *if* investment k_2 is undertaken — at the terms at which equity is raised in period 2, less a discount, δ. In other words, SAFE investors provide capital k_1 in the first period in exchange for $k_1/(1-\delta)$ in shares in the second period if the investment in k_2 is undertaken. Investment in k_2 is always financed with equity. The timing in the model is summarized in Table 1.

In this simple model, we rule out by assumption the option of debt financing. The idea is that the near-zero role for debt financing in early-stage venture financing is clear without incorporating the prohibitive costs of debt in the model. Instead, we focus on the choice that is actually observed, non-priced financing versus equity. At the same time, we will show that while SAFE financing neatly avoids the prohibitive costs of debt (e.g., the need to pay with cash; and bankruptcy costs), the instrument introduces a moral-hazard problem, debt overhang, that is parallel to but more severe than the debt-overhang problem involved in debt financing.

This model contains three market parameters: the share of equity, λ_1, that the market requires for financing k_1 if the financing is through equity; λ_2, the share required for financing investment in k_2; and the discount rate, δ, required by the market on a SAFE if used to finance k_1.[17] The entrepreneur's decisions are: selecting the instrument to finance first-period investment, equity or a SAFE, or to declining investment in k_1; and the second-period decision on whether to invest in k_2 (if the history to that point includes investment in k_1). We

[17] We assume that the share λ_2 is provided from the founders' equity. This means that the share λ_1 required by the capital market in period 1 need not take into account the anticipated dilution from shares issued in period 2. This assumption simplifies the algebra, but is innocuous.

denote these decisions as $f_1 \in \{e, s, n\}$, n indicating a decision not to invest, and $I_2 \in \{0, k_2\}$. The parameter λ_2 and the action I_2 are function of the history up to investment decision in the second period, (a, θ, f_1).

We adopt the competitive equilibrium concept: $\{\lambda_1, \lambda_2(a, \theta, f_1), \delta; f_1, I_2(a, \theta, f_1)\}$ is an equilibrium if: (1) the the entrepreneur's strategy maximizes expected profits given the market parameters; (2) the market parameters ensure that in each period the market gains expected value equal to the amount invested, given rational expectations as to the entrepreneur's strategy.

We characterize the equilibrium below. We find that if SAFEs are adopted they will be adopted by the better types. Equity is adopted by sufficiently low types whether or not SAFEs are also adopted.[18] The intuition is that equity investment involves an adverse selection (mispricing) problem. For any firm financing with equity, the cost of capital, λ_1, reflects not its true type but rather the average quality of all types investing with equity.

This adverse-selection problem disappears for types approaching the lowest type, $\underline{\theta}$. The cost of a SAFE, on the other hand, is the expected inefficiency arising from a moral hazard or debt-overhang problem: with a history of a SAFE from period 1, the first $k_1/(1-\delta)$ dollars of any equity raised in period 2 will be allocated to the SAFE holders. This has the effect of reducing the return to the entrepreneur from investing in k_2 by a fixed cost $k_1/(1-\delta)$ independent of type. This fixed cost will induce the entrepreneur to invest in k_2 in fewer states of the world — which is an inefficiency because the fixed cost is merely a transfer to other agents in the SAFE contract. The entrepreneur, facing a competitive capital market, must bear ex ante the loss in expected profits due to the distortion in the investment decision, i.e. to the inability to commit credibly to an efficient investment choice.

A SAFE dominates not investing whenever a SAFE is feasible, i.e. whenever there is a SAFE that meets the fair-pricing constraint of yielding an expected return to investors equal to their investment, k_1. This is because SAFE contains as one *option* not investing in period 2 and not paying investors for their period 1 investment, k_1, once a is realized; exercising this option generates the same payoffs to entrepreneur as not investing in period 1. The payoff to financing with a SAFE therefore equals the payoff to not investing in period 1, plus the value of the option to invest in period 2. Thus the emergence of a SAFE in equilibrium depends

[18] One might be tempted to say that SAFEs are used to *signal* a venture's type. Once a SAFE is adopted, however, the venture does not care about the market's expectation as to its type in this simple model. A SAFE is not chosen for the purpose of signaling, i.e., affecting the market's expectation. Rather, a SAFE is adopted to avoid the adverse selection problem presented by equity financing.

entirely on whether a SAFE is feasible.

When both a SAFE and equity are used in equilibrium, the cost of SAFE financing is balanced against the mis-pricing cost of equity financing. We develop intuition and an outline of results in the text and present omitted proofs in Appendix 2.

3.2 Second-period equilibrium:

We start with the investment decision in the second period, given market pricing parameters. As a benchmark, we note that the efficient decision for type θ is to invest if the investment generates a non-negative expected value: $ak_2 - k_2 \geq 0$. Thus, it is efficient to invest if a is realized in the range $a \geq 1$.

To set out the equilibrium of the second period following a history of first-period financing with equity, note that the equity market in period 2 demands a share of gross return that covers its investment, k_2. This implies that the entrepreneur's expected return from investing in period 2 (after issuing λ_1 in first period equity) increases by $(1 - \lambda_1)[ak_2 - k_2]$, which is positive if $a \geq 1$. This is identical to the first-best efficiency criterion. As is well-known, a history of equity investing introduces no inherent inefficiencies in investment decisions.

Not so with SAFE financing. Given a history of SAFE financing in period 1, the entrepreneur faces a contingent liability in that *if period 2 investment is undertaken* the entrepreneur must give SAFE holders an amount of equity equal in value to $k_1/(1 - \delta)$. If investment does not take place, SAFE-holders get nothing. The second-period equity market transactions take place under perfect information, and both parties to the transaction are risk-neutral.

This means that with a history of SAFE financing, for investment to be undertaken by the entrepreneur in the second period the expected gross value of the investment, ak_2, must cover not only the cost of the investment, k_2, but also the SAFE liability, $k_1/(1-\delta)$. The investment criterion in period 2 following a history of SAFE financing is to invest if $ak_2 \geq k_2 + k_1/(1-\delta)$, or equivalently:

$$a \geq 1 + \frac{k_1}{(1 - \delta)k_2}.$$

The second term on the right-hand side of this inequality represents the distortionary debt-overhang effect of SAFE financing.

Proposition 1. *Following equity financing, the entrepreneur's investment decision is efficient. Following SAFE financing, the investment opportunity is inefficiently turned down* *when* $a \in (1, 1 + \frac{k_1}{(1-\delta)k_2})$.

3.3 First-period equilibrium:

Feasible actions: In the first period, the entrepreneur can raise k_1 in capital by issuing equity, and of course not investing at all is also a feasible option. Financing with a SAFE, however, may or may not be feasible. There may be no discount rate δ at which SAFE purchasers are fairly compensated for the risk of not being paid in the second period.

To understand when a SAFE is a feasible option consider the following. The fair value of δ is determined by equating the payment by SAFE-holders with their expected return. SAFE holders provide an amount k_1 of financing. SAFE-holders receive an amount of equity worth $k_1/(1-\delta)$ if the security pays off, i.e., if the real option to invest in period 2 is exercised. The probability of this exercise is $1 - G\left(1 + [k_1/(1-\delta)k_2]\right)$. Equating k_1 with the expected return to SAFE holders, $[k_1/(1-\delta)] \cdot [1 - G\left(1 + [k/(1-\delta)k_2]\right)]$ yields

$$G\left(1 + \frac{k_1}{(1-\delta)k_2}\right) - \delta = 0. \tag{3}$$

When there is a solution in δ to (3), a SAFE is feasible. Note that at $\delta = 0$, the left-hand side of (3) is $G(1 + k_1/k_2) > 0$. If the left hand side remains positive at all $\delta \in (0, 1)$ there is no non-degenerate solution to (3).[19] See Figure 1(a). At the source of this possibility is a dilemma in financing with a SAFE. An increase in the compensation to SAFE-holders, δ, exacerbates the moral hazard problem because the probability of a realization of a in the moral hazard region, $(1, 1 + k_1/(1-\delta)k_2)$, increases. That is, any attempt to increase the risk premium (discount rate) to SAFE-holders makes the *necessary* risk premium higher. If there is no solution to (3), then financing with a SAFE is not feasible. If there is one value of δ for which (3) holds then that value is the equilibrium value.

Because the moral hazard increases in δ, another possibility is that there are multiple solutions to (3) as in Figure 1 (b). For example, if $\hat{\delta}$ is a fair compensation to SAFE-holders for the moral hazard problem associated with δ, doubling the compensation to $2\hat{\delta}$ might also be fair because the expected risk to SAFE-holders of not getting paid might also double. We adopt as an equilibrium selection mechanism the most efficient contract. This is the smallest δ solving (3).

[19] A degenerate solution exists at $\delta = 1$, which involves no investment and a full refund to SAFE-holders of their investment.

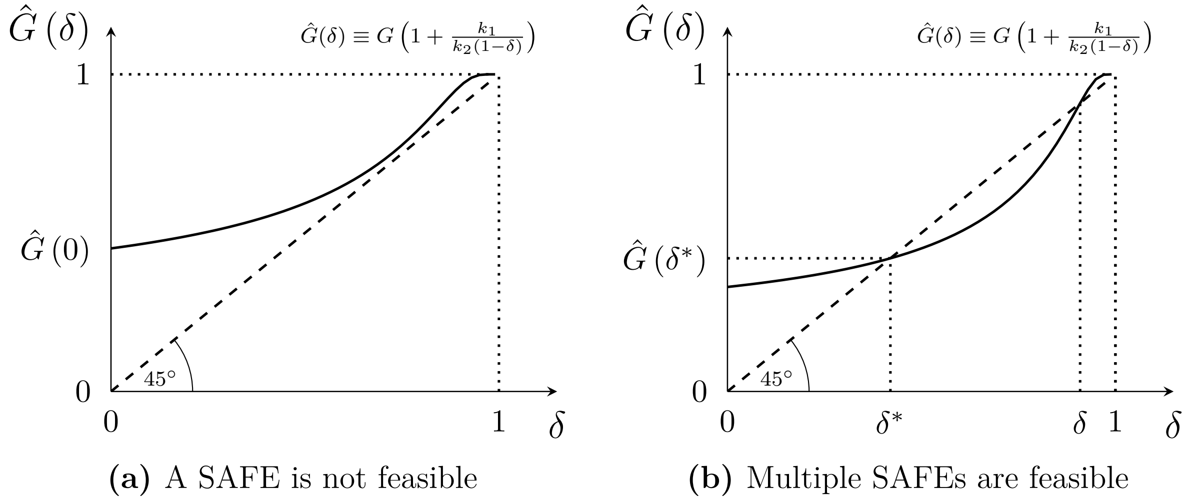

Figure 1: Equilibrium in the SAFE market.

