Early-Stage Venture Financing

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Abstract

This paper develops a theory of the earliest stage of venture financing. Ventures choose between equity and "SAFE's" — a promise of shares as priced at a future equity round. When information asymmetries between entrepreneurs and the market shrink over time, higher quality types prefer SAFE's over equity because their types will be revealed before the determination of the price applicable to the conversion of their investment into shares. Equity financing involves adverse selection whereas SAFE financing involves favorable selection but also a moral hazard problem. We find empirical support for the theory in a data set of 500 financing rounds.

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1 Introduction

A corporation finances investment by selling claims on future returns to its assets. 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 kinds of claims, debt and equity.[1] A literature has also examined optimal financing by venture capitalists in middle and later stages of ventures.[2]

This paper addresses optimal financing at an even 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 and early-stage ventures typically financed by angel investors.[3]

A theory of early-stage financing must start with a basic observation. In early stage financing we observe only two kinds of claims: equity and a class of securities not used at any other stage: non-priced claims. These claims are for a specified dollar value of equity in a future round, as determined by the price of equity in that round. The simplest and an 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.[4]

Non-priced claims include the basic SAFE described above; SAFE's with caps on the valuation of the firm at which the SAFE is converted to shares; SAFE's with MFN clauses; and convertible notes. A convertible note also provides for equity at the future 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. SAFE's 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 SAFE's continue to grow as a popular instrument for early financing, being described in the practitioner literature as ubiquitous.

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

[2]See Cornelli and Yosha (2003), Gilson and Schizer (2003) and Schmidt (2003).

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

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

Each round of financing involves only one kind of security. The choice of financing in any round can therefore be described as a *binary choice between equity and non-priced claims* and, if non-priced financing is selected, a choice of which type of non-priced claim to issue (e.g., a basic SAFE, a SAFE with a cap, or a convertible note). We develop a theory of the binary choice between equity and non-priced claims, adopting the simplest form of the latter, the basic SAFE. Our contribution is an explanation of why non-priced financing might be preferred to equity in raising capital. We offer as well an initial empirical analysis of a set of about 500 rounds of financing, testing three of the implications of the theory.

Both the (simple) theory of why non-priced financing may be an optimal strategy and the empirical tests are robust to the consideration that non-priced instruments vary beyond the basic SAFE that we assume in the model. We demonstrate the robustness of our theory to the inclusion of valuation caps specifically in an online appendix, summarized in this paper. The empirical tests, which estimate the binary choice between equity and the aggregate of all types of non-priced financing, are robust because the implications tested depend only on the feature common to all non-priced claims: a reliance on future prices rather than current prices to translate investment amounts into shares.

Non-priced financing presents a puzzle. Why would investors and a corporation agree on a sale of equity where the terms of exchange (the number of shares awarded per dollar invested) depend on the price in a *future* market? Parties to any kind of economic transaction normally agree on a price as part of the transaction.

Our theory of why we observe non-priced financing begins with an assumption of asymmetric information between entrepreneurs and investors as to the value of a venture's assets in place. This assumption is at the heart of much of the theory of optimal financing (see especially Myers and Majluf 1984) and indeed the modern theory of the firm (e.g., Hart 1995, Gibbons 2005). When equity alone is available, the consequence of asymmetric information is that the market cost of capital must be identical for all firms issuing equity. A possible outcome is that only the worst types will choose to invest. Better types may prefer to retain full ownership over assets in place, forgoing investment rather than financing at a cost of capital reflecting the average quality of all ventures choosing to invest. This is the familiar lemons-market property of equity financing. Another possibility is that all types invest, but the best types pay a cost of capital greater than warranted given their quality.

When SAFE's are added as a financing option, better types prefer SAFE's to equity. And if some types had been excluded from the market by the lemons-market feature of equity financing, these types may be brought back into the market.

This result is driven by a *difference-in-difference* assumption: the difference *over time* in the difference in information between entrepreneurs and the market. Specifically, investors' ignorance is at its maximum when an entrepreneur is undertaking its first external financing: at this stage an investor has no history of pricing to rely on to infer value; the venture is typically pre-revenue so that there is no proof-of-market acceptance of its idea or product; and the financing may even precede proof-of-concept, i.e., proof that the product actually works as planned. On the other hand, at the future round of equity, e.g., the series A round, many of these informational requirements are likely to be resolved. By relying in the current financing on future prices, established when the asymmetry in information has been substantially resolved, the parties can minimize the lemons market problem of equity financing. The entrepreneurs of the best types, confident that their types will be revealed to some extent in the future, are willing to finance based on future share prices because these future share prices will be a more accurate reflection of their high value.

The equilibrium in our theory is thus a mix of *adverse selection* in that the worst ventures self-select into equity financing and *favorable selection* in that the best types self-select into financing with SAFE's. The model accords with the ubiquitous claim in the practitioner literature that SAFE's are used when it is difficult to determine the fair price of equity. For example, wefunder.com writes "SAFE's are used by early-stage startups because they delay the difficult task of figuring out how much a startup is worth."[5]

The benefits of SAFE financing come at a cost. A SAFE introduces a moral hazard problem parallel to a debt-overhang problem, related to the the liability created with a SAFE.[6] This liability is the obligation to provide to SAFE-holders a share of firm, a share of known dollar value, contingent upon the date and event of the future equity round. But this date and eventuality are endogenous choices of the entrepreneur. The liability effectively creates a fixed cost in the entrepreneur's decision to issue future equity and then invest: the investors of 100,000 in a SAFE in our earlier example have the right to the first 125,000 dollars raised in the future round of financing. This transfer to SAFE-holders is a pure cost for an entrepreneur, acting in its own interest, but zero cost to contractual parties as a whole. Ex ante this moral hazard cost is of course borne entirely by the entrepreneur if one assumes (as we do) that capital markets are perfectly competitive. The ex ante moral hazard cost, we show, is related to the difference in values of two real options on future investment: the

[5]https://help.wefunder.com/contracts/304785-safe-simple-agreement-for-future-equity#/investorundefined ; accessed February 17 2021.

[6]A debt overhang problem, first discussed by Myers (1977) is a particular moral hazard problem. Management, acting in the interest of equity-holders, will be discouraged from investment that benefits mainly existing debt holders. Management's inability to commit to acting on behalf of all security-holders harms equity-holders by raising the cost of debt. See also Diamond and He (2014).

entrepreneur's option to invest at the "efficient" exercise price and the option to invest at the exercise price distorted by the transfer to SAFE holders.[7] The optimal mix of SAFE and equity financing depends on the balance at the margin between the selection or *hidden-information benefit* and the moral hazard or *hidden-action cost* of SAFE financing.

The existing literature on financing and capital structure, almost entirely focused on seasoned corporations, is reviewed and synthesized in Myers (2003). Our adverse selection theory of equity financing is a simplification of the Myers and Majluf (1984) model via an application of Akerlof (1970). The favorable selection aspect of SAFE financing is parallel to the theory under which corporations decide whether to disclose information (Grossman (1981), Dye (1983), Verrecchia (1985). A venture in our model has the option of "disclosing" in sense of delaying the pricing of its equity via a SAFE. The role of the cost of disclosure in this literature is played in our model by the debt-overhang or moral hazard cost of SAFE's.

In an intriguing discussion that anticipates the ideas of our paper, Myers (2003) comments on a weakness he perceives in his own pecking order theory of capital structure, the Myers-Majluf model in particular:

> The pecking-order theory cannot explain why financing tactics are not developed to avoid the financing consequences of managers' superior information. For example, suppose that any special information available to the manager today will reach investors within the next year. Then the firm could issue 'deferred equity' securities. For example, the firm could issue debt with a face value of $1000, to be repaid after one year by newly issued shares worth $1000 at the year-one stock price. (Myers 2003, p.236)

Myers' suggested "deferred equity" securities are very similar to the SAFE instrument developed ten years after Myers' proposal. Contrary to Myers' discussion, however, we suggest this instrument would not generally be optimal for mature corporations, his focus. The share price one year into the future cannot be assumed to be a more reliable indicator of value that today's price because of the continual arrival of *new* information. As this new information flows to the market over the next year, it will reach managers first. The share price will continually be subject to asymmetric information. What is needed to make the argument work

[7] The practitioner literature discusses what we describe as the moral hazard cost of SAFE's. The following is an example: "there may be scenarios where the triggers aren't activated and the SAFE is not converted, leaving you with nothing. For example, if a company in which you invested makes enough money that it never again needs to raise capital, and it's not acquired by another company, then the conversion of the SAFE may never be triggered." (https://www.finra.org/investors/insights/safe-securities; accessed May 31 2021)

is an additional assumption, our difference-in-difference assumption: the rate of information flow to investors is greater over the next year than it is to managers, so that investors "catch up" to managers in their information. This assumption is most convincing for the case of very early venture financing engaged in their first external financing — for the reasons we have offered, this is where the asymmetry in information peaks — and it is for this reason, we suggest, that the SAFE instrument is becoming popular for early venture financing but not for mature corporations.

Our theory might seem to be an efficiency explanation of SAFE's. But we ask explicitly whether the availability of SAFE's as a financing option is always to the benefit of the entrepreneur. We find, paradoxically, that the option to finance with SAFE's — an option that the entrepreneur is free to turn down — may *harm* the entrepreneur on average (across types). This illustrates the principle that under asymmetric information an expansion of a contract set (in our context, to includes SAFE's rather than just equity) can leave agents worse off (Hermalin and Katz, 1993).

In section 2 of this paper, we develop the simplest model of the financing choice between a SAFE and equity, in which the asymmetric information is limited to the value of assets in place. We also outline two extensions to the theory, which are developed fully in an online appendix. One extension allows a more general asymmetric information structure. The second explicitly incorporates valuation caps, which are part of most SAFE contracts. At the end of section 2 we delineate the testable implications of the model. In section 3 we test three implications of the theory. Our data are a set of 500 rounds of venture financing from the Creative Destruction Lab, one of the largest platforms bringing together entrepreneurs and angel investors. Section 4 concludes the paper with a summary and discussion of an alternative theory of non-priced instruments.

2 Model: SAFE versus Equity financing

We offer a model in which entrepreneurs, facing an investment opportunity, choose between equity financing, financing with a SAFE or not investing at all. They will also face a new investment opportunity in the future. Ventures have assets-in-place that are of hidden quality, or "type". Investment by all types would be undertaken in a world with full information. The asymmetry in information is reduced — in fact resolved completely in our model — between the date of the first investment opportunity and the date at which the option to invest in the new opportunity is available.

In addition to our difference-in-differences assumption, we place a restriction on the class of assets for which information is (initially) asymmetric. We assume that these are the assets in place at the time of the initial financing, rather than the assets being acquired with new investments. One can think of the new investments as building capacity to satisfy near-term demand, i.e., pent-up demand for the product. Often startups can credibly inform investors that there is some pent-up demand for its product, by pointing to expressed enthusiasm or even commitments among prospective customers. The return on investment to satisfy pent-up demand is less uncertain to investors. The greater uncertainty is the potential for the product to generate a long-term demand, represented by the assets-in-place, k_0. The distinction between the relative certainty of pent-up demand and the uncertainty of long-run demand is one interpretation of Jeffrey Moore's (1991) thesis. Moore argues that the biggest challenge for startups is "crossing the chasm" between early adopters of the startup's technology and later adopters.

2.1 Assumptions

Consider a venture with both assets in place and opportunities for further investment. The entrepreneur owning the venture can invest in a project that requires k_1 in period 1 and in another project that requires k_2 in period 2. Ventures are of different *types*. The venture's type, θ, is chosen by nature and known to the entrepreneur from the outset. θ is distributed on an interval $[\underline{\theta}, \overline{\theta}]$, with a continuous c.d.f. $F(\theta)$. $F(\overline{\theta}) = 1$. The worst type is $\underline{\theta} > 0$, which will turn so that all types would be financed by equityunder full information. The value of initial assets is θk_0; the rate of return on investment k_1 is a; and the rate of return on investment in k_2 is b. At the end of period 2 a random component, ϵ, is realized.

The value of the venture, realized at the end of period 2, is therefore

$$V = \theta k_0 + (1 + a)I_1 + (1 + b)I_2 + \epsilon \tag{1}$$

where the investment amount $I_t \in \{0, k_t\}$ captures the entrepreneur's decision on whether or not to invest in the project available in period t. small

The entrepreneur, who is is risk-neutral, has no internal capital and must therefore rely entirely on external capital. The entrepreneur obtains financing (if it so chooses) from a perfectly competitive capital market. Interest rates are zero and investors are risk-neutral. This means that capital k_i can be raised at either stage at a rate that ensures that investors' expected gross return on the investment is k_i.

