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# Financing Commitments and Investor's Incentives in Entrepreneurial Firms

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# Financing Commitments and Investor's Incentives in Entrepreneurial Firms

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**Abstract**

This paper considers an entrepreneur seeking early-stage finance from either a business angel or a venture capitalist in the context of stage financing. A business angel can only finance the first round due to limited resources, while a venture capitalist can also participate in follow-up rounds. The benefit of selecting a business angel initially is the increased incentives in the first round for the investor, which ought to generate additional value-adding to the entrepreneurial venture. This in turn improves valuation at the interim round, and thereby mitigates the risk of dilution against follow-up investors and possibly even inefficient discontinuation of the project. Opting for a venture capitalist secures follow-up funding, but at the same time reduces incentives for the venture capitalist to put as much effort as a business angel. We provide several empirical implications derived from this tradeoff on the optimal investor choice.

*Keywords: entrepreneurship, financing strategy, business angel, venture capital, start-up finance, stage financing*

*JEL classifications: G24; G32; L10; O31*

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## Non-Technical Abstract

A crucial strategic decision in entrepreneurial ventures is the choice of financier, as this may ultimately affect the shape of the company and the way goals are pursued. This is particularly true for the initial steps as it often entails significant dilution of the entrepreneurial stakes and thus the ability of the entrepreneur to sustain appropriate incentives to work hard and thereby to ultimately create successful companies. To mitigate dilution costs, the financing of such firms is very often staged in several rounds, with the investment amounts increasing from round to round.

This paper investigates the optimal choice between business angel and venture capital finance in the context of stage finance in entrepreneurial firms. It considers an entrepreneur that requires early-stage finance for an innovative project that can be implemented in two stages, an early-stage and a later-stage. We consider two different types of investors, business angels and venture capitalists. We assume that a business angel can only finance the first round due to limited resources, while a venture capitalist can also participate in follow-up rounds. This means that if the project is started with a business angel, the entrepreneur still needs to rely on venture capital finance for the second round.

From the entrepreneurial perspective, this could lead to the following trade-off. By selecting a financially-constrained investor (a business angel), the entrepreneur opts for an investor that has the right incentives to add value in the firm, since this is needed in order to secure follow-up finance without being diluted by the entry of a venture capitalist. Alternatively, when taking venture capital in the first round instead, the entrepreneur opts for a financially unconstrained investor (a venture capitalist) that is able to secure continuation of the project, even when the prospects have become less promising at the interim stage; this however goes at the expense of increased risk of a "down round", since an unconstrained investor has less incentives to add value to the entrepreneurial project to the same extent as a business angel. This is because a venture capitalist does not face discontinuity risk, since he can finance the follow-up round himself (so that only the entrepreneur gets diluted). Therefore, while each type of investor creates its own costs and benefits, the entrepreneur needs to weight them based on his own project characteristics.

This tradeoff finds empirical support from recent studies. For instance, one (Stanco and Akah, 2005) documents that 58% of the responding business angels declared their previous experience with venture capitalists as "negative", primarily due to disagreements in the exit strategy and "onerous agreement in their terms" at the time of their entry. In particular, when the entrepreneur could not show clear signs of success at the time the venture capitalist arrives, the business angel and the entrepreneur face great risk of getting highly diluted and thus losing equity value and control rights.

This theoretical study provides several empirical implications about the optimal investor choice. As a direct consequence of their limited resources, business angels are more likely to provide

more value adding, given that the risk of dilution in case of an unsuccessful round. As a result, expected returns should be higher on average (keeping everything else constant) for ventures that started with investors with limited capacities, because of their greater incentives to add value. Investors with large resources (such as large venture capitalists) have less incentives since they are able to finance follow-up rounds even when no new investors are willing to participate.

The theoretical framework also has empirical predictions with respect to important changes in the supply of venture capital by institutional investors (e.g., Cressy, 2002, and Ibrahim, 2008), in particular when a gap may appear subsequent to large capital inflows into the venture capital market (as witnessed during the IT bubble and again now, though at a lesser extent). This is likely affecting the supply of early-stage finance, since venture capitalists then avoid smaller transactions. Business angels, in turn, face less competition from venture capitalists for smaller investments. Our model predicts which entrepreneurs are most likely affected adversely from such a supply-driven shock (even if the supply of business angel is highly competitive), namely those who would otherwise prefer to be funded by a financially unconstrained investor. When an equity gap arises, less valuable ventures are at highest risk of incurring important economic costs, since then venture capital finance is more likely to be optimal for these ventures while not being available to them. On the other hand, most valuable ventures do not seem to be affected since for them business angel finance is preferred anyway in which case the inefficiency costs are likely to be negligible.

# 1 Introduction

While many entrepreneurs start their new activity with own financial resources (Bhidé, 1999), the most innovative ones typically require significant outside capital quickly after a self-financed kick-off round (if not even from the very beginning).[1] From the perspective of entrepreneurs, a crucial strategic decision is the type of financier to opt for in order to pursue their goals. This is particularly true for the initial steps as it often entails significant dilution of their own stakes and thus their ability to sustain appropriate incentives to work hard and thereby to ultimately create successful companies. To mitigate dilution costs, the financing of such firms is very often staged in several rounds (see, e.g., Gompers, 1995, Bergemann and Hege, 1998, and more recently Bergemann, Hege and Peng, 2008), with the investment amounts increasing from round to round.

Sometimes entrepreneurs with innovative ideas rely in early rounds on private investors who invest their own money, so-called *business angels* (Fenn et al., 1998; Prowse, 1998; Goldfarb et al., 2008; Wong, 2002). Business angels tend to provide smaller amounts of capital but are ready to commit resources at very early stages of companies. However, business angels do not have the resources to participate in larger, follow-up rounds. For instance, Goldfarb et al. (2008) finds that "sophisticated" business angels invest on average around $150,000 (and a median of $25,000), implying that the "average" business angel should make even smaller investments. Then, larger investors such as venture capitalists need to step in at subsequent growth phases, since they have much larger financial resources to back entrepreneurial firms than angel investors (empirical evidence is provided, e.g., by Goldfarb et al., 2008). Given the size of their funds, venture capitalists generally have enough resources to cover several rounds of financing in a same company.

The entry of larger investors such as venture capitalists in later rounds does not always occur without tensions. Indeed, several studies and surveys report deep concerns about their arrival in entrepreneurial firms that first received angel financing (Leavitt, 2005; Stanco and Akah, 2005). According to a relatively recent survey (Stanco and Akah, 2005), 58% of the responding business angels declared their previous experience with venture capitalists as "negative", primarily due to disagreements in the exit strategy and "onerous agreement in their terms" at the time of their entry. These conflicts between different types of investors inevitably affect the entrepreneur also, as his own stake is directly affected.

In particular, when the entrepreneur could not show clear signs of success at the time the venture capitalist arrives, the business angel and the entrepreneur face great risk of getting highly diluted and thus losing equity value and control rights. Interestingly, this puts the entrepreneur at times on the same side of the negotiation table as the business angel.

[1] A recent survey of the Kauffman Foundation on the financing decisions of US SMEs in their first year of existence yields similar conclusions (Robb and Robinson, 2008).

An important contractual feature of startup finance aims at anticipating these issues by the inclusion of contractual covenants that explicitly specify how early-round investors deal with the risk of dilution after a "down round".[2] To avoid bearing these costs, anti-dilution provisions (full-rachet or weighted average provisions) are often included in contracts (Bartlett, 1999; Kaplan and Strömberg, 2003; Bienz and Walz, 2005; Cumming, 2008), at least for investors. They guarantee that early-round investors receive compensation in form of additional shares and/or a more favorable conversion rate (for convertible securities) in the event of a down round. However, they are typically accompanied by a key condition, namely that early-round investors also participate in the follow-up round (the so-called "pay-to-play" condition). If an investor is not able or willing to put additional money on the table in the next round, he cannot claim any anti-dilution protection. And even without the pay-to-play condition, financially constrained investors can hardly avoid dilution if there is a lack of interest by venture capitalists for the investment, as it puts strong limits to the bargaining power of constrained investors when new capital injection is crucially needed. Contractual arrangements made in previous rounds tend to be worthless when the entrepreneurial project cannot be pursued without the participation of new and larger investors, which gives the latter strong bargaining power against the entrepreneur and small investors such as business angels. This creates costs and benefits from choosing a first-round investor (such as a business angel) that is unlikely to be able to participate in follow-up rounds.[3]

This paper investigates the optimal choice between business angel and venture capital finance in the context of stage finance in entrepreneurial firms. While the optimal choice of investor type has received some attention in recent studies (e.g., Chemmanur and Chen, 2002; Fluck et al., 2006; Schwienbacher, 2007), they are largely silent about its impact on follow-up rounds. Existing studies have focused on the effect of investor choice on a single investment decision, but not how it may impact future financing choices. The only notable exception is the study by Chemmanur and Chen (2002), as we discuss below. We shed light into how it can affect the dilution of equity claims of entrepreneurs and early-stage investors as well as the likelihood of receiving follow-up funding. Bargaining in follow-up rounds may crucially depend on the type of early-stage investors an entrepreneur has selected initially.