Payoffs: The second-period equilibrium investment decision folds into the expected payoffs to the entrepreneur in the first period. Denote by $v(x)$ the value of a call option on an asset with distribution G, with an exercise price of x. That is, $v(x) = \int_x^\infty (a-x)dG(a)$. The expected payoff for type θ in period 1 from investing and financing with equity is:[20]

$$\pi(e;\theta) = (1-\lambda_1)\left[\theta + k_2 \int_1^\infty (a-1)dG(a)\right] = (1-\lambda_1)\left[\theta + k_2 v(1)\right]. \tag{4}$$

The payoff to financing with a SAFE, if a SAFE is feasible, is given by

$$\pi(s;\theta) = \theta + k_2 \int_{1+k_1/(1-\delta)k_2}^\infty \left[a - 1 - \frac{k_1}{(1-\delta)k_2}\right] dG(a) = \theta + k_2 v\left(1 + \frac{k_1}{(1-\delta)k_2}\right) \tag{5}$$

and of course the payoff from not investing is given by

$$\pi(n;\theta) = \theta. \tag{6}$$

To this list of payoffs we can add as a benchmark the expression for the first-best payoff to the entrepreneur from investing in k_1:

$$\pi^*(\theta) = \theta + k_2 \int_1^\infty (a-1)\, dG(a) - k_1 = \theta + k_2 v(1) - k_1. \tag{7}$$

In a world where the entrepreneur's type were known, the entrepreneur could invest k_1 in

[20] We omit market parameters λ_1 and δ as arguments of the payoff functions.

the efficient real option at the cost of promising k_1 to the capital market.[21]

Comparing (5) and (6), we see that the payoff from financing with a SAFE always dominates the payoff from not investing. A SAFE provides the *option* of not investing in period 2, in which case the entrepreneur gets neither the prospective returns from investment in k_2 nor — because equity is not issued in period 2 — does the entrepreneur incur the liability of paying k_1 to SAFE-holders. Exercising the option not to invest (after a is realized) thus leaves the entrepreneur with the same payoffs as having not invested. Of course, the SAFE-holder has in addition the real option to invest; the value of this option is the last term in (5).

A comparison of (4) and (5), reveals the trade-off in financing with a SAFE instead of equity. Financing with a SAFE allows the entrepreneur to retain full ownership of the venture, instead of giving up a share λ_1. But the venture is less valuable because of the distortion in the exercise of the real option. The efficient exercise price is 1, whereas the distorted exercise price under SAFE financing is $1 + \frac{k_1}{(1-\delta)k_2}$.

Equilibrium Actions when only equity financing is available: We first consider the equilibrium when equity financing and not investing are the only period-1 alternatives. As in any model with adverse selection, the key step towards characterizing the equilibrium is the identification of a single-crossing property. This is the condition describing how the relative preference for e versus n in the first period varies with θ. From (4) and (6),

$$\frac{\partial}{\partial\theta}[\pi(n;\theta) - \pi(e;\theta)] = \lambda_1 > 0. \tag{8}$$

The inequality (8) shows that the payoff to not investing relative to financing with equity is increasing in θ. This implies that if only equity is available as a financing instrument, then all types up to some marginal type θ_{en} invest, financing with equity. Types higher than θ_{en} do not invest.

The equilibrium under equity financing is a pair $(\theta_{en}; \lambda_1)$ satisfying an indifference condition and a market pricing condition on equity:

$$\pi(n;\theta_{en}) - \pi(e;\theta_{en}) = 0 \tag{9}$$

$$\lambda_1 \int_{\underline{\theta}}^{\theta_{en}} [\theta + k_2 v(1)]dF = k_1. \tag{10}$$

[21]We assume that in a first-best world, investing has positive net value, i.e. $k_2 v(1) - k_1 > 0$. Otherwise the equilibrium in the model would be trivial: never invest.

It is straightforward to show that there is at least one equilibrium with equity only as determined by (9) and (10). In the case of multiple solutions to (9) and (10), we select as the equilibrium pair the most efficient, which is the solution with the highest θ_{en}.

Equilibrium Actions when a SAFE is introduced: When a SAFE is introduced (and is feasible) then the strategy of not investing is dominated. The only possible equilibrium strategies in period 1 are then e and s. From (4) and (5), we again have a single-crossing property:

$$\frac{\partial}{\partial\theta}[\pi(s;\theta) - \pi(e;\theta)] = \lambda_1 > 0.$$

This inequality means that whenever SAFEs and equity are both used in equilibrium, then equity is adopted for all types up to some marginal type θ_{es}, and a SAFE is adopted for all higher types. Parallel to the case where only equity is available, the equilibrium when a feasible SAFE is an option is a set $(\theta_{es}; \lambda_1, \delta)$ satisfying an indifference condition (11); a market pricing condition for equity (12), and a market pricing for the SAFE ((3), repeated below):

$$\pi(s;\theta_{es}) - \pi(e;\theta_{es}) = 0 \tag{11}$$

$$\lambda_1 \int_{\underline{\theta}}^{\theta_{es}} [\theta + k_2 v(1)]dF = k_1 \tag{12}$$

$$G\left(1 + \frac{k_1}{(1-\delta)k_2}\right) - \delta = 0.$$

Again, in the case of multiple solutions we select the equilibrium with the highest θ_{es}, which we show below to be the solution yielding the highest expected payoff for the entrepreneur. The following proposition characterizes the equilibrium.

Proposition 2 (Period 1 equilibrium choice)**.** *Assume that in the first-best, investment in k_1 is optimal. Then an equilibrium satisfies the following:*

(a) If $\underline{a} \geq 1 + k_1/k_2$ then a SAFE is feasible and yields first-best investment in period 2. All financing is with a SAFE and the equilibrium discount on the SAFE is $\delta = 0$.

(b) If $\underline{a} < 1 + k_1/k_2$ then a SAFE may or may not be feasible.

- *(i) If a SAFE is feasible, then all types up to some marginal type $\theta_{es} > \underline{\theta}$ finance with equity. All higher types finance with a SAFE.*
- *(ii) If a SAFE is not feasible, then all types up to some marginal type $\theta_{en} > \underline{\theta}$ finance with equity. All higher types do not invest.*

The equilibrium mix of SAFE and equity financing is determined by equating, for a marginal type, the cost of mis-pricing of equity and the expected moral hazard cost of SAFE.[22]

Characterizing the Marginal Types: Consider $\tilde{\theta}$ as a candidate for a marginal type between equity and either a SAFE or not investing. Define the lemons market premium for equity financing, $L(\tilde{\theta})$, as the expected cost to $\tilde{\theta}$ from having to offer the market a share of the venture that is reflective of the average of all types lower than $\tilde{\theta}$ instead of its true type, $\tilde{\theta}$. The difference in these shares is given by

$$\frac{k_1}{E(\theta|\theta \le \tilde{\theta}) + k_2 v(1)} - \frac{k_1}{\tilde{\theta} + k_2 v(1)}.$$

Multiplying this difference by the (true) expected value of the venture, $\tilde{\theta} + k_2 v(1)$, and simplifying yields

$$L(\tilde{\theta}) = \left[\frac{\tilde{\theta} - E(\theta|\theta \le \tilde{\theta})}{E(\theta|\theta \le \tilde{\theta}) + k_2 v(1)}\right] k_1.$$

Let the expected cost of the debt-overhang associated with a feasible SAFE be $D(\delta)$. $D(\delta)$, which is is independent of θ, is given by the integral of the loss in surplus or total efficiency from the inefficient decision not to invest in states $a \in [1, 1 + \frac{k_1}{(1-\delta)k_2}]$. In each state a within this region, the loss in surplus from not investing is given by $k_2(a-1)$. The expected cost $D(\delta)$ can therefore be expressed as

$$D(\delta) = k_2 \int_1^{1+\frac{k_1}{(1-\delta)k_2}} (a-1) dG(a). \tag{13}$$

Because the entrepreneur is the only party making positive surplus, $D(\delta)$ is equal to the difference between the profit under the (efficient) complete contract, $\pi^*(\theta)$, and the profit

[22] Note that the debt-overhang distortion with a SAFE is larger than it would be for debt, *if* debt were allowed in the model. Debt financing of the first-period investment would be defined as the provision of capital k_1 in return for a payment B in period 2, with the transfer of existing assets (worth θ) to debt holders if the payment is not made. Assume the value of these assets in the hands of debt holders is $\mu\theta$ for some $\mu < 1$, i.e., less than the value would be to the entrepreneur. For a given face value of the second-period liability, $k_1/(1-\delta)$ in the case of SAFE financing and B in the case of debt financing, the entrepreneur would have greater incentive to invest under debt financing that under SAFE financing because of the additional threat of the value of losing assets in place, θ. An entrepreneur after issuing a SAFE bears no contractual penalty from a decision not to convert the SAFE. Moreover the equilibrium B is less than the equilibrium SAFE liability $k_1/(1-\delta)$ when $\mu < 1$: the anticipation of a positive payment to debt holders in the event of bankruptcy lowers the value of B necessary to compensate debt holders for the provision of k_1. The message that we take from this comparison is not that debt is a superior instrument — its costs have been set aside entirely in the model — but rather that the debt-overhang cost is potentially severe for SAFE financing.

under the distortionary SAFE contract, $\pi(s;\theta)$. Using (5) and (7) we have

$$D(\delta) = \pi^*(\theta) - \pi(s;\theta) = k_2 \left[v(1) - v(1 + \frac{k_1}{(1-\delta)k_2}) \right] - k_1.$$

Applying the definition $v(x) = \int_x^\infty (a-x)dG(a)$ to both $x = 1$ and $x = 1 + \frac{k_1}{(1-\delta)k_2}$ on the right hand side of this expression yields

$$D(\delta) = k_2 \int_1^{1+\frac{k_1}{(1-\delta)k_2}} (a-1)dG(a) + \left[\frac{k_1}{(1-\delta)k_2} \right] \left[1 - G\left(1 + \frac{k_1}{(1-\delta)k_2} \right) \right] k_2 - k_1. \quad (14)$$

Finally, it is straightforward to show that given the market pricing condition for δ, (3), the last two terms of (14) cancel out, leaving (14) equivalent to (13). This shows that $D(\delta)$ can be expressed either as the loss in efficiency from the investment decisions under a SAFE or as $\pi^*(\theta) - \pi(s;\theta)$.

