Bargaining with Venture Capitalists when Non-Supportive Financing is an Option

Antoine Renucci

Université Paris-Dauphine, DRM-CEREG, Place du Maréchal de Lattre, 75775 Paris cedex 16, France, antoine.renucci@dauphine.fr

WORKING PAPER DRM-FINANCE n° 2008-8

In this paper, I examine the bargaining process between entrepreneurs looking for funds to finance a project and supportive financiers such as venture capitalists. I study the impact of the level of competition between supportive financiers, and the opportunity to resort to non-supportive financiers such as banks and uninformed bondholders, on the outcome of the negotiation and on the entrepreneur's decision to address one type of financiers rather than the other. I show that the entrepreneur's personal wealth, even when it is not invested in the project, is crucial.

Key words: Bank; venture capital; supportive financing; non-supportive financing; competition

Bargaining with Venture Capitalists when Non-Supportive Financing is an Option

Antoine Renucci

Université Paris-Dauphine, DRM-CEREG, Place du Maréchal de Lattre, 75775 Paris cedex 16, France,

antoine.renucci@dauphine.fr

In this paper, I examine bargaining between entrepreneurs looking for funds to finance a project and supportive financiers such as venture capitalists. I study the impact of the level of competition between supportive financiers, and the opportunity to resort to non-supportive financiers such as banks and uninformed bondholders, on the outcome of the negotiation and on the entrepreneur's decision to address one type of financiers rather than the other. I show that the entrepreneur's personal wealth, even when it is not invested in the project, is crucial.

Key words: Bank; venture capital; supportive financing; non-supportive financing; competition

1. Introduction

The choice of a source of financing is one of the most important decisions entrepreneurs have to make, especially when firms are young. There is ample anecdotal evidence that the entrepreneurs' bargaining power when negotiating contracts with supportive financiers such as venture capitalists or business angels varies over time[1]. Also, many entrepreneurs address banks or lenders that do not play a supportive role. The present paper studies the impact of competition in the venture capital industry, and the entrepreneur's opportunity to resort to non-supportive financiers, on the outcome of the negotiation and the entrepreneurs' choice to address supportive financiers rather than non-supportive financing.

[1] For instance, B. Pavey, general partner by Morgenthaler Ventures, a venture capital firm based in Menlo Park, California, reports that "The economic downturn in high tech has given venture investors exceptional bargaining power" (News.com, October 3, 2002). R. Garland, editor of a research study by Dow Jones Venture One contrasts the entrepreneurs' bargaining power in 2006 with their bargaining power a couple of years before: "I think it is fair to say that entrepreneurs do not have to take rotten deals" (Silicon Valley - San Jose Business Journal, November 17, 2006).

I develop the following simple, agency complete contract model to answer this question. An entrepreneur, protected by limited liability, has an investment project and some wealth, but needs external funds to realize the investment. These funds can be obtained either from a non-supportive financier or from a supportive financier, also protected by limited liability. The supportive financier must exert proper costly effort to advise the entrepreneur. Also, the entrepreneur must exert proper costly effort to make the project profitable and benefit from the supportive financier's advice. There exists some fixed costs to contracting with supportive financiers. Finally, the model takes into account that supportive financiers, contrary to non-supportive financiers, are non-competitive, and that the degree of competition is not steady.

One could expect that entrepreneurs benefit from tougher competition between supportive financiers. Indeed, conditional on supportive financing being possible, the entrepreneur obtains a higher fraction of cash flows as the outcome of the negotiation when there is more competition between suppliers of supportive capital. However, tougher competition between supportive financiers can also be detrimental to the entrepreneur. When competition rises, supportive financiers must abandon some profits in the bargaining process. Then, inducing the financier funding the entrepreneur to exert proper effort can become impossible. Thus, access to supportive financing can be easier when there is *less* competition in the industry.

The outcome of the negotiation between the entrepreneur and the non-competitive supportive financier is given in the model by the generalized Nash bargaining solution, based on market conditions and the options the parties have. In particular, the entrepreneur can benefit from the option to address a non-supportive financier if bargaining with a supportive financier breaks down. Thus, supportive financing makes the entrepreneur obtain at least what he would have with non-supportive financing. It has two consequences. First, when less competition in the industry facilitates access to supportive financing, it implies that *less* competition between supportive financiers can make entrepreneurs earn more money. Second, the option is endogenous, i.e., rich entrepreneurs have an easier access to non-supportive financing (see Holmström and Tirole, 1997). It implies that rich entrepreneurs obtain a higher percentage of the net present value (NPV) than poor entrepreneurs when bargaining with supportive financiers. This is true even if supportive financing demands a lower financial contribution by the entrepreneur than non-supportive financing so that entrepreneurs do not invest all they wealth in the project. But personal wealth makes credible the threat to resort to non-supportive financing.

Contrary to the maintained hypothesis, suppose that the entrepreneur is not protected by limited liability. Access to non-supportive financing is easier since the contract can impose a penalty on the entrepreneur when the project fails, which fosters incentives. It implies that entrepreneurs obtain a higher percentage of the NPV as the outcome of the negotiation with supportive financiers when they have the option to abandon the protection of limited liability.

Previous research has analyzed the entrepreneurs' choice of a financier. By emphasizing the supportive role played by financiers, the present paper differs from a stream of research (e.g., Hellwig 1991, Aghion and Bolton 1992, Rajan 1992, Von Thadden 1995, Yosha 1995, Burkart et al. 1997, Holmström and Tirole 1997, Pagano and Röell 1998, and Ueda 2004) that trades off the benefits of monitoring and its costs (e.g., too much intervention of the financier, extraction of rents and leakage of information to competitors by banks, expropriation of ideas by venture capitalists, etc.). The focus on cash flows rights also distinguishes the present paper from that of Gertner et al. (1994) who rely on control rights. They contrast the high-powered incentives of headquarters endowed with control rights to implement value-enhancing ideas with the low-powered incentives of banks deprived from such rights, and analyze the resulting incentives for project managers[2]. The analysis of a double-sided incentive problem differentiates the present research from that of Marx (1998) where benevolent entrepreneurs are supported by non-benevolent financiers.

The present paper also differs from more recent research on the design of optimal venture capital contracts under double-sided moral hazard (Schmidt 2003, Inderst and Müller 2004, and Repullo and

[2] For a general trade-off between activity of a principal and muted incentives for an agent, see Aghion and Tirole (1997), and Stein (2002).

Suarez 2004) since these papers assume that the supportive financier's participation is always optimal at the start of the business venture. The exception is Casamatta (2003) who studies the choice to resort to consultants or supportive financiers. However, the opportunity to address non-supportive investors is irrelevant in her framework since entrepreneurs are not wealth-constrained.

The paper proceeds as follows. Section 2 presents the model and a full-information benchmark. Section 3 determines what type of financing is best for the entrepreneur when actions are not observable. Conclusions follow. All proofs are in the Appendix.

2. The Model

2.1. Assumptions

An entrepreneur has a project that requires a financial investment I, and owns liquid assets A, with $A < I$. Thus, the entrepreneur needs external funding. He can address a non-supportive financier (NSF). NSFs are competitive. After obtaining financing and burning I, the entrepreneur must exert proper effort, as in Holmström and Tirole (1997). Exerting proper effort costs B, is private information for the entrepreneur, and makes the project succeed with probability $p_h < 1$. Then, the NPV is $v \stackrel{d}{=} p_h R^s + (1 - p_h) R^f - I - B \geq 0$, where R^s are the verifiable cash flows when the project succeeds, and R^f are the verifiable cash flows when the project fails (with $R^s > I > R^f > 0$). Observe that $v \geq 0$ imposes that $B \leq p_h R^s + (1 - p_h) R^f - I$. To make the problem interesting, let $I < p_h R^s + (1 - p_h) R^f$. Exerting insufficient effort reduces the probability of success from p_h to $p_l < p_h$. It makes the project unprofitable: $p_l R^s + (1 - p_l) R^f - I < 0$.