From the entrepreneurial perspective, this could lead to the following trade-off. By selecting a financially-constrained investor (a business angel), the entrepreneur opts for an investor that has the right incentives to add value in the firm, since this is needed in order to secure follow-up finance

[2] In stage financing, a "down round" occurs when the entrepreneur issues new shares at a price below the previous round due to a reduced valuation in the follow-up round; i.e., the pre-money valuation of the new round of financing is below the post-money valuation of the previous round. Early-rounds investors then get their own shares devaluated (thus, diluted) as newcomers can purchase new shares cheaper than previous investors.

[3] Note that in principle, dilution in follow-up rounds can even happen for control rights, not only cash flow rights. In this case, early investors give up some previously negotiated rights when new investors arrive.

without being diluted by the entry of a venture capitalist. Alternatively, when taking venture capital in the first round instead, the entrepreneur opts for a financially unconstrained investor (a venture capitalist[4]) that is able to secure continuation of the project, even when the prospects have become less promissing at the interim stage; this however goes at the expense of increased risk of a "down round", since an unconstrained investor has less incentives to add value to the entrepreneurial project to the same extent as a business angel. This is because a VC does not face discontinuity risk, since he can finance the follow-up round himself (so that only the entrepreneur gets diluted). Therefore, while each type of investor creates its own costs and benefits, the entrepreneur needs to weight them based on his own project characteristics.

Solving for optimality conditions on investor choice generates several empirical implications based on specific project characteristics. As a direct consequence of their limited resources, business angels are more likely to provide more value adding, given that the risk of dilution in case of an unsuccessful round. As a result, expected returns should be higher on average (keeping everything else constant) for ventures that started with investors with limited capacities (either BAs or small VCs), because of their greater incentives to add value. Investors with large resources (such as large venture capitalists) have less incentives since they are able to finance follow-up rounds even when no new investors are willing to participate.

The theoretical framework also has empirical predictions with respect to important changes in the supply of venture capital by institutional investors (e.g., Cressy, 2002, and Ibrahim, 2008), in particular when a gap may appear subsequent to large capital inflows into the venture capital market (as witnessed during the IT bubble and again now, though at a lesser extent). This is likely affecting the supply of early-stage finance, since venture capitalists then avoid smaller transactions. Business angels, in turn, face less competition from venture capitalists for smaller investments. Our model predicts which entrepreneurs are most likely affected adversely from such a supply-driven shock (even if the supply of business angel is highly competitive), namely those who would otherwise prefer to be funded by a financially unconstrained investor. When an equity gap arises, less valuable ventures are at highest risk of incurring important economic costs, since then VC finance is more likely to be optimal for these ventures while not being available to them. On the other hand, most valuable ventures do not seem to be affected since for them BA finance is preferred anyway in which case the inefficiency costs are likely to be negligible.

A further interesting area where the presented analysis offers predictions is with respect to control-driven entrepreneurs. Further details and a discussion on empirical support are provided in a later section of this paper.

To our knowledge, most of these predictions have not been tested empirically so far in the form stated here, most likely due to lack of data availability on investor choice.

[4] A syndicate of business angels instead of a venture capitalist yields the same effect.

With a few exceptions only, empirical studies typically focus on a single type of investors. Yet, the predictions derived in this paper also have important policy implications that aimed at encouraging entrepreneurial activities in the real economy.

The remainder of this article is structured as follows. The next section presents the relevant related literature. Section 3 described the model that is solved in Section 4. Section 5 looks at extensions and robustness. Section 6 derives empirical implications and concludes.

## 2 Related Literature

This work relates to several studies in economics and finance. The literature on venture capital finance is large. The one on business angels however much less. Comparing both types of investors has been the subject of even fewer studies. A noticeable exception is the paper by Chemmanur and Chen (2002) that also examines the optimal investor choice in the context of stage financing. Their analysis is however different, since the distinction between business angel and venture capitalist does not come from the resource constraints but rather their ability to add value. The authors exogenously impose the assumption that only venture capitalists can add value; business angels are passive investors who only provide money. The choice of investor is then driven by whether the entrepreneur prefers an active or passive investor. In our paper, we endogenize this by allowing both types to be active investors. We however fix the amounts they can invest, by assuming that business angels have limited cash resources but not venture capitalists. Empirical evidence for this distinction can be found in Ibrahim (2008) and Goldfarb et al. (2008). As we will see, this generates new and distinct predictions.

Schwienbacher (2007) takes a different perspective by examining the choice between business angel and venture capital finance when entrepreneurs find it difficult to raise enough outside money (see also Hellmann, 2007, on issues related to attracting investors' attention). They can decide between starting with a smaller, but insufficient amount of angel capital, or search longer with the aim of potentially attracting a capital-unconstrained investor (a venture capitalist). However this paper does not consider any effect on follow-up rounds, which is the topic of the current analysis.

Complementary to these papers, a small set of studies investigate the choice between venture capital and bank finance. A recent one is by de Bettignies and Brander (2007). While entrepreneurial ownership is maximized with bank finance (and thus also incentives of the entrepreneur) due to debt (i.e., non-equity) finance, VC finance brings additional value-adding, which is most beneficial to entrepreneurial ventures where VC productivity is potentially greatest. In contrast, Ueda (2004) develops a framework based on asymmetric information in which venture capitalists are better than banks at resolving the information problem by learning the private information of the entrepreneur before investing. The latter is however refrained from contracting with a VC

if intellectual property rights are weak, since learning about the entrepreneurial information may drive the VC to expropriate the entrepreneur.

One paper strongly related to mine is the one by Inderst et al. (2007) that takes a portfolio approach of venture capital finance. They show that having an investor with limited cash reserves ("shallow pockets") may improve entrepreneurial incentives by creating competition among them for the remaining resources. Those projects that do not obtain follow-up finance for the initial investors and are still profitable need to find more expensive sources of capital (for instance due to asymmetric information). This creates a tournament between entrepreneurs inside the portfolio of a same venture capitalist. This study therefore endogenizes incentives of investors to limit the size of their funds, which differs from my approach. While the similarity with my analysis lies in the fact that we consider an entrepreneur at time preferring a wealth-constrained investor who will however have better incentives to provide appropriate effort, instead of focusing on the entrepreneurial side. Here, we do not take a portfolio approach that leads to a tournament but rather the problem of dilution of equity stakes. Their analysis is also largely silent about how first round terms affect the ones offered in the second round.

Further related studies investigate practice of stage financing in entrepreneurial ventures. Several empirical studies document its widespread use in venture capital finance (e.g., Gompers, 1995). On the theoretical front, Bergemann and Hege (1998) derive the optimal staging strategy in the context of dynamic agency problems, when equity investors learn about the project over time. Cornelli and Yosha (2003) show how convertible securities can mitigate short-term biases in entrepreneurial firms that may result from stage financing. More recently, Fluck et al. (2006) take a distinct approach by focusing on the interaction between different contract provisions where each solves its own agency problem over time. None of these theoretical papers consider the relation between staging and investor choice. Instead, only venture capital finance is considered.

# 3 The Base Model

We consider an entrepreneur (EN) who has a project that requires two stages of finance, an early stage and an expansion stage.[5] The project generates a commercializable product or service only if it has passed both stages. The investment amount required for the first stage is $k$, and for the second stage $K$, where $K, k > 0$. We suppose that $k < K$.

We consider two types of investors: business angels (BAs) and venture capitalists (VCs). In both cases, the economy is populated by a large number of both types. The primary difference is the investment size they are able to make. While business angels invest small amounts only,

[5] Throughout the analysis, we use the terms "early stage" and "first round" interchangeably. The same is true for "expansion stage" and "second round".

namely up to the amount $k$, venture capitalists are financially unconstrained so that they may finance either one or both rounds (early stage and expansion stage).[6] All the parties involved (EN, BAs, VCs) are assumed risk neutral and face outside options equal to zero.

The final value of the venture can be either good (in which case it is worth $G$) or average (with value $A$).[7] By assumption, we obtain $G > A > 0$. Investors have the ability to affect the potential outcome of the venture's performance during the first stage. The investor can exert effort at private cost $c > 0$ in the early stage, yielding $G$ with probability $X$, and $A$ with probability $1 - X$. If no appropriate effort is exerted (with effort cost equal to 0), the probability of achieving outcome $G$ is $x$, where $0 \leq x < X \leq 1$. And with probability $1 - x$, the outcome is $A$. If the project is stopped after the first round, its value is zero. Let us further define $\delta$ as the ratio $X/x$ (i.e., $X \equiv \delta x$), which is strictly larger than one by construction.