It is straightforward to show from (7), (12) and (3) that for the marginal type, θ_{es}, we have $\pi(e;\theta_{es}) = \pi^*(\theta_{es}) - L(\theta_{es})$ and $\pi(s;\theta_{es}) = \pi^*(\theta_{es}) - D(\delta)$. Proposition 3 follows:

Proposition 3. *In equilibrium, the marginal types and discount rate satisfy:*

(a) $\pi(e;\theta_{es}) = \pi(s;\theta_{es})$ *and* $L(\theta_{es}) = D(\delta)$

(b) $\pi(e;\theta_{en}) = \pi(n;\theta_{en})$ *and* $L(\theta_{en}) = \pi^*(\theta_{en})$.

(c) $\theta_{es} < \theta_{en}$.

The marginal type in an equilibrium involving both equity and SAFEs equates the equity lemons-market premium to the debt-overhang cost. And in an equilibrium involving both e and n, the lemons market premium exhausts all profits for the marginal type.

The inequality (c) of the proposition is important. This inequality follows from the fact that the type θ_{es} earns positive profits from investment with equity financing and is therefore *infra-marginal* in the choice of equity financing versus not investing. The marginal type θ_{en} must therefore be higher than the marginal type θ_{es}.

This inequality means that when a SAFE is feasible, the financing instrument plays two roles: a SAFE brings into the market all types that would not invest if equity were the only financing instrument available. And SAFE financing *displaces* equity financing for a range of types. These roles are illustrated in Figure 2. This figure depicts the partition of types into

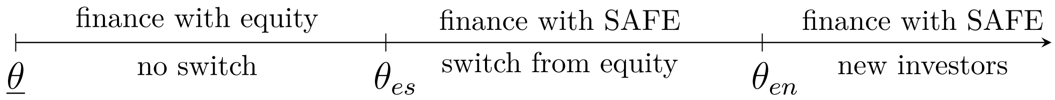

Figure 2: The Impact of Introducing SAFE Financing.

those that finance with equity whether a SAFE is available or not; those that finance with a SAFE when a SAFE is feasible; and those that switch from equity to a SAFE when a SAFE becomes available. The non-empty set of switchers is important for considering the efficiency of the equilibrium with SAFE financing. We turn next to the consideration of efficiency.

3.4 Efficiency

The availability of SAFEs as a financing option always benefits an individual entrepreneur, disregarding market effects. Expanding the feasible set of financing options cannot make an entrepreneur worse off. Does this benefit extend to the market as a whole? No. Surprisingly, the introduction of SAFEs can be harmful.

In assessing the efficiency of the market, we evaluate the welfare of the entrepreneur at the beginning of the game, prior to Nature choosing the entrepreneur's type.[23] The expected profit of the entrepreneur behind the veil of ignorance gives the ex ante expected profits across all types, which measures the efficiency of the market. (With a competitive capital market only the entrepreneur earns positive expected profits.)

There are two offsetting effects on efficiency from the introduction of a feasible SAFE. In the region $[\theta_{en}, \infty]$, the introduction of a SAFE moves decisions from not investing to investing and financing with a SAFE. This can only increase total profits. But consider agents in the set of switchers, $[\theta_{es}, \theta_{en}]$. Investment under equity financing is first-best efficient in both periods because investment takes place in period 1 (as it should) and in period 2 investment takes place when $a \geq 1$, which is the first-best efficiency criterion. When the feasible SAFE is introduced, for types in $[\theta_{es}, \theta_{en}]$ investment continues to take place in period 1. But the real option to invest in period 2 is exercised in too few states following a SAFE in period 1 because of the debt-overhang moral hazard problem. Total efficiency generated by the decisions of agents in this set must fall.

It is easy to construct an example in which total efficiency falls. Suppose that the distri-

[23]In any game with imperfect information, there is implicitly a move at the beginning of the game where Nature chooses the type of the agent.

bution of types has finite support, an interval $[\underline{\theta}, \overline{\theta}]$.[24] Suppose that distribution G satisfies $G\left(1+\frac{k_1}{(1-\delta)k_2}\right) > 0$, so that a SAFE involves a dead-overhang distortion, but above $1+\frac{k_1}{(1-\delta)k_2}$, G is large enough (in the sense of F.O.S.D.) that the condition for the marginal type θ_{en} is satisfied at $\overline{\theta}$. (The highest type is indifferent between n and e.) Then the equilibrium when equity alone is feasible leads to full investment in the first period and investment if $a \geq 1$ in the second period — the first-best set of investment decisions. But if a SAFE is introduced, total efficiency falls because in the range $[\theta_{es}, \overline{\theta}]$ the debt-overhang distortion reduces total efficiency. Period 2 investment is not undertaken for as many realizations of a as it should be to maximize expected profits.

The expression for the change in total profits with the introduction of the option of SAFE financing is given in the following proposition.

Proposition 4. *The change in total expected entrepreneur profits when a feasible SAFE is introduced is given by*

$$\triangle\pi = k_2\left\{[1-F(\theta_{en})]v\left(1+\frac{k_1}{(1-\delta)k_2}\right) - [F(\theta_{en})-F(\theta_{es})]\left[v(1)-v\left(1+\frac{k_1}{(1-\delta)k_2}\right)\right]\right\}.$$

This change in total expected profits may be positive or negative.

This expression is the sum of the expected value across θ of two terms: (1) the profits that are earned as a result of the new option to invest (at the distorted exercise price) for the types (θ_{en}, ∞) that were not investing in the equity-only case but do invest when a SAFE becomes available; and (2) the decrease in the value of the option to invest as a result of the debt-overhang distortion for the types $(\theta_{es}, \theta_{en})$ that switch from equity to SAFE financing when a feasible SAFE is introduced.

In the case of a decrease in profits, which types bear the cost of the introduction of a SAFE? After all, the new financing option could be ignored by any agent. The answer is that all agents in $[\underline{\theta}, \theta_{es}]$ are worse off. Instead of facing a cost of capital that is fair for the average type in $[\underline{\theta}, \theta_{en}]$, they each face a cost of capital that is fair for the average type in $[\underline{\theta}, \theta_{es}]$. This is a higher cost of capital, since the average type on which the equity market is basing the cost of capital is lower. The decision by those types in $[\theta_{es}, \theta_{en}]$ to switch imposes a negative externality on all lower types, by raising their cost of capital.[25]

[24] We have assumed infinite support for the distribution F in our model. The example discussed in this paragraph works if instead of assuming an upper bound, $\overline{\theta}$, we assume that $\overline{\theta}$ is a point in the support above which the probability is sufficiently small.

[25] We are evaluating the expected profits of the entrepreneur behind the veil of ignorance, but can still refer

The result that contracting agents can be harmed by the availability of less restrictive contracts was demonstrated by (Hermalin and Katz, 1993). The more general contract may provide an agent with the incentive to disclose or signal its type ex post that is to its disadvantage ex ante. In our context, the agent would be better off if it could *commit*, prior to Nature choosing its type at the beginning of the game, to investing and financing with equity. But it cannot commit. The choice of a SAFE, to avoid the lemons market premium, is too tempting for the very best types even at the cost of incurring the moral hazard cost: The inability of the best types to commit not to finance with equity leads to a higher cost of equity capital from the inference drawn by the capital market for types in the lower interval. The result can be a reduction in average wealth across types. Paradoxically, the addition of a financing option can make entrepreneurs worse off.

3.5 Testable Implications of the Theory

We have developed a theory of the binary choice between SAFEs and equity in the financing of early-stage ventures. In bringing this theory to the data, we will not test formal restrictions imposed on the data by our highly stylized model. Instead, we set out the general implications of our theory for when SAFEs are more likely to be used. The basic test of any theory of a new method of financing is whether the method is used when the theory predicts it should be. From this high-level perspective, the theory offers two simple testable implications, both regarding the ex ante probabilities of each choice.

Financing Across Stages

The first implication is related to financing in early stages relative to later stages. In the first period of our model, with asymmetric information, the prediction is that non-priced (SAFE) financing will be observed for a fraction of those ventures financed. If there were no such asymmetry, then only equity financing would be observed. This suggests that, on average, as the amount of investors' information increases the fraction of ventures financed with non-priced instruments should fall. Our fundamental assumption is that the market learns information that is private at the first external financing. In our simple model, this learning is complete. More generally, a reasonable assumption that learning between stages by the market is strongest in the early financing stages. It is in these early stages that the market is least informed and has the most to learn.

to externalities across types.

Hence the test: as we move through the stages of financing from early to late — pre-seed financing, seed financing, financing rounds between seed and venture capital financing, and then series A and B venture financing — the fraction of ventures financed with non-priced instruments should decline on average.