The flow of information is key. While θ is private information in period 1 but is revealed to the capital market in period 2, prior to the financing of any investment in k_2. The rate of return, a, on investment I_1 is known at the outset. The rate of return b on investment I_2 is unknown in period 1 to either the entrepreneur or the capital market, and has a continuous distribution $G(\cdot)$. This distribution satisfies $0 < G(0) < 1$ and has a connected and unbounded support. All parties know the distribution $G(b)$ in period 1 and the realization b at the beginning period 2. Thus at the time of the period 2 investment decision, θ and b are both common knowledge. (The realized b will affect the decision on whether to proceed with the investment in k_2.)

The investment in period 2, if undertaken, is financed by issuing equity, a claim to a share λ_2 of the gross return. The investment in period 1, on the other hand, can be financed with an equity claim to a share λ_1 of final return, or with a SAFE at a discount rate δ. A SAFE issued for x dollars in period 1, at a discount δ, entitles the holder to a share on equity as of period 2 worth $x/(1-\delta)$ – but only *if* the entrepreneur issues equity and invests in the second period. If the entrepreneur does not invest, then no share price has been established and the SAFE holders end up with a zero return.

Let $f_1 \in \{0, e, s\}$ be the entrepreneur's action in period 1, where these indicate respectively zero investment, investment in k_1 financed by equity, and investment in k_1 financed by a SAFE. Let the history of the game at the time of the entrepreneur's decision in period 2 be $h = \{f_1; \theta, b\}$ and the entrepreneur's action in period 2 (invest in k_2, financed with equity; or not) as a function of the history be $f_2(h) \in \{0, e\}$. The agent chooses a strategy $\{f_1, f_2(h)\}$ to maximize expected wealth.

The market parameters are endogenous in the model, but taken by the entrepreneur as given in their decisions. These parameters are, to summarize: the share of equity λ_1 that must be offered to the capital market to finance k_1 if the entrepreneur chooses to finance with equity; the discount δ that must be offered if k_1 is financed with a SAFE; and the share of equity $\lambda_2(h)$ that must be offered to finance k_2 in period 2.

The timing of the model is summarized in Figure 1. We invoke a concept of competitive equilibrium: (1) taking the market parameters $\{\lambda_1, \delta, \lambda_2(h)\}$ as given, the entrepreneur is sequentially rational in the decisions $\{f_1, f_2(h)\}$; and, (2) investor expectations are rational. Given the entrepreneur's strategy, the market parameters imply that the purchasers of each security receive an expected payoff equal to the price of the security.

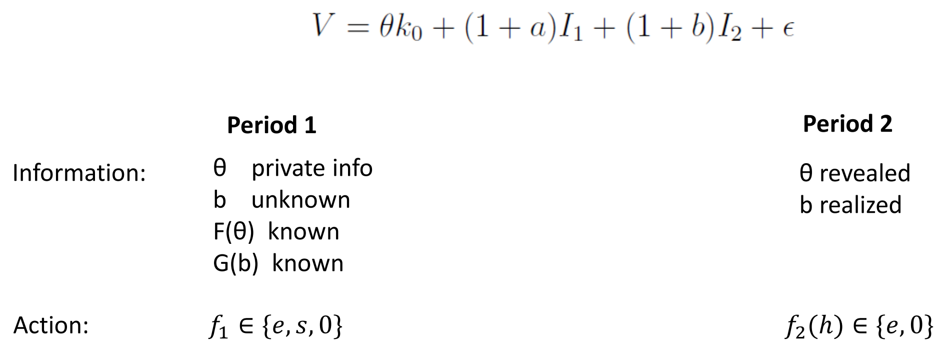

Figure 1: Timing in the Model

2.2 Discussion

This model captures the essential elements needed to set out more precisely our hypothesis that SAFE's can be explained by the reduction over time in the asymmetry of information between investors and entrepreneurs. There is a future round of equity in period 2 but the financing round in period 1 is our focus.

The motivation for one element of the model may be less obvious: the random (as of period 1) b. The randomness in the period 2 expected return, and its realization before the investment decision in period 2 allows a non-trivial *real option* to be impacted by the financing decision in period 1. As outlined in the introduction, the cost of financing with a SAFE is a distortion in the exercise of this real option.

To isolate on the incentives for SAFE's we abstract from a number of important features of venture financing. First, we assume a perfect capital market, whereas in reality early ventures face an upward-sloping supply of capital because a limited number of local angel investors are knowledgeable and interested in the venture. Second, the flow of information (towards a complete resolution of the asymmetry of information) is exogenous in the basic model; in reality the very purpose of the initial capital may be to fund the acquisition of information in the form of proof-of-concept or proof-of-market acceptance. Third, the first financing round, I_1, has no impact on the venture's ability to finance in the future. In reality, early financing is often essential for the venture to proceed.

In examining the trade-off between the hidden-information-related benefits of SAFE's against the hidden-action related benefits of equity (avoiding the debt-overhang or moral hazard problem) we abstract from a standard moral hazard problem associated with equity financing: sharing the residual claim leaves the entrepreneur with less incentive to undertake effort. Finally, the risk to SAFE holders in reality is a matter of degree – a delay in the issuance of the equity with a non-issue (and zero gross return) being one possibility. In our two-period model, the risk is 0 - 1; either the future equity is issued and the SAFE holders paid in full, or the equity is not issued and the SAFE holders return is zero.

Like most 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 SAFE's here) rather than deriving the form of financing as optimal form.[8] In a mechanism-design approach to the problem, the SAFE contract itself would be explained. The mechanism-design approach is inconsistent with the evidence that this instrument has been used only since late 2013, when it was first developed. Mechanism design theory cannot explain why SAFE's were used in 2014 but not in 2012.

2.3 Equilibrium

The entrepreneur's expected payoff at the outset of the game is a function of: type θ; actions $[f_1, f_2(h)]$; and market parameters (both current and future) $(\lambda_1, \delta, \lambda_2(h))$. We denote this payoff as $\pi_1(f_1, f_2(h); \theta; \lambda_1, \delta, \lambda_2(h))$. In period 2, the expected payoff is a function of action f_2; the entire history up to the decision point, h; and market parameters: $\pi_2(f_2; h; \lambda_1, \delta, \lambda_2(h))$.[9] We first characterize the equilibrium in period 2, when all parties have full information. We then derive payoffs for period 1 from the second period sub-game equilibria, for each type.

2.3.1 Period 2

Because there is full information in period 2, the equilibrium is straightforward. Define the first-best investment decision in period 2 as the decision that maximizes the combined wealth of the entrepreneur and the claim-holders (either equity-holders or SAFE holders). It is straightforward to show that this decision is: invest if $b \geq 0$. The following proposition provides the period 2 equilibrium actions and market parameters, given the history including $f_1 = 0$, e, or s. (Proofs are in Appendix 2.)

[8] The exceptions are Gale and Hellwig (1985) and the literature following.

[9] We will generally suppress market parameters in writing these payoff functions; and where we do include market parameters we will abuse notation by including only the parameters relevant for the action specified.

Proposition 1. *In period 2:*

(a) the equilibrium given a history h= $(0; \theta, b)$ *that includes no investment in period 1, is: first-best investment (invest if* $b \geq 0$*) and a cost of equity given by*

$$\lambda_2(0; \theta, b) = k_2/[\theta k_0 + (1+b)k_2]. \tag{2}$$

(b) the equilibrium given a history h= $(e; \theta, b)$ *that includes equity financing in period 1, is: first-best investment (invest if* $b \geq 0$*) and a cost of equity given by*

$$\lambda_2(e; \theta, b) = k_2/[\theta k_0 + (1+a)k_1 + (1+b)k_2]. \tag{3}$$

(c) the equilibrium given a history h= $(s; \theta, b)$ *that includes safe financing in period 1, involves a distorted investment decision (investment takes place in too few states). This decision is: invest if*

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

The cost of equity is identical to the case of a history of equity financing:

$$\lambda_2(s; \theta, b) = k_2/[\theta k_0 + (1+a)k_1 + (1+b)k_2]. \tag{4}$$

Following a history of no investment or equity financing in period 1, period 2 investments are efficient because there is full information and no externalities involved in the investment decision. Following a history of SAFE financing, the entrepreneur requires not merely a positive expected rate of return on investment in k_2, but a rate of return sufficient to cover the obligation to SAFE-holders, $k_1/(1-\delta)$. The investment decision is distorted because the additional investment required is simply a transfer to other claimants.

The distortion in investment incentives following the issuance of a SAFE is exactly parallel to the conventional *debt overhang* problem in investment in the presence of existing debt. In the standard debt-equity setting, given outstanding debt, equity-holders or management operating in the interests of equity-holders may have little interest in an investment that pays off mainly in states of the world where return accrues mainly to debt-holders. Such an investment benefits mainly debt-holders at the cost borne by all security holders. Investments that are efficient in terms of maximizing the combined benefit to all claimants are foregone. In our case, the additional fixed cost introduced by a SAFE will dissuade the entrepreneur from entering some efficient investments.

In anticipation of moving to period 1, we derive the ex ante cost, m, of the moral hazard distortion in the period 2 investment decision. Let $v(x) = \int_x^\infty (s - x) dG(s)$ denote the value of a call option on with exercise price x, on an asset whose value is distributed according to G. The efficient investment decision in period 2 is given by the exercise of an option on B at exercise price 0.[10] (That is, invest if $b \geq 0$.) With a SAFE outstanding, the exercise price on the real option is distorted; it is given by $x \equiv \frac{k_1}{(1-\delta)k_2} > 0$. The expected moral hazard cost, m, from issuing a SAFE, is defined to be the difference between the entrepreneur's expected wealth if a *complete contract* were possible, including the commitment to invest if $b \geq 0$, and the expected wealth under the SAFE contract. Equivalently, it is the difference in total expected wealth of the entrepreneur and the investors:

$$m(\delta) = k_2 \int_0^x b dG(b) \tag{5}$$

(We write m as a function to recognize its dependence upon the endogenous variable, δ.)

Lemma 1. *The expected moral hazard cost, $m(\delta)$, is given by the following:*

$$m(\delta) = k_2[v(0) - v(x)] \; - \; [1 - G(x)]\frac{k_1}{(1-\delta)} \tag{6}$$

This moral hazard cost is related by Lemma 1 to the difference in the values between the two real options, the option under efficient investing and the option with the distorted exercise price, given an outstanding SAFE used to finance k_1. The first term of equation (30) is the difference in the values of the two real options. In the distorted real option, however, the *collective* opportunity cost of exercising the distorted option is not its exercise price, $\frac{k_1}{(1-\delta)k_2}$. The exercise price, x, is merely a transfer to other parties to the financing contract, the investors. The second term of (6) accounts for this effect: this term equals the correction in opportunity costs, $k_2(x - 1)$ times the probability that the (distorted) real option is exercised, $1 - G(x)$. The ex ante moral hazard cost, which is independent of θ, will be borne entirely by the entrepreneur, because the supply of capital is perfectly elastic.

[10] Rather than thinking of an option with an exercise price of 0 one could formulate the real option in terms of the distribution of gross return, $B = 1 + b$, with an exercise price of 1.

2.3.2 Period 1

Overview:

Proposition 1 characterizes market parameters $\lambda_2(h)$ as well as the entrepreneur's investment decision given the history h. This leaves the following components of equilibrium to be characterized: the market parameters λ_1 and δ; and the partition of types θ into three sets – types that invest in k_1 and finance with equity; types that invest and finance with a SAFE; and types that do not invest. We label these sets $\{E, S, N\}$. The first-period equilibrium requirements are that each type chooses its action e, s or n optimally given $[\lambda_1, \delta, \lambda_2(h)]$; and that (λ_1, δ) be consistent with market rationality given the partition.