Right after the first round, all parties receive an accurate signal about the quality of the project. This signal reveals whether the venture will achieve a value $G$ or $A$ after the second round of financing. However, we suppose that VCs need to incur "significant screening costs for the pessimistic ones – those with a bad signal revealing an outcome $A$. Let us denote these costs by $S > 0$ and assume:

**Condition 1:** *We assume that* $A - K - S < 0$.

Condition 1 can be motivated by the fact that projects perceived as "pessimistic" (or bad) require substantially more due diligence than projects perceived as being "promising" (or good). Screening costs for optimistic projects are normalized to zero. This due diligence (which may include costs related to figuring out how to assist the venture in its expansion stage) is "less costly" for investors who have been on board already in the first round. This means that a VC that financed the first round will not incur these costs $S$.[8]

To limit the analysis to the most interesting cases, we consider only situations satisfying Condition 2:

**Condition 2:** *We assume that* $A > K$.

[6] Empirical evdence largely confirm that fundamental difference in investment size between business angels and venture capitalists (see, among others, Goldfarb et al., 2008, and Wong, 2002, just to cite a few).

[7] One could think of a third outcome, namely a bad one characterizing the failure of the project. For sake of simplicity, we set this probability here to zero.

[8] An alternative setting that would yield qualitatively similar results is one in which we define a parameter, say $\rho$, that determines the probability of obtaining offers from different outside venture capitalists after a "pessimistic" round. Then, with probability $\rho$, the EN has all the barginaing power; otherwise the single VC interested in the deal. In the spirit of Hellmann (2007), that could measure the likelihood of "attracting attention" from potential investors. We can then assume that "pessimistic" projects have a lower value of $\rho$. While this does not rely on exogenous costs $S$, it generates similar effects as far as it generates a risk of discontinuation under angel finance (though now only with probability $1 - \rho$) and significant dilution under VC finance.

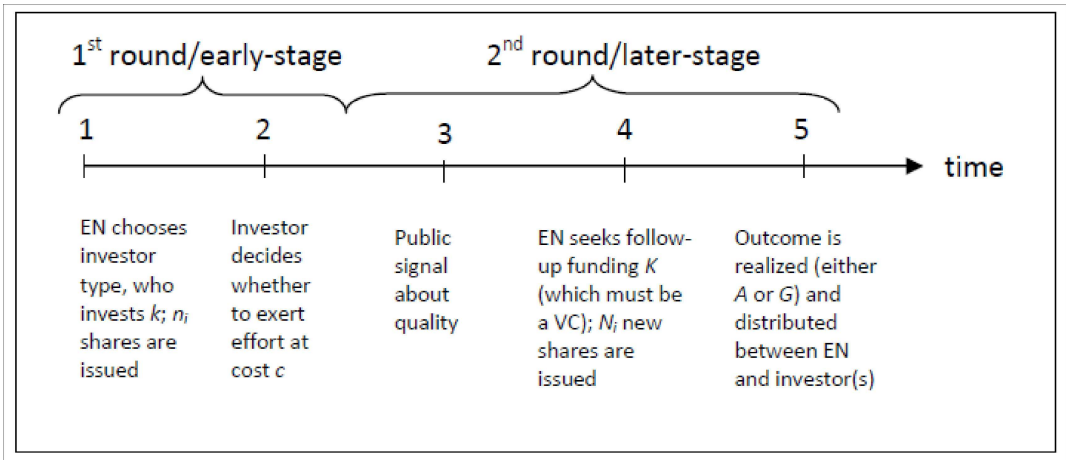


Figure 1: Time Line

Combining Condition 1 and Condition 2 implies that informed investors (i.e., first round investors) will find it worthwhile to pursue the project after at a "pessimistic" signal, but not new investors.[9]

We consider the following time line, which is depicted in Figure 1. At $t = 1$, the entrepreneur seeks financing for his first round (early stage finance), which can be financed either by a business angel or a VC. The participating investor then provides $k$ dollars for which he receives $n_i$ shares (the EN holds a single share), with $i \in \{ba, vc\}$ denoting the type of first-round investor. At $t = 2$, the investor decides whether to exert effort into the venture at private cost $c > 0$. This affects the likelihood of achieving a good signal at the interim stage, as described above. At $t = 3$, all parties (entrepreneur, current investor, new investors) receive a signal of the project quality. At $t = 4$, the EN requires an additional amount of investment $K$ to continue the project; otherwise it is stopped and the final value is zero. If the project is continued, the second round of financing must be done by a venture capitalist (either a new one or the one from the first round if being financed by a VC initially), who provides $K$ dollars for $N_i$ shares, with $i \in \{ba, vc\}$ denoting again the type of first-round investor. Finally, at $t = 5$, the outcome is realized. The venture is worth either $G$ or $A$. Parties receive payments according to the fraction of of outstanding shares they hold.

[9] To keep the analysis simple, we exclude the possibility that an angel investor can partially finance the second round. This means that the difference between $k$ and $K$ must be "sufficiently large" or that the business angel's available wealth for investments in a single venture is limited to $k$.

# 4 Selecting an early stage investor

To investigate the trade-off on investor choice for the first financing round, we proceed as follows. In Section 4.1, we analyze the outcome under BA finance, while in Section 4.2 the outcome under VC finance. In Section 4.3, we then compare these two outcomes to derive optimality conditions. Note that the analysis provided in this section can be generalized by considering the choice between constrained and unconstrained investors, given that the sole difference between business angels and venture capitalists merely is with respect to the amount of capital that can be supplied to the EN. In Section 4.4, we then derive implications for the ownership structure of these ventures.

But before this, let us derive the first-best outcome as interesting benchmark for the subsequent analysis. The first-best is characterized as the outcome that is based on joint profit maximization.

**Lemma 1 (First-best):** *The first-best outcome is achieved when the effort of the first-round investor is verifiable. In this case, it always involves venture capital finance in both rounds. The resulting expected profit for the EN is* $\Pi_{fb}^{en} = X(G-K) - k - c$ *whenever exerting effort is optimal.*

**Proof:** See Appendix.

For the first-best to be achieved, VC finance must be chosen, since it guarantees efficient continuation; even in the event of a "pessimistic" outcome $A$. To ensure that first-best level of effort is exerted, effort must however be verifiable. Any inefficiency (second-best outcome) due to a lack of verifiability would reduce incentives to add appropriate value, especially for venture capitalists. The resulting expected profit for the EN, $\Pi_{fb}^{en}$, provides an important benchmark for what follows in this section to understand the inefficiency costs obtained in the context examined in this paper.

## 4.1 Early stage financed by a business angel (constrained investor)

In this subsection, we focus on situations where the first round is financed by a business angel, and the second round (if follow-up financing is secured) by a venture capitalist. We consider only equilibria in which the participating BA exerts appropriate effort to affect the intermediate outcome.[10] Let us solve the game at hand using backward induction.

If the interim signal at $t = 3$ is "pessimistic", the venture is stopped under Condition 1, since it refrains outside VCs from screening the project. If the signal is "promising", then many venture capitalists compete for financing the second round, in which case they require at least to

[10] Otherwise, it is always optimal for the EN to select a VC (even if the VC would not exert any effort either), since at least it guarantees project continuation.

be compensated for their capital investment $K$ in the second round:

$$\left(\frac{N}{1+n+N}\right) G \geq K \tag{1}$$

Under perfect competition between venture capitalists, Equation (1) becomes binding so that the equilibrium number of shares is:

$$N_{ba}^{*} = (1+n)\,\frac{K}{G-K} \tag{2}$$

Otherwise, no venture capitalist will invest and the project is stopped. Note that $N_{ba}^{*}$ is increasing in $n$, the number of shares issued the first round to the BA. This stems from the fact that the VC requires more shares to achieve a certain fraction of shareholding in the venture, the greater the number of shares already issued so far (the total number of shares issued at $t=1$ being $(1+n)$). This inevitably also impacts the ownership stake of the entrepreneur if he issued too many shares previously. Terms offered in the previous round therefore critically affect terms to be offered in follow-up rounds. Similarly, first-round investors need to properly anticipate the impact of future dilution in the terms set at $t=1$.