Variation in the Size of the Financing Round

We have assumed that in period 1 the entrepreneur accepts the informational asymmetry as a constraint, and chooses whether to invest and how to finance the investment. In reality, entrepreneurs do not have to take the information asymmetry as given. They can invest resources to reduce the asymmetry by informing investors through an audit, facilitating due diligence on the part of investors, or simply marketing the firm to investors. This type of information provision is often represented in the accounting literature as a costly revelation of information type (e.g., Verreccia, 1983). The benefit of type revelation is the ability to finance immediately with equity at a fair cost of capital — avoiding both the lemons premium for equity financing and the moral hazard cost of a SAFE.

Recognizing this option on the part of the entrepreneur generates a testable implication. The costs of providing information (such as time on the part of the CEO and CFO spent marketing a new issue) are a *fixed*, or at least not proportional to the amount of capital raised. The benefits of providing information, on the other hand, are proportional to the size of the issue. Thus the option to provide information — and then finance entirely with equity — should be invoked to a greater degree the larger the amount of capital raised in the financing round. Non-priced equity should be used in greater proportion the smaller the round. Intuitively, if an entrepreneur is going to raise only 20 or 30 thousand to get an initial start, neither the entrepreneur nor the investor is going to spend many hours trying to bridge the informational gap in order to determine the "right" price for equity.

These testable implications depend on a single property of the SAFE: the reliance of the SAFE in allocating shares based on the future equity price. Since this is the key property of *any* non-priced financing, the implications apply to equity versus any non-priced financing, i.e. convertible notes as well as SAFEs. The testable implications are patterns implied by the general idea that we are proposing, that non-priced financing emerges when the asymmetry in information diminishes over time. As discussed, we therefore aggregate both types of non-priced financing, SAFEs and convertible notes, in looking at data on rounds of financing.

Other testable implications

Bridge Financing: A category of financing rounds that warrants special discussion in light of our theory is *bridge financing*. Bridge financing is generally short-term financing intended to bridge the gap between the date at which a venture's funds run out and the date of a larger financing round. (For example, if a venture is running out of cash; is planning a large round in 4 months; and has a burn rate of 50,000 per month, it might raise about 250,000 in bridge financing to cover costs before the larger round.)

Bridge financing rounds are omitted from the binary choice empirical model that we use to test our theory, because bridge financing does fit naturally into the ordering of the stages of financing from pre-seed financing through to Series A and B financing. Bridge financing has several important properties, however, that generate predictions on the form of financing in light of our perspective. First, bridge financing rounds tend to be small in terms of *absolute* size. This leads to the prediction of a greater share for non-priced financing for bridge rounds, as discussed above. Second, bridge financing rounds are invariably small *relative* to the size of the next round of financing. This property also leads to a reduced reliance on equity financing. Estimating a fair price is inherently risky: if a venture ended up with a higher equity price for the bridge financing than for the (much larger) future equity round that is planned, then the venture would be in a position of raising the larger equity round as a *down round*, which would deter some investors. Estimating an equity price for the bridge that is too low, on the other hand, would mean an excessive cost of capital. The price of equity is soon to be determined in the larger equity round; it makes sense to rely on this price determination for the bridge financing rather than risk mis-pricing the small bridge round. Finally, bridge financing is often used to cover cash flow needs up to an equity round planned for a relatively specific date or within short time period. The debt-overhang cost of delaying the financing is unlikely to be problematic, and the debt-overhang cost of deferring the financing entirely will not be large if the venture is to be cash-constrained as is often the case at the end of a term of bridge financing. The last feature means that not only is non-priced financing likely to be preferred to equity financing because the debt overhang cost is low. The last feature, having a next round of equity planned for a relatively specific date, also means (to go beyond the question analyzed in this paper) that the *form* of non-priced financing is likely to be a convertible note rather than a SAFE. The greater commitment to a future financing date that is inherent in a convertible note is of low cost to the venture in terms of reducing flexibility in the timing of the round, which flexibility is the advantage of the SAFE form of non-priced financing over a note. In summary, while bridge financing is outside our formal model economic considerations stemming from our perspective suggest a high share of the non-priced class of financing for bridge rounds and, within the non-priced class, a preference for convertible notes over SAFEs.

Testing the choice of financing instrument across types: A test of the model might seem to be that better types should finance with SAFEs to a greater degree than poorer types. The theoretical proposition, however, is about the ordering of types in those dimensions of quality that are *unobservable* to the investors (and to us). One could in principle examine the correlation of financing choices with ex post surprises in predicted venture success — but real-world data does not come close to allowing this kind of refined test. This implication, in other words, is testable in principle but not in practice.

4 Empirical Evidence

In this section, we describe the patterns of early-stage financing and take a first step towards testing the predictions of our theory of the choice between SAFEs and equity for early-stage financing. We use a data set of early ventures produced by the Creative Destruction Lab and described in Sariri (2020). The data are from a survey of the set of 924 ventures engaged in the CDL program over the period 2017 through 2019. Among these ventures, 338 entered into financing rounds during their tenures at CDL. In turn, 93 of these ventures entered into multiple rounds of financing. The total number of financing rounds contained within the resulting set was 501. Of these data points, 492 were early-stage financing rounds, up to and including series A preferred equity financing; early-stage financing is our focus.

Included in the data are the type of external financing (our dependent variable) — a SAFE or a convertible note; the size of the round of financing; the stage of financing represented by the round. Other variables include the pre-money valuation for equity rounds; the valuation cap for convertible notes; and a valuation cap for those SAFEs that have a cap.[26] The lack of a market valuation statistic for ventures means that we cannot control for firm size in our regressions.

Table 2 summarizes the frequency of the types of instruments used in our sample. Table 3 disaggregates the choice of financing instrument by stage, summarizing the relationship between the financing methods and one of our key independent variables, the stage of financing (as well as bridge financing).

[26]The CDL data also include a number of variables that we do not use, including the site (university location) of the venture engaged in the round; the business category (tech, med-tech, AI, etc.) and the academic year, or cohort of the venture.

Financing Instruments	N	Proportion
Equity	256	52.0%
Convertible Notes	181	36.8%
SAFE	55	11.2%
Total	492	100%

Table 2: The Aggregate Mix of Financing Instruments Used.

Financing Stage	N	Equity	CN	SAFE	Equity percent
pre-seed	150	12	135	3	8
seed	270	196	25	49	73
series A	50	45	2	3	90
bridge	22	3	19	0	14

Table 3: Financing Instrument by Stage of Financing.

In the key early stage of financing, the seed stage, non-priced financing accounts for about a quarter of financing choices. The percentage is surely greater in the current market for early stage ventures. The practitioner literature refers to SAFEs as ubiquitous, and some practitioners have told us that in their experience SAFEs are now the default choice for the first external financing of early ventures. The first three entries of the last column of Table 3 suggest support for our prediction that equity financing is used to a greater extent the further along is the venture. Of course, the descriptive data do not control for size.

To test the theory, we move to a regression framework so that the size of the round and the stage of the round can each be controlled for in examining the effects. The discrete choice faced by ventures is among the three alternatives at each round of financing: a convertible note, a SAFE or equity financing. As discussed in the previous section, we aggregate SAFEs and convertible notes into non-priced financing in estimating the discrete financing choice. The choice is therefore between equity and non-priced financing. The independent variables in this choice are those at the core of the testable implications of the model: dummies for the three stages of financing — pre-seed, seed and series A — and a measure of the size of the round. We found a strong multi-collinearity between these two variables. To resolve this problem we measure size as relative to the average of the size of rounds at the same stage. The size variable is *log relative size*: log(amount raised / average amount raised across observations at the same stage). Table 4 provides the results of the binary logit estimation.

Our estimates of the coefficients on size and financing stages of the ex ante probability of choosing NP are consistent with the predictions of our theoretical model. The probability

non-priced financing instrument dummy	coefficient	st. error	z	p > z
log relative size	-0.373	0.122	-3.07	0.002
pre-seed round dummy	3.43	0.335	10.24	0.000
series A dummy	-1.268	0.495	-2.56	0.010
constant	-1.146	0.152	-7.53	0.000

Notes: Seed round dummy omitted; n = 470; log-likelihood = -211.82; pseudo R squared = 0.347.

Table 4: Binary Logit Estimates of the Choice of Financing Instrument.

of choosing non-priced financing is negatively related to relative size. The probability of non-priced financing falls as the stage of financing progresses: with the seed round dummy omitted, the coefficient on pre-seed is positive and the coefficient on the series A dummy is negative. The hypotheses of zero coefficients are rejected with p values at or below 0.01. The coefficients are economically significant: when log relative size increases from the 10th percentile to the 90th percentile, the probability of non-priced financing decreases from 0.53 to 0.40. The strong impact of proceeding to further stages of financing is clearly evident even in the raw data, in the "CN" and "SAFE" columns of Table 2. These results are not sensitive to functional form: similar results are reported in Appendix 3 for log-linear and probit.[27]

To summarize, the evidence for our theory of the choice between equity and non-priced financing in venture financing rounds supports the following implications : the basic point that non-priced financing may be optimal; the fact that early-stage ventures use non-priced financing whereas established corporations do not; even within the set of early-stage ventures, the extent of non-priced financing declines on average as a venture progresses through stages; non-priced financing is used to a greater extent for smaller rounds of financing. In the sample of those ventures adopting both non-priced financing and equity financing at different stages, non-priced financing virtually never follows equity financing, consistent with the assumed structure of our model.

[27] The implication that the ex ante probability of non-priced financing decreases as we move through stages of financing has a parallel in the *ex post* or realized data. Under our model, by construction a venture never follows an equity issue with a SAFE issue. This is essentially by assumption. Testing this against the data is a test of the assumed structure of the model.