Supportive financiers (SFs) are an alternative to NSFs for the entrepreneur. An SF finances the project *and* helps the entrepreneur. The SF's advice increases the probability of success of the project from p_h to $p_h + \alpha$, with $0 < \alpha \leq 1 - p_h$, conditional on the entrepreneur exerting proper effort[3]. The

[3] An alternative interpretation of the model is that the entrepreneur must choose between maximizing profits and enjoying some private benefits, and that the latter choice is incompatible with benefiting from the SF's advice. Consider the following examples. In a family-run firm, an SF proposes a new marketing policy. This value-enhancing policy is feasible only if the design of the product is modified, which can require replacing some family members by specialists. Similarly, the founder of a firm who enjoys controlling every decision can be forced to change the style of management if

latter assumption reflects that the entrepreneur's managerial contribution to the project is essential. Advising requires exerting proper effort, is private information for the SF, and costs E, with $E < \alpha\Delta R$, where $\Delta R \stackrel{d}{=} R^s - R^f$. The SF and the entrepreneur decide simultaneously and non-cooperatively to exert proper effort or not. Contracting with an SF imposes up-front fixed costs C. Thus, if the entrepreneur and the SF "behave", i.e., exert proper effort, supportive financing ($\mathcal{SF}$) yields $V = v+[(\alpha\Delta R - E) - C)]$, where the term in square brackets represents the net gain or loss of $\mathcal{SF}$ over non-supportive financing ($\mathcal{NSF}$). This net gain (or loss) is the difference between the additional expected cash flows derived from the SF's advice net of the SF's cost of effort, and the costs of writing a complex contract. To make the problem interesting, these costs are not prohibitive, i.e., $C < \min[\alpha\Delta R; \alpha\Delta R - E + v]$. In particular, $C < \alpha\Delta R - E + v$ implies that, although $v > V$ is possible, $V > 0$ always holds. The entrepreneur possibly faces differing market conditions in the market for funds, and in the market for funds and advice: SFs need not be competitive. Thus, the entrepreneur bargains with SFs. The generalized Nash bargaining solution where the entrepreneur obtains λ of the surplus created while the SF obtains $(1 - \lambda)$ is the solution concept adopted here. It is the outcome of a non-cooperative game where parties alternatively make offers until the point where one agrees to what is proposed by the other. It is usual to assume $0 \leq \lambda \leq 1$. Here, $\lambda > 0$ is further imposed for technical purposes. I interpret λ as the level of competition in the $\mathcal{SF}$ industry. In order to determine the outcome of the negotiation, generalized Nash bargaining necessitates to identify the "disagreement point", i.e., the utility of each party if bargaining fails. In this case, the entrepreneur's utility depends on whether $\mathcal{NSF}$ is feasible as discussed later in the text. The SF obtains a reservation utility normalized to 0.

The entrepreneur and the financiers are risk-neutral. They are protected by limited liability in the sense that the only thing to be shared is the outcome of the project. The consequences of relaxing this assumption are discussed later. Let the financier receive F in case of failure of the project and S in

the SF advises that salesmen be empowered in order to best cope with consumers' needs. In the same way, an entrepreneur can invest in research projects that will bring greater recognition among scientific fellows, but will provide less financial return and fall outside the scope of the SF's activities.

case of success of the project. Limited liability imposes that

$$0 \leq F \leq R^f \tag{1}$$

$$0 \leq S \leq R^s. \tag{2}$$

Finally, the entrepreneur cannot raise more than the amount that is necessary to finance the investment because financiers fear to attract fraudulent entrepreneurs.

2.2. First-best Case

Assuming that actions are contractible provides a benchmark. The entrepreneur is required to exert proper effort. Otherwise, the NPV of the project is negative so that obtaining funds is impossible. When $\mathcal{SF}$ is opted for, the SF is also required to exert proper effort.

If $C > \alpha\Delta R - E$, $\mathcal{NSF}$ yields a strictly higher NPV than $\mathcal{SF}$, i.e., $v > V$. NSFs being competitive, the entrepreneur earns v under $\mathcal{NSF}$. He would earn less under $\mathcal{SF}$ since he would have to share a strictly lower NPV with possibly non-competitive SFs. Thus, the entrepreneur opts for $\mathcal{NSF}$. The NSF earns 0.

If $C \leq \alpha\Delta R - E$, $\mathcal{SF}$ yields a higher NPV than $\mathcal{NSF}$, i.e., $V \geq v$. However, V must be shared when SFs are not competitive. If bargaining fails, the entrepreneur obtains v since $\mathcal{NSF}$ is feasible and NSFs are competitive; the SF obtains 0. Thus, the entrepreneur earns $v + \lambda (V - v)$ under $\mathcal{SF}$: $\mathcal{NSF}$ works as a lever in the bargaining process. Hence, the entrepreneur opts for $\mathcal{SF}$ whatever $\lambda < 1$. A fortiori, the entrepreneur prefers $\mathcal{SF}$ when $\lambda = 1$, i.e., SFs are competitive. The SF earns $0 + (1 - \lambda)(V - v)$ whatever $0 < \lambda \leq 1$.

Any sharing rule of cash flows allows to implement the first-best solution provided that every party recoups the funds it invested, market conditions are respected, and limited liability holds. These conclusions do not hold under moral hazard as the next section shows.

3. Optimal Financing

This section explores the entrepreneur's choice of a source of financing under moral hazard.

3.1. Non-Supportive Versus Supportive Financing

First consider $\mathcal{NSF}$. The analysis is similar to that in Holmström and Tirole (1997) except that the project yields strictly positive cash flows when it fails. The sharing rule of cash flows must ensure that the entrepreneur behaves. Thus, the entrepreneur's utility when exerting proper effort must be higher than his utility when exerting insufficient effort, which reduces to

$$(R^s - S) - \left(R^f - F\right) \geq \frac{B}{\delta p}, \tag{3}$$

where $\delta p \overset{d}{=} p_h - p_l$[4]. In words, the difference between the entrepreneur's share of cash flows in case of success of the project and his share of cash flows in case of failure of the project must be sufficient. Suppose that the entrepreneur decides to invest A^* (with $A^* \leq A$). The contract must also ensure that the NSF and the entrepreneur break even, i.e.,

$$p_h S + (1 - p_h)\, F \geq I - A^*, \text{ and} \tag{4}$$

$$p_h\,(R^s - S) + (1 - p_h)\left(R^f - F\right) - B \geq A^*. \tag{5}$$

$\mathcal{NSF}$ is feasible when (**??**), (**??**), (**??**), (**??**), and (**??**) are compatible. The next proposition characterizes the condition on B, the entrepreneur's cost of effort, under which $\mathcal{NSF}$ is feasible, and the value $\mathcal{NSF}$ yields to the entrepreneur[5].

Proposition 1 *There exists* $B_A^{\mathcal{NSF}} > 0$ *such that* $\mathcal{NSF}$ *is feasible if* $B \leq B_A^{\mathcal{NSF}}$. *The entrepreneur earns* v *on* $\left[0, B_A^{\mathcal{NSF}}\right]$.

The intuitions for these results are the following. Suppose limited liability does not hold. Whatever

[4] The entrepreneur exerts proper effort when indifferent between exerting proper effort or not.

[5] When characterizing access to $\mathcal{SF}$, the SF's cost of effort is introduced as a second dimension of the problem. Then, the conditions mentioned just above delineate $B_A^{\mathcal{NSF}}$, the feasibility frontier of $\mathcal{NSF}$ (see Figure 1 below). The subscript A reflects that the frontier depends on this parameter, a relation that is detailed in Corollary **??**.

the magnitude of B (with the qualification that $v \geq 0$), setting F high enough and adjusting S would make the entrepreneur exert proper effort, and the financier and the entrepreneur break even. Here, the entrepreneur is protected by limited liability: F cannot be greater than R^f. As a result, $\mathcal{NSF}$ is impossible when entrepreneurial moral hazard is severe, i.e., $B > B_A^{\mathcal{NSF}}$. Investing $A^* = A$ facilitates the design of incentives. Indeed, the lower the external resources used, the smaller the amount that must be paid back to the NSF, and in turn, the higher the share of cash flows that the entrepreneur receives when the project succeeds. Since SFs are competitive, the entrepreneur obtains v, the NPV of the project when $\mathcal{NSF}$ is feasible.

$\mathcal{SF}$ is the alternative to $\mathcal{NSF}$. Again, the contract must ensure that the entrepreneur exerts effort. It reduces, here, to

$$S - F \leq \Delta R - \frac{B}{\delta p + \alpha}. \tag{6}$$

I will refer to (**??**) as the entrepreneur's incentive compatibility constraint. Observe that the financier's advice makes it more attractive for the entrepreneur to maximize profits- compare (**??**) and (**??**) -since it raises the probability of success of the project by α. This disciplining effect is an indirect benefit of $\mathcal{SF}$[6]. Conditional on (**??**) being verified, the financier exerts effort if

$$S - F \geq \frac{E}{\alpha}. \tag{7}$$

I will refer to (**??**) as the SF's incentive compatibility constraint.

Suppose that $\mathcal{NSF}$ is feasible. If $V < v$, $\mathcal{SF}$ is unfeasible. Indeed, the entrepreneur can obtain v with $\mathcal{NSF}$, which is impossible under $\mathcal{SF}$ since the SF must at least break even. If $V \geq v$, generalized

[6]Discipline can be obtained by other means. For instance, in Holmström and Tirole (1997), the financier *directly* impacts on the entrepreneur's incentives by reducing the entrepreneur's private benefit (i.e., the financier monitors the entrepreneur).