The key step in our characterization of an equilibrium in this model (as in any adverse selection model) is the demonstration of *single-crossing properties* (SCP's). The first SCP refers to the increasing preference, as θ increases, for not investing over financing with equity; this SCP guarantees that if both E and N are non-empty in equilibrium then $E < N$ where the partial order " $<$ " over sets is defined in the obvious way. The second SCP refers to to the increasing preference, as θ increases, for financing with a SAFE over financing with equity; this SCP guarantees that if both E and S are non-empty in equilibrium then $E < S$. Intuitively, the better the type, the greater the advantage to staying out of the market and retaining full ownership of both k_0 and the future real option to invest in I_2 rather than give up the market required share of equity, λ_1, to finance investment in k_1 (the first SCP). And the better the type, the more willing the venture is to incur the moral hazard cost of a SAFE in order to invest in k_1 at its full-information cost of capital.

To preview the structure of this section, we show (i) that any equilibrium must have E non-empty, because the lemons-market premium for the marginal type indifferent between equity and either a SAFE or not investing approaches 0 as this marginal type shrinks to zero. (The costs of choices other than equity do not approach zero.) In addition, (ii) the difference between the expected payoff from financing with a SAFE, $\pi_1(s;\theta)$, and the expected payoff from not investing, $\pi_1(0;\theta)$, is independent of θ. These two facts imply that any equilibrium must be one of three types: **all equity** (which will occur if (a) the return to investment I_1 is so high for every type that the lemons market premium does not deter any type from investing and financing with equity, and (b) the moral hazard problem with financing with SAFE's is too high for SAFE's to attract even the best type); **equity and SAFE's**, with $E < S$, covering the entire set of types; or **equity and not-investing**, with $E < N$, covering the entire set of types. That is, SAFE and not investing, i.e. S and N, do not appear together in any equilibrium partition of types.[11]

Given this necessary condition for the equilibrium partition, we demonstrate that an equilibrium exists and characterize the equilibrium constructively as follows. We first characterize the "fair" δ, i.e. the δ that compensates SAFE holders fairly – and the conditions under which such a δ exists. If a fair δ does not exist then the equilibrium partition is of the form $\{E, N\}$; and we complete the construction of the equilibrium by characterizing with simultaneous conditions the "fair" λ_1 and the marginal type θ_{e0}. If a fair δ does exist, then we compare $\pi_1(0;\theta)$ and $\pi_1(s;\theta)$ given the fair δ. (Recall that the difference between these payoffs is independent of θ.) If $\pi_1(s;\theta) < \pi_1(0;\theta)$ then the equilibrium is again the partition $\{E, N\}$ with θ_{e0} and λ_1 as constructed. If $\pi_1(s;\theta) \geq \pi_1(0;\theta)$, then the equilibrium partition is of the form $\{E, S\}$. We complete the characterization with a simultaneous determination of λ_1 and the marginal type θ_{es} or θ_{e0}

We begin by setting out the expected payoff functions in period 1.

Expected Payoffs:

We set out the period-1 expected payoffs to the entrepreneur from the three feasible actions, $\pi_1(f_1;\theta)$, for $f_1 \in (e, s, n)$, given the period 2 payoffs as derived above, and given market parameters. We also set out as a benchmark the payoffs that the entrepreneur would earn from a *complete contract* that would be established in a full-information world. The expected payoffs from 0 and e are:

$$\pi_1(0;\theta) = \theta k_0 + k_2 v(0) \tag{7}$$

$$\pi_1(e;\theta) = (1-\lambda_1)[\theta k_0 + (1+a)k_1 + k_2 v(0)] \tag{8}$$

The expected payoff from adopting a SAFE in period 1 reflects the higher bar for future investing in k_2, that b exceed $k_1/(1-\delta)k_2$ rather than 0. This higher bar translates into a real option with a higher exercise price and hence lower value. This expected payoff is

$$\pi_1(s;\theta) = \theta k_0 + (1+a)k_1 + k_2 v\left(\frac{k_1}{k_2(1-\delta)}\right) \tag{9}$$

The first two terms in the payoff (9) capture the fact that the entrepreneur has the choice of not exercising the real option to invest in k_2 — a choice that will result in capturing the full

[11] This prediction depends on our assumption that only the assets-in-place are subject to asymmetric information in period 1. When we relax the assumption in an extended model, summarized below and analyzed in an online appendix, we cannot rule out an equilibrium with $E < N < S$, with the best types selecting into SAFE's; the worst types into equity; and the middle types into not investing.

gross returns from assets in place, k_0 as well as k_1. The gross returns accrue entirely to the entrepreneur because if the entrepreneur stands pat in period 2 and does *not* raise additional equity, the SAFE holders will have paid for the period 1 investment with zero compensation. In other words, *a SAFE presents the entrepreneur with an option in period 2 to have obtained period 1 capital at a zero cost.* The entrepreneur, beyond this, has the option of investing in k_2.

In addition to these payoffs from first-period actions, we have as a benchmark the *first-best* expected payoff π^*_θ:

$$\pi^*_\theta = \theta k_0 + ak_1 + k_2 v\left(0\right) \tag{10}$$

From (9) and (10) the loss from financing with a SAFE contract instead of the first-best contract yields an alternative formulation of the expected moral hazard cost, $m(\delta)$:

$$m(\delta) \equiv \pi^*_\theta - \pi_1(s;\theta) = k_2\left[v(0) - v\left(\frac{k_1}{(1-\delta)k_2}\right)\right] - k_1 \tag{11}$$

This is consistent with Lemma 1 because $k_1 = [1 - G(x)]\frac{k_1}{(1-\delta)}$ from the requirement that investors in a SAFE achieve an expected return equal to k_1. As noted, the entrepreneur bears the entire moral hazard cost from the inability to write a first-best contract that would commit them to the efficient exercise of the real option.[12]

Single-Crossing Properties:

Single-crossing properties involve the comparison of the relative value of actions as θ varies. As an initial matter, note that from (7) and (9)

$$\pi_1(s;\theta) - \pi_1(0;\theta) = (1+a)k_1 - k_2\left[v(0) - v\left(\frac{k_1}{k_2(1-\delta)}\right)\right] \tag{12}$$

$$= ak_1 - m(\delta)$$

This difference is independent of θ. Therefore either N or S is empty in equilibrium (except in the coincidental event that (12) equals 0). As (12) reveals, the entrepreneur prefers financing with s to not investing if the gain from investing, ak_1, exceeds the expected moral hazard cost, $m(\delta)$, incurred with SAFE financing.

The two critical SCP's are $\frac{\partial}{\partial\theta}[\pi_1(0;\theta) - \pi_1(e;\theta)] > 0$ and $\frac{\partial}{\partial\theta}[\pi_1(s;\theta) - \pi_1(e;\theta)] > 0$. From the payoff functions (7), (8), (9) we have

[12]Note that m is independent of θ because of our assumption that only assets-in-place are subject to hidden information.

Lemma 2. *(Single Crossing Properties)*

$$\frac{\partial}{\partial\theta}[\pi_1(0;\theta) - \pi_1(e;\theta)] = \lambda_1 k_0 > 0 \tag{13}$$

$$\frac{\partial}{\partial\theta}[\pi_1(s;\theta) - \pi_1(e;\theta)] = \lambda_1 k_0 > 0 \tag{14}$$

The following proposition is immediate.

Proposition 2. *There are only three possible kinds of equilibrium partitions in period 1: $\{E, N\}$ with $E < N$; $\{E,S\}$ with $E < S$; or just E.*

Equilibrium when only equity is available as a financing instrument:

We first characterize the equilibrium marginal type θ_{e0} and the λ_1 under the supposition that only equity is available as a financing instrument. We then extend this to illustrate the impact of the option to finance with a SAFE. With the options of equity financing or no investment the equilibrium (λ_1, θ_{e0}) is determined by two conditions, an indifference condition for the marginal type θ_{e0}; and a fair pricing condition.

The marginal type satisfies $\pi_1(0;\theta_{e0}) = \pi_1(e;\theta_{e0})$ for an interior solution. For this type, the benefit of the gross return from investing, $(1-\lambda_1)(1+a)k_1$, exactly offsets the cost of giving up a share λ_1 of ownership of existing assets (including the real option on period 2 investment):

$$(1-\lambda_1)(1+a)k_1 - \lambda_1\left[\theta_{e0}k_0 + k_2 v(0)\right] = 0 \tag{15}$$

Denoting the solution in λ_1 to (15) as $\Lambda_e^{\text{marg}}(\theta_{e0})$, we have

$$\Lambda_e^{\text{marg}}(\theta_{e0}) = \frac{(1+a)k_1}{(1+a)k_1 + \theta_{e0}k_0 + k_2 v(0)} \tag{16}$$

The fair pricing condition guarantees that investors receive a fair share of equity to compensate for their investment of k_1:

$$\Lambda_e^{\text{fp}}(\theta_{e0}) = \frac{k_1}{(1+a)k_1 + k_2 v(0) + k_0 E[\theta|\theta \in [0, \theta_{e0}]]} \tag{17}$$

The equilibrium share of new equity-holders in the equity-only cases is given by equating

$\mathit{\Lambda}^{\text{marg}}(\theta_{e0})$ and $\Lambda^{\text{fp}}(\theta_{e0})$:

$$\mathit{\Lambda}_e^{\text{marg}}(\theta_{e0}) = \frac{(1+a)k_1}{(1+a)k_1 + \theta_{e0}k_0 + k_2 v(0)} = \frac{k_1}{(1+a)k_1 + k_2 v(0) + k_0 E[\theta|\theta \in [0, \theta_{e0}]]} = \Lambda_e^{\text{fp}}(\theta_{e0})$$

The two relationships $\mathit{\Lambda}_e^{\text{marg}}(\theta_{e0})$ and $\Lambda_e^{\text{fp}}(\theta_{e0})$ are depicted in (λ_1, θ_{e0}) space in Figure 2, for the particular case of a unique interior equilibrium.

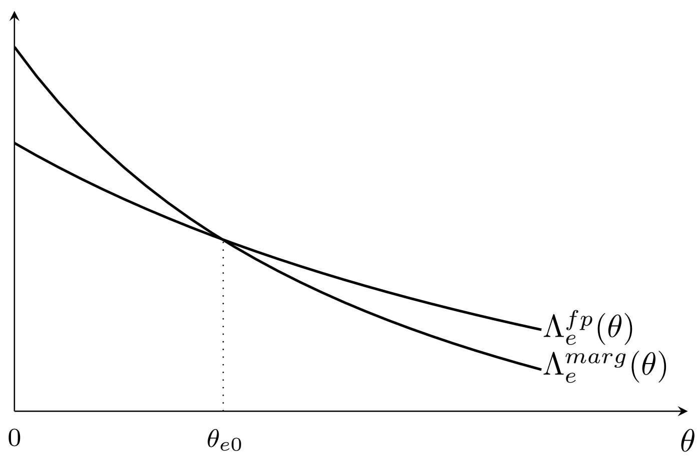

Figure 2: Equilibrium Share of Equity.

The following lemma sets out properties of $\mathit{\Lambda}_e^{\text{marg}}(\theta_{e0})$ and $\mathit{\Lambda}_e^{\text{fp}}(\theta_{e0})$ that allow us to establish equilibrium possibilities. The lemma is obvious from inspection of (16) and (17).

Lemma 3. *The functions $\mathit{\Lambda}_e^{marg}(\theta_{e0})$ and $\mathit{\Lambda}_e^{fp}(\theta_{e0})$ are both well-defined. Both functions are positive, differentiable and decreasing. Furthermore, $\mathit{\Lambda}_e^{marg}(0) > \Lambda_e^{fp}(0)$.*

Given the lemma, the equilibrium or equilibria fall into one of three classes. The first equilibrium possibility arises when $\mathit{\Lambda}_e^{\text{marg}}(\theta) > \Lambda_e^{\text{fp}}(\theta)$ for all θ. This simply means that the net value of the project is so high and the distribution of types so tight that the lemons market problem does not deter even the strongest type from investing. The second case is as depicted in Figure 2, a unique equilibrium. But there is no reason that the curves intersect only once. The third case consists of multiple intersections and therefore multiple equilibria.[13] Because it is convenient to discuss "the" equilibrium in terms of comparative statics and the impact of introducing an additional financing instrument, we select as the equilibrium the one with the largest set of types issuing equity and lowest λ. This is the

[13]We ignore the ("zero measure") possibility of a tangency between the two curves at their highest common point.

most efficient among the equilibria; any other equilibrium is Pareto dominated and therefore would involve a coordination failure. The lowest-λ equilibrium is also the only equilibrium that would survive a switch to a game-theoretic equilibrium concept in which types were price setters, rather than as price takers. We retain the concept of competitive equilibrium, but use the efficient-contracting argument to select the most efficient among (possibly) multiple equilibria.[14] The characterization of the equilibrium follows from lemma 3:

Proposition 3. *Suppose that only equity financing is available. Sufficiently low types are always financed with equity. When $\overline{\theta}$ is sufficiently high ceteris paribus, an equilibrium in (λ_1, θ_{e0}) exists with $\theta \leq \theta_{e0}$ financing k_1 with equity and $\theta \geq \theta_{e0}$ declining to invest.*

Thus when only equity financing is available, we have the standard Gresham's law effect of adverse selection. Low-quality ventures drive high-quality ventures from the market. Higher quality ventures would prefer to forgo investment rather than share in the value of their existing assets.