In our sample, 93 of the ventures issued multiple rounds. Of these 43 ventures financed with both equity and SAFEs (in different rounds); 42 of the 43 ventures financed with SAFEs at earlier round(s) and equity at later rounds. In contrast, of the 43 ventures adopting both non-priced financing and equity financing for different rounds, only 1 adopted equity financing prior to a non-priced round. This is evidence consistent with the assumed structure of our model.

5 Open Questions

We have taken a first step towards a theory of early-stage venture financing, analyzing the binary choice between equity and non-priced financing. A complete characterization of the incentives for SAFE financing would require a more complex model than ours. We outline below some questions raised by our characterization.

Partial **resolution of information asymmetry:** Our simple model assumes the complete resolution of informational asymmetries between periods 1 and 2. This assumption implies that SAFEs are very close to debt in the model. This is exactly the right framework to make our point: SAFEs avoid entirely the prohibitive costs of debt for startups but retain the advantages of debt in protection against the effect of adverse selection — once our assumption of the complete resolution of the asymmetry information is accepted. To explain a new type of security one would ideally like a model in which the new security is distinct from established securities. A model in which the equity market receives only an imperfect signal of firm type between the initial financing date and the second financing date, rather than full information, would meet this condition. A SAFE would in this model be a clear hybrid of equity and debt rather than being very close to debt.

Dynamic model with incentives to delay the equity issue: Understanding SAFEs more fully would benefit from a dynamic model, in which the debt-overhang cost of SAFEs involves as one possibility an inefficient *delay* in the issuing of new equity. In our model, SAFEs are either paid in full or not at all. Delaying a financing round is not possible, whereas it is in reality.

Full range of incentives to raise or defer equity issue: In our model the debt-overhang problem is synonymous with a decision not to invest. In reality, a venture may find itself successful in terms of generating enough cash to fund its operations, so that external financing to expand the venture is not needed. The venture can ignore SAFE-holders, financing its operations internally. Payment of the SAFE liability would be avoided because the firm was *too* successful in generating case. Clearly, a model with a full range of possible outcomes including the risk to SAFE holders that the venture is too successful would allow a richer analysis.

Incorporating additional elements in the trade-off between SAFEs and equity: As a first step towards theory of early stage financing, we have characterized optimal financing as a trade-off between two factors, the mis-pricing of equity and the debt-overhang cost of a SAFE. There are additional elements favoring equity or SAFEs. One is the well-known advantage of debt-like instruments (SAFEs in our context) is in leaving the residual claim on earnings with the agent, or entrepreneur, so that entrepreneurial incentives to exert effort are stronger. Sharing the residual claim with other equity-holders would seem to generate a conventional moral hazard problem of reduced effort. We suggest, however, that entrepreneurs are strongly incentivized by the desire for a reputation (and identity) as successful, mitigating this moral hazard problem. In analyzing effort, two alternative considerations are more important. The first is the *direction* rather than the amount of the entrepreneur's effort. An entrepreneur seeking equity capital must spend time marketing the venture to potential investors, especially in the early stages when there is not yet concrete concrete evidence of success. Financing with a SAFE instead allows the entrepreneur to focus on building the venture, leaving marketing and information conveyance to later stages of finance. The second consideration is in the effort — more specifically, the time input — of angel investors, rather than the entrepreneur. Venture financing, including early-stage financing, is usually characterized by strong advisory input by experienced investors. Angel investors typically have a substantial portfolio of projects and are limited in the time that they spend with any one venture. Investor effort incentives provided by a simple SAFE are limited because any effort between the first and second rounds of financing that raises the value of the firm simply reduces the investor's share allocated under the SAFE. A share of equity to investors will enhance their involvement with the venture.[28] An asymmetric information model incorporating these additional incentive would be valuable. We discuss below a contractual feature of most SAFEs, a cap on conversion value, that we suggest is a response to the angel-incentive concern.

Security-design approach to explaining SAFEs: Like much of the literature on capital structure, our model takes as given the forms of financing (equity and debt in most of the literature; equity and SAFEs here) rather than deriving the security designs as optimal forms of financing.[29] In a security-design approach to the problem, the SAFE contract itself would be explained. The security-design approach, however, cannot explain innovation in contractual design. The SAFE instrument has been used only since late 2013, when it was first developed after months of consultation by the innovator with industry participants.

[28]As discussed above, a SAFE investor has some incentive, of course, to spend time with the venture to increase the chance of success and therefore a higher probability of payoff of the SAFE. And the later-stage effort of the SAFE holder after the payment of the SAFE liability is strengthened by the conversion of the SAFE into equity.

[29]The security design literature includes Gale and Hellwig (1985), Allen and Gale (1988) and the literature following these papers.

Mechanism design theory cannot explain why SAFEs were used in 2014 but not in 2012. But the security-design approach, we conjecture, could explain the key feature of SAFEs — reliance on future prices to allocate shares — as a consequence of the informational assumption that we think is central to the early startup context, learning by the market of information that is initially private.

Explaining the form of SAFEs, especially caps on valuation: Finally, we have adopted the simplest possible form of a SAFE. Most SAFEs include a feature not incorporated in our model: a cap on the valuation that is to be used for conversion of the face value of the SAFE into shares. A cap on the valuation basis is equivalent to awarding the entrepreneur a call option on the venture — more precisely, a call option contingent on the entrepreneur's decision to issue equity. The simplest SAFE (without a cap) awards a share of the venture to the SAFE-holder equal to

$$\frac{k_1/(1-\delta)}{v}$$

where v is the expected value of the firm at the time of issuing equity in period 2. The value of this share of v is of course $k_1/(1-\delta)$, independent of the realization of v. A cap $\overline{v}$ on the valuation basis for conversion, means that the share awarded to the SAFE-holder is

$$\frac{k_1/(1-\delta)}{\min\{v, \overline{v}\}}$$

The value of this capped share can be expressed as follows:

$$\begin{aligned} v \cdot \frac{k_1/(1-\delta)}{\min\{v, \overline{v}\}} &= v \cdot \max\left\{\frac{k_1}{v(1-\delta)}, \frac{k_1}{\overline{v}(1-\delta)}\right\} \\ &= \frac{k_1}{(1-\delta)} + \max\left\{0, v \cdot \frac{k_1}{\overline{v}(1-\delta)} - \frac{k_1}{(1-\delta)}\right\} \end{aligned} \tag{15}$$

The last term in the expression (15) is the value of a call option for a share $k_1/[\overline{v}(1-\delta)]$ of the firm at an exercise price of $k_1/(1-\delta)$. This "contingent call option," which pays off in the event of a future equity issue, is an addition to the basic SAFE without a cap.[30] (All payoffs to the call option are contingent on the entrepreneur's decision to issue equity.)

The cap thus gives the investor a claim on the upper tail of the return distribution. The

[30]From put-call parity, we know that the cap can also be written in terms of a put option. The cap is equivalent to awarding to the investor a share $k_1/[(1-\delta)v]$ of the firm with a guarantee or *floor* on the value of this share given by $k_1/(1-\delta)$. That is, the investor is given the share plus a put option on the share with an exercise price given by the floor.

popularity of caps can be explained as a means of enhancing the incentive of an angel investor to exert effort, i.e. to remain intensely involved as an adviser in the venture. Startups are unique as we have discussed in that the ventures try to attract "smart money," i.e. angel investors who typically have experience of successful exits from their own ventures; the cap as an incentive mechanism is directed at the investor, not the entrepreneur. Without the cap, the investment itself provides the investor with less incentive to exert effort between the SAFE issue and the equity issue since any increase in value (contingent upon the SAFE being converted) is offset exactly by a reduction in the number of shares allocated to the investor.[31]

Empirical Questions: On the empirical side, development of larger data bases would allow investigation of the types of ventures that employ SAFEs and the other variation of non-priced financing, convertible notes. Given our data, we have focused on two elements: the stage of financing and the size of the financing round. We have aggregated SAFEs and convertible notes, as well as convertible preferred equity and common equity — focusing entirely on the binary choice of equity versus non-priced financing. Theoretical and empirical analysis of the choice of which type of non-priced financing, SAFEs or convertible notes, in particular is an important and outstanding issue. Table 3 in the previous section of this paper yields some suggestive patterns in this regard.[32]

6 Conclusion

This paper offers a theory of early-stage venture financing. We frame the theory in terms of a binary choice between the two kinds of financing that we observe, equity and non-priced financing. Non-priced financing is the provision of capital at terms to be set in a future

[31] Angels holding a SAFE still have the incentive to exert effort to increase the likelihood that the SAFE is converted; and to exert effort for which any resulting increase in value will not be observed by the market until after the next financing round.

[32] Table 3 is consistent with the following informal analysis. Convertible notes are particularly well suited to bridge financing and pre-seed financing because the timing of the next round of financing is relatively predictable in both cases: it is the date at which funds will are required as the venture is typically cash-flow negative when (and after) these types of financing are undertaken. The venture can easily commit to a maximum date for conversion of investors' liability to the known value of shares. A maturity date is a defining feature of convertible notes. For seed financing, on the other hand, the date of the next round of financing is typically years into the future and much more difficult to predict with any precision. The commitment to a date by which equity must be issued to avoid the convertible-note moral hazard problem is clearly more difficult, and the advantages of convertible note financing are less — evidently not enough to overcome the substantial practical advantages of SAFE financing in terms of simplicity.

round of equity financing. We adopt a model of investment and financing in two stages. Our key assumption is that between the financing rounds, the market learns information that is initially private to the entrepreneur.

Higher quality types prefer SAFE financing over equity financing in the first round, because under SAFE financing they know that their cost of capital — the share of equity that must be given up in exchange for external financing — will be determined in the future by a price that reflects their type. Under our assumption of learning by the market, SAFEs carry the advantage (well-known for debt financing) of avoiding the mis-pricing of equity in the first round. Like debt, SAFEs involve a moral-hazard or debt-overhang problem — but for SAFEs this is a debt-overhang problem more severe than that inherent in debt financing. A decision not to pay SAFE-holders carries no penalty in terms of bankruptcy and transfer of ownership; following SAFE financing, a venture that does not pay back SAFE holders incurs only the loss of future investment.