In $t=2$, the BA will exert effort if and only if his expected gains from exerting effort is greater than what he would obtain without effort (for a given contract). In other words, the following incentive compatibility constraint needs to be satisfied:

$$X\left(\frac{n}{1+n+N_{ba}^{*}}\right) G + (1-X)\,0 - k - c \geq x\left(\frac{n}{1+n+N_{ba}^{*}}\right) G + (1-x)\,0 - k \qquad \text{or:}$$

$$x\,(\delta-1)\left(\frac{n}{1+n+N_{ba}^{*}}\right) G \geq c \tag{3}$$

To ensure that this is the case, appropriate compensation needs to be offered to the BA at $t=1$. Equation (3) says that for the BA the additional gains from exerting such effort (left-hand side) must outweigh the implied costs (right-hand side). Under strong competition among business angels at $t=1$, the BA's incentive compatibility condition (equation (3)) is binding so that the equilibrium number of shares, $n_{ba}^{*}$, equals:[11]

$$n_{ba}^{*} = \frac{c}{x\,(\delta-1)\,(G-K) - c} \tag{4}$$

[11] The BA's participation constraint is $X\left(\frac{n}{1+n+N_{ba}^{*}}\right) G + (1-X)\,0 - k - c \geq 0$, which sets an upper bound on $k$, if the incentive compatibility constraint is to be binding; cf. the BA's incentive-compatibility constraint. Otherwise, the participation constraint would drive contract design and not the incentive compatibility constraint. We examine the case where the participation constraint is binding in the robustness section. There, we also derive the condition under which the participation constraint is not binding, namely $k \leq c/(\delta-1)$ (see equation (29)).

The EN's expected profit under early stage BA finance, $\Pi_{ba}^{en}$, is[12]

$$\Pi_{ba}^{en} = X\left(\frac{1}{1+n_{ba}^{*}+N_{ba}^{*}}\right)G + (1-X)\cdot 0 = \delta x\,(G-K) - \frac{\delta c}{\delta - 1} \tag{5}$$

The first term gives the expected value of the venture, gross of any first-round costs. The second term are the first-round costs associated with providing the right incentives to the BA in the first-round (and implicitly meeting his participation constraint for his capital investment $k$) and thus the total compensation accruing to the BA (under the first-best, this was equal to $k+c$). This result (equation (5)) is summarized in the next proposition:

**Proposition 1 (BA finance):** *Under BA finance in the first round, the entrepreneurial expected profit is increasing in $G$ and $\delta$, but decreasing in $K$ and $c$.*

**Proof:** Simply derive first-order conditions from Equation (5).

While the results regarding $G$, $K$, and $c$ are intuitive (they are either direct benefits or costs),[13] a brief discussion about $\delta$ is perhaps warranted (recall that $\delta \equiv X/x$). An increase in the difference in probabilities measures the effectiveness of the first-round investor's effort. Thus, the more effective is effort on the project outcome, the greater the expected value of the project and thus the greater the expected profit level of the entrepreneur.

The resulting *expected* entrepreneurial ownership, $\alpha_{ba}^{en}$, equals

$$\alpha_{ba}^{en} = X\left(1 - \frac{N_{ba}^{*}}{1+n_{ba}^{*}+N_{ba}^{*}} - \frac{n_{ba}^{*}}{1+n_{ba}^{*}+N_{ba}^{*}}\right) + (1-X)\cdot 0 \tag{6}$$

$$= x\delta\left(1 - \frac{K}{G} - \frac{c}{Gx\,(\delta-1)}\right) \tag{7}$$

Equation (7) gives information on the equity stake that in equilibrium the EN needs to give up in the first round ($c/G\,(X-x)$) and second round ($K/G$) to investors, however only in case of successful interim stage; therefore the parameter $X$ in front of the whole bracket.

### 4.2 Early stage financed by a venture capitalist (unconstrained investor)

In this section, we examine outcomes when the venture capitalist gets involved from the beginning and thus finances both rounds. Again, we solve using backward induction.

If the signal is good at time $t=3$, we still obtain:

$$N_{vc}^{*} = (1+n)\,\frac{K}{G-K} \tag{8}$$

[12] The fact that the amount $k$ does not enter the equation is a direct implication from the assumption that the participation constraint of the BA is not binding. In Section 5.4, we derive solutions when this condition is binding.

[13] Note that the amoutn $k$ does not enter the condition, since we consider the participation constraint of the BA not binding.

It now differs however if the signal is bad due to the less promising outcome $A$. Under Condition 2 (Section 3), the current VC will still find it worthwhile to continue the project by injecting the additional amount $K$, since he does not require screening costs. But instead he will benefit from full bargaining power vis-a-vis the EN. The latter will be fully diluted by the first-round VC investor. For simplicity, let us suppose that the EN only receives a small epsilon that still makes him willing to pursue the project, but that this epsilon is close to zero. This means that $N$ eventually converges to infinity as epsilon goes to zero.[14]

Note that the first-round VC will not be fully diluted by the EN if the signal is good, since he is at least able to receive what another (i.e., new) VC would ask. This is given by equation (8). The number of shares, $N_{vc}^*$, gives what another VC would require for financing the expansion stage, which in this case also gives what the first-round VC investor can obtain; otherwise he would leave the financing of the second round to another VC investor. In equilibrium there is no difference between the same VC and another VC if interim outcome is "optimistic" (thus, $G$). It only matters for the "pessimistic" outcome.[15]

At time $t = 2$, the first-round VC will exert effort iff

$$X\left(\frac{n}{1+n+N_{vc}^*}\right)G + (1-X)A - k - c \geq x\left(\frac{n}{1+n+N_{vc}^*}\right)G + (1-x)A - k \tag{9}$$

The fact that the VC obtains the value of $A$ in case the venture does not achieve the best outcome $G$ reduces his incentives to exert as much effort as a BA (whose benefit in this situation would be zero, just like the EN). To this end, the VC needs to be given more shares for the same level of effort induced, namely

$$n_{vc}^* = \frac{x(\delta-1)A + c}{x(\delta-1)(G-A-K) - c} \tag{10}$$

which requires that $x(\delta-1)(G-A-K) - c > 0$. The EN's expected profit then is

$$\Pi_{vc}^{en} = X\left(\frac{1}{1+n_{vc}^*+N_{vc}^*}\right)G + (1-X)\cdot 0 = \delta x(G-K-A) - \frac{\delta c}{\delta-1} \tag{11}$$

This is always less than under BA finance (see equation (5)), which means that it is never optimal to ask a VC to finance the first round while at the same time expecting him to be incentivized as

[14] Here we take an extreme view by assuming that the VC has all the bargaining power. In principle, we do not need such an extreme assumption to achieve qualitativeley similar results, but only that the VC has more bargaining power than under the optimistic outcome. It avoids introducing an additional parameter into the analysis that measures how the value $A$ is shared between the EN and the VC. One often evoked scenario that supports the assumption that the EN may retain some bargaining power is the inalienability of the entrepreneurial human capital (in the spirit of Hart and Moore, 1994).

[15] Venture capital contracts typically include so-called rights of first refusal clauses. This guarantess the early investors can participate in follow-up round at least up to the same fraction as their current shareholding. This means that the EN first needs to offer the shares to current investors before offering them to outsiders. Since however the price that insiders need to pay under this clause is the same a outsiders would pay, the inclusion of a right of first refusal clause is irrelevant to the outcome examined here.

much as a BA. The costs for providing him proper incentives are higher due to the fact that the VC can secure the value of $A$ in the event of the "pessimistic" outcome, while the BA would obtain no value at all. This requires that the EN gives up more equity stake to a VC than a BA.[16] We summarize this in the next Proposition.

**Proposition 2 (Incentivized VC finance):** *When the VC is given the same incentives as a BA, venture capital finance becomes more expensive for the entrepreneur.*

**Proof:** See Appendix.

The incentives of the VC are always lower due to the positive value of $A$. This requires from the entrepreneur to give the VC a higher equity stake to provide incentives similar to a business angel.

If however the EN decides not to provide appropriate incentives to the VC, the equilibrium equity contract (now denoted $n_{vc}^{**}$) must be such that the VC is at least ready to provide first-round finance. In other words, only his participation constraint must be satisfied. This requires that:

$$x\left(\frac{n}{1+n+N_{vc}^{*}}\right)G+(1-x)\,A-k\geq 0 \tag{12}$$

$$\text{i.e.,}\quad n_{vc}^{**}=\frac{k-A\,(1-x)}{x\,(G-A-K)+A-k} \tag{13}$$

In equilibrium, the expected shareholding of a VC if he finances both rounds is:

$$\alpha^{vc} = x\left(\frac{n_{vc}^{**}+N_{vc}^{*}}{1+n_{vc}^{**}+N_{vc}^{*}}\right)+(1-x)\,1 \tag{14}$$

$$= 1-\frac{1}{G}\left[x\,(G-A-K)+A-k\right] \tag{15}$$

which is increasing in $k$ and $K$, but decreasing in $G$, $A$ and $x$.