Nash bargaining implies that F and S must verify, to respect market conditions,

$$(p_h + \alpha)\, S + (1 - p_h - \alpha)F - (I + C - A^*) - E = (1 - \lambda)\,(V - v)\,, \tag{8}$$

where A^* (with $A^* \leq A$) is the entrepreneur's financial contribution to the project. The LHS in (**??**) is simply the SF's expected share of cash flows net of the SF's financial investment and cost of effort. In contrast to the first best, $\mathcal{NSF}$ is not feasible when $B > B_A^{\mathcal{NSF}}$ under moral hazard (see Proposition **??**). If $\mathcal{NSF}$ is not feasible, both parties obtain 0 if bargaining fails. Hence, generalized Nash bargaining implies that the entrepreneur obtains $0 + \lambda V$, and the SF, $0 + (1 - \lambda)\, V$, given market conditions λ. Thus, if $\mathcal{NSF}$ is not feasible, F and S must verify

$$(p_h + \alpha)\, S + (1 - p_h - \alpha)F - (I + C - A^*) - E = (1 - \lambda)\, V. \tag{9}$$

Since $0 < \lambda \leq 1$ and $V > 0$, the SF and the entrepreneur break even when $\mathcal{NSF}$ is not feasible. Also, since $0 < \lambda \leq 1$ and $V \geq v \geq 0$ under $\mathcal{SF}$, the SF and the entrepreneur break even when $\mathcal{NSF}$ is feasible. Overall, $\mathcal{SF}$ requires that (**??**), (**??**), (**??**), (**??**), and (**??**) along with $V \geq v$ (or simply (**??**) if $\mathcal{NSF}$ is not feasible) are compatible, which delineates $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$, the feasibility frontier of $\mathcal{SF}$[7]. The frontier is represented in Figure 1, and its characteristics are summarized in the next proposition.

Proposition 2 *There exist* $B_{A,\lambda,\Delta R}^{\mathcal{SF}} \geq B_A^{\mathcal{NSF}}$ *and a function* $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ *defined on* $\left[0, B_{A,\lambda,\Delta R}^{\mathcal{SF}}\right]$ *such that* $\mathcal{SF}$ *is feasible on* $\left\{B \geq 0; E \geq 0; E \leq E_{A,\lambda,\Delta R}^{\mathcal{SF}}(B)\right\}$*. The function* $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ *is non-increasing on* $[0, B_A^{\mathcal{NSF}}]$ *and* $\left]B_A^{\mathcal{NSF}}, B_{A,\lambda,\Delta R}^{\mathcal{SF}}\right]$*. The set* $\left\{B > 0; E > 0; E \leq E_{A,\lambda,\Delta R}^{\mathcal{SF}}(B)\right\}$ *is non-empty. The entrepreneur earns* $v + \lambda\,(V - v)$ *on* $[0, B_A^{\mathcal{NSF}}]$*, and* λV *on* $\left]B_A^{\mathcal{NSF}}, B_{A,\lambda,\Delta R}^{\mathcal{SF}}\right]$*.*

I develop below the intuition for these results when $\mathcal{NSF}$ is feasible. If there is no moral hazard on the SF's side, i.e., $E = 0$, only moral hazard on the entrepreneur's side can make $\mathcal{SF}$ impossible.

[7] The subscripts A, ΔR and λ reflect that the frontier depends on these parameters, a relation that is detailed in Corollary **??** and Corollary **??**, respectively.

Define $B^{\mathcal{SF}}_{A,\lambda,\Delta R}$ as the highest value of B for which $\mathcal{SF}$ is feasible when $E = 0$[8]. $\mathcal{SF}$ must yield higher expected cash flows than $\mathcal{NSF}$ to be feasible. It facilitates the design of the entrepreneur's incentives, and implies that $\mathcal{SF}$ is feasible wherever $\mathcal{NSF}$ is feasible, i.e., $B^{\mathcal{SF}}_{A,\lambda,\Delta R} \geq B^{\mathcal{NSF}}_{A}$.

In general, $E > 0$. Let us examine the shape of $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$. For a start, let $C = 0$. Inspection of (**??**) and (**??**) shows that motivating the entrepreneur conflicts with motivating the SF, which is an indirect cost of $\mathcal{SF}$. For example, granting the SF a large share of cash flows when the project fails fosters the entrepreneur's incentives but automatically diminishes the SF's incentives, and vice versa. It explains the shape of the frontier, at least when $C = 0$: $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is non-increasing in B.

The frontier is given by the combination of (**??**) and (**??**) for intermediate values of B as shown in Figure 1. Otherwise, limited liability and market conditions further constrain $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$. Suppose that B is high. Eq. (**??**) shows that it makes it more difficult to motivate the entrepreneur. At some point, the entrepreneur's incentive problem is so serious that punishing him severely by allocating all cash flows to the SF in case of failure of the project, i.e., setting $F = R^f$, is necessary. If B further rises, motivating the entrepreneur commands to either increase F or decrease S. Increasing F is impossible since it violates the entrepreneur's limited liability. Decreasing S is impossible since the SF would receive less than that dictated by market conditions. Also observe that investing less assets than A would increase the SF's financial contribution to the project, and in turn, the amount that must be paid back to the SF, for given market conditions. Thus, setting $F = R^f$ would be necessary for lower values of B, which would restrain the feasibility of $\mathcal{SF}$. To summarize, when B is high, $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is given by the combination of $F = R^f$ (i.e., the second condition in (**??**) is satisfied with equality), (**??**) binding, and (**??**) where $A^* = A$.

Suppose that B is low. Eq. (**??**) shows that it facilitates the design of the entrepreneur's incentive scheme. Thus, (**??**) is verified for values of E that are larger than when B takes on intermediate values. Inducing the SF to work is all the more difficult as E rises. At some point, F must be set equal to zero

[8] The existence of $B^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is derived by using the same line of argument as the one used when deriving the existence of $B^{\mathcal{NSF}}_{A}$. See the proof of Proposition **??** in the Appendix.

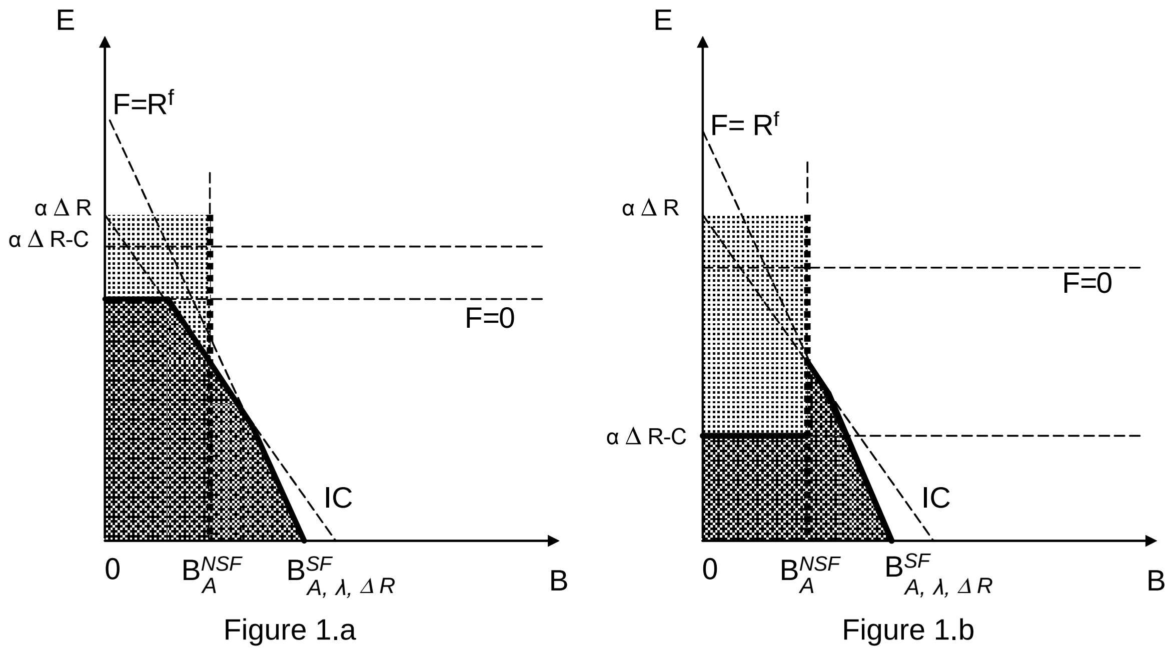

Figure 1: The dashed lines represent (i) the combination of the entrepreneur's and SF's incentive compatibility constraints, denoted IC, (ii) the combination of market conditions, the entrepreneur's incentive compatibility and limited liability constraints, denoted $F = R^F$, (iii) the combination of market conditions, the SF's incentive compatibility and limited liability constraints, denoted $F = 0$, and (iv) the constraint that $V \geq v$, or $E \leq \alpha\Delta R - C$. The bold dotted segments represent the feasibility frontier of $\mathcal{NSF}$. The bold solid line segments represent the feasibility frontier of $\mathcal{SF}$. Figure 1.a shows the feasibility frontier of $\mathcal{SF}$ and the optimal type of financing when contracting costs C are low. The darker hatched area represents the region where $\mathcal{SF}$ is optimal. The lighter hatched area represents the region where $\mathcal{NSF}$ is optimal. The white area represents the region where funding is not possible. Fig. 1.b shows the frontier of $\mathcal{SF}$ and the optimal type of financing when C is large enough that $V \geq v$ binds for some values of B and E.

to punish the SF when the project fails. If E further rises, motivating the SF commands to either set $F < 0$ or increase S. Setting $F < 0$ is impossible without violating the SF's limited liability. Increasing S makes the SF earn a rent above that dictated by market conditions. Since the SF cannot invest more than $I + C$, which would allow her to transfer ex ante some funds to the entrepreneur in exchange for the ex post rent, and since the contract must respect market conditions, this, again, is impossible. Also observe that the entrepreneur increases the SF's financial investment when he reduces his personal contribution to the project from A to $A^* = 0$. In turn, it increases the amount that must be paid back to the SF, for given market conditions, which facilitates the design of the SF's incentives. Thus, $\mathcal{SF}$ is possible for higher values of E. To summarize, when B is low, $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is given by the combination of $F = 0$ (i.e., the first condition in (**??**) is satisfied with equality), (**??**) binding, and (**??**) where $A^* = 0$.