The basic test of a theory of a new form of financing is whether the financing is used where the theory predicts it should be used. Interpreting our theory broadly, we find support in a small but new data-set of venture financing choices. SAFEs are more likely to be used for earlier stages of financing, as predicted. SAFEs are also more likely to be used for smaller financing rounds given asymmetric information because (and here we step beyond the formal model) the fixed costs of conveying information about the venture and investors' fixed costs of due diligence can be avoided. These costs are inherent in equity financing.

Our final contribution is an outline of open questions to address in further research on the theory of early-stage financing. Among these is a greater attention to moral hazard problems. We suggest that moral hazard on the part of the angel investor is particularly important and that a feature of SAFEs commonly observed (a cap on the valuation basis for conversion) can be explained as a response to this problem. Finally, we conjecture that an alternative approach, an optimal security design theory with fully rational agents, would yield the prediction of financing with a cost of capital that depended on future prices, under our pivotal assumption that the market learns over time information that is initially private to the entrepreneur.

Appendix

Appendix 1: Non-priced Financing: SAFEs and Convertible Notes

SAFE's: Simplified Agreements to purchase Future Equity ("SAFE's") are instruments by which an investor in an early start-up is compensated in equity in the future, at the time that the venture issues its first round of equity. The number of shares awarded to the investor is determined by the share price at which the equity is issued. The following are variations and typical features of a SAFE:

- A SAFE can take 3 main forms:
  - A SAFE with a discount. In this case, the number of shares is allocated to the investor is given by the invested capital divided by a discounted future share price. Discounts range from 0 to 20 percent.
  - A SAFE may instead have a cap on the valuation of the venture at the time of the first equity issue. If the venture does well and equity is issued at a valuation exceeding the cap, the valuation of the company for purposes of determining the share awarded to the SAFE holders is determined by the cap. The cap gives the SAFE holders a claim on the upper tail of the distribution of the venture value, i.e., the cap is equivalent to adding to the contract a call option with an exercise price equal to the SAFE-holders share of the valuation at the cap.
  - A SAFE may have both a discount and a cap. In this case, the higher of the value (the number of shares) generated by the discount rate or the cap applies in the event of conversion
- There may be a minimum size of a future equity issue that will trigger payment (share allocation) to the SAFE holders. A basic SAFE therefore has three parameters: the minimum equity size, the discount rate and the amount of capital provided.
- A SAFE may have a most favored nation (MFN) clause, which guarantees that the SAFE holder obtain terms at least as good as any other security holder. For example, if a future SAFE is issued with better terms, the terms to existing SAFE holders would change to match the new terms.
- Beyond (MFN) rights, the SAFE contract may include rights of first offer (preemptive rights), "major investor" rights, expense reimbursement rights, information rights, and observer rights.

- In a liquidity event (e.g. purchase of the start-up), the SAFE holder will typically get the maximum of the financing amount or the conversion value.
- In the event of dissolution of the venture prior to payment of the SAFE, the SAFE holders' claim is senior to common equity but junior to any debt or payments to employees.
- SAFEs can use a pre-money or a post-money valuation cap. (Pre-money valuation refers to the value of the firm prior to the addition of the capital in the future equity round; post-money valuation refers to the value incorporating the capital raised.) A post-money SAFE is generally more favorable to investors. In 2018, Y Combinator (the originator of SAFE's) changed its standard form SAFE from a pre-money to a post-money valuation cap, and much of the industry has followed.
- A key practical feature of a SAFE is its simplicity, as its label suggests, and low cost. Some standard forms for SAFE's are only 4 pages, with 2 of the pages being simply definitions. Debt contracts can run to dozens of pages.

Convertible Notes: A convertible note is more complex than a SAFE but shares the essential feature of conversion to shares at a future price. A convertible note has the following parameters: a maturity date, a valuation cap, a discount rate, and an interest rate. When the venture issues equity prior to the maturity date, the investor has the option to convert the principal and accrued interest into preferred equity shares at the share price paid by new equity investors — with adjustments given by the discount rate and valuation cap as under a SAFE. The exercise of the option at the first issue of equity is generally optimal (as opposed to waiting for a future equity round and likely receiving the same dollar value of equity in the future). Thus, a convertible note is approximately the same as a SAFE with the additional components of (1) a guaranteed date (the maturity date) by which the note can be converted to equity; and (2) interest payments. The accrual of interest payments can be either compounded or simple.

In the typical convertible note contract, if the maturity date has been reached without a round of equity financing, then the note holders have the option to demand repayment in cash (an option that is rarely exercised given the cash-poor nature of the typical startup) or to convert into equity with the valuation cap in the contract serving as the default basis for determining the number of shares to which the note converts on the maturity date. More often, the maturity date is renegotiated, perhaps with additional consideration.

Appendix 2: Omitted Proofs

Proof of Proposition 1. As a benchmark note that the efficient investment decision in period 2 is to invest if it increases total wealth. This is the condition that $ak_2 + \theta - k_2 \geq \theta$, which is equivalent to $a \geq 1$. Following a history of equity financing, the entrepreneur's expected payoff from financing with a share of equity λ_2 in period 2 is

$$(1 - \lambda_1)(1 - \lambda_2)(ak_2 + \theta). \tag{16}$$

The market sets the price of equity in the second period to satisfy

$$\lambda_2(ak_2 + \theta) = k_2.$$

Solving for λ_2 and substituting into (16), yields the expected payoff $(1 - \lambda_1)(ak_2 + \theta - k_2)$ from investing in period 2, following equity financing in period 1. This exceeds the expected payoff from not investing, $(1 - \lambda_1)\theta$, if $a \geq 1$. Thus the investment decision in period 2 following a history of equity financing in period 1 is efficient.

Following a history of SAFE financing, the entrepreneur's expected payoff from investing in period 2 and financing by issuing a share of equity λ_2 is

$$(1 - \lambda_2)(ak_2 + \theta). \tag{17}$$

With a SAFE outstanding, the new equity financing holders must cover the costs of the investment, k_2, as well as the liability to SAFE-holders, $k_1/(1 - \delta)$. The market pricing condition in this case is therefore

$$\lambda_2(ak_2 + \theta) = k_2 + \frac{k_1}{(1 - \delta)}$$

Solving this for λ_2 and substituting into (17) yields the expected payoff to the entrepreneur from investing

$$ak_2 + \theta - k_2 - \frac{k_1}{(1 - \delta)}$$

This exceeds the expected payoff from not investing, θ, whenever

$$a \geq 1 + \frac{k_1}{(1 - \delta)k_2}.$$

Following SAFE financing the entrepreneur inefficiently turns down the period 2 investment when $a \in (1, 1 + \frac{k_1}{(1-\delta)k_2})$. This proves Proposition 1. $\square$

Proof of Proposition 2. Under $\overline{a} \geq 1 + k_1/k_2$, we have $G(1 + k_1/k_2) = 0$. Therefore, $\delta = 0$ solves (3). We start proving claim (a). That is, a SAFE is feasible with $\delta = 0$ such that (3) holds. Under this SAFE, it is easily verified that investment takes place in period 2 under every realization of a both in equilibrium and in the first-best. The SAFE is thus efficient, yielding first-best profits. To show that all financing is with a SAFE, suppose to the contrary that some types finance with equity. We have shown that the set of types financing with equity must be an interval of the lowest types (we show this in the paragraph following equation (8) in the text.). The highest type in this interval earns less than first-best profits because it gives up a share of equity λ_1 that reflects that average type in the interval rather than its true type. This contradicts the supposition that equity is the equilibrium choice for this type.

To prove claim (b) first observe that the expected payoffs in period 1 for the actions e, s and n in period 1 — equations (4), (5), and (6) respectively — are obtained by taking expectations of the period 2 payoffs. Note, however, that $\pi(s;\theta)$ requires that a SAFE is feasible. Where a SAFE is feasible, the payoff from issuing a SAFE dominates not investing, from a comparison of (5) and (6); compared to not investing, a SAFE provides the entrepreneur with a free option. If a SAFE is feasible, then all entrepreneurs invest.

The single crossing properties are $\frac{\partial}{\partial\theta}[\pi(n;\theta) - \pi(e;\theta)] = \lambda_1 > 0$; $\frac{\partial}{\partial\theta}[\pi(s;\theta) - \pi(e;\theta)] = \lambda_1 > 0$. These guarantee that if equity financing is issued by any types in equilibrium, these will be an interval of the lowest types.

(i) No SAFE is available: Consider first the case where only equity financing is available. An equilibrium is characterized by two parameters (λ, θ_{en}) that solve two conditions: that θ_{en} is indifferent between financing with equity and not investing; and that market earns zero profits:

$$\theta_{en} = (1 - \lambda_1)\left[\theta_{en} + k_2 \int_1^{\infty} (a-1) dG(a)\right] = (1 - \lambda_1)[\theta_{en} + k_2 v(1)] \tag{18}$$

$$k_1 = \lambda_1 E\left(\theta + k_2 \int_1^{\infty} (a-1) dG(a) \middle| \theta \in [\underline{\theta}, \theta_{en}]\right) = \lambda_1 \left[E\left(\theta | \theta \in [\underline{\theta}, \theta_{en}]\right) + k_2 v(1)\right]. \tag{19}$$

The market condition is that the average value of equity λ, across all types θ issuing equity, covers the cost of investment.