Then, effort is not provided but funding continuation is guaranteed through the early involvement of a VC, who is then committed to provide second-round finance even when the venture lacks optimistic prospects at $t=3$. Under this scenario, the EN's expected profit level is given by

$$\Pi_{vc}^{en} = x\left(\frac{1}{1+n_{vc}^{**}+N_{vc}^{*}}\right)G+(1-x)\,0 \tag{16}$$

$$= x\,(G-K)-\left[k-(1-x)\,A\right] \tag{17}$$

[16] This result is specific to the assumptions made on bargaining power when the signal is bad. If the VC only gets part of $A$, this then results in improved incentives to the VC while still securing continuation. It highlights the main source of inefficiency in the frameowrk considered, namely the dilution effect that reduces VC's incentives and makes the EN at times prefer BA finance over VC finance.

Now, the value $A$ enters the EN's profit level positively, due to the fact that it enables him to reduce $n_{vc}^{**}$ in the event that the VC is not properly incentivized. This contrasts with equation (11), where $A$ negatively affects the entrepreneur's expected profits.

The next Proposition provides results on the optimality of providing incentives to the VC under sole VC finance:

**Proposition 3 (VC finance without incentives):** *Under VC finance, it is optimal for the EN to provide right incentives to the VC iff*

$$\text{i.e., } x\left(\delta-1\right)\left(G-K-A\right) \geq A+\frac{c\delta}{\delta-1}-k \tag{18}$$

**Proof:** Simply compare equations (11) and (16) and see when the former is larger. □

The condition stated in Proposition 3 compares additional benefits and costs from providing incentives to exert effort to the venture capitalist in the first round of financing.

The EN's expected ownership under complete VC finance (but without effort at the early stage) is:

$$\alpha_{vc}^{en} = x\left(1-\frac{N_{vc}^{*}+n_{vc}^{**}}{1+n_{vc}^{**}+N_{vc}^{*}}\right)+\left(1-x\right)0 = 1-\left(x\frac{N_{vc}^{*}+n_{vc}^{**}}{1+n_{vc}^{**}+N_{vc}^{*}}\right)-\left(1-x\right)1 \tag{19}$$

$$= 1-\frac{1}{G}\left(Kx+k-\left(1-x\right)A\right)-\left(1-x\right) \tag{20}$$

where the first term is the total equity stake issued to investors (both rounds combined) in case of successful interim stage (namely $\left(\frac{N_{vc}^{*}+n_{vc}^{**}}{1+n_{vc}^{**}+N_{vc}^{*}}\right)$), and the second term in case of unsuccessful interim stage (namely 1, since the EN gets fully diluted).

### 4.3 Optimal choice of investor type

We now turn to the comparison between VC finance and BA finance in the first round. To focus on the most interesting cases, we limit our analysis to parameter values that compare scenarios in which the BA would exert effort but not the VC. We examine the optimal financing source from the perspective of the entrepreneur. The optimal choice trades off the gains associated with better incentivized business angels in the first round (see equation (5)) against seeking the early commitment of a venture capitalist in the first round in order to secure follow-up funding but at sub-optimal effort level and risk of dilution (given by equation (16)). The result is given in the following Proposition:

**Proposition 4 (Optimal type of investor):** *It is optimal for the entrepreneur to choose BA finance over VC finance for the first round of investment whenever*

$$x\left(\delta-1\right)\left(G-K\right) > \frac{c\delta}{\left(\delta-1\right)}+\left[\left(1-x\right)A-k\right] \tag{21}$$

**Proof:** We need to solve for $\Pi_{ba}^{en} > \Pi_{vc}^{en}$ using equations (5) and (16), and rearrange terms. □

The left-hand side of the condition stated in Proposition 4 represents the additional expected valuation for the EN, the first term on the right-hand side the compensation of the first-round BA and the second term on the same side is the compensation under VC finance in the first round. In other words, the right-hand side is the additional costs associated with choosing a BA in the first round, knowing that he needs to be given appropriate incentives.

Corollary 1 provides comparative statics results on equation (21).

**Corrolary 1 (Comparative statics on the optimal type of investor):** *Business angel finance is more likely when $\delta$ is large, $c$ small, $A$ small, $G$ high, $k$ large and $K$ small.*

A large value of $k$ makes VC finance more costly, while low effort costs $c$ makes BA finance less expensive. The parameter $k$ is present in the condition through the participation compatibility of the VC. A high value of $G$ or a small $K$ leads to higher valuations after the second round, resulting in a lower dilution of the entrepreneurial equity stake. While this makes both types of financing sources cheaper, it particularly affects angel finance, since the highest valuation is most likely through angel finance (given the effort exerted by the business angel). A similar intuition holds for $\delta$, as it further increases gains from angel finance via effort-induced value-adding. In economic terms, $\delta$ measures that quality of active investors, both BAs and VCs.

### 4.4 Impact on entrepreneurial ownership and "living deads"

In this section, we translate the optimal investor choice derived in Section 4.3 into its impact on expected entrepreneurial ownership, measured by the expected fraction of shares held by the entrepreneur. We further extend the analysis in the case of so-called "living deads" (as defined below).

Results obtained so far relate to entrepreneurs who are solely driven by pure profit-maximization. Empirical studies on entrepreneurial firms however provide evidence that control issues often play a critical role in entrepreneurial startups next to monetary rewards.[17] Hamilton (2000), Dyck and Zingales (2004), Frey and Benz (2004) and Moskowitz and Vissing-Jorgensen (2002) indicate that control benefits may be substantial and therefore are likely to also affect an entrepreneur's decisions related to control. For instance, Hamilton (2000) finds that the median earnings differential between self-employment and paid employment is 35% for individuals in business for 10 years, a findings that can only be explained by substantial non-pecuniary benefits that compensate self-employed persons. Similarly, Moskowitz and Vissing-Jorgensen (2002) show that the return on private equity is lower than public equity, while at the same time those holding private equity

[17] Kirilenko (2001) provides a theoretical discussion of venture capital finance and control benefits.

(through the own business they run) hold under-diversified portfolios. The authors argue that this can only be explained through other, non-monetary gains.

In theoretical modeling, this is typically dealt with by including the value of private benefits of control perceived by the entrepreneur as exogenous parameter (see, e.g., Dewatripont and Tirole, 1994 and Schwienbacher, 2008a, just to cite a few).[18] This in turn creates a mix of objectives as the entrepreneur will maximize expected profits as well as take into account the impact on his extent of control over the firm. In some cases, these two objectives have conflicting interests, in other cases not. When benefits are directly related to control, an alternative approach is to see which outcome maximizes the entrepreneur's equity stake (Kirilenko, 2001; Schwienbacher, 2007). Control-driven entrepreneurs will aim at minimizing the number of share to be issued so that their "independence" vis-a-vis investors is greatest. Let us adopt this second approach here as it seems more appropriate.[19]

Let us simplify the analysis by considering purely control-driven entrepreneurs whose sole objective is to maximize his own expected ownership rather than expected profits (or more generally his personal expected wealth). The next proposition shows the result from comparing the different expected equity stakes of the entrepreneur for the different investor types:

**Proposition 5 (Entrepreneurial ownership):** *The outcome discussed in Proposition 4 also maximizes entrepreneurial expected ownership in the context described in Section 3.*

**Proof:** See Appendix.

In the setting at hand, maximizing expected ownership is equal to maximizing expected profits of the entrepreneur so that both maximization problems yields exactly the same outcome. This is because the EN received a fraction of realized profits. Maximizing this fraction represents at the same time the entrepreneur's expected ownership when only common equity is considered.

One important reason for this irrelevance result is the fact that the venture is stopped under BA finance after an unsuccessful first round. This then results in a zero equity stake for the entrepreneur. Let us now consider a case that is not uncommon in venture finance, namely when ventures can continue to live as "living deads"; i.e., they failed to achieve their growth objectives but do not make losses so that they can in principle continue to "live". In such cases, some entrepreneurs may want to continue running the firm as long as it give him a subsistence revenue and allows him to stay independent.

[18] This differs from private benefits that entrepreneurs (and managers in general) may extract from the company they manage in the form of perks that reduced company value as a result of imperfect monitoring by shareholders. In this case, these benefits are endogenous. (In fact, Kirilenko, 2001, combines both approaches.)

[19] In fact, the first approach is often problematic, since it is unclear in our base model which investor type would lead to more control benefits for the entrepreneur. The second approach (Kirilenko, 2001; Schwienbacher, 2007) circumvents many of these concerns, while making the value of control benefits an endogenous outcome.