Now consider the impact of $C > 0$ on the shape of the frontier. To be feasible, $\mathcal{SF}$ must yield higher expected cash flows than $\mathcal{NSF}$. It translates into $E \leq \alpha \Delta R - C$. This constraint can bind when C is large and $\mathcal{NSF}$ is feasible as Figure 1.b shows.

The same intuitions apply when $\mathcal{NSF}$ is not feasible, except that $E \leq \alpha \Delta R - C$ is never binding.

Proposition **??** also states that $\left\{B > 0; E > 0; E \leq E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$ is not empty. It simply results from the fact that when the costs B, C, and E are sufficiently low, motivating all parties is compatible with respecting limited liability, market conditions, and $V \geq v$.

The next proposition characterizes the conditions under which one type of financing is preferred to the other.

Proposition 3 *$\mathcal{SF}$ is optimal on $\left\{B \geq 0; E \geq 0; E \leq E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$. $\mathcal{NSF}$ is optimal on $\{B \geq 0; E \geq 0;$ $B \leq B^{\mathcal{NSF}}_A; E > E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\big\}$. Elsewhere, financing is impossible.*

Proposition **??** states that the entrepreneur opts for $\mathcal{SF}$ whenever $\mathcal{SF}$ is sustainable. Indeed, either $\mathcal{NSF}$ is not feasible, and $\mathcal{SF}$ is the only solution, or $\mathcal{NSF}$ is feasible and then works as a lever in the bargaining process so that the entrepreneur earns more under $\mathcal{SF}$, whatever λ. Hence, $\mathcal{SF}$ is optimal when, for a given B, E is sufficiently low to make it possible to simultaneously induce the entrepreneur and the SF to work while respecting limited liability and market conditions, and contracting costs do not reduce the NPV of the project so much that $V < v$. It corresponds to the darker hatched area in Figure 1. Next, suppose that $\mathcal{SF}$ is not feasible. Then, if $B \leq B_A^{\mathcal{NSF}}$, $\mathcal{NSF}$ is feasible and thus, optimal. It corresponds to the lighter hatched area in Figure 1. Otherwise, the project cannot be funded. It corresponds to the white area in Figure 1.

3.2. The Role of Liquid Assets

The next corollary details the impact of the level of liquid assets that the entrepreneur can invest on the feasibility frontiers.

Corollary 1 *A higher A shifts the feasibility frontiers of $\mathcal{NSF}$ and $\mathcal{SF}$ to the right.*

Since the entrepreneur chooses the level of liquid assets he invests in the project, being endowed with more assets makes him at least weakly better off. Consider $\mathcal{NSF}$. When B is large, being rich is useful since it diminishes the external capital required, and in turn, the amount that must be paid back to the NSF. Ultimately, it facilitates the design of the entrepreneur's incentives, as shown in the discussion of Proposition **??**, in the spirit of Holmström and Tirole (1997). This result holds for $\mathcal{SF}$ as well (see the discussion of Proposition **??**). Thus, a higher A shifts $B_A^{\mathcal{NSF}}$ and $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ to the right. However, two remarks are in order here. First, all the segments that delineate $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ are not shifted to the right. In particular, being endowed with larger liquid assets is useless when E is high: The SF is all the more easily motivated as her investment is large (for a related argument, see Casamatta 2003). It is also useless when C is large. Second, the non-negative relation between the entrepreneur's liquid assets and investment capacity is different from that obtained in Gale and Hellwig (1986). They show that the amount the entrepreneur can borrow from lenders is all but a monotonic function of his wealth in their costly state verification framework. The intuition for why investment capacity can decrease in net worth for some parameter values is the following. Let existing debt be substantial so that the borrower's net worth is negative. It can be optimal for NSFs to lend more than when the borrower's net worth is slightly positive. Indeed, in the former case, lending a large amount can allow the entrepreneur to realize a project the size of which will make NSFs recoup the funds they invested (including their initial loan), without increasing that much the already substantial bankruptcy costs. In contrast, when net worth is slightly positive, a large loan makes bankruptcy costs rocket. In the present paper, the borrower's net worth A is positive.

Since the option to resort to $\mathcal{NSF}$ is endogenous and depends on A, the outcome of the negotiation with an SF also depends on A. In terms of percentage of the NPV, the entrepreneur earns $\frac{v+\lambda(V-v)}{V} = \lambda + (1-\lambda)\frac{v}{V}$ if $\mathcal{NSF}$ is feasible, and $\frac{\lambda V}{V} = \lambda$ if otherwise. Thus, Corollary **??** implies that:

For a given level of competition between SFs, rich entrepreneurs obtain a higher percentage of the NPV than poor entrepreneurs when bargaining with SFs.

Observe that the above implication considers the entrepreneur's total personal wealth rather than the wealth actually invested in the project. Indeed, when $\mathcal{NSF}$ is feasible, $\mathcal{SF}$ demands a lower financial contribution by the entrepreneur than $\mathcal{NSF}$ (e.g., $A^* = 0$ when B is low and E is high as seen above). Thus, under $\mathcal{SF}$, entrepreneurs sometimes do not invest all their wealth in the project, whereas they should do so under $\mathcal{NSF}$. But (total) personal wealth makes credible the threat to resort to $\mathcal{NSF}$, and so enables entrepreneurs to get more when bargaining with SFs.

3.3. Competition in the Venture Capital Industry

The venture capital industry is characterized by large variations in capital raised over short periods of time. For instance, according to the National Venture Capital Association, \$104.6 billion were raised in the United States in 2000, \$3.8 billion in 2002, and \$28.6 billion in 2006. The adjustment process between supply and demand is slow, which leads to substantial and persisting imbalances (Lerner 2002). Thus, λ plausibly varies over time. One could expect that the tougher competition in the $\mathcal{SF}$ industry, the lower the price demanded by an SF for funding the project, and thus, the more attractive $\mathcal{SF}$ is for entrepreneurs. It is true that conditional on obtaining supportive financing, the entrepreneur's percentage of the NPV increases in λ (see above). However, less competition can benefit the entrepreneur under the conditions described in the next corollary.

Corollary 2 *A lower λ has no impact on the feasibility frontier of $\mathcal{NSF}$, whereas it shifts the feasibility frontier of $\mathcal{SF}$ up when B and C are low.*

The first result is straightforward. The intuition for the second result is the following. Assume that contracting costs are limited so that $V \geq v$ is never binding. Suppose that B is low. According to the discussion of Proposition **??**, the frontier is given by the combination of $F = 0$ (i.e., the first condition in (**??**) is satisfied with equality), (**??**) binding, and (**??**) where $A^* = 0$. At $\left(\widehat{B}, E^{\mathcal{SF}}_{A,\lambda,\Delta R}(\widehat{B})\right)$, $F = 0$. At $\left(\widehat{B}, E\right)$, where $E > E^{\mathcal{SF}}_{A,\lambda,\Delta R}(\widehat{B})$, $\mathcal{SF}$ is impossible. Indeed, the magnitude of E would require to set $F < 0$, which is impossible since the SF is protected by limited liability, or to increase S, which is impossible since the SF already obtains what market conditions command. If competition decreases, the SF has a right to a higher share of cash flows so that it is possible to simultaneously let $F = 0$ and increase S. Thus, $\mathcal{SF}$ can become possible at $\left(\widehat{B}, E\right)$. A lower λ shifts $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ up as Figure 2 shows[9].

The above result requires that the entrepreneur cannot allocate the SF a share of the profits higher than that required by market conditions. Observe that the entrepreneur in this model is a "black box". Firms are often established by entrepreneurs *and* a management team. Suppose that the entrepreneur proposes to increase the SF's share of profits. Asymmetric information can be an impediment to convince the managers that the entrepreneur does not collude with the SF in order to expropriate them from part of cash flows. Also, asymmetric information can force the entrepreneur to invest part of his financial capital in the project, along with his human capital. In fact, this financial capital often consists of the entrepreneur's actual personal resources but also of friends' and family's contributions. Again, it can be impossible to convince friends and family that the entrepreneur does not collude with the SF to expropriate them. Finally, asymmetric information can make the entrepreneur forgoing profits appear

[9] However, a lower λ can shift the frontier to the left when B is large as Figure 2 shows for $C = 0$.