Equilibrium when both equity and SAFE's are available as financing instruments:

Proposition 2 shows that there are only three possible equilibrium partitions, $\{E\}$, $\{E, N\}$ or $\{E, S\}$. To show that there is always an equilibrium, we start by considering the condition determining the fair SAFE premium, δ, and then use this to compare the profits from the strategies s and 0, thus eliminating one of these strategies. If the strategy 0 dominates s, then the determination of equilibrium as $\{E\}$ or $\{E, N\}$ is as characterized in Proposition 3; if s dominates 0 an analogous derivation follows.

The fair value of δ is determined by equating the payment by SAFE-holders with their expected return. The payment by SAFE-holders is k_1. SAFE-holders receive an amount of equity worth $k_1/(1-\delta)$ if the security pays off, i.e., if the real option in period 2 is exercised, and 0 otherwise. The probability of this exercise is $1 - G(k/(1-\delta)k_2)$. Equating k_1 and $[1 - G(k_1/(1-\delta)k_2)] \cdot k_1/(1-\delta)$ yields the following equation:

$$G\left(\frac{k_1}{(1-\delta)k_2}\right) - \delta = 0 \tag{18}$$

Note that at $\delta = 0$, the left-hand side of (18) is $G(k_1/k_2) > 0$. If the left hand side remains positive at all $\delta \in (0, 1)$ there is no solution to (18) in $(0, 1)$. (A degenerate solution exists at $\delta = 1$,which involves no investment and a full refund to SAFE-holders of their investment.)

[14] This is a standard argument in adverse selection models. See MasColell, Whinston and Green (1995), chapter 14.

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 b in the moral hazard region, $(0, k_1/(1-\delta)k_2)$, 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 fair discount, then financing with a SAFE cannot be profitable, let alone more profitable than financing with equity. The equity-only equilibrium obtains.

Because the moral hazard increases in δ, another possibility is that there are multiple solutions to (18). For example, if $\hat{\hat{\delta}}$ is a fair compensation to SAFE-holders for the moral hazard problem associated with δ, doubling the compensation to $2\hat{\hat{\delta}}$ might also be fair because the expected risk to SAFE-holders of not getting paid might also double. As in the previous section of the paper we adopt as an equilibrium selection mechanism the most efficient contract. This is the smallest δ solving (18). Let this value of δ (where it exists), be denoted by δ^*.

Next, we compare profits from not investing and financing with a SAFE, given a discount δ^*. The inequality (12) implies that if $ak_1 < m(\delta^*)$, then the equilibrium is either $\{E, N\}$ or the corner solution $\{E\}$.

The equilibrium parameters to be determined, under the alternative condition that $ak_1 \geq m(\delta^*)$, when the partition is of the form $\{E, S\}$, are the marginal type θ_{es} and the fair return on equity. Similar to the equity-only case, these two parameters are determined simultaneously by a marginal θ_{es} condition and a fair pricing condition. From (8) and (9), the marginal θ_{es} condition is

$$(1-\lambda_1)[\theta k_0 + (1+a)k_1 + k_2 v(0)] = \theta k_0 + (1+a)k_1 + k_2 v\left(\frac{k_1}{k_2(1-\delta^*)}\right)$$

which, similar to (16), we write (using the same notation) as

$$\Lambda^{\text{marg}}(\theta_{es}) = \frac{k_2[v(0) - v(\frac{k_1}{k_2(1-\delta^*)})]}{\theta_{es}k_0 + (1+a)k_1 + k_2 v(0)} \tag{19}$$

The fair pricing condition, parallel to (17), is

$$\Lambda^{\text{fp}}(\theta_{es}) = \frac{k_1}{(1+a)k_1 + k_2 v(0) + k_0 E[\theta | \theta \in [0, \theta_{es}]]} \tag{20}$$

An interior θ_{es} satisfying $\Lambda^{\text{marg}}(\theta_{es}) = \Lambda^{\text{fp}}(\theta_{es})$ is an equilibrium.

At $\theta_{es} = 0$,the denominators of the right hand sides of (19) and (20) are equal. The difference between the numerators is $k_2[v(0) - v\left(\frac{k_1}{(1-\delta^*)k_2}\right)] - k_1 = m(\delta^*) > 0$. Thus, at $\theta_{es} = 0, \Lambda^{\text{marg}}(\theta_{es}) > \Lambda^{\text{fp}}(\theta_{es})$. Both functions are decreasing in θ_{es}. If $\Lambda^{\text{marg}}(\theta_{es}) > \Lambda^{\text{fp}}(\theta_{es})$ for all $\theta_{es} \in (0, \overline{\theta}]$ then S does not appear in the equilibrium condition, and the equilibrium partition is as derived as above when equity is the only equilibrium. (Recall that this always includes E at the lowest types.) When the functions intersect at least once, there are multiple equilibria; we select the lowest intersection as the equilibrium since it Pareto dominates the others.

In summary,

Proposition 4. *Under the assumptions set out in section 2.1, an equilibrium exists. The equilibrium partition always includes E for the lowest types. Defining δ^* as the smallest solution to (18), including the degenerate solution $\delta = 1$. If $ak_1 < m(\delta^*)$ or if $\delta^* = 1$, then the equilibrium partition is: $\{E\}$ if $\Lambda_e^{marg}(\theta) > \lambda_e^{fp}(\theta)$ for all θ and {E,N} if not. If $\delta^* < 1$ and if $ak_1 \geq m(\delta^*)$ then: the equilibrium partition is: $\{E\}$ if $\Lambda_s^{marg}(\theta) > \lambda_s^{fp}(\theta)$ for all θ and {E,S} if not.*

This proposition captures our basic argument for the role of SAFE financing. High types that would not be financed when only equity is available as a financing instrument are brought back into the market when SAFE's are introduced — providing that the inherent moral hazard cost of SAFE's is small enough and the value to investing large enough that a SAFE dominates not investing at all.

In fact, as the next proposition shows, the role of SAFE's extends beyond financing those ventures that would be deterred from investing when only equity is available. Some equity-financed ventures switch to SAFE's when the new instrument is introduced:

Proposition 5. *Comparing the marginal types in the equity-only case, and in any equilibrium involving SAFE's, we have $\theta_{es} \leq \theta_{e0}$; types in $(\theta_{es}, \theta_{e0})$ are switch from equity financing to SAFE financing when the latter becomes available.*

The proof of this proposition follows directly from the characterizations of the marginal types, (15) and (20); the fact that when a SAFE is part of the equilibrium $\pi(0, \theta) \leq \pi(s, \theta)$; and (7) and (9).

2.3.3 Efficiency of the Equilibrium with SAFE Financing

We have emphasized the role of SAFE's in inducing investment of those ventures deterred by the adverse selection problem with equity financing. This is an efficiency effect. But does this mean that the availability of SAFE financing *always* makes the entrepreneur better off? (We are evaluating the entrepreneur's welfare as the expected payoff across types, i.e. the entrepreneur's expected payoff behind the veil of ignorance, prior to Nature's choice of θ.) It might seem that the option to use an additional instrument cannot make the entrepreneur worse off.

It is an immediate corollary of Proposition 5, however, that the entrepreneur can be *harmed* by the availability of SAFE financing as an option. The investment decisions of all types in the interval $(\theta_{es}, \theta_{e0})$ are first-best efficient in the equity-only case, since for these types investment takes place in both periods 1 and 2. But when SAFE's are a financing option, these types invest in period 1, as is efficient, but their investment decisions in period 2 are distorted by moral hazard or debt-overhang problem inherent in SAFE financing. There is a trade-off, involved in the efficiency impact of the availability of SAFE financing: expected surplus is increased by SAFE financing for types in $(\theta_{e0},\overline{\theta})$ since these types are not financed in period 1 with equity alone; but for types in $(\theta_{es}, \theta_{e0})$ investment in period 2 is efficient (and undertaken if equity is the only option) but not undertaken when SAFE financing available and when b is realized in the interval $(1, \frac{k_1}{(1-\delta)k_2})$.

Consider the case, for example, where the best type, $\overline{\theta}$,is just indifferent between investing with equity and not investing, i.e. $\theta_{e0} =\overline{\theta}$. Investment in both periods is first best. When SAFE's are introduced as an option, the very best types, in $(\theta_{es},\overline{\theta})$, will switch to SAFE's – thus introducing the distortion in second period investment decision and reducing efficiency. Since the capital market is perfectly competitive, the burden of reduced total efficiency, or total wealth, falls entirely on the entrepreneur.

To set out the efficiency effects of SAFE's more generally, let $W_{es} = \int_0^{\overline{\theta}} \theta k_0 dF(\theta) + ak_1 + v(0)k_2 - m[1 - F(\theta_{es})]$ be the expected profit across types when both equity and SAFE's are available as financing instruments. Let $W_e = \int_0^{\overline{\theta}} \theta k_0 dF(\theta) + ak_1 F(\theta_{e0}) + v(0)k_2$ be the expected profit across types when only equity is available as an option.

The impact of the availability of SAFE's (as well as equity) on expected profit across types (i.e., the expected profit of the entrepreneur prior to Nature's choice of type at the beginning of the model) is

$$W_{es} - W_e = ak_1[1 - F(\theta_{e0})] - m[1 - F(\theta_{es})]$$

When SAFE's are available all types invest, which has a positive effect on welfare — but the types above θ_{es} incur the moral hazard cost m, which has a negative effect.

The exogenous parameters in the model are $\{a, G(b), F(\theta); k_0, k_1, k_2\}$. Define $\overline{a}$ as the value that renders the highest type, $\overline{\theta}$, indifferent between financing with equity (at a cost of capital distorted by the lemons-market premium) and not investing at all. The parameter $\overline{a}$ is defined by $\pi_1(e;\overline{\theta}) = \pi_1(0,\overline{\theta})$,i.e.

$$[1 - \Lambda_2(\overline{\theta})][\overline{\theta}k_0 + (1 + \overline{a})k_1 + k_2v(0)] = \overline{\theta}k_0 + k_2v(0).$$

Proposition 6. *Given the values of all other exogenous parameters, there is an interval* $(\overline{a} - d, \overline{a})$ *of the parameter* a *for which any equilibrium involving a SAFE involves lower expected wealth for the agent (across types) than the equity-only equilibrium.*

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, to its disadvantage ex ante. In our context, continuing with the example of $\theta_{e0} = \overline{\theta}$, the agent would be better off if it could commit, prior to Nature choosing its type at the beginning of the game, to financing with equity. But it cannot. 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 m. The inability of the best types to commit not to finance with equity leads to a higher cost of capital from the inference drawn by the capital market that these types are not in the highest interval. The result is a reduction in average wealth across types. Paradoxically, the addition of an financing option can make entrepreneurs worse off.

2.4 Extensions:

2.4.1 An Alternative Assumption on Informational Asymmetry

The model as developed adopts a simple assumption on informational asymmetry: assets in place, but not the returns to new investment, are subject to an informational asymmetry. The equilibrium under this assumption captures the role of SAFE's in the simplest way: if the inherent debt-overhang cost of a SAFE is low enough, it completely solves the lemons-market problem of equity financing. All types worth the investment are then financed. Because the profits from not investing and financing with a SAFE are independent of θ, SAFE financing and not investing never appear together in an equilibrium partition.

In an online appendix, we develop an extension: allowing the expected return on future investment, I_2, to depend on a firm's type as well. This is a natural assumption because future options to invest are part of assets-in-place, with values that are unknown to investors. We place (1) with the following value function, but retain the other assumptions of the model:

$$V = \theta k_0 + (1 + a)I_1 + (1 + b)\theta I_2 + \epsilon \tag{21}$$

The equilibrium in the new formulation is complicated by the fact that the single-crossing properties involving SAFE's are no longer satisfied universally. This rules out a simple characterization of the entire equilibrium partition. But the basic economic prediction of our theory is preserved: SAFE's emerge as the financing choice of best types when the inherent cost of SAFE's (the moral hazard problem) is small and the inherent cost of equity (the adverse selection effect) is large. That is, there is an interval of the highest types that issue SAFE's and an interval of the lowest types that issue equity.