To be more specific, suppose the venture can be pursued after a bad first-round without any additional funding but that the continuation value is only a very small $\varepsilon \geq 0$. This typically characterizes "living deads" that venture investors sometimes continue to hold in their portfolio (largely because there is no way to generate a meaningful value nor to exit them). In this case, without a second round of financing the equity stake of the EN remains as in the first round. Note that this additional assumption does not affect the outcome for purely profit-maximizing ENs, since continuation value remains close to zero. Let us also impose that the VC can force a second round of financing even after an unsuccessful first round. This assumption can be motivated by the fact that VCs typically hold more control rights such as the right to replace management. This means that the EN would be fired and lose control of the venture if he opposes against new capital injection by the VC (this threat is however only credible if the investor has deep pockets, thus not for BA). Moreover, it has the financial resources to undertake the second round that then yields $A$.

Then, the outcome under VC finance would remain the same as previously, but it would be different under BA finance, making the latter more interesting for "control-driven" entrepreneurs.[20] This is summarized in Proposition 6.

**Proposition 6 (Living deads):** *If the venture can become a living dead after an unsuccessful first round, then control-driven entrepreneurs will more often prefer BA finance than purely profit-maximizing entrepreneurs.*

**Proof:** See Appendix.

This results is driven by the different outcome for BA finance (for VC finance, there is no impact of entrepreneurial type). This provides a possible explanation for why some entrepreneurs prefer to rely on business angels for their first round while others bypass them by seeking venture capital right up-front.

Goldfarb et al. (2008), for instance, show strong evidence that angel financed ventures are more likely to end up in a low growth state than under VC finance. Instead of being stopped, these ventures continue to survive and generate low returns to investors. Eventually, they are spun off by selling shares at very low price back to founders.

While it could be argued that VCs are less reluctant than BAs to pull the plug (the reason for this is not clear however), we provide here an alternative rationale, stemming from the type of entrepreneurial ventures that business angels select ex ante. This self-selection effect is at the core of our channel that drives results.

[20] In our model, we would obtain qualitatively similar results for entrepreneurs maximizing the probability of survival.

# 5 Extensions and Robustness

## 5.1 Early-stage finance by unskilled investors

Venture capital and business angel investors outside the US are often considered as lacking required skills to add value in their entrepreneurial investees, although some catching up have started to occur (Bottazzi and Da Rin, 2004; Lerner and Schoar, 2005; Hege et al., 2006; Da Rin et al., 2006; Schwienbacher, 2008b; Kaplan et al., 2007; Armour and Cumming, 2008). Given country-level differences in the degree of market development for the provision of equity capital to entrepreneurs, we extend here our base model to investigate how the optimal investor choice is affected by this difference.

Let us consider the absence of skilled business angels and venture capitalists in the economy considered in our base model. In other words, suppose we only have passive investors in the economy. Under passive investors, we do not mean investors that are passive in equilibrium – due to their decision not to become active – but investors who do not have the skills to add value nor assist their investees in the way considered in the previous section.

We obtain the following proposition:

**Proposition 7 (Passive investors):** *In an economy without any skilled early-stage investors, first-round funding never occurs by business angels in equilibrium but by venture capitalists. The outcome is equivalent to opting for venture capitalists that lack incentives in the first round.*

**Proof:** See Appendix.

From our analysis above, we can see that there is little room for passive investors in the first round as their participation constraint becomes binding and their IC constraint irrelevant. In our trade-off, active participation of early-stage investors is key to secure follow-up financing whenever the EN takes angel capital in his first round. Otherwise, the entrepreneur faces discontinuity risk. Then he would always be better off with a venture capitalist, even if he does not provide the appropriate incentives to add value (which we impose in this subsection), but at least the entrepreneur secures follow-up funding.

## 5.2 Syndication between the BA and the VC in first round

One concern about the base model discussed in Sections 3 and 4 may be that a business angel and a venture capitalist could co-invest (so-called "deal syndication") together in the first round, where the business angel takes an equity stake that gives him the incentives to exert appropriate effort while the venture capitalist takes a very small, residual stake in order to be an "insider" for the

second round of financing.[21] In this case, the VC would not need to incur screening costs $S$ before providing second-round financing $K$. This would ensure right value-adding in the first round by the BA as well as secure follow-up financing through co-investment of the venture capitalist. The BA would still have incentive to exert effort (if rewarded through appropriate equity stake), since he still risks dilution of his stake after an unsuccessful first round (regardless whether the project is continued).

To be more specific, suppose that in the first round the BA provides a fraction $\phi$ of the amount $k$ and the VC the rest (i.e., the amount $(1-\phi)\,k$).[22] This generates several effects. The first direct effect is to reduce the incentives of the BA, since he then holds less equity for the solution given by equation (4). This then requires giving more shares to him than $\phi n^*_{ba}$; on the other hand, it increases the chances of continuity of the project, since a VC is involved early. Therefore, syndication generates a linear combination between costs/benefits of BA finance and VC finance at the early-stage round. However, the additional costs associated with syndication increases with $(1-\phi)$, the fraction of the first round that is financed by the venture capitalist.

Note that as long as the BA's incentive-compatibility constraint (equation (3)) is binding, this will always entail some costs to the EN, since the BA nevertheless requires the same stake as before (to make him exert appropriate effort) but additional shares need to be issued to the VC for the investment $(1-\phi)\,k$. To keep the BA's fraction constant requires however that more shares are given to the BA too. Thus, benefits from syndication largely depend on the extent to which the VC can dilute the others in the second round. If EN and BA get fully diluted, the venture will be continued but the gains go to the VC, eliminating all the monetary benefits for the EN.[23] This means that it would entail costs for the EN but without benefits, besides the fact that at least continuation is guaranteed at fully diluted second round. This means that our results are largely robust to syndication.

[21] Empirical evidence on syndication between venture capitalists is large. For syndication between venture capitalists and business angels, cf., e.g., Goldberg et al. (2008).

[22] For sake of realism, a lower bound should be set to $\phi$. Among other reasons, this can be motivated by its limitation in getting involved in ventures. This can be easily rationalized. For instance, suppose that a fund has \$3 available and that all ventures require \$1 in their second round. This fund can then either fund three ventures at their second round, or fund two second rounds while using the remaining \$1 to finance the first round of these two same ventures (for instance \$0.50 each). Here, it is useless for this VC to finance further ventures at their first round, since the VC is not able to provide any follow-up finance to them (and thus the EN still faces the discontinuity risk).

[23] If syndication also affects bargaining power so that the VC has no more full power (as assumed throughout the analysis), results may change. Indeed, syndication would only make sense in this context if the EN had some bargaining power in the second round to share $A$ with the VC even without counter-offer. However, this only works if it allows the EN to attract more than what compensates him for his outside options (which here has normalized to zero). However, it is not clear why this should happen.

### 5.3 Absence of competition between BAs and VCs in the first round

In this section, we investigate the impact of a lack of competition between both types of investors on the entrepreneurial outcome. This scenario is likely when VC funds are particularly large, as we have witnessed in recent years due to significant inflows of capital (Gompers and Lerner, 1999; Jeng and Wells, 2000; Cumming et al., 2005; Kaplan and Schoar, 2005). Indeed, several studies have argued that an "equity gap" may exist below a certain amount, since VCs do not invest in ventures anymore at the time they require small amounts of capital only. The "niche" is then left to business angels (Cressy, 2002; Ibrahim, 2008). This in turn generates a lack of competition between these two types of investors.[24]

In this case, only BAs may ultimately be willing to finance the first round. In this section, we consider how such a market segmentation between both types of investors would affect the outcome obtained in Section 4. A difference arises when it would have been optimal to choose VC finance, since then the entrepreneur must rely on the second-best source of finance. In this specific case, this will lead to more angel finance. This directly impacts entrepreneurial activities in the economy in various ways. In scenarios where the optimal source of finance is angel finance, the presence of an equity gap has no effect on outcome (as long as the BA market remains competitive after the market segmentation). The general condition is given in Proposition 8.

**Proposition 8 (Absence of competition):** *In the absence of competition between business angels and venture capitalists in the first round (through an "equity gap"), an inefficiency may arise whenever Equation (21) is not satisfied. This leads to the following inefficiency costs:*

$$\text{inefficiency cost} = \quad (xG + (1-x)A - k - Kx) - \delta x (G - K) - \frac{c\delta}{\delta - 1} \tag{22}$$

In other words, the economic cost is more likely to affect less valuable ventures, since then VC finance is more likely to be optimal while at the same time generating highest inefficiency costs (costs increases as $G$ decreases). On the other hand, most valuable ventures do not seem to be affected since for them BA finance is preferred anyway (see Proposition 4 and Corollary 1) in which case the inefficiency costs are zero.