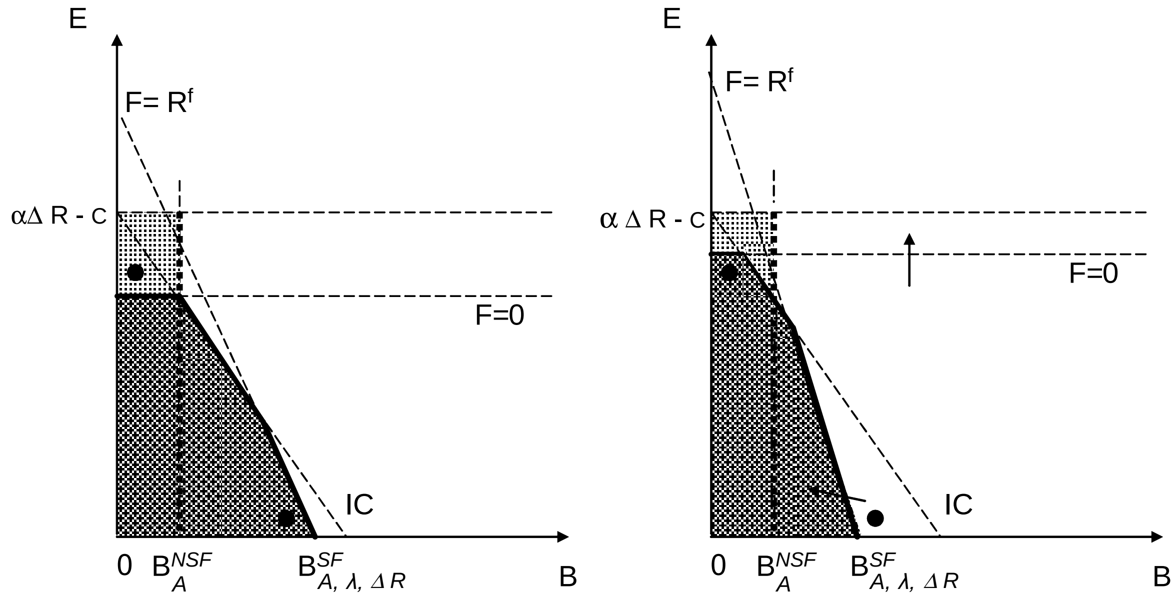

Figure 2.a Figure 2.b

Figure 2: The arrows show the impact of a decrease in the level of competition in the $\mathcal{SF}$ market (i.e., a decrease in λ) on the frontier of $\mathcal{SF}$ and the optimal type of financing. For simplicity, $C = 0$.

an untalented bargainer to outsiders. It can pose too severe problems for future rounds of financing with other partners. The model implicitly assumes that one of these hypotheses is verified. Thus,

Less competition in the $\mathcal{SF}$ industry can (i) ease the access to $\mathcal{SF}$ and (ii) make entrepreneurs earn more money.

As in the present paper, Inderst and Müller (2004) analyze competition between venture capitalists. However, they do not examine whether contracting with an SF is optimal. More specifically, they study the impact of competition on incentives and the valuation of firms. They find that a decrease in competition can raise firms' value if the entrepreneurs' bargaining power previously deprived SFs from the rents necessary to foster their incentives to play a supportive role. However, SFs appropriate this additional value so that entrepreneurs do not benefit from less competition in their context.

3.4. The Absence of Limited Liability

A legal system offering entrepreneurs limited liability has been adopted by most countries in order to encourage enterprise since the former may be reluctant to pledge some of their personal assets, e.g., their house, to obtain financing. However, limited liability is a choice, not an obligation, for entrepreneurs. Contrary to the maintained hypothesis, assume that the entrepreneur is not protected by limited liability, i.e., $F > R^f$ and $S > R^s$ are allowed. Let the entrepreneur own not only liquid assets but also illiquid assets. The entrepreneur can pledge these illiquid assets to the financiers to relax the credit constraint. Because of illiquidity, the value of a unit of illiquid assets is only $\gamma \leq 1$ to the financiers[10]. Thus, every unit of illiquid assets that is pledged reduces the NPV. Hence, pledging the minimum amount of illiquid assets that allows the entrepreneur to be financed is optimal. In particular, when liquid assets are sufficient to obtain financing, illiquid assets should not be used. Besides, pledging these assets only upon project failure is optimal for incentive purposes: It increases the difference between the entrepreneur's revenue in case of success and his revenue in case of failure of the project. It also minimizes the reduction in NPV. The next corollary details the impact of the absence of limited liability on the feasibility frontiers.

Corollary 3 *Suppose the entrepreneur is not protected by limited liability and owns illiquid assets. The feasibility frontiers of* $\mathcal{NSF}$ *and* $\mathcal{SF}$ *are shifted to the right.*

The intuitions for these results are the following. Remember from the discussion of Proposition **??** that setting F high makes the entrepreneur exert proper effort, and the financier and the entrepreneur break even. Since $F > R^f$ is possible when the entrepreneur is not protected by limited liability, $\mathcal{NSF}$ is feasible for higher values of B, which is consistent with standard principal-agent theory under risk-neutrality (e.g., Laffont and Martimort 2002). For the same reason, the credit constraint is relaxed under $\mathcal{SF}$, and $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is shifted to the right when B is high. Overall, more projects are funded. Also, more projects are funded through $\mathcal{SF}$ since $\mathcal{SF}$ is optimal when feasible (see Proposition **??**). However, remember from the discussion of Proposition **??** that inducing simultaneously both parties to

[10] The case where the entrepreneur owns liquid assets larger than A, but chooses to invest A in the project and use the rest as collateral, corresponds to $\gamma = 1$. The case where the entrepreneur incurs a large non-financial penalty P when the project fails, such as being sent to jail, corresponds to $\gamma = 0$.

exert proper effort is difficult under $\mathcal{SF}$. Even without limited liability, this problem remains. Besides, allowing $F > R^f$ does not relax the credit constraint when B is low, so that E can be large, and when C is large. Thus, if under $\mathcal{NSF}$ almost all projects verifying $v \geq 0$ can be funded when the entrepreneur is not protected by limited liability, owns substantial illiquid assets, and these assets are not so illiquid (i.e., γ is close to 1), things are quite different under $\mathcal{SF}$.

Since $\mathcal{NSF}$ is feasible for higher values of B without limited liability, the entrepreneur obtains better financing conditions also for higher values of B. Thus, Corollary **??** implies that:

When bargaining with SFs, entrepreneurs obtain a higher percentage of the NPV when they are not protected by limited liability.

However, this NPV is reduced. Consider an entrepreneur contemplating the choice of a legal form for his firm. Let this entrepreneur anticipate being denied access to $\mathcal{NSF}$ but not to $\mathcal{SF}$ if choosing limited liability, and having access to both types of financing if otherwise. Thus, the entrepreneur faces a trade-off between increasing his share of the NPV and reducing the NPV. Refusing limited liability is all the more attractive as γ is close to 1.

So far, it was implicitly assumed that the entrepreneur's choice to be protected (or not) by limited liability was to be made before the decision to address a financier. Instead, imagine that an entrepreneur protected by limited liability can bargain with a SF while maintaining credible the threat to resort to a NSF because $\mathcal{NSF}$ is feasible if he abandons limited liability. Then, the entrepreneur facing this opportunity obtains a higher share of the NPV.

3.5. First-Best Case Versus Second-Best Case

Let us stress important differences between the first-best and second-best cases. First, under moral hazard, $\mathcal{NSF}$ can be optimal when E is high, even if $C \leq \alpha\Delta R - E$ so that $\mathcal{SF}$ would be worth adopting in the first-best case. Second, even if $\mathcal{SF}$ is feasible in the second best, the entrepreneur earns a lower revenue when $B > B_A^{\mathcal{NSF}}$ because $\mathcal{NSF}$ cannot work as a lever in the bargaining process.

Third, if $C > \alpha\Delta R - E$, $\mathcal{NSF}$ is optimal in the first-best case. However, $\mathcal{NSF}$ is not feasible in the second-best case if $B > B_A^{\mathcal{NSF}}$. Then, $\mathcal{SF}$ can be the only solution available because of its disciplining effect. Fourth, the level of liquid assets owned by the entrepreneur and the level of competition in the $\mathcal{SF}$ industry matter in the second best in terms of access to financing. Also, the level of liquid assets impacts on the entrepreneur's gains in the second best, whereas it does not in the first best. Fifth, some projects are not funded in the second-best case that would, in the first best, optimally receive $\mathcal{NSF}$ if $C > \alpha\Delta R - E$ and $\mathcal{SF}$ if otherwise. Finally, since the sharing rule of cash flows matters in the second-best case, financial claims that are issued have an impact on real decisions. Recent research investigates the optimal securities to be used when moral hazard is double-sided. Casamatta (2003) shows that convertibles implement the optimal sharing rule of cash flows with SFs when efforts are substitutes. It was shown in a former version of the paper (Renucci 2005) that convertibles or a mix of debt and outside equity[11] are optimal when efforts are complements. Schmidt (2003) demonstrates the strict optimality of convertibles when the project's type is unknown at the outset. Finally, Repullo and Suarez (2004) obtain optimal combinations of equity-like claims in a multiple-stage framework with interim information about the project's profitability. These equity-like claims are observed in real-world venture capital contracts (Kaplan and Stromberg 2003). Finally, by using the same line of argument as Innes (1990), straight debt can be shown to implement $\mathcal{NSF}$ (Renucci 2005).