2.4.2 Introducing Caps on the Valuation Basis for SAFE conversion

Our theory to this point considers basic SAFE's characterized by a single parameter, the discount rate δ. This is the right starting point to understand the binary choice between equity and SAFE's, in particular to set out the role of SAFE's as attracting better ventures away from equity financing - and possibly to bring into the market venture investments that would not be funded if only equity were available. The assumption allows a focus on the defining feature of SAFE's: the reliance on future prices for determining the allocation of shares.

In the online appendix, we extend the model in a limited way to include the most important parameter after the discount rate: a valuation cap. This takes us from an adverse selection model to a signaling model. For tractability of this more complex model, we assume only two types of entrepreneurs in this extension (a common assumption in signaling theory). With these more complex contracts, the predicted role of SAFE's is preserved: when SAFE's become available and are of low moral-hazard cost, they displace equity financing for the higher type. For the lower type, equity always dominates a SAFE.

To better understand the nature of the cap in the SAFE contract, it is helpful to note the equivalence between three interpretations of the cap in a SAFE contract (δ, c):

1. A cap provides a maximum valuation basis for the firm in converting the SAFE to shares. We illustrate this by extending the numerical example in our introduction. An investor in a SAFE provides \$100,000 in a SAFE with a discount of 20 percent. Without a discount this means that the investor is provided with \$125,000 worth of stock as valued at the issue price of shares, the first time that the venture issues shares. If the valuation of the firm in the equity round turns out to be 12.5 million dollars, for example, this is a 1

percent share of the firm; if the valuation is 6.25 million dollars, the investor is awarded 2 percent of the firm. Suppose now that there is a valuation cap of 12.5 million dollars. With values up to 12.5 million dollars, the payoff to the investor remains the same as in a SAFE contract without a cap. But as the valuation ranges higher than 12.5 million, the investor's share of the venture remains at 1 percent. The investor's payoff, in millions of dollars, is $.0125/min(v, c)$ where c is the cap.

In the notation of our model, with v being the realized value of the venture in period 2, the investor's payoff from a capped SAFE is

$$v \cdot \frac{k_1/(1-\delta)}{\min[v.c]} \tag{22}$$

2. The cap is equivalent to adding a call option, with a payoff contingent on conversion of the SAFE. The value of the SAFE claim, from (22), can be written as

$$v \cdot \frac{k_1/(1-\delta)}{\min[v.c]} = v \cdot \max\left\{\frac{k_1/(1-\delta)}{v}, \frac{k_1/(1-\delta)}{c}\right\} \tag{23}$$

$$= k_1/(1-\delta) + \max\left\{0, v \cdot \frac{k_1/(1-\delta)}{c} - k_1/(1-\delta)\right\}$$

The final term in (23) is the value of a call option for a share $k_1/[c(1-\delta)]$ of the firm at an exercise price of $k_1/(1-\delta)$. This is what the cap adds to value of the SAFE without a cap, which is $k_1/(1-\delta)$. (The payoff to the call option is of course contingent on the entrepreneur's decision to issue equity.)

3. The cap is also equivalent to awarding to the investor a share $k_1/[c(1-\delta)]$ of the firm with the 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. This is just invoking put-call parity.[15] To see this algebraically, note that

$$k_1/(1-\delta)+max\{0, v\cdot\frac{k_1/(1-\delta)}{c}-k_1/(1-\delta)\} = v\cdot\frac{k_1/(1-\delta)}{c}+max\{0, k_1/(1-\delta)-v\cdot\frac{k_1/(1-\delta)}{c}\}.$$

The last term is the value of the put option.

All of these interpretations describe the payoff depicted in Fig 3. Given a fixed θ, the investor contingent payoff is a function of realized b.

[15] Put-call parity in this context (with zero interest rates) means that conditional upon equity being issued at a future date, and all payments being made in future shares: (1) the payment of $k_1/(1-\delta)$ plus the call option to purchase a share $k_1/[(1-\delta)c]$ at an exercise price of $k_1/(1-\delta)$ is equivalent to (2) the share plus a put option at the same exercise price.

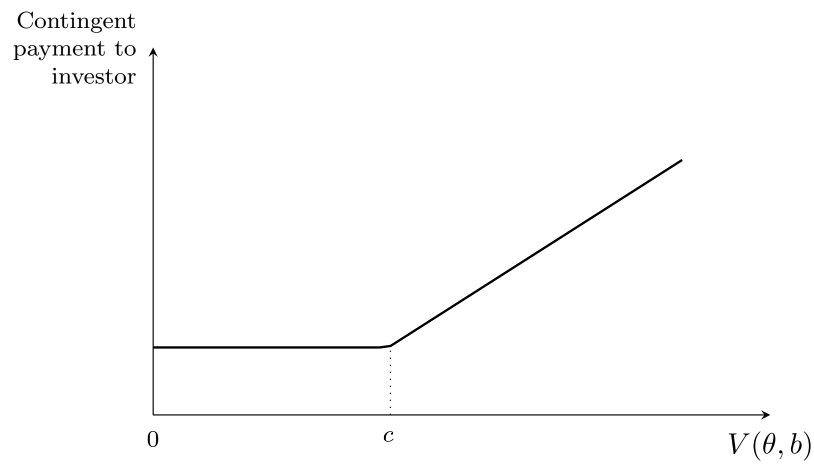

Figure 3: Payment to SAFE investor, depending on realized $V(\theta, b)$, contingent on entrepreneur's period 2 decision to issue equity.

Extending the contract in our model to include caps means increasing the dimension of contractual parameters from 1 to 2, (δ, c). This increase in dimensions takes us from the *adverse selection* class of theories to a more complex *signaling* theory.[16] In the equilibrium of this model as analyzed in the appendix, higher quality entrepreneurs may finance with equity or adopt a SAFE (with a cap) while lower quality entrepreneurs always finance with equity. The SAFE serves to signal entrepreneur quality, at a signaling cost that includes the moral hazard cost that we have examined. The cap does not play a direct role in signaling the type of the venture.[17] because issuing equity is a dominant strategy for the low type any SAFE contract would signal a high type. The cap serves to minimize the signaling cost of adopting a SAFE, which is the moral hazard cost of SAFE's as analyzed in our basic model.

2.5 Testable Implications

We have developed a theory of the binary choice between SAFE's and equity in the financing of early-stage ventures. From a high-level perspective, the theory offers three simple testable implications, two regarding the relative frequency, or ex ante probability of each choice, and one implication on the realized history of financing choices across different stages of financing.

[16]The *signaling* theory approach is based on an assumption that the entrepreneur sets the contract parameters, letting the market respond. An alternative assumption — that a large angel financier or platform sets the contract parameters. letting the set of entrepreneur types respond, would lead to a *screening* model.

[17]This is perhaps not surprising, because a cap is *more* costly for the higher type, for which it is more likely to be binding. For any contractual parameter to be a signal of quality, it must be less costly for higher types.

Exogenous changes in the Asymmetry of Information: Financing Across Stages

The first implication is related to exogenous changes in the degree of the asymmetry of information between investors and the entrepreneur. 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 observed. This means that, on average, as the amount of investors' information increases to the point where they know as much as the entrepreneur, the fraction of ventures financed with non-priced instruments falls. Our fundamental assumption is that the asymmetry in information is maximized at the point of the first external financing, and declines as time passes. 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.[18] [19]

Endogenous changes in the Asymmetry of Information: Variation in the Size of Round

We have assumed that in period 1 the entrepreneur accepts the informational asymmetry

[18]The reduction in asymmetry of information to zero is predicted to reduce the fraction of ventures financed with non-priced instruments *on average*. The implication is weaker than we would like: we have not been able to prove monotonicity of the fraction financed with equity in the quality of information available to equity-holders.

[19]To elaborate on the stages of financing referred to:

- **pre-seed financing:** very early financing financing, in amounts too small to be considered seed capital (e.g.20 thousand dollars). This is financing that helps the venture to get off the ground.
- **seed financing:** the first substantial investment round of financing.. 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 even initial revenue, financing takes place in much larger amounts develop the business. This almost invariably involves venture capitalists as investors and is most often the first financing obtained from V.C.'s. The term "series A" comes from the most frequent form of this financing, preferred equity. The first round of preferred equity financing is referred to as "series A," and second round as "series B," and so on.
- **Series B financing**: The second round of substantial VC financing.
- **Bridge financing:** discussed below, refers to small rounds of financing to carry the venture to the next larger round - often planned for a fairly specific time period.

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 as a strong investment. Consider as one example that informing investors takes the (extreme) form of revelation of the entrepreneur's type as in some of the disclosure literature in accounting. 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 cost*, 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 are going to spend many hours trying to bridge the informational gap in order to determine the "right" price for equity.

These two implications are about the ex ante probability of choosing non-priced financing versus equity financing. The third, discussed next, is an implication for the realized history of financing.

The Sequencing of Non-priced and Priced Financing

A sharp implication of our model is that when we observe in the history of a venture that has engaged in rounds of non-priced financing and equity financing, then the non-priced rounds should precede the equity rounds. Financing with equity in both rounds is a possible equilibrium in our model; in an extension with three periods of investment, it is clear that the first two may both involve SAFE's (and we may observe only these two rounds in the data). In testing this implication, therefore, we can restrict attention to the subset of ventures for which we observe multiple rounds of financing that switch between SAFE's and equity. The switch, according to the theory, should always be in one direction.

It is important to note that all of 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. These are implications of the general idea that we are proposing, that non-priced financing emerges when the asymmetry in information diminishes over time. We can therefore aggregate both types of non-priced financing, SAFE's and convertible notes.

Other testable implications

A test of the model might seem to be that better types should finance with SAFE's to a greater degree than poorer types. This theoretical proposition, however, is about the ordering of types in those dimensions of quality that are *unobservable* to the investors (and we are even less informed). 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. Another implication that is testable in principle is that projects with a stronger potential have a more certain need for capital within the next year or two and therefore a lower risk that the future round of equity will be delayed. This makes the ex ante moral hazard cost lower and the likelihood of SAFE financing greater. This implication would be well suited to testing in a data base with a wider range of product characteristics and history than the data set than ours.

Bridge Financing: There is a category of financing rounds to which our theory does not apply: bridge financing. Bridge financing is a small round of generally short-term financing intended to bridge the gap between when a venture's funds run out and 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 to cover costs before the larger round.) It would rarely make sense for a venture to issue equity for a bridge round, incurring the costs of marketing the round; in addition, estimating a price that ends up being higher than the price in the near-term larger round would mean a *down round,* which might deter investors, and estimating a price that is too low would mean an excessive cost of capital. Instead, a link to the larger round's (as yet unknown) price via a SAFE or convertible note makes more sense. Non-priced financing would generally be optimal whatever the financing history of the firm, so the third of our testable implications delineated above is not predicted. And bridge financing can occur any time, rather than being part of an ordered sequence of stages, so the third prediction would also not hold.

3 Patterns in Early-Stage Financing and Empirical Tests

We describe the patterns of early-stage financing and take a first step towards testing the predictions of our model using a data set of early ventures produced by Creative Destruction Lab and described in Sariri (2020). Creative Destruction Lab (CDL) is a program that brings together promising ventures with angel investors and mentors. The program differs from other venture incubators or accelerators in that the relationship with each venture is maintained for a period up to a year. 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.[20] Other variables include the pre-money valuation for equity rounds; the valuation cap for convertible notes; and a valuation cap for those SAFE that have a cap. The lack of a market valuation for all instruments means that we cannot control for firm size in our regressions.

Table 1 summarizes the frequency of the types of instruments used in our sample.

Equity	256	52.0%
Convertible Notes	181	36.8%
SAFE	55	11.2%
Total	492	100%

Table 1: The Aggregate Mix of Financing Instruments Used

Table 2 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):

[20] 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 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 2: 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 SAFE's as ubiquitous, and practitioners have told us that SAFE's are now the default, most common choice for the first external financing of early ventures.