Define the solutions to these two conditions, in λ_1 as a function of θ_{en}, to be λ_i and λ_m, respectively (for "indifference" and "market"). From (18) and (19), respectively, we can write

$$\lambda_i(\theta_{en}) = \frac{k_2 v(1)}{\theta_{en} + k_2 v(1)} \tag{20}$$

and

$$\lambda_m(\theta_{en}) = \frac{k_1}{E\left(\theta | \theta \in [\underline{\theta}, \theta_{en}]\right) + k_2 v(1)}. \tag{21}$$

These functions evaluated at $\theta = \underline{\theta}$ are given by

$$\lambda_i(\underline{\theta}) = \frac{k_2 v(1)}{\underline{\theta} + k_2 v(1)}, \quad \text{and} \qquad \lambda_m(\underline{\theta}) = \frac{k_1}{\underline{\theta} + k_2 v(1)}.$$

By the assumption that investment in k_1 is profitable at the first-best, $k_1 < k_2 v(1)$. Hence $\lambda_m(\underline{\theta}) < \lambda_i(\underline{\theta})$. From (20) and (21), we have

$$\lim_{\theta_{en} \to \infty} \lambda_i(\theta_{en}) = 0, \quad \text{and} \qquad \lim_{\theta_{en} \to \infty} \lambda_m(\theta_{en}) = \frac{k_1}{E\left(\theta\right) + k_2 v(1)} > 0.$$

These conditions imply that for θ sufficiently large, $\lambda_i(\theta_{en}) < \lambda_m(\theta_{en})$. The facts that $\lambda_m(\underline{\theta}) < \lambda_i(\underline{\theta})$ and $\lambda_i(\theta_{en}) < \lambda_m(\theta_{en})$ for θ_{en} sufficiently large, and the continuity of the functions, imply that for some θ_{en}, $\lambda_i(\theta_{en}) = \lambda(\theta_{en})$ by the intermediate value theorem. At these crossing points for the functions λ_i and λ_m, the equilibrium conditions are met. We cannot rule out multiple equilibria (as is typical for adverse selection models) and take as an equilibrium selection the highest of these crossing points, which is the most efficient of the equilibrium candidates. This proves claim (i) of Proposition 2(b).

(ii) SAFE is available: Suppose that a SAFE is feasible, i.e., there is a discount δ such that the SAFE with δ satisfies the fair pricing condition (3). Then the strategy of not investing is dominated for all θ. From the single-crossing property between e and s, all types up to some type θ_{es} finance with equity; all higher types finance with SAFEs. To find the equilibrium $(\delta, \lambda, \theta_{es})$, start by setting δ to the (lowest) the value of the discount that satisfies the fair pricing condition.[33] We proceed slightly differently from above, by comparing the payoffs across θ from financing with equity at the λ satisfying the market pricing condition, with the payoffs with a SAFE at the market-provided δ.

Substituting the market-pricing condition (19) into (4) yields the profit $\widetilde{\pi}(e; \theta)$ from investing

[33] Note that this value is independent of θ under our simplifying assumption that only the value of assets in place varies with θ.

in equity at the market clearing value of λ:

$$\widetilde{\pi}(e;\theta_{es}) = \left[1 - \frac{k_1}{E\left(\theta|\theta \in [\underline{\theta}, \theta_{es}]\right) + k_2 v(1)}\right] [\theta_{es} + k_2 v(1)]. \tag{22}$$

The profit from financing with a SAFE at the market value of δ is given by (5) since the market value of δ is independent of θ.

Evaluating the two profit functions at $\underline{\theta}$ we have

$$\widetilde{\pi}(e;\underline{\theta}) = \left[1 - \frac{k_1}{\underline{\theta} + k_2 v(1)}\right] [\underline{\theta} + k_2 v(1)] = \underline{\theta} + k_2 v(1) - k_1 = \pi^*(\theta)$$

and

$$\pi(s;\underline{\theta}) = \underline{\theta} + k_2 v \left(1 + \frac{k_1}{(1-\delta)k_2}\right). \tag{23}$$

Substituting the market condition for δ, $k_1 = [k_1/(1-\delta)] \cdot [1 - G\left(1 + [k/(1-\delta)k_2)]\right)]$, into (23) yields $\pi(s;\underline{\theta}) = \underline{\theta} + k_2 v\left(1 + \frac{k_1}{(1-\delta)k_2}\right) - k_1 < \pi^*(\underline{\theta})$. Thus $\pi(s;\underline{\theta}) < \widetilde{\pi}(e;\underline{\theta})$.

Next we show that for sufficiently large θ, $\widetilde{\pi}(e;\theta) < \pi(s;\theta)$. In (22) note that as $\theta \to \infty$, $E\left(\theta|\theta \in [\underline{\theta}, \theta_{es}]\right)$ converges to $E(\theta)$. From (22) and (23), it follows that

$$\lim_{\theta\to\infty} \widetilde{\pi}(e;\theta)/\pi(s;\theta) = 1 - \frac{k_1}{E(\theta) + k_2 v(1)} < 1.$$

Therefore, for θ sufficiently large, $\widetilde{\pi}(e;\theta) < \pi(s;\theta)$. From continuity and the Intermediate Value Theorem, it follows that there is at least one value of θ satisfying $\widetilde{\pi}(e;\theta) = \pi(s;\theta)$, the condition for equilibrium. Again, if there are multiple such θ, we select the largest one as the equilibrium value. From continuity, the inequality $\pi(s;\underline{\theta}) < \widetilde{\pi}(e;\underline{\theta})$ also holds in a neighbourhood of $\underline{\theta}$, proving the claim. □

Proof of Proposition 3. Claims (a) and (b) follow directly from (5), (6) and (22). To prove claim (c) note that when a SAFE is feasible, $\pi(n;\theta) < \pi(s;\theta)$ for all θ. From $\widetilde{\pi}(e;\theta_{es}) = \pi(s;\theta_{es})$, it follows that $\widetilde{\pi}(e;\theta_{es}) > \pi(n,\theta_{es})$. From this inequality and the single crossing property (8), it follows that $\theta_{es} < \theta_{en}$. □

Proof of Proposition 4. It follows from the discussion in the main text. □

Appendix 3

The Linear Probability model and the Probit model yield the same results as the Binary Logit model in the text: the probability of choosing non-priced financing is decreasing in the relative size of the issue, measured by the size of the round relative to the average size for other rounds at the same stage, and the stage of financing as we move from pre-seed financing, through seed financing, to series A financing.

non-priced financing instrument dummy	**coefficient**	**st. error**	t	**p**
log relative size	-.053	.017	-3.07	.002
pre-seed round dummy	.633	.039	16.21	.000
series A dummy	-.176	.059	-3.00	.003
constant	.253	.024	10.48	.000

Notes: Seed round dummy omitted; $n = 470$; R squared = 0.419.

Table 5: Linear Probability Estimates of the Choice of Financing Instrument.

non-priced financing instrument dummy	**coefficient**	**st. error**	**z**	**p>|z|**
log relative size	-.214	.069	-3.11	.002
pre-seed round dummy	2.00	.172	11.65	.000
series A dummy	-.729	.263	-2.77	.006
constant	-.699	.089	7.85	.000

Notes: Seed round dummy omitted; $n = 470$; pseudo R squared = 0.347.

Table 6: Probit Estimates of the Choice of Financing Instrument.

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Online Appendix to "Early-Stage Venture Financing:

Extending the Model to Allow for Dependence of Future Returns on Venture Type

In the text of this paper, we consider a model of venture financing that contains three periods. The type of the venture, θ, is private information in the period 1. The venture enters the first period with assets in place worth θ. The venture chooses an action in period 1 from: invest, financing with equity; invest, financing with a SAFE, and do not invest. The returns from investing depended on a variable a that is random as of period 1 even to the venture. In period 2, θ is revealed to the market, and a is realized. Investment in k_1 in period 1 serves only to create the option of investing in period 2. In period 3, ϵ and the gross value of the venture are realized. This value is $V = \theta + ak_2 + \epsilon$ if investment takes place in period 2. If the investment does not take place in period 2 (either because the investment of k_1 to provide the *option* to invest in period 2 was not undertaken in period 1 or because this option is not exercised in period 2) then the gross value is $V = \theta + \epsilon$. The first-best or complete contracting equilibrium would involve investment in period 1 for all types.

The model as formulated in the text assumes that only the value of assets in place is affected by the type, θ. Future investment returns do not depend on the type of venture. This allows for a relatively simple characterization of equilbria, but is not realistic. In this appendix, we extend the model to allow future investment returns to depend on θ, via the following:

$$V = \theta k_0 + ah(\theta)k_2 + \epsilon,$$

where the assets in place are denoted by k_0 rather than normalized to 1. The function $h(\theta)$ is strictly increasing and differentiable function and satisfies $h(\underline{\theta}) \geq 0$ and $\partial \ln (h(\theta)) / \partial \ln(\theta) < m$ for some $m < 1$. That is, the sensitivity of the new investment to type is less than the sensitivity of assets-in-place to type. The restriction on $h(\theta)$ implies that $\lim_{\theta \to \infty} h(\theta)/\theta = 0$.

We consider first the case in which only equity is available for financing, and then the case in which a feasible SAFE is a financing option. We find that the main results of the simple model are robust: when only equity financing is available, sufficiently high types might not invest, preferring to retain full ownership of existing assets. An interval of the lowest types always invest, financing with equity. When feasible SAFE financing is introduced, all types invest in period 1 (as is efficient): an interval of low types continues to invest with equity (unless the distribution of a is so high that a SAFE involves no debt-overhang for any type).

Types that did not invest when only equity is available now invest, financing with a SAFE. And some types financing with equity switch to financing with a SAFE.

The role of SAFEs is thus to bring into the market efficient investment that would otherwise be deterred by the lemons-market premium inherent in equity financing. A conceptual difference from the simple model is that the fair value of δ, the SAFE premium, now depends on the set of types adopting a SAFE. In the simple model, the risk to SAFE holders, and therefore the compensation to SAFE holders for the risk, are independent of θ.

We start by describing the period 2 equilibrium conditional upon a history of equity financing and the period 2 equilibrium conditional upon SAFE financing. We then move to period 1.