4. Conclusion

In this paper, I show that *less* competition between venture capitalists can benefit entrepreneurs since it provides supportive financiers with a sufficient share of cash flows to induce them to help the entrepreneur. Less competition can also make them obtain better financing terms. Besides, entrepreneurs obtain better deals when bargaining with supportive financiers if they have the option to resort to non-supportive financing. This option is endogenous, i.e., rich entrepreneurs, or those who are not protected by limited liability, have an easier access to non-supportive financing. Thus, they obtain a

[11] The first paper to give a role to outside equity is Flück (1998), but in a context where cash flows are not contractible.

higher percentage of the NPV as the outcome of the negotiation.

While I emphasize the supporting role of financiers, future research could investigate the link between supporting and monitoring functions.

Appendix

Proof of Proposition ??. Were sharing rules of cash flows allowing $F > S$ authorized, the entrepreneur could be induced to collude with a wealthy third party when the project fails if the *origin* of cash flows is not verifiable (Innes 1990). The third party would provide ΔR, and the entrepreneur claim that the project has succeeded so as to pay back S instead of F to the NSF. Let us focus in the proof on sharing rules verifying $S \geq F$ to obtain results that are robust to this specification about the origin of cash flows. Since it turns out that this condition is not binding (see the conclusion of the proof below), it was not mentioned in the text for the sake of brevity.

Observe that (**??**) is satisfied if $S \geq F$, (**??**) and (**??**) hold. It is natural to examine the choice of $A^* = A$ by the entrepreneur since the entrepreneur's incentive problem stems from the fact that he lacks liquid assets. Consider the two following cases.

- Case 1: $A < I - R^f$. Setting $F = R^f$ satisfies (**??**), and relaxes both (**??**) and (**??**). Making (**??**) bind, which is best for the entrepreneur, gives $S = R^f + \frac{I-R^f-A}{p_h}$. Since $A < I - R^f$, $S > F$, and a fortiori $S \geq F$ is verified. Combining (**??**) binding and (**??**) leads to $B \leq \frac{\delta p}{p_h}(p_h\Delta R + R^f - I + A)$.
- Case 2: $A \geq I - R^f$. Setting $S = F = I - A$ satisfies $S \geq F$, and also (**??**) since $I - R^f \leq A < I$. It satisfies (**??**) until $B \leq \delta p \Delta R$. It implies that (**??**) binds.

Since (**??**) binds both in Case 1 and Case 2, the entrepreneur obtains v. Condition (**??**) is satisfied since $v \geq 0$, or $B \leq p_h\Delta R + R^f - I$. Observe that the latter is more stringent a constraint than $B \leq \delta p \Delta R$ since $p_l\Delta R + R^f - I < 0$. To summarize, $\mathcal{NSF}$ is feasible if

$$B \leq B_A^{\mathcal{NSF}} \stackrel{d}{=} \min\{\frac{\delta p}{p_h}(p_h\Delta R + R^f - I + A); p_h\Delta R + R^f - I\}. \quad (10)$$

Observe that $B_A^{\mathcal{NSF}} > 0$ since $I < p_h \Delta R + R^f$.

Finally, note that $S \geq F$ is never binding, even in Case 2 (i.e., when $A \geq I - R^f$), provided that the entrepreneur invests $A^* < I - R^f$ (as in Case 1), instead of $A^* = A \geq I - R^f$.

Proof of Proposition ??. In a first step, let us determine $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$, the feasibility frontier of $\mathcal{SF}$. Observe that (i) the combination of (**??**) and the first inequality in (**??**) implies the first inequality in (**??**), and (ii) the combination of (**??**) and the second inequality in (**??**) implies the second inequality in (**??**). Also observe that (**??**) assures that the sharing rule of cash flows verifies $S \geq F$[12]. To summarize, the following constraints must be compatible[13]:

$$S - F \leq \Delta R - \frac{B}{\delta p + \alpha} \tag{IC_e}$$

$$S - F \geq \frac{E}{\alpha} \tag{IC_{SF}}$$

$$(p_h + \alpha) S + (1 - p_h - \alpha) F - (I + C - A^*) - E = (1 - \lambda)(V - v) \text{ if } B \leq B_A^{\mathcal{NSF}} \tag{$O^{\mathcal{NSF}}$}$$

$$V - v \geq 0 \text{ if } B \leq B_A^{\mathcal{NSF}} \tag{$\mathcal{SF}$}$$

$$(p_h + \alpha) S + (1 - p_h - \alpha) F - (I + C - A^*) - E = (1 - \lambda) V \text{ if } B > B_A^{\mathcal{NSF}} \tag{$NO^{\mathcal{NSF}}$}$$

$$0 \leq F \leq R^f. \tag{LL^f}$$

Consider the two following cases.

- Case 1: $\mathcal{NSF}$ is feasible, i.e., (**??**) holds. Consider A^* as given. Conditions (**??**) and (**??**) are

[12] Note that introducing a third party, for example an NSF entitled to all cash flows in case of failure of the project, and no cash flows in case of success, would theoretically facilitate the design of incentives. Indeed, both the SF and the entrepreneur would be severely punished when the project fails. It would break the budget constraint, in the spirit of Holmström (1982). Nevertheless, such a third party's reward scheme is difficult to implement since the SF and the entrepreneur are induced to collude when the project fails if the *origin* of cash flows is not verifiable: The wealthy SF provides ΔR, and claims, along with the entrepreneur, that the venture has succeeded in order not to pay back R^f to the NSF. Again, when the third party's reward is non-decreasing in the outcome, introducing such a third party eventually does not facilitate the design of incentives.

[13] IC stands for incentive compatibility, while the subscript e refers to the entrepreneur. $O^{\mathcal{NSF}}$ stands for option to resort to $\mathcal{NSF}$, and $NO^{\mathcal{NSF}}$ for no option to resort to $\mathcal{NSF}$. LL stands for limited liability and the superscript f (respectively, s) refers to the failure (respectively, success) of the project.

compatible provided that

$$E \leq \alpha \left(\Delta R - \frac{B}{\delta p + \alpha} \right). \tag{11}$$

Rewrite (??) as $S = \frac{I - A^* + (1-\lambda)\alpha\Delta R + \lambda(C+E) - (1-p_h-\alpha)F}{p_h+\alpha}$. Condition (??) imposes that F be sufficiently high, i.e., $F \geq S - \Delta R + \frac{B}{\delta p + \alpha}$, for a given S verifying (??). It is compatible with $F \geq 0$, the first inequality in (??). It is compatible with $F \leq R^f$, the second inequality in (??), provided that

$$E \leq \frac{p_h \Delta R + R^f - I + A^* + \lambda (\alpha \Delta R - C) - \left(\frac{p_h+\alpha}{\delta p+\alpha}\right) B}{\lambda}. \tag{12}$$

Condition (??) imposes that F be sufficiently low, i.e., $F \leq S - \frac{E}{\alpha}$, for a given S verifying (??). It is compatible with the second inequality in (??). It is compatible with the first inequality in (??), provided that

$$E \leq \frac{\alpha}{\alpha (1-\lambda) + p_h} \left[I - A^* + \lambda C + (1-\lambda) \alpha \Delta R \right]. \tag{13}$$

Besides, (??) must hold, or

$$E \leq \alpha \Delta R - C. \tag{14}$$

Let us determine the conditions under which each of these constraints is binding. First compare (??) and (??), that do not depend on B. Note that (??) is more stringent than (??) if $C < \frac{\alpha[p_h \Delta R - (I - A^*)]}{\alpha + p_h}$. In this case, and keeping in mind that $B \leq B_A^{\mathcal{NSF}}$, observe that (??) binds when B is low. When B rises, (??) binds. When B further rises, (??) binds. If $C \geq \frac{\alpha[p_h \Delta R - (I - A^*)]}{\alpha + p_h}$, (??) is more stringent than (??) and binds when E takes on sufficiently high values.

Consider the impact of A^* on the frontier. Setting $A^* = A$ relaxes (??). Conversely, setting $A^* = 0$ relaxes (??). The level of liquid assets invested by the entrepreneur neither impacts on (??) nor on (??). Thus, the combination of (??), (??) where $A^* = A$, (??) where $A^* = 0$, and (??) determines the feasibility frontier of $\mathcal{SF}$ when $\mathcal{NSF}$ is feasible.