The first three entries of the last column of Table 2 suggest support for our prediction that equity financing is used to a greater extent the further along is the venture, but of course this does not control for size, which as the next table confirms is correlated with the number of stages passed.

The average size for each type of financing, and each stage of financing is provided by Table 3:

Financing Stage	N	Equity	CN	SAFE	NP	Overall
pre-seed	150	0.31	0.24	0.38	0.24	0.25
seed	270	2.3	1.34	1.42	1.39	2.05
series A	50	11.89	2.56	3.75	3.24	11.03
bridge	22	0.52	1.5	.	1.5	0.65

Table 3: Average size (in $millions) of Financing Round by Instrument and Stage of Financing

Tables 2 and 3 reveal simple correlations among financing instruments, size and stages. (Tests of the theory of course require that in estimating the impact on the probabilities of instrument choice of one variable – size or stage– the other variable be controlled for; this is the point of using regressions.) The percentage of equity rounds is increasing as we move from pre-seed to seed to series A rounds in the last column of Table 2, as predicted by the theory. Bridge financing can occur at any time and is therefore not relevant for testing the prediction that the later the round, the greater the probability of equity financing.

The discrete choice faced by ventures is among the three alternatives at each round of financing: a convertible notes, a SAFE or equity financing. As discussed in the previous section, we aggregate SAFE's and convertible notes into non-priced financing in estimating the discrete financing choice, which is therefore: equity or 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. The data in Table 3 reveal 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).

The following table provides the results of the binary logit estimation:

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

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

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 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 results are not sensitive to functional form: similar results are reported in Appendix 3 for log-linear and probit.

Let us move to the ex post testable implication on the sequencing of non-priced and equity financing over the course of a startup's life cycle. This is the implication that looking at the history of a venture in our sample using both equity and non-priced financing over the period of observation, should adopt non-priced financing before equity financing.

In our sample 93 ventures issued multiple rounds in our period of observation. Table 5 categorizes these into the number of ventures that used only equity; ventures that used only non-priced financing in the period; and ventures that used both non-priced financing and equity, separated by the order of adoption. In this table, we have omitted the 24 firms that had multiple rounds of financing at the same financing stage, and 1 firm that adopted non-priced financing for a bridge round; we also omitted 5 ventures that provided a date for pre-seed financing that was after the date listed for seed financing on the basis that these dates were very likely mistaken (e.g. switched). This leaves 68 firms in the sample.

Financing Pattern	**Number**	
venture has only equity rounds	23	
venture has only non-priced rounds	2	
Non-priced financing rounds preceding equity rounds	42	
Equity round preceding non-priced rounds	1	
Total	68	

Table 5: Timing of equity financing rounds and non-priced rounds for ventures with multiple rounds of financing

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 strong evidence consistent with our theory, including the assumption that the asymmetry of information is higher at the earliest stages of external financing than at later stages.

To summarize the evidence for our theory of non-priced versus equity financing, the evidence supports the following implications of our theoretical model: the basic point that non-priced financing may be optimal; the fact that early stage ventures and not seasoned firms use non-priced financing; 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; and 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.

We have focused entirely on the binary choice of equity versus non-priced financing. More formal analysis of the optimal choice of the type of non-priced financing, SAFE's versus convertible notes,is an important topic for further analysis but is beyond the scope of this paper. We can offer some informal economics to explain this choice as reflected in the data of Table 2. Convertible notes are particularly 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

4 Conclusion

This paper has offered a theory to explain the choice between equity and non-priced instruments, SAFE's in particular, for early rounds of venture financing. The key factor behind the efficiency of these methods of financing in our theory is not simply asymmetric information between an entrepreneurs and investors about the quality of the venture – it is the reduction over time in this asymmetry, starting from the earliest stage. SAFE financing has an advantage over equity financing in the hidden-information or selection dimension of our theory in that they involve a favorable selection effect as compared to the adverse selection quality of equity financing. But SAFE's involve a moral hazard or debt-overhang problem. The trade-off between the benefit and cost of SAFE's as compared to equity generates the optimal choice of financing instrument. We find empirical support for the theory in a new data base on early venture financing.

Our model would serve as a benchmark towards the development of a more complete model of early stage financing, which would distinguish between SAFE's and convertible notes. Another extension would be to a dynamic model that allows for timing of equity issues. This would alter the 0 - 1 nature of the debt-overhang problem in our theory to allow for a more realistic distortion in the timing of the equity issue subsequent to the issue of a SAFE. A dynamic model would also allow for a flow of information to the market (at a higher rate to investors than to the entrepreneur, as investors catch up), allowing a more formal development of our implication that later stages of financing are more likely to be financed with equity than with non-priced instruments.

In closing, we discuss an alternative explanation of SAFE's, a behavioral theory. Entrepreneurs, being optimistic, and angel investors, being relatively jaded, typically have very different expectations about the future prospects of a venture. The SAFE is an ideal instrument for exploiting the gains to trade from this difference in expectations: entrepreneurs believe that relying on a high future price of equity will give them a low cost of capital. Angel financiers have expectations for a lower price and therefore a high allocation of shares. The difference in expectations arguably creates a gain to trade in a SAFE because each side thinks it is getting a "good deal" compared to equity financing as the future share price will reflect its current expectations. This is a behavioral explanation of SAFE's in the sense that in a fully rational model, differences in expectations of future returns are not a source of gains to trade; this is the point of the no-trade theorems such as Stokey and Lucas (1982). In our context the starting point of this explanation – that entrepreneurs are systematically more optimistic that angel investors – is not consistent with full rationality. We have restricted attention to fully rational agents in our theory, but believe the behavioral theory should be explored.

Appendix 1: Non-priced Financing: SAFE's and Convertible Notes

SAFE's

Simplified Agreements to purchase Future Equity ("SAFE's") are an instrument by which an investor in an early start-up is compensated in preferred 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 equity issue that will trigger payment (share allocation) to the SAFE holders. A SAFE therefore has three parameters: the minimum equity size, the discount rate and
- A SAFE may have an 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 would 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.

- SAFE's can use a post-money or a pre-money valuation cap. 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.

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 principle 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.

Discussion: SAFE's versus Equity and Debt

We elaborate here on the nature of SAFE's relative to equity and deft. A SAFE contrasts with equity. The purchase of equity provides for a known share of ownership of the firm and the right to a known share of distributed future profits. A SAFE, on the other hand, translates a dollar amount of financing into shares based on a future share price. But a SAFE is similar to equity financing in that it incorporates a commitment to buy shares.

A SAFE is in some respects closer to debt financing than equity financing. The "value" that the SAFE holder receives at the payment date, the date of first issuance of equity, is a fixed amount — independent of the share price or how well the venture has done. A low share price, whether due to poor fortunes of the firm or simply to the decision to issue many shares, is offset completely by an increase in the number of shares allocated to the SAFE holder. In our numerical example, a SAFE holder that provides 100,000 dollars in financing in exchange for a SAFE with a discount of 20 percent is paid back with 125,000 worth of equity, whatever the share price at the payment date.

Three differences between a SAFE and conventional debt are fundamental, however. First, debt is paid back with cash. A SAFE holder is paid back with equity. In the case of debt the value of the repayment (in dollars) is obviously common knowledge. In the case of a SAFE, the parties may anticipate some degree of asymmetric information remaining at the time of repayment. The SAFE involves a genuine commitment to purchase equity, which debt does not. Second, debt has a maturity date at which the principal must be paid back. The payment date for a SAFE is endogenous: it is the date at which the venture chooses to issue equity, most often preferred equity in the Series A round. If the issuance of equity is delayed, SAFE holders end up with a delayed payment — and nothing if the delay is indefinite. The event of indefinite delay or cancellation of equity may be due to dissolution of the firm. It can also reflect a decision on the part of the entrepreneur to grow via internal capital, in part to avoid the payment of the SAFE. Finally, debt-holders may receive partial payment in the event of bankruptcy. A SAFE holder gets either the full value or zero. Substantial debt financing is rarely observed for early venture financing, given the high risk of ventures (fewer than half survive) and the inefficiencies of debt for risky, cash-tight ventures. SAFE's are a means of achieving the non-dilutive feature of debt without the costly features of debt financing in a risky setting.

Appendix 2: Proofs not contained in the text

Proof of Proposition 1:

Investment decision given a history including 0 or e: Consider the entrepreneur's optimal decision in period 2, given a history $h = (0; \theta, b)$. The entrepreneur's expected payoff from not investing given this history is $\pi_2(0; 0, \theta, b) = \theta k_0$. The payoff from the alternative, investing in k_2 and financing with equity, is $\pi_2(e; 0, \theta, b) = [(1 - \lambda_2(0; \theta, b)](\theta k_0 + (1 + b)k_2)$. From (2), with a fair value of $\lambda_2(h)$ this payoff simplifies to $\pi_2(e; 0, \theta, \beta) = \theta k_0 + bk_2$.[21] This exceeds the payoff from not investing whenever $b \geq 0$.

Following a history (e, θ, b), a parallel logic shows that the payoffs from not investing in period 2, and investing, are $\pi_2(0; e, \theta, \beta) = (1 - \lambda_1)[\theta k_0 + (1 + a)k_1]$ and $\pi_2(e; e, \theta, \beta) = (1 - \lambda_1)[\theta k + (1 + a)k_1) + bk_2]$ respectively. Again, the entrepreneur invests if $b \geq 0$.

Investment decision given a history including s: In this case, any equity issued must cover not just the cost k_2 (via shares issued to new shareholders), but also the obligation to SAFE-holders. This obligation is in shares, covering compensation for the capital, k_1, provided in the first period, plus an amount to cover the discount, δ. The obligation would be met by providing the SAFE-holders with period 2 equity worth $k_1/(1 - \delta)$ at the price $p(h)$ of equity. The price of equity (a share being 100% ownership) satisfies $\lambda_2(h).p(h) = k_2$, i.e.

$$p(h) = \frac{k_2}{\lambda_2(h)} \tag{24}$$

The holder of a SAFE has the right to be repaid, in period 2 of their investment k_1, in shares at a price $p(h).(1 - \delta)$ if equity is issued. That is, is equity is issued the SAFE holder is given a share of equity in period 2 equal to $\lambda_s = \dfrac{k_1}{p(h).(1 - \delta)}$

From (24),

$$\lambda_s = \frac{k_1}{k_2} . \frac{\lambda_2(h)}{1 - \delta} \tag{25}$$

To consider the investment incentives in period 2 given a history of financing with a SAFE in period 1,we compare the payoffs from $f_2 = e$ with f_2 =0 given an outstanding SAFE. The payoff from $f_2 = e$ given this history is

$$[1 - \lambda_2(h) - \lambda_s][\theta k_o + (1 + a)k_1 + (1 + b)k_2] \tag{26}$$

[21] $[(1 - \lambda_2(0; \theta, \beta)](\theta k_0 + \beta k_2) = [(1 - k_2/(\theta k_0 + \beta k_2)](\theta k_0 + \beta k_2) = \theta k_0 + (\beta - 1)k_2$

whereas the payoff from $f_2 = 0$ is

$$\theta k_o + (1+a)k_1 \tag{27}$$

Substituting λ_s from (25) into (26) yields

$$\left[1 - \lambda_2(h) - \frac{k_1}{k_2}.\frac{\lambda_2(h)}{(1-\delta)}\right][\theta k_o + (1+a)k_1 + (1+b)k_2]$$
$$= \left[1 - (1 + \frac{k_1}{k_2(1-\delta)})\lambda_2(h)\right].[\theta k_o + (1+a)k_1 + (1+b)k_2]$$

Into this we substitute the fair rate $\lambda_2(h)$ given by (4):

$$\left[1 - \left(1 + \frac{k_1}{k_2(1-\delta)}\right)\frac{k_2}{(\theta k_o + (1+a)k_1 + (1+b)k_2)}\right][\theta k_o + (1+a)k_1 + (1+b)k_2]$$
$$= (\theta k_o + (1+a)k_1 + (1+b)k_2) - \left(1 + \frac{k_1}{k_2(1-\delta)}\right).k_2$$

$$= (\theta k_o + (1+a)k_1 + (1+b)k_2) - \left(\frac{k_1}{(1-\delta)} + k_2\right) \tag{28}$$

The strategy $f_1 = e$ dominates $f_1 = 0$ (following a history of $f_1 = s$) if and only if (28) $\geq$ (27): which is equivalent to

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

Equivalently

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

i.e.

$$b \geq \frac{k_1}{(1-\delta)k_2} \tag{29}$$

Lemma 1: *The expected moral hazard cost, m, is given by the following:*

$$= k_2[\nu(1) - \nu(x)] \; - \; [1 - G(x)]\frac{k_1}{(1-\delta)}$$

proof:

$$m = k_2 \cdot \int_0^x bdG(b) = k_2\left[\int_0^\infty bdG(b) - \int_x^\infty bdG(b)\right]$$

$$= k_2\left[\int_0^\infty bdG(b) - [\int_x^\infty (b-x)dG(b) + x(1 - G(x))\right]$$

$$= k_2[\nu(1) - \nu(x)] \; - \; [1 - G(x)]k_2 x \tag{30}$$

$$= k_2[\nu(1) - \nu(x)] \; - \; [1 - G(x)]\frac{k_1}{(1-\delta)} \tag{31}$$

.