### 5.4 When the participation constraint of the BA is binding

We can extend the analysis to the case where the BA's participation constraint is binding; i.e.,

$$X\left(\frac{n}{1+n+N_{ba}^{*}}\right)G + (1-X)\,0 - k - c = 0 \tag{23}$$

[24] Along a complementary vein, Kanniainen and Keuschnigg (2004) examines how investments in entrepreneurial firms are affected by scarce venture capital support. However, it does not incorporate angel finance into the analysis.

where $N^*_{ba} = (1+n)\frac{K}{G-K}$. This will become more likely when the initial capital requirement $k$ is "large" relative to project value $G$; i.e., keeping $G$ constant. Note that the BA's IC constraint still needs to be satisfied (equation (3)). Then, the business angel needs to be given more equity than to simply satisfy his incentive-compatibility constraint. This is given by equation (23), which in equilibrium gives the following equity outcome:

$$n^{**}_{ba} = \frac{c+k}{x\delta\,(G-K)-(c+k)} \tag{24}$$

The resulting entrepreneur's expected profit level under optimal provision of incentives to the business angel then is

$$\begin{aligned} \Pi^{en}_{ba} &= X\left(\frac{1}{1+n^{**}_{ba}+N^*_{ba}}\right)G + (1-X)\cdot 0 && (25)\\ &= x\delta\,(G-K)-(c+k) && (26)\end{aligned}$$

In this case, the costs for providing incentives is exactly equal to $c$ (under the scenarios that the IC constraint is not binding, which we examine below). This is exactly the same as in the first-best outcome; however without insuring continuation of the venture. To see its impact on the choice of optimal investor, this outcome (equation (26)) needs to be compared with the entrepreneur's expected profit level under VC finance (equation (11)).

In equilibrium the participation constraint only becomes binding iff

$$X\left(\frac{n^*_{ba}}{1+n^*_{ba}+\left(1+n^*_{ba}\right)\frac{K}{G-K}}\right)G-k-c=0 \text{ with } n^*_{ba}=\frac{c}{x\,(\delta-1)\,(G-K)-c} \text{ (see equation (4))} \tag{27}$$

i.e.,

$$k = \frac{c}{(\delta-1)} \tag{28}$$

which yields the following expected profit level for the entrepreneur:

$$\Pi^{en}_{ba} = \begin{cases} \delta x\,(G-K)-\frac{\delta c}{\delta-1} & \text{if } k \le \frac{c}{(\delta-1)} \text{ or } \delta \le \frac{c+k}{k} \\ \delta x\,(G-K)-(c+k) & \text{otherwise} \end{cases} \tag{29}$$

**Proposition 9 (Effect on optimal choice of investor):** *Whenever $k > \frac{c}{(\delta-1)}$, BA becomes less likely since more costly. BA finance is then preferred only when*

$$x\,(\delta-1)\,(G-K) > c+(1-x)\,A$$

**Proof:** Simply compare equation (29) with equation (5). It shows that both profit levels are the same for $k \le \frac{c}{(\delta-1)}$, but that (29) is lower than in equation (5) otherwise. This is because BA now requires more share to receive proper incentives. In this case, angel finance becomes less likely than in Proposition 4. To show this, one needs to compare equation (26) with equation (11).

In other words, angel finance becomes more costly for large initial investments $k$, since the BA's participation constraint is more likely to be binding. This in turn makes venture capital finance at times more attractive. Moreover, greater value-adding (the parameter $\delta$) also makes angel finance more costly when the BA's participation constraint is binding. This is because the BA's incentive compatibility constraint is more likely binding quickly, lowering the number of shares that need to be given to the BA for appropriate effort (i.e., $n_{ba}^*$). In this case, it is more likely that his PC becomes binding.

Overall, BA finance becomes less likely. This corresponds to the doted surface in Figure 2. This is due to the fact that when $k$ is small, the BA's participation constraint is more likely to become binding; this in turn requires the EN to relinquish a greater equity stake to the BA in the first round. Angel finance then becomes less worthwhile in relative terms.

# 6 Empirical Implications and Concluding Remarks

In this section, we derive empirical implications from the theoretical results obtained in previous sections. We further present empirical results that pertain to these predictions that have already been tested to indicate for which we find empirical support.

A first set of predictions pertain to the optimal choice of investor in early stages. Our model derived optimality conditions that trades off discontinuation risk and appropriate incentives. It shows that business angels are more likely to provide more value adding, given the risk of dilution in case of an unsuccessful early-stage round. As a result, expected returns should be higher on average (keeping everything else constant) for ventures that started with investors with limited capacities, because of their greater incentives to add value. These constrained investors can be business angels or small VCs. On the other hand, investors with large resources (such as large venture capitalists) have less incentives in helping entrepreneurial firms in early rounds, since they are able to finance follow-up rounds even when no new investors are willing to participate. Testing this prediction empirically requires controlling for differences in other investor-specific characteristics such as reputation and skills.

To our knowledge, the only paper that clearly compares venture capital investments with business angel investments is the study by Goldfarb et al. (2008). Other studies usually focus on either one or the other type of investor.[25] For instance, Wong (2002) only have data on business angel transactions. Importantly, studies perform an ex post analysis while the prediction stated above is on ex ante nature. Ex post, those financed by business angels may actually have a higher failure rate due to discontinuation risk.

[25] Cosh et al. (2009) investigated an even larger spectrum of sources of finance, incl. banks, leasing forms and suppliers; however in a broader theoretical and empirical setting than the one of interest here.

Moreover, this does not imply that the most successful companies will first be funded by business angels, since entrepreneurs with largest investment requirements are more likely to prefer venture capital, especially given the financial constraints of business angels. Our prediction pertains to entrepreneurs that can endogenously choose between both types of finance. This limitation is consistent with one of the major findings provided by Goldfarb et al. (2008); i.e., deal size segments both markets.

The theoretical framework also has empirical predictions with respect to important changes in supply to venture capital by institutional investors. As argued by other studies (e.g., Cressy, 2002, and Ibrahim, 2008), a gap may appear subsequent to large capital inflows into the venture capital market (as witnessed during the IT bubble and again now, though at a lesser extent). This is likely affecting the supply of early-stage finance, since venture capitalists now avoid smaller transactions (consistent with findings of Cosh et al., 2009). Indeed, since they now have larger funds to manage but cannot invest in much more companies due to the amount of time needed in each company, VC managers invest in larger deals. This makes early-stage investments less attractive to them. Business angels then face less competition from venture capitalists for smaller investments. Our model predicts that this however may come at the expense of entrepreneurs (even if the supply of business angel is highly competitive), especially if they would otherwise prefer to be funded by a financially unconstrained investor such as a venture capitalist. When an equity gap arises, less valuable ventures are at highest risk of incurring important economic costs, since then VC finance is more likely to be optimal for these ventures while not being available to them. On the other hand, most valuable ventures do not seem to be affected since for them BA finance is preferred anyway in which case the inefficiency costs are likely to be negligible.

A further interesting area where the presented analysis offers predictions is with respect to control-driven entrepreneurs. Living deads are more likely under BA finance, however not because of lack of incentives of business angels to be involved but rather because angel capital is the preferred source of finance for ventures that are not liquidated after unsuccessful round (where follow-up funding is not optimal). Related evidence is provided by Goldfarb et al. (2008) who indicate that living deads are more likely under angel finance (even after controlling for several firm and contracting characteristics). Their results fully support the idea that control-driven entrepreneurs more often use angel finance, especially when deal size is small.

To conclude, this study enables to explain an important difference between business angels and venture capitalists in terms of involvement in startup companies. Within the trade-off considered, it provides optimality conditions for the choice of early-stage investor, from the perspective of the entrepreneur. At the same time, this study raises several new questions. One is whether and when the interests of the entrepreneur are in line with those of the early investors. Whenever this is the case, the latter can rely on the entrepreneur for negotiating follow-up financing (leaving bargaining

power issues aside) by large investors such as venture capitalists. Otherwise, business angels will need to be involved in the negotiation process to defend their own interests. In this study, both interests were aligned so that no conflict raised between entrepreneur and business angel at the interim stage. But in other contexts this may not be the case, creating additional problems for entrepreneurs as he looks at making his venture grow. For instance, the entrepreneur at times may want to deliberately dilute the influence of initial investors by inviting new ones to enter if he finds it optimal to transfer more shareholder power to other investors (either because they are more skilled or their vision on how the venture should grow is more in line with the vision of the entrepreneur). More generally, further investigation is needed to understand how such a conflict of interest could affect the choice of investor but also the incentives of investors to add value in entrepreneurial firms in the context of deal syndication, stage financing and the bargaining process itself.

# 7 Appendix

**Proof of Lemma 1 (First-best outcome):** The first-best outcome is the one that maximizes joint profits of all parties involved. This may be achieved if the investor's effort is contractible (and thus verifiable). Then, it is best to choose a venture capitalist who is financially unconstrained for the second round and that can be induced to exert optimal level of effort through contractibility of effort. Under the assumption of effort verifiability, the cost of compensating for exerting effort is the same for both investor types, namely $c$.