- Case 2: $\mathcal{NSF}$ is not feasible, i.e., $B > B_A^{\mathcal{NSF}}$. Consider A^* as given. Again, condition (??) must hold. Condition (??) imposes that F be sufficiently high, i.e., $F \geq S - \Delta R + \frac{B}{\delta p + \alpha}$, for a given S verifying (??). It is compatible with $F \geq 0$, the first inequality in (??). It is compatible with $F \leq R^f$, the second inequality in (??), provided that

$$E \leq \frac{\lambda\left[(p_h+\alpha)\Delta R + R^f - (I+C)\right] + A^* - \left[\frac{p_h+\alpha}{\delta p+\alpha} - (1-\lambda)\right]B}{\lambda}. \tag{15}$$

  Condition (??) imposes that F be sufficiently low, i.e., $F \leq S - \frac{E}{\alpha}$, for a given S verifying (??). It is compatible with the second inequality in (??). It is compatible with the first inequality in (??), provided that

$$E \leq \frac{\alpha}{\alpha(1-\lambda)+p_h}\left\{(1-\lambda)\left[(p_h+\alpha)\Delta R + R^f\right] + \lambda(I+C) - A^* - (1-\lambda)B\right\}. \tag{16}$$

  Keeping in mind that $B > B_A^{\mathcal{NSF}}$, observe that (??) binds when B takes on high values. When B diminishes, (??) binds. When B further diminishes, (??) binds.

  Consider the impact of A^* on the frontier. Setting $A^* = A$ relaxes (??). Conversely, setting $A^* = 0$ relaxes (??). Thus, the combination of (??), (??) where $A^* = A$, and (??) where $A^* = 0$ determines the feasibility frontier of $\mathcal{SF}$ when $\mathcal{NSF}$ is not feasible.

In a second step, let us show that, when $E = 0$, there exists $B_{A,\lambda,\Delta R}^{\mathcal{SF}} \geq B_A^{\mathcal{NSF}}$ such that $\mathcal{SF}$ is possible for $B \leq B_{A,\lambda,\Delta R}^{\mathcal{SF}}$. Since $E = 0$, it is optimal to set $A^* = A$ (see the discussion above). First, suppose that $A < I - R^f$ so that $B_A^{\mathcal{NSF}} = \frac{\delta p}{p_h}(p_h\Delta R + R^f - I + A) < p_h\Delta R + R^f - I$.

- Let $\mathcal{NSF}$ be feasible. Setting $F = R^f$ relaxes (??) and satisfies (??). It implies, according to (??), that $S = R^f + \frac{I+\lambda C - R^f - A + (1-\lambda)\alpha\Delta R}{p_h+\alpha}$, which ensures that (??) is verified since $C < \alpha\Delta R$ and $A < I - R^f$. Combining (??) and (??) leads to $B \leq \frac{\delta p+\alpha}{p_h+\alpha}(\left[p_h\Delta R + R^f - I + \lambda(\alpha\Delta R - C) + A\right]$. This threshold is higher than $B_A^{\mathcal{NSF}}$. Hence,

$\mathcal{SF}$ is feasible wherever $\mathcal{NSF}$ is feasible.

- Let $\mathcal{NSF}$ be unfeasible. Setting $F = R^f$ relaxes (??) and satisfies (??). It implies, according to (??), that $S = R^f + \frac{I-R^f+C+(1-\lambda)V-A}{p_h+\alpha}$, which ensures that (??) is verified since $A < I-R^f$ and $V > 0$. Combining (??) and (??) leads to $B \leq \frac{\delta p+\alpha}{(\delta p+\alpha)\lambda+p_l}\left[\lambda(p_h\Delta R + R^f - I + (\alpha\Delta R - C)) + A\right]$.

Next, suppose that $A \geq I - R^f$ so that $B_A^{\mathcal{NSF}} = p_h\Delta R + R^f - I$. Using the same line of argument as above (i.e., when $\mathcal{NSF}$ is feasible), one shows that $B_{A,\lambda,\Delta R}^{\mathcal{SF}} = p_h\Delta R + R^f - I$. Recall that $B > p_h\Delta R + R^f - I$ would imply $v < 0$.

To summarize, when $E = 0$, $\mathcal{SF}$ is feasible if

$$B \leq B_{A,\lambda,\Delta R}^{\mathcal{SF}} \overset{d}{=} \max\left\{B_A^{\mathcal{NSF}}; \min\{\frac{\delta p+\alpha}{(\delta p+\alpha)\lambda+p_l}\left[\lambda(p_h\Delta R + R^f - I + (\alpha\Delta R - C)) + A\right]; p_h\Delta R + R^f - I\right\}. \tag{17}$$

Observe that $B_{A,\lambda,\Delta R}^{\mathcal{SF}} > B_A^{\mathcal{NSF}}$ can require that $A > 0$, in particular when λ is low. When $\lambda = 1$, $B_{A,\lambda,\Delta R}^{\mathcal{SF}} > B_A^{\mathcal{NSF}}$ whatever $A < I - R^f$ since $C < \alpha\Delta R$.

In a third step, let us determine the properties of $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$. Step 1 and Step 2 of the proof imply that $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ is a function of B defined on $\left[0, B_{A,\lambda,\Delta R}^{\mathcal{SF}}\right]$. Inspection of (??), (??) where $A^* = A$, (??) where $A^* = 0$, and (??) shows that $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ is non-increasing on $\left[0, B_A^{\mathcal{NSF}}\right]$. The function $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ is not continuous at $B = B_A^{\mathcal{NSF}}$ when (??) binds. Inspection of (??), (??) where $A^* = A$, and (??) where $A^* = 0$ shows that $E_{A,\lambda,\Delta R}^{\mathcal{SF}}$ is non-increasing on $\left]B_A^{\mathcal{NSF}}, B_{A,\lambda,\Delta R}^{\mathcal{SF}}\right]$.

In a fourth step, let us show that $\left\{B > 0; E > 0; E \leq E_{A,\lambda,\Delta R}^{\mathcal{SF}}(B)\right\}$ is non-empty. By definition, $\mathcal{SF}$ is feasible on $\left\{B \geq 0; E \geq 0; E \leq E_{A,\lambda,\Delta R}^{\mathcal{SF}}(B)\right\}$. According to Proposition ??, there exists $B_A^{\mathcal{NSF}} > 0$ such that $\mathcal{NSF}$ is feasible if $B \leq B_A^{\mathcal{NSF}}$. Let $\mathcal{NSF}$ be feasible. The RHS in (??) is strictly positive because $v \geq 0 \Leftrightarrow B \leq p_h\Delta R + R^f - I$, which is- strictly -more stringent a constraint than $B \leq (\delta p + \alpha)\Delta R$ since $p_l\Delta R^s + R^f - I < 0$. Observe that there exists $B > 0$ such that the RHS in (??) where $A^* = A$ is strictly positive since $C < \alpha\Delta R$. The RHS in (??) where $A^* = 0$ and the RHS in (??) are strictly positive since $C < \alpha\Delta R$. Thus, $\left\{B > 0; E > 0; B \leq B_A^{\mathcal{NSF}}; E \leq E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$ is non-empty, which implies that $\left\{B > 0; E > 0; E \leq E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$ is non-empty.

Finally, it was shown above that $B_A^{\mathcal{NSF}} \leq B^{\mathcal{SF}}_{A,\lambda,\Delta R}$. It is a direct consequence of generalized Nash bargaining that the entrepreneur obtains $v + \lambda\left(V - v\right)$ on $\left[0, B_A^{\mathcal{NSF}}\right]$, and λV on $\left]B_A^{\mathcal{NSF}}, B^{\mathcal{SF}}_{A,\lambda,\Delta R}\right]$.

Proof of Proposition ??. First, $\mathcal{SF}$ is optimal when feasible, i.e., on $\left\{B \geq 0; E \geq 0; E \leq E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$ since the generalized Nash Bargaining solution guaranties a higher revenue to the entrepreneur under $\mathcal{SF}$ than under $\mathcal{NSF}$ both when $\mathcal{NSF}$ is a credible alternative, and when $\mathcal{NSF}$ is unfeasible. Second, when $\mathcal{SF}$ is not feasible, $\mathcal{NSF}$ is optimal if feasible, i.e., if (??) is verified. Thus, $\mathcal{NSF}$ is optimal on $\left\{B \geq 0; E \geq 0; B \leq B_A^{\mathcal{NSF}}; E > E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$. Third, the project is not funded on $\left\{B \geq 0; E \geq 0; B > B_A^{\mathcal{NSF}}; E > E^{\mathcal{SF}}_{A,\lambda,\Delta R}(B)\right\}$.

Proof of Corollary ??. First, it is straightforward from the Proof of Proposition ?? that $B_A^{\mathcal{NSF}}$ increases in A, up to $p_h\Delta R + R^f - I$ (see (??)). Thus, a higher A shifts $B_A^{\mathcal{NSF}}$ to the right. Second, it was shown in the Proof of Proposition ?? that investing all the entrepreneur's liquid assets matters only when B is high. Then, a higher A relaxes (??) and (??), and shifts $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ to the right.

Proof of Corollary ??. First, it is straightforward from the Proof of Proposition ?? that a lower λ has no impact on $B_A^{\mathcal{NSF}}$ (see (??)). Second, consider $\mathcal{SF}$. Suppose that B is so low that $\mathcal{NSF}$ is feasible and $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ is given by (??) or (??) (see the proof of Proposition ??). If $C < \frac{\alpha\ [p_h\Delta R - I]}{\alpha + p_h}$, (??) is more stringent than (??) and the RHS of (??) decreases in λ. Hence, if B and C are low, a lower λ shifts $E^{\mathcal{SF}}_{A,\lambda,\Delta R}$ up.