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

seed round dummy omitted; n = 470; R squared = 0.419

Table 6: 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

seed round dummy omitted; n = 470; pseudo R squared = 0.347

Table 7: Probit Estimates of the Choice of Financing Instrument

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On-line Appendix

Extensions

Extension 1: An alternative assumption on asymmetry of information

In the text of the paper, we develop the model of SAFE versus equity financing with the following value function for the venture, realized at the end of period 2:

$$V = \theta k_0 + (1 + a)I_1 + (1 + b)I_2 + \epsilon$$

The model as developed in the previous section adopts a simple assumption informational asymmetry: that assets in place, but not new the returns to new investment, are subject to an informational asymmetry. In this online appendix, we develop an extension: information structure to allow the expected return on future investment, I_2, to depend on a firm's type as well. This is a natural assumption because future options to invest are part of assets-in-place, with values that are unknown to investors. We place (1) with the following value function, but retain the other assumptions of the model:

$$V = \theta k_0 + (1 + a)I_1 + (1 + b)\theta I_2 + \epsilon \tag{32}$$

The new formulation is complicated by the fact that the single-crossing properties involving SAFE's are no longer satisfied universally, once the option to invest depends on θ. This rules out a simple characterization of the entire equilibrium partition. But the basic economic prediction of the theory continues to hold: SAFE's emerge as the financing choice of best types when the inherent cost of SAFE's (the moral hazard problem) is small and the inherent cost of equity (the adverse selection effect) is large. That is, there is an interval of the highest types that issue SAFE's and an interval of the lowest types that issues equity.

We express this in terms of the proposition below. Define $x(\theta; \delta) = \left(\frac{1-\theta}{\theta}\right) + \frac{k_1}{(1-\delta)\theta k_2}$. As we explain below, $x(\theta, \delta)$ is the minimum rate of return, b, that a firm of type θ requires in order to invest in k_2. This cut-off rate of return exceeds the efficient cut-off, which as we will explain is $(1 - \theta)/\theta$.

Proposition 7: *Suppose that the value function (1) is replaced with (32) and the other assumptions of the model are retained. Then:*
(1) *In any equilibrium, the lowest types, $[\underline{\theta}, \widetilde{\theta}_1]$, for some $\widetilde{\theta}_1$, finance with equity.*
(2) If $G\left(x(\overline{\theta}; 0)\right)$ is sufficiently small, ceteris paribus, then in any equilibrium the highest types, i.e., types in $(\widetilde{\theta}_2, \overline{\theta})$ for some $\widetilde{\theta}_2$, finance with SAFE's.

proof and outline of extended model:

The new value function is (32). Given a realization b in period 2, the expected net dollar return on investment k_2 is $[(1+b)\theta - 1]k_2 = \theta k_2[b - (1-\theta)/\theta]$. The efficient investment rule in period 2 for a firm of type θ is to invest if $(1+b)\theta \geq 1$, i.e., $b \geq (1-\theta)/\theta$. This is also the rule following a histories of equity finance or no investment in period 1, parallel to the development of the basic model. Ex ante, the expected value of this real option is

$$\theta k_2 \int_{(1-\theta)/\theta}^{\infty} b - \left(\frac{1-\theta}{\theta}\right) dG(b) = \theta k_2 v\left(\frac{1-\theta}{\theta}\right)$$

Following a history of issuing a SAFE in period 1, to invest the entrepreneur of type θ will require not only a non-negative profit, $\theta k_2[b - (1-\theta)/\theta]$, but also an amount to cover the obligation to SAFE-holders, $k_1/(1-\delta)$. The net profit to the entrepreneur from investing following a safe is

$$\theta k_2 \left[b - \frac{(1-\theta)}{\theta}\right] - \frac{k_1}{1-\delta} = \theta k_2 \left[b - \frac{(1-\theta)}{\theta} - \frac{k_1}{(1-\delta)\theta k_2}\right]$$

Hence the ex ante value of the real option following a SAFE is

$$\theta k_2 \int_{x}^{\infty} \left[b - \left(\frac{1-\theta}{\theta}\right) - \frac{k_1}{(1-\delta)\theta k_2}\right] dG(b) = \theta k_2 v(x)$$

where $x = \left(\frac{1-\theta}{\theta}\right) + \frac{k_1}{(1-\delta)\theta k_2}$ (which exceeds $\left(\frac{1-\theta}{\theta}\right)$). As in the simple model, the debt-overhang distortion translates into a real option that is less valuable due to the higher, distorted exercise price.

The expected payoffs to the three strategies $\{0, e, s\}$ as of period 1 are:

$$\pi_1(0;\theta) = \theta k_0 + \theta k_2 v\left(\frac{1-\theta}{\theta}\right) \tag{33}$$

$$\pi_1(e;\theta) = (1-\lambda_1)\left(\theta k_0 + (1+a)k_1 + \theta k_2 v\left((1-\theta)\right)\right) \tag{34}$$

$$\pi_1(s;\theta) = \theta k_0 + (1+a)k_1 + \theta k_2 v(x) \tag{35}$$

when a fair discount δ for the SAFE exists, as described below. When a fair discount δ for a SAFE does not exist, we define $\pi_1(s;\theta) = 0$. The first-best profits, which the entrepreneur would earn with a complete contract, specifying investment in k_2 if $b > (1-\theta)/\theta$ with investors knowing the venture's type, would be

$$\pi_1^*(\theta) = [\theta k_0 + a k_1 + \theta k_2 v \left(\frac{1-\theta}{\theta}\right)] \tag{36}$$

Regarding the single crossing properties, note that $\frac{\partial}{\partial\theta}[\pi_1(e;\theta) - \pi_1(0;\theta)] < 0$ is easily demonstrated, but the single crossing properties involving $\pi_1(s;\theta)$ cannot be demonstrated in general.

The equilibrium involves, as in the basic model, a set of parameters $[\lambda_1, \delta, \lambda_2(h)]$ and a set of actions $f_1(\theta) \in \{e, s, 0\}$ and $f_2(h;\theta) \in \{e, 0\}$, where h is the history as of period 2. The sets E, S and N are the sets of types taking actions e, s and 0 as in the basic model. The conditions of market rationality and sequential rationality of the entrepreneur apply as in the basic model. The equilibrium in the second period is straightforward, as discussed above: given $[\lambda_1, \delta, \lambda_2(h)]$ and a history including e or 0 in period 1, the entrepreneur takes the first-best investment decision in period 2: invest if $b \geq (1-\theta)/\theta$. Given a history including s in period 1, the entrepreneur in period 2 invests if $b \geq x$.

The conditions determining $\lambda_2(h)$ are analogous to the basic model. The conditions determining λ_1 and δ (when it exists) are:

$$\lambda_1 = \frac{k_1}{(1+a)k_1 + \boldsymbol{E}\left[\theta k_0 + k_2[1 + \theta v(\frac{1-\theta}{\theta})] \mid \theta \in E\right]} \tag{37}$$

$$k_1 = \frac{k_1}{(1-\delta)}\boldsymbol{E}\left[1 - G\left(\frac{1-\theta}{\theta} + \frac{k_1}{(1-\delta)\theta k_2}\right) \mid \theta \in S\right] \tag{38}$$

where $\boldsymbol{E}$ refers to expectation.

The equilibrium requirement that the action $f_1(\theta) \in \{e, s, 0\}$ be optimal, given the market parameters, is that it maximize $\pi_1(f_1;\theta)$ as determined by (33) through (35).

To prove (1), note that the worst type, $\underline{\theta}$, can achieve at least first-best profits by issuing equity, since it faces a required λ_1 no greater than the required $\lambda^*(\underline{\theta})$ it would face with full information. That is, $\pi_1(e;\underline{\theta}) \geq \pi_1^*(\underline{\theta})$. Continuity of the profit functions then implies that for a sufficiently small interval starting at $\underline{\theta}$, $\pi_1(e;\theta)$ can be made arbitrarily close to $\pi_1^*(\theta)$ (or greater) for any θ in the interval. But $\pi_1(0;\underline{\theta})$ and $\pi_1(s;\underline{\theta})$ are bounded away from $\pi_1^*(\underline{\theta})$ and therefore for all θ in a sufficiently small interval starting at $\underline{\theta}$, $\pi_1(e;\theta)$ exceeds $\pi_1(0;\underline{\theta})$

and $\pi_1(s;\underline{\theta})$. Let this interval be $[\underline{\theta}, \widetilde{\theta}_1]$.

To prove (2): Note that if $G\left(x(\overline{\theta},0)\right) = 0$, then the probability of b being less than the cut-off value is 0. Investment in k_2 is then always undertaken in equilibrium as in the first-best. Thus, a SAFE achieves first-best investment and therefore profits. From continuity of the profit functions $\pi_1(s;\theta) \to \pi_1^*(\overline{\theta})$, as $\theta \to \overline{\theta}$ and as $G\left(x(\overline{\theta},0)\right) \to 0$. But there is a uniform upper bound to $\pi_1(0,\theta)$ that is strictly less than $\pi_1^*(\overline{\theta})$ over any interval. This implies that for a sufficiently small interval ending in $\overline{\theta}$, $\pi_1(s;\theta) > \pi_1(0;\theta)$ for any θ in the interval as $G\left(x(\overline{\theta},0)\right) \to 0$. To show that in the limit $\pi_1(s;\theta) > \pi_1(e;\theta)$, and therefore that there is an interval where s dominates e , consider equation (37) which gives the value of λ_1 required by the market. It is straightforward to show (and obvious) that whenever λ_1 exceeds the value that $\overline{\theta}$ would face in a full-information economy, then $\pi_1(e;\overline{\theta}) < \pi^*(\overline{\theta})$. The value of λ_1 that would be required from $\overline{\theta}$ in a full information economy is given by

$$\lambda_1^*(\overline{\theta}) = \frac{k_1}{(1+a)k_1 + \overline{\theta}k_0 + k_2[1+\overline{\theta}v(\frac{1-\overline{\theta}}{\overline{\theta}})]} \tag{39}$$

To compare (39) with (37), consider the denominators of each. There are two cases: E is empty; and E is non-empty. In former case, we know that s dominates 0 at $\overline{\theta}$ as $G\left(x(\overline{\theta},0)\right) \to 0$, and the profit functions are continuous in θ; it follows that S includes an interval $(\widetilde{\theta}_2, \overline{\theta})$ for some $\widetilde{\theta}_2$, as claimed. In the case of nonempty E, we have $\boldsymbol{E}\left[\theta k_0|\theta \in E\right] < \overline{\theta}k_0$ and, since $v(\frac{1-\theta}{\theta})$ is increasing in θ, $\boldsymbol{E}\left(k_2[1+\theta v(\frac{1-\theta}{\theta})]|\theta \in E\right) < k_2[1+\overline{\theta}v(\frac{1-\overline{\theta}}{\overline{\theta}})]$. This shows that for type $\overline{\theta}$,the required share of equity λ under equity-financing is greater than at the first-best. Equity financing is therefore less profitable than the first-best profits. But first-best profits are approached with safe financing as $G\left(x(\overline{\theta},0)\right) \to 0$, showing as claimed that there is an interval an interval $(\widetilde{\theta}_2, \overline{\theta})$ for some $\widetilde{\theta}_2$, over which s dominates e. Since s dominates 0 over a (possibly different) interval, choosing the smaller of the two intervals satisfies (2) of the proposition.