Period 2 equilibrium: The action in period 2 is whether to exercise the real option to invest in k_2, given the history of financing of k_1 in period 1. Investment in period 2, if undertaken, is financed with equity. The first-best investment decision is to invest if $ah(\theta)k_2 \geq k_2$, i.e., if $a \geq 1/h(\theta)$. Following financing of k_1 with a share λ_1 of equity in period 1, the entrepreneur will invest if this leads to an increase in expected return, i.e., if $(1-\lambda_1)[ah(\theta)k_2 - k_2] \geq 0$. This is equivalent to the first-best period 2 investment criterion, $a \geq 1/h(\theta)$.

Following a history of SAFE financing in period 1, the entrepreneur will invest in period 2 if the expected gross value of the investment in k_2 is enough to cover both the cost of investment, k_2, as well as the liability to SAFE holders: $ah(\theta)k_2 \geq k_2 + k_1/(1-\delta)$. That is, the entrepreneur will invest in period 2 if

$$a \geq \frac{1}{h(\theta)}\left(1 + \frac{k_1}{(1-\delta)k_2}\right).$$

Parallel to the simple model, the tighter criterion induced by the last term on the right-hand side captures the debt-overhang distortion of SAFE financing.

Period 1 equilibrium: Given a choice of equity financing, the option to invest in period 2 has a period-1 value of

$$E\left[\max\{0, ah(\theta)k_2 - k_2\}\right] = h(\theta)k_2 E\left[\max\left\{0, a - \frac{1}{h(\theta)}\right\}\right] = h(\theta)k_2 v\left(\frac{1}{h(\theta)}\right)$$

where $v(x)$ is the value of an option to invest in an asset with value distributed according to G, at an exercise price x. Similarly given a choice of SAFE financing, the option to invest in period 2 has a period 1 value

$$E\left[\max\left\{0, ah(\theta)k_2 - k_2 - \frac{k_1}{(1-\delta)}\right\}\right] = h(\theta)k_2 E\left[\max\left\{0, a - \frac{1}{h(\theta)}\left(1 + \frac{k_1}{(1-\delta)k_2}\right)\right\}\right]$$
$$= h(\theta)k_2 v\left(\frac{1}{h(\theta)}\left(1 + \frac{k_1}{(1-\delta)k_2}\right)\right).$$

This implies that the following are the (expected) payoffs to the entrepreneur from taking actions e, s, or n (i.e. financing with equity, with a SAFE, or not investing) in period 1. (We suppress the market pricing parameters λ_1 and δ in these payoffs):

$$\pi(n;\theta) = \theta k_0 \tag{24}$$

$$\pi(e;\theta) = (1-\lambda_1)\left[\theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\right)\right] \tag{25}$$

$$\pi(s;\theta) = \theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\left(1 + \frac{k_1}{(1-\delta)k_2}\right)\right). \tag{26}$$

We add as a benchmark the entrepreneur's payoff under a complete contract:

$$\pi^*(\theta) = \theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\right) - k_1$$

which exceeds θk_0 by assumption. (Investment in k_1 is first-best efficient for all types.) We denote by E, S and N the types choosing equity, a SAFE, or not investing.

Equity Financing Only: When only equity financing is available, the relevant payoffs are $\pi(n;\theta)$ and $\pi(e;\theta)$. In place of the standard single crossing property, that the difference between $\pi(e;\theta)$ and $\pi(n;\theta)$ be strictly decreasing in θ, we show in this extended model that $\pi(e;\theta)/\pi(n;\theta)$ is larger than one at the lowest type, $\underline{\theta}$, but converges to zero when the type θ is unboundedly large. This is enough for a simple characterization of the equilibrium when equity is chosen for low types and no investment for high types. From (24) and (25), this ratio is:

$$\frac{\pi(e;\theta)}{\pi(n;\theta)} = (1-\lambda_1)\left(1 + \frac{h(\theta)}{\theta}\frac{k_2}{k_0}v\left(\frac{1}{h(\theta)}\right)\right), \tag{27}$$

where $dv/d\theta > 0$. This ratio might be non-monotonic in θ. Observe, however, as $v(1/h(\theta))$ is bounded and $h(\theta)/\theta \to 0$ when $\theta \to \infty$, the limit of (27) as $\theta \to \infty$ is $1 - \lambda_1 < 1$. By continuity, as the function are continuous, this implies there exists $\overline{\theta}_{en}$ such that $\pi(n;\theta) > \pi(e;\theta)$ for every $\theta > \overline{\theta}_{en}$. That is, the set N is non empty, as high-type entrepreneurs never invest in a equity-only scenario.

Now λ_1 must meet the market constraint, which is

$$k_1 = \lambda_1 \int_E \left[\theta k_0 + h(\theta) k_2 v \left(\frac{1}{h(\theta)}\right)\right] dF(\theta|E) \tag{28}$$

and implies

$$\lambda_1 = \frac{k_1}{\int_E \left[\theta k_0 + h(\theta) k_2 v \left(\frac{1}{h(\theta)}\right)\right] dF(\theta|E)}.$$

Using $dv/d\theta > 0$, we have that

$$\lambda_1 \leq \frac{k_1}{\underline{\theta} k_0 + h(\underline{\theta}) k_2 v \left(\frac{1}{h(\underline{\theta})}\right)}. \tag{29}$$

From (25) and (29), we have $\pi(e;\underline{\theta}) \geq \pi^*(\underline{\theta})$. Since $k_2 h(\theta) v(1/h(\theta)) - k_1 > 0$ for all $\theta \geq \underline{\theta}$ by assumption (investment in period 1 is first-best efficient for all types), we have $\pi^*(\underline{\theta}) > \pi(n;\underline{\theta})$, implying $\pi(e;\underline{\theta}) > \pi(n;\underline{\theta})$. This means that when equity is the only financing option, there is always an interval of the lowest types that invests, financing with equity.

Introducing SAFE Financing: We begin the analysis of SAFE financing in this extended model by noting that, in contrast to the simple model, the condition for a *feasible* SAFE cannot defined *prior* to the determination of the equilibrium partition of types, $\{E, S, N\}$ and discount, δ. This is because in this extended model, the fair compensation to SAFE-holders depends on the set of types adopting a SAFE. The equilibrium is defined (as in the simple model) as set of actions for each type in the first period, i.e., a partition of types $\{E, S, N\}$; a set of investment decisions in the second period; and market prices λ_1,$\lambda_2(H)$ and δ that satisfy (i) optimality of actions given the set of market prices; and (ii) an expected return of 0 to holders of equity or SAFEs. (Here, H represents the history as of period 2.)

The conditions for equilibrium equity shares are analogous to the conditions in the simple model. The condition for an equilibrium discount, δ, is the following:

$$E\left[1 - G\left(\frac{1}{h(\theta)}\left(1 + \frac{k_1}{(1-\delta)k_2}\right)\right)\middle|\, \theta \in S\right] \frac{k_1}{(1-\delta)} = k_1. \tag{30}$$

The following properties of any equilibrium can be demonstrated (details are straightforward):

- Either S or N is empty in equilibrium. This is because if a SAFE is offered in period 1 (and adopted by some types) then it dominates not investing: as in the simple model, a SAFE contains the *option* of not investing in period 2 and paying nothing for the capital k_1, which would be the choice of not investing. In algebraic terms, we have

$$\pi(s;\theta) = \theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\left(1+\frac{k_1}{(1-\delta)k_2}\right)\right) > \theta k_0 = \pi(n;\theta).$$

- $\delta > 0$ in any equilibrium where S is non-empty unless the support of a is so high that the probability of debt overhang is zero, in which case financing is with a SAFE for all types and investment is first-best.
- As we have shown $\pi(e,\underline{\theta}) \geq \pi^*(\underline{\theta})$. Since $\delta > 0$, $\pi(s,\underline{\theta}) < \pi(e,\underline{\theta})$. By continuity, there is in any equilibrium an interval $[\underline{\theta},\tilde{\theta}] \in E$.
- The ratio $\pi(e;\theta)/\pi(s;\theta)$ is given by

$$\frac{(1-\lambda)[\theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\right)]}{\theta k_0 + h(\theta)k_2 v\left(\frac{1}{h(\theta)}\left(1+\frac{k_1}{(1-\delta)k_2}\right)\right)} = \frac{(1-\lambda)\left[k_0 + \frac{h(\theta)}{\theta}k_2 v\left(\frac{1}{h(\theta)}\right)\right]}{k_0 + \frac{h(\theta)}{\theta}k_2 v\left(\frac{1}{h(\theta)}\left(1+\frac{k_1}{(1-\delta)k_2}\right)\right)}.$$

  As $\theta \to \infty$, the exercise prices of both options in this expression converge to 0. Hence the ratio $\pi(e;\theta)/\pi(s;\theta)$ converges to $(1-\lambda) < 1$, given the equilibrium λ and δ. This implies that there is a type $\hat{\theta}$ beyond which all types choose a SAFE.

The last two points mean that in any equilibrium in which a SAFE appears, the lowest types choose equity financing and the highest types choose SAFE financing. We note that whether a SAFE appears in equilibrium depends on there being a partition $\{E, S\}$ in which (30) is satisfied and in which each type in E and S is making the optimal choice. The introduction of SAFEs as a financing option always leads to a positive measure of types switching from equity to SAFE financing. The result that sufficiently high types adopt N in the equity-only equilibrium shows that these types switch to SAFE financing with the introduction of SAFEs as a feasible option.

In summary, the main results of the model in the text are established for the more realistic model of this appendix. The role of SAFEs, is to bring into the market all types that do not invest when only equity is available.[34] SAFEs when they emerge in equilibrium as a choice for any type are always the optimal choice for the highest types. SAFEs always displace some equity financing, but the lowest types continue to finance with equity.

[34] We cannot rule out the possibility that the introduction of SAFEs lowers the cost of equity capital, λ, so much that some types switch to equity rather than a SAFE, when SAFEs are introduced as a feasible financing option.