Proof of Corollary ??. First consider $\mathcal{NSF}$. It has been shown in the proof of Proposition ?? that if $A \geq I - R^f$, $B_A^{\mathcal{NSF}} = p_h\Delta R + R^f - I$, i.e., $\mathcal{NSF}$ is always feasible so that illiquid assets and the absence of limited liability for the entrepreneur are useless.

If $A < I - R^f$, $B_A^{\mathcal{NSF}} = \frac{\delta p}{p_h}(p_h\Delta R + R^f - I + A) < p_h\Delta R + R^f - I$. When $B \leq B_A^{\mathcal{NSF}}$, $\mathcal{NSF}$ is feasible so that illiquid assets and the absence of limited liability are also useless. Suppose instead that

$B > B_A^{\mathcal{NSF}}$. As when the entrepreneur is protected by limited liability, setting $A^* = A$ and granting R^f to the NSF out of the cash flows when the project fails is best for incentive purposes. Also for incentive purposes, it is optimal to pledge illiquid assets to the NSF *only* when the project fails. Since the value of a unit of illiquid assets is 1 to the entrepreneur and $\gamma \leq 1$ to the financier, it also minimizes the negative impact on the NPV. When the entrepreneur pledges a, the NPV is $v - (1 - p_h)(1 - \gamma)\ a$. Leaving $F = R^f + \gamma\ a \geq 0$ to the NSF costs $R^f + a$ to the entrepreneur. Thus, the latter exerts proper effort if $S \leq R^s + a - \frac{B}{\delta p}$. The NSF just breaks even if $S = \frac{I - A - (1-p_h)\left(R^f + \gamma\ a\right)}{p_h}$, which is compatible with the entrepreneur exerting effort if

$$B \leq \frac{\delta p}{p_h}\left[p_h \Delta R + R^f - I + A + ((1 - p_h)\ \gamma + p_h)\ a\right]. \tag{18}$$

The entrepreneur breaks even if $v - (1 - p_h)(1 - \gamma)\ a \geq 0$, or

$$B \leq p_h \Delta R + R^f - I - (1 - p_h)(1 - \gamma)\ a. \tag{19}$$

Inspection of (**??**) and (**??**) shows that a maximum of $a = max\left\{0; \frac{p_l\left(p_h \Delta R + R^f - I\right) - \delta p A}{p_h(1-p_l) - (1-p_h)\ p_l \gamma}\right\}$ can be pledged to the NSF. Comparing (**??**) and (**??**) with (**??**) shows that pledging $a > 0$ shifts the frontier of $\mathcal{NSF}$ to the right.

To be complete, observe that the sharing rule of cash flows satisfies $S \geq F$, and a fortiori $S \geq 0$, if $a \leq \frac{I - R^f - A}{\gamma}$. Thus, $\mathcal{NSF}$ is feasible and the sharing rule satisfies $S \geq F$ if

$$\begin{aligned} &B \leq \min\left\{p_h \Delta R + R^f - I - (1 - p_h)(1 - \gamma)\ a; \frac{\delta p}{p_h}\left[p_h \Delta R + R^f - I + A + ((1 - p_h)\ \gamma + p_h)\ a\right]\right\}, \\ &\text{where } a \leq \underline{a} \overset{d}{=} \min\left\{max\left\{0; \frac{p_l\left(p_h \Delta R + R^f - I\right) - \delta p A}{p_h(1 - p_l) - (1 - p_h)\ p_l \gamma}\right\}; \frac{I - R^f - A}{\gamma}\right\}. \end{aligned} \tag{20}$$

Next consider $\mathcal{SF}$. Suppose that $\mathcal{NSF}$ is feasible. Allowing for unlimited liability neither relaxes (**??**) (see the proof of Proposition **??**), nor (**??**) where $A^* = 0$ and (**??**). Condition (**??**) is relaxed since

$F \leq R^f$ is not any more binding. Thus, the frontier is shifted to the right. The same line of reasoning applies when $\mathcal{NSF}$ is not feasible. Overall, when the entrepreneur is not protected by limited liability, pledging illiquid assets to the SF shifts the frontier of $\mathcal{SF}$ to the right.

References

Aghion, P., P. Bolton. 1992. An incomplete contracts approach to financial contracting. *Rev. Econ. Stud.* **59** 473-494.

Aghion, P., J. Tirole. 1997. Formal and real authority in organizations. *J. Polit. Economy.* **105** 1-29.

Allen, F., D. Gale. 2000. Comparing financial systems. The MIT Press, Cambridge, Massachusetts.

Barry, C. B., C. J. Muscarella, J. W. Peavy, M. R. Vetsuypens. 1990. The role of venture capital in the creation of public companies: Evidence from going public process. *J. Finan. Econ.* **27** 447-471.

Berglöf, E., E. Perotti. 1994. The governance structure of the Japanese financial Keiretsu. *J. Finan. Econ.* **36** 259-284.

Bhattacharya, S., G. Chiesa. 1995. Proprietary information, financial intermediation, and research incentives. *J. Finan. Intermediation* **4** 328-357.

Burkart, M., D. Gromb, F. Panunzi. 1997. Large shareholders, monitoring and the value of the firm. *Quart. J. Econ.* **112** 693-728.

Casamatta, C. 2003. Financing and advising: Optimal financial contracts with venture-capitalists. *J. Finance* **58** 2059-2085.

Fluck, S. 1998. Optimal financial contracting: Debt versus outside equity. *Rev. Financial Stud.* **11** 383-418.

Gale, D., M. Hellwig. 1986. The optimal debt contract: A comparative static analysis. Caress Working paper 86-06.

Gertner, R. H., D. S. Sharfstein, J. C. Stein. 1994. Internal versus external capital markets. *Quart. J. Econ.* **109** 1211-1230.

Gompers, P. A. 1996. A clinical examination of convertible securities in venture capital investments. Working paper, Harvard Business School.

Gompers, P. A., J. Lerner. 2004. *The venture capital cycle.* The MIT Press, Cambridge, Massachusetts.

Gorman, M., W. A. Sahlman. 1989. What do venture capitalists do?. *J. Bus. Vent.* **4** 231-254.

Hellmann, T., M. Puri. 2002. Venture capital and the professionalization of start-up firms: Empirical evidence. *J. Finance* **57** 169-197.

Hellwig, M. 1991. Banking, financial intermediation and corporate finance. Giovaninni A., C. Mayer, eds. *European Financial Integration.* Cambridge University Press, Cambridge UK.

Holmström, B. 1982. Moral hazard in teams. *Bell J. Econ.* **13** 324-340.

Holmström, B., J. Tirole. 1997. Financial intermediation, loanable funds and the real sector. *Quart. J. Econ.* **112** 663-691.

Inderst, R., H.G. Müller, 2004. The effect of capital market characteristics on the value of start-up firms. *J. Finan. Econ.* **72** 319-356.

Innes, R. D. 1990. Limited liability and incentive contracting with ex ante action choices. *J. Econ. Theory* **52** 45-67.

Kaplan, S. N., P. Strömberg. 2003. Financial contracting theory meets the real world: An empirical analysis of venture capital contracts. *Rev. Econ. Stud.* **67** 281-315.

Laffont, J.-J., D. Martimort. 2002. *The theory of incentives.* Princeton University Press, New Jersey, USA.

Lerner, J. 2002. Boom and bust in the venture capital industry and the impact on innovation. *Federal Reserve Bank of Atlanta Economic Review*, 25-39.

Marx, L. M. 1998. Efficient venture capital financing combining debt and equity. *Rev. Econ. Des.* **3** 371-387.

Pagano, M., A. Röell. 1998. The choice of stock ownership structure: Agency costs, monitoring, and the decision to go public. *Quart. J. Econ.* **113** 187-225.

Rajan, R. G. 1992. Insider and outsiders: The choice between informed and arm's-length debt. *J. Finance* **47** 1367-1399.

Renucci, A. 2005. Optimal relationships with value-enhancing financiers. Working paper CEREG, Paris-Dauphine University.

Repullo, R., J. Suarez. 2004. Venture capital finance: A security design approach. *Rev. Fin* **8** 75-108.

Sahlman, W. A. 1990. The structure and governance of venture capital organizations. *J. Finan. Econ.* **27** 473-521.

Schmidt, K. M. 2003. Convertible securities and venture capital finance. *J. Finance* **58** 1139-1166.

Stein, J. 2002. Information production and capital allocation: decentralized vs. hierarchical firms. *J. Finance.* **57** 1891-1921.

Ueda, M. 2004. Banks versus venture capital: Project evaluation, screening and expropriation. *J. Finance* **59** 601-630.

Von Thadden, E.-L. 1995. Long-term contracts, short-term investments, and monitoring. *Rev. Econ. Stud.* **62** 557-575.

Yosha, O. 1995. Information disclosure and the choice of financing source. *J. Finan. Intermediation* **4** 3-20.