Extension 2: Incorporating valuation caps in SAFE's

Extending the contract to include caps means increasing the dimension of contractual parameters from 1 to 2, the discount and the cap. This increase in dimensions takes us from the *adverse selection* class of theories to a *signaling* theories. The *signaling* theory approach is based on an assumption that the entrepreneur sets the contract parameters, letting the market respond. An alternative assumption — that a large angel financier or platform sets the contract parameters. letting the set of entrepreneur types respond, would lead to a *screening* model. We illustrate with a simple model that our basic theme is preserved in the extension to caps: higher quality entrepreneurs may finance with equity or adopt a SAFE (with a cap) while lower quality entrepreneurs always finance with equity. The SAFE serves to signal entrepreneur quality, at a signaling cost given by the moral hazard cost that we have examined. The signaling equilibrium is particularly simple.

We retain the payoff and informational structure of the basic model. To recap, there are two periods with investment opportunities k_1 and k_2; the entrepreneur enters period 1 with assets-in-place, k_0. The value of the firm at the end of the second period is given by equation (1); the type of the firm is private information until the beginning of period 2 (prior to the investment decision I_2); the rate of return on I_2, b, is unknown to all agents in period 1 but also revealed at the beginning of period 2.

$$V(\theta, b) = \theta k_0 + (1+a)I_1 + (1+b)I_2 + \epsilon$$

We make three changes to the assumptions of the model. First, we allow only two types of entrepreneurs, $\theta = L$ or H, with $L < H$. There are n entrepreneurs, and the fraction of high types is γ. We restrict our attention to equilibria in which all entrepreneurs of the same type choose the same strategy. Second, an entrepreneur in period 1 decides whether or not to offer a SAFE, which is a contract (δ, c) where δ is the discount rate and c is the cap on valuation. If the entrepreneur does not offer a SAFE, then it enters the equity market to sell a share of the firm.[22] (We assume, to keep thing simple, that a is high enough that the strategy of not investing is always dominated.) A cap that is high enough that it is never binding is of course equivalent to a contract without a cap.

Following a SAFE contract without a cap, if the investment I_2 is undertaken in period 2, the valuation basis for conversion of SAFE's to equity is $v(\theta, b) = \theta k_0 + (1+a)k_1 + (1+b)k_2$.[23] That is, the share of the corporation that SAFE-holders are allocated in period 2 in return for their investment of $k_1$in period 1, is

$$\frac{k_1/(1-\delta)}{v(\theta, b)} \tag{40}$$

[22]The equity market observes the SAFE contracts that have been offered it opens, and clears at a price reflecting the mix of types issuing equity. This structure allows the firms to offer SAFE contracts (when they choose to) but still be price-taking in the equity market.

[23]This is the *post-money* valuation as of the time of issue of equity (and investment) in period 2, in that the value includes the value k_0 raised in equity to finance the period-2 investment. The *pre-money* valuation is the market valuation of assets prior to the raise of second-period capital: $v = \theta k_0 + (1+a)k_1 + bk_2$. In practice, SAFE's started with conversion based on pre-money valuation but are moving towards post-money valuation following a change by Y-Combinator several years ago.

and the value of the shares awarded is of course $k_1/(1-\delta)$. Where the SAFE contract is (δ, c), including a cap c, the valuation basis for conversion of the SAFE into equity is $min[v(\theta, b), c]$. The share of the corporation awarded to SAFE-holders in the event that the entrepreneur invests in period 2 is then

$$\frac{k_1/(1-\delta)}{min[v(\theta, b), c]} \tag{41}$$

Our final change from the basic model is in the concept of equilibrium. Our competitive, price-taking equilibrium concept cannot be applied when SAFE contracts vary in more than one dimension. We adopt instead a standard equilibrium concept in games with imperfect information: *perfect Bayesian equilibrium* (PBE). Given the decisions on issuing equity or SAFE's, and the parameters of the SAFE contracts, the market attaches a probability, to each strategy (equity or SAFE) and the SAFE contract, being adopted by high type. Order the two observed strategies 1 and 2; and denote the strategy i as $s_i = (f_i, (\delta_i, c_i))$ where $f_i \in \{e, s\}$ and (δ_i, c_i) is the SAFE contract offered if $f_i = s$ and $(0, 0))$ if $f_i = e$. Let the set of possible strategies be S. The market expectations are given by a mapping E from SxS to $[0, 1]$, giving the probability that the market assigns to firms adopting each strategy of being the high type. An equilibrium consists of a strategy pair and an expectation mapping, $(s_H, s_L; E)$ such that the strategies are individually rational given E and the expectation mapping E is consistent with the strategies. The PBE concept is often narrowed by imposing restrictions on the expectations of uninformed agents (here, the market) on off-equilibrium strategies. We impose a common refinement of the PBE concept, equilibrium dominance: if a strategy is dominated by a particular type, then the expectation E places zero probability that the strategy was played by that type (see Mas-Colell, Whinston and Green (1985),p.468).

We supplement this concept of equilibrium by requiring that the market price of equity is market-clearing, i.e., equals the expected payment to equity-holders given knowledge of the types selecting equity as a strategy.

We characterize the equilibrium strategies in following proposition below:

Proposition 8 *In equilibrium:*

1) L issues equity. Issuing equity is a dominant strategy for L.

2) For a sufficiently small difference between types, $H - L$, H also issues equity. For larger differences, H issues a SAFE (δ, c) with a cap c at $V(H, \hat{b})$ where $\hat{b}$ is the value of b that is marginal for investment in the second period given δ in the contract.

3) The entire allocation of shares to investors under the SAFE contract, and investment in k_2, takes place in the event that the cap in the SAFE is binding.

We first offer some intuition for the proposition to complement the proof below. The equilibrium strategy of type L is straightforward. A SAFE contract is a decision to wait until the revelation of types for the equity to be priced – wait at a cost, δ. The worst type in any disclosure game has no incentive to spend resources to be revealed as the worst type. With respect to the H strategy, one might have expected the cap in its SAFE contract to play a role in signaling the type. It does not. The selection of *any* SAFE contract would identify the H type, since any SAFE contract is dominated for the L type.

Instead the selection of $V(H, \hat{b})$ as the cap serves to minimize the expected moral hazard cost (which, recall, is entirely borne by the entrepreneur). We can think of the contractual payment to investors depicted in Figure 3 as a *tax* on the entrepreneur's (binary) investment decision in period 2, as a function of the realized value $V(H, b)$. The tax is a function of b, since $V(H, b)$ is monotonic in b and therefore invertible. The idea is that the optimal tax must be as low as possible in a small interval around the $\hat{b}$ since this is the only point at which the tax is distortionary, subject to the financing constraint that investors expected return equals their investment. At higher or lower realizations of b, the investment decision is unaffected by marginal changes in the tax.[24]

How does setting the cap at $V(H, \hat{b})$ achieve the lowest rate at $\hat{b}$? Note that a decrease in the cap, c, in Figure 3 induces a drop in the initial fixed payment, $k_1/(1-\delta)$.[25] If $\hat{b} < c$, then the tax at the marginal decision can be reduced with a decrease in c. And similarly, if $\hat{b} > c$ the tax at the marginal decision can be reduced by an increase in c.

That the cap is set at exactly the marginal value that will induce investment is a prediction of a very stylized model. The more important take-away from the model is that one role of the cap is to allow the discount rate, δ, to be lower, which reduces the debt-overhang type of distortion in the investment decision under the SAFE contract.[26]

[24] A principle from public finance is that an efficient tax is placed, to the greatest extent possible, on *non-marginal* choices.

[25] In economic terms, the cap and the discount are the two means of compensating investors. If the cap is decreased (which increases expected compensation to investors) then the discount can be decreased while still meeting financing requirement that the expected return on investment equal k_1.

[26] Extending the model of SAFE's even further by endogenizing effort on the part of the entrepreneur and investor would allow a compelling explanation of caps. A cap gives the angel investor a claim on the upper tail of the distribution of increase in value between initial investment and the conversion of the SAFE. Without the cap, the angel return is flat over this period, since an increase in the value of the firm is exactly offset by a reduction in the number of shares allocated to the investor. A claim on the upper tail may induce an (invariably busy) angel investor to spend more time with a venture. The theory of early stage venture

proof of Proposition 8

In the model extended to caps, the period 1 expected payoff to L from issuing equity is no less than the payoff if L is identified as the only issuer of equity (the full information payoff to L). The full information payoff, π_L^*, is

$$\pi_L^* = (1-\lambda)[Lk_0 + (1+a)k_1 + bk_2]$$

where λ satisfies the market fair pricing condition

$$\lambda = \frac{k_1}{Lk_0 + (1+a)k_1 + bk_2}$$

These two equations solve to yield

$$\pi_L^* = Lk_0 + ak_1 + bk_2 \tag{42}$$

Compare the payoff in (42)to L from issuing a SAFE (δ, c). If the SAFE is accepted by the market, the first-best profit for L minus the ex ante cost of the moral hazard: $\pi_L^* - m$. To derive the ex ante moral hazard cost, denote by $\hat{b}$ the value of b that renders L indifferent to investing or not in the second period given the history of a SAFE contract, (δ, c). ($\hat{b}$ is the "marginal b." We omit the subscript L on $\hat{b}$.) The value $\hat{b}$ equates the expected profit from not investing in k_2 in period 2 with the profit from investing, given the history of having issued the SAFE (δ, c) in period 1. That is, $\hat{b}$ is the solution in b to the following

$$Lk + (1+a)k_1 = Lk_0 + ak_1 + bk_2 - v(L,b) \cdot \frac{k_1/(1-\delta)}{min[v(L,b), c]} \tag{43}$$

The profit from investing, on the right hand side, is the first-best profit minus the return contractually required by the SAFE-holders. The value $\hat{b}$ defined by (43) is positive. The ex ante moral hazard cost, m, is the expected net return on the efficient period 2 investments that are forgone:

$$m = \int_0^{\hat{b}} bk_2 dG(b) > 0 \tag{44}$$

The payoff from issuing equity, π_L^*, exceeds the payoff from issuing a SAFE, $\pi_L^* - m$. Thus issuing equity is a dominant strategy for type L.

financing should be extended to incorporate effort decisions on the part of agents. Even in our simpler model of the choice between equity and a SAFE, the cap plays a role in mitigating an incentive distortion

Turning to part (2) of the proposition, suppose that H types offer a SAFE contract, (δ, c). They are then identified by the market as H types, since issuing a SAFE contract is a dominated strategy for L types. Let b^* satisfy $V(H, b^*) = c$. $V(H, b^*)$ is the value of the venture at which the cap becomes binding. For $b \leq b^*$, the equity share allocated to the SAFE-holders (if the entrepreneur chooses to convert) is $\frac{k_1/(1-\delta)}{v(H,b)}$ whereas for $b > b^*$, this share is $\frac{k_1/(1-\delta)}{c}$. Letting $\hat{b}$ now denote the marginal b for the H type, we consider two cases: $\hat{b} < b^*$ and $\hat{b} > b^*$, showing that in each case H's profit can be increased by changing the SAFE contract. This will prove that $\hat{b} = b^*$ and therefore that $V(H, \hat{b}) = c$. Suppose first that $\hat{b} < b^*$. The market constraint (that the market expected return be at least their investment) on (δ, c) in this case is

$$k_1 \leq \int_{\hat{b}}^{b^*} \frac{k_1}{(1-\delta)} dG(b) + \int_{b^*}^{\infty} \frac{k_1 v}{(1-\delta)c} dG(b) \tag{45}$$

The parameter $\hat{b}$ in this case equates profit without investing with profit from investing, which nets out the value of the required payment to SAFE-holders:

$$Hk + (1+a)k_1 = Hk_0 + ak_1 + \hat{b}k_2 - \frac{k_1}{(1-\delta)} \tag{46}$$

Total differentiation of (45) shows that $d\delta/dc > 0$, i.e. if the firm raises c, it must also raise δ to continue to meet the market constraint. From (46) it follows that $d\hat{b}/d\delta > 0$ and from (44) it follows that $dm/d\hat{b} > 0$. It follows from these three total derivatives that if the firm lowers c, it can lower δ, which lowers m. Since H's profit from a SAFE are first-best profits minus m , i.e. $\pi_L^* = Hk_0 + ak_1 + bk_2 - m$, it follows that lowering m and lowering δ to maintain the market constraint raises profit.

In the case $\hat{b} > b^*$, a parallel argument shows that raising c reduces m and again increases profits. Thus at the optimal SAFE contract $\hat{b} = b^*$ and therefore $V(H, \hat{b}) = c$.