Under BA finance, the joint profit is $XG + (1 - X) 0 - k - XK - c$. Under VC finance, joint profit is $XG + (1 - X) A - k - K - c$. Thus, VC finance is preferred to BA finance iff

$$XG + (1 - X) A - k - K - c \geq XG + (1 - X) 0 - k - XK - c$$

This holds whenever $A \geq K$, which is the case under Condition 2. □

**Proof of Proposition 2 (on the difference in expected profits between incentivized angel and venture capital finance)** We need to compare the entrepreneur's expected profits when both are given the incentives to exert effort. This requires that we compare the result in equation (5) for angel finance with the one in equation (11) for VC finance. Taking the difference yields

$$\begin{aligned} &= \left[\delta x (G - K) - \frac{\delta c}{\delta - 1}\right] - \left[\delta x (G - K - A) - \frac{\delta c}{\delta - 1}\right] \\ &= \delta x A \end{aligned}$$

which is strictly positive. □

**Proof of Proposition 5 (on entrepreneurial ownership)** We need to show that an entrepreneur that maximizes expected ownership (as opposed to his own expected profits) yield the same outcome on the type of investors as derived in Proposition 4. This proportion considers the case where the BA is given optimal effort, while VCs not. Such an entrepreneur will then receive the following expected fraction of shares:

$$\alpha_{ba}^{en} = X\left(1 - \frac{K}{G} - \frac{c}{G\left(X-x\right)}\right)$$

under BA finance (see equations (6) and (7)), and

$$\alpha_{vc}^{en} = 1 - \frac{1}{G}\left(Kx + k - \left(1-X\right)A\right) - \left(1-x\right)$$

under VC finance (see equations (19) and (20)). In this case, BA finance is strictly preferred to VC finance whenever $\alpha_{ba}^{en} > \alpha_{vc}^{en}$. Plugging into the equations above the optimal levels of $n_{ba}^{*}$, $N_{ba}^{*}$, $n_{vc}^{**}$, and $N_{vc}^{*}$, as done in equations (7) and (20), yields the following condition for $\alpha_{ba}^{en} > \alpha_{vc}^{en}$:

$$X\left(1 - \frac{K}{G} - \frac{c}{G\left(X-x\right)}\right) > 1 - \frac{1}{G}\left(Kx + k - \left(1-X\right)A\right) - \left(1-x\right)$$

After rearranging terms, we obtain the same condition as in Proposition 4. This means that maximizing the entrepreneur's expected profits is yields the same outcome as maximizing his expected ownership in the company. □

**Proof of Proposition 6 (on "living deads")** Under VC finance, the outcome is as before: $\Pi_{vc}^{en} = x\left(G-K\right) - \left[k - \left(1-x\right)A\right]$, with $\alpha_{vc}^{en} = x\left(1 - \frac{N_{vc}^{*}+n_{vc}^{**}}{1+n_{vc}^{**}+N_{vc}^{*}}\right) = 1 - \frac{1}{G}\left(Kx + k - \left(1-x\right)A\right) - \left(1-x\right)$. This is because the VC can enforce a second financing round through his deep pockets, which allows him to credibly threaten the EN to replace him otherwise. Under BA finance, the EN's equity stake now is: $\alpha_{ba}^{en} = X\left(1 - \frac{N_{ba}^{*}}{1+n_{ba}^{*}+N_{ba}^{*}} - \frac{n_{ba}^{*}}{1+n_{ba}^{*}+N_{ba}^{*}}\right) + \left(1-X\right)\left(\frac{1}{1+n_{ba}^{*}}\right)$. The last term is new, since previously this term was equal to zero. However, the BA still requires the same equity stake $n_{ba}^{*}$ in the first finance round (see equation (4)). This directly implies that control-driven ENs are more likely to choose BA finance as compared to pure profit-maximizing ones, for whom the last term equals zero. □

**Proof of Proposition 7 (on unskilled investors)** We need to show that unskiled investors are always suboptimal in the first round, regardless whether VC or BA. The relevant benchmark is provided in Proposition 4, with the entrepreneurial expected profits given by equation (5). We therefore need to show that (1) unskilled BAs are strictly inferior to active BAs, and (2) unskilled BAs are inferior to passive VCs. The third case (unskilled VCs versus passive VCs) is irrelevant here, since they lead exactly to the same outcome. As for the forth possible case (unskilled VCs

versus active BAs), the analysis is similar to comparing acitve BAs with passive VCs in the context examined here.

The outcome for active angel investors is provided in Section 4.1; cf. equation (5). There, expected profits for the EN is $\delta x\left(G-K\right)-\frac{\delta c}{\delta-1}$. As for passive angels, we need to consider a first-round BA that does not exert the effort. This eliminates BA's incentive compatibility constraint and leaves us with the following participation constraint for the BA:

$$X\left(\frac{n}{1+n+N^{*}}\right)G+\left(1-X\right)0-k\geq 0$$

with $N^{*}=\left(1+n\right)\frac{K}{G-K}$. This yields $n^{*}=\frac{k}{Gx-k-Kx}$ and, as a result, $\Pi^{en}=x\left(G-K\right)-k+\left(1-x\right)A$.

As soon as it is optimal for the BA to exert effort (which are the scenarios we focus on), this level of profit is inferior by assumption; otherwise, it is identical to a business angel that does not exert appropriate effort. For Case 2, unskilled BAs will always be inferior, since it does not guarantee continuation while effort level is the same (namely zero). □

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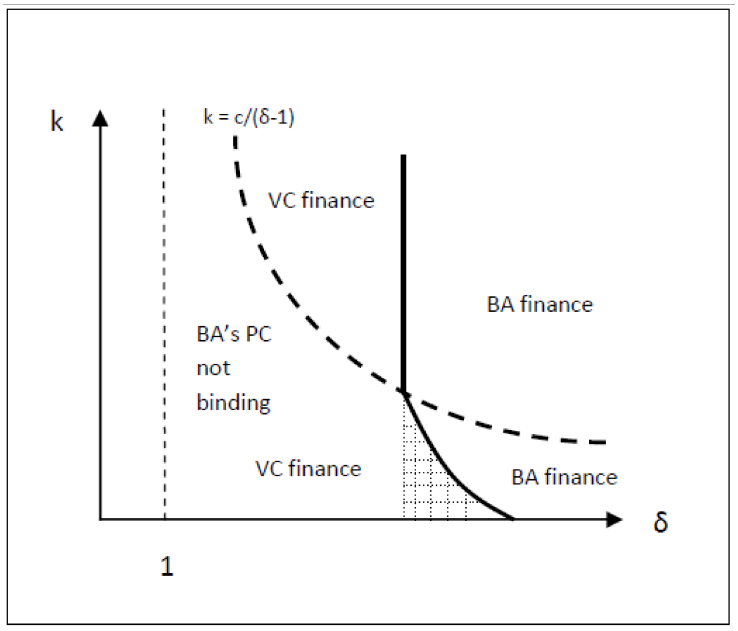


Figure 2: Optimal investor choice – initial investment and value-adding; Note: the doted line represents the condition below which the BA's participation constriant is binding, while the dark line determines the conditions on the optimal investor choice.

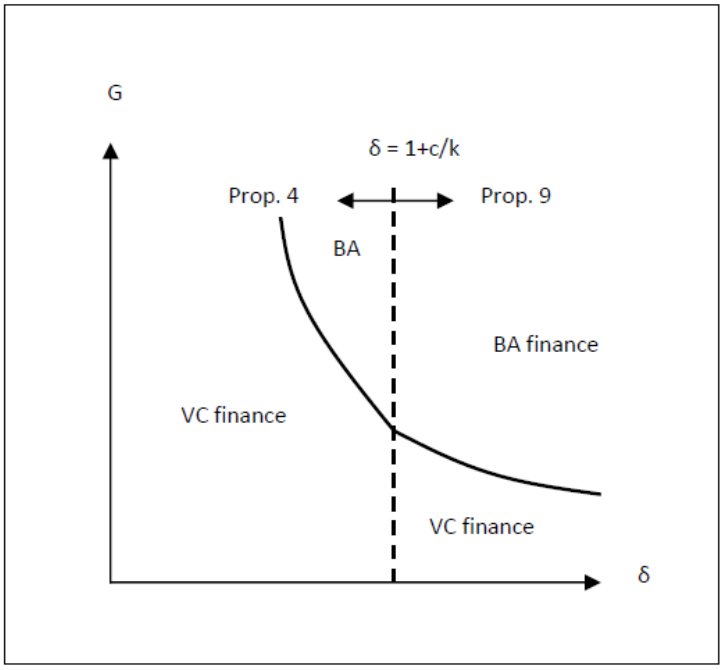


Figure 3: Optimal investor choice – upside potential and value-adding; Note: the doted line represents the condition below which the BA's participation constriant is binding, while the dark line determines the conditions on the optimal investor choice.