Optimal Relationships with Value-Enhancing Investors

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Abstract

This paper studies the decision of entrepreneurs to have tight relationships with value-enhancing financiers like venture capitalists, or loose relationships with non-supportive financiers like banks or uninformed bondholders. Without moral hazard, tight relationships are optimal if their higher up-front contracting costs are limited. Under double-sided moral hazard, two opposite effects are at work. Involving supportive financiers discourages entrepreneurs to abandon private benefits since profits must be shared. On the other hand, involving supportive financiers disciplines entrepreneurs since pursuing private benefits undermines the value of the financiers' advice. In this context, tight relationships are optimal when entrepreneurial moral hazard is limited enough to leave financiers with sufficient residual incentives to improve profits. They are also optimal when entrepreneurial moral hazard is significant while entrepreneurs are poor since they discipline entrepreneurs, and thus relax credit constraints. If contracting costs of tight relationships are significant, loose relationships are optimal in the first best, but fail to be feasible in the second best when entrepreneurial moral hazard is severe while entrepreneurs are poor. While straight debt is shown to implement loose relationships, tight relationships command more complex financial arrangements like selling the project, or issuing convertible preferred equity or participating convertible preferred.

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1. Introduction

In addition to funding, venture capitalists (or business angels) can provide entrepreneurs with information and advice (Gorman and Sahlman 1989, Sahlman 1990, Barry and al. 1990, and Hellmann and Puri 2002). For instance, venture capitalists professionalize their portfolio companies, help them build strategy, look for key personnel, and attract other financiers. They have tight relationships with the firms they finance. Yet, some entrepreneurs contract with banks (or uninformed lenders) that do not play this value-enhancing (or supportive) role, which is puzzling and raises the following questions. When do entrepreneurs resort to tight relationships with supportive financial intermediaries or to loose relationships with non-supportive financiers? What are the financial claims that foster the desired relationships? Why in the United States do banks typically not play the same value-enhancing role as venture capitalists do?

I develop a simple agency complete contract model in order to answer these questions. An entrepreneur is endowed with a project. The entrepreneur needs outside funds from a financier, and can also ask for the financier's advice. Importantly, the project is not profitable and the financier's advice is inefficient if the entrepreneur does not maximize profits[1]. The model captures that contracting with value-enhancing financiers such as venture capitalists is particularly costly since it requires negotiating and writing a complex contract, and paying lawyers large compensations as well as other transaction costs (Gompers 1995). When these contracting costs are limited, tight relationships are optimal in the first best.

This conclusion does not hold under moral hazard, that is, when the entrepreneur can privately pursue goals that do not maximize the value of the project but yield a private benefit, while the

[1] Consider the following examples. In family-run firms, entrepreneurs often prefer employing relatives at the expense of higher profitability. Imagine a supportive financier proposing a new marketing policy which is feasible only if the design of the product is modified. In that case, some of the family members have to be replaced by specialists. Similarly, the founder of a company who enjoys a psychological benefit by controlling decisions can be forced to change the style of management if the venture capitalist's advice implies that salesmen have to be empowered in order to best cope with the 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 will fall outside the scope of the venture capitalist's activities.

financier's costly effort to increase profits is unobservable. Then, the answer to the first question depends on three dimensions: the size of the contracting costs induced by tight relationships (hereafter referred to as contracting costs), the magnitude of entrepreneurial moral hazard, and the level of the entrepreneur's personal wealth. More specifically, the entrepreneur has tight relationships with the financier when entrepreneurial moral hazard is low and contracting costs are limited whatever the entrepreneur's wealth, and also when entrepreneurial moral hazard is severe and the entrepreneur's wealth is limited whatever the contracting costs. Otherwise, and in particular when the magnitude of entrepreneurial moral hazard is intermediate, relationships are loose, that is, the entrepreneur benefits from the financier's money but gives up the financier's help, and accordingly saves the cost of writing a complex contract. The intuitions for these results are developed below.

Consider the case where contracting costs are limited. Tight relationships create more value than loose relationships if the financier exerts a sufficient level of effort to increase profits. However, such an effort requires high-powered incentives for the financier. Unfortunately, motivating the entrepreneur conflicts with motivating the financier since moral hazard is double-sided. This limitation implies that the effort exerted by the financier diminishes when entrepreneurial moral hazard rises. Thus, the entrepreneur would rather organize loose relationships beyond some level of entrepreneurial moral hazard. However, loose relationships can turn out to be infeasible since they are less efficient than tight relationships in providing incentives for the entrepreneur when the latter is poor. The reason is that the financier's advice makes it easier to induce the entrepreneur to abstain from enjoying the private benefit since maximizing profits is then relatively more attractive. Hence, some projects cannot be financed without the financier's advice when entrepreneurial moral hazard is severe. This conclusion is tempered by the fact that personal wealth allows the entrepreneur to have loose relationships with the financier when it is worth. The reason is that the larger the entrepreneur's financial contribution to the project, the fewer the external funds the entrepreneur needs to raise. The entrepreneur must accordingly promise fewer cash flows to the financier when the project succeeds, which facilitates the design of the entrepreneur's incentives. Hence, the larger the entrepreneur's personal wealth is, the higher the level of entrepreneurial moral hazard compatible with financing becomes.

In order to complete the analysis, consider the case where contracting costs are significant. Then, relationships are loose in the first best. This time again, the first-best conclusion does not hold under moral hazard. Indeed, either loose relationships are feasible, hence optimal, or only tight relationships are feasible, hence optimal, thanks to the "disciplining" effect analyzed above.

The answer to the second question is that implementing tight relationships requires more sophisticated financial claims than implementing loose relationships. Loose relationships, typical of bank financing (or financing with bondholders) in the United States, are realized with straight debt which disciplines the entrepreneur, in the spirit of Innes (1990). Two cases arise if relationships are tight. When entrepreneurial moral hazard is low, the initiator of the project sells it (possibly out) to the provider of funds who, as a sole equity owner, has powerful incentives to increase profits. The initiator of the project stays in the firm, undertakes the project, and is induced to maximize profits with a fixed wage and a bonus. When entrepreneurial moral hazard is severe, the financier holds convertible preferred equity or participating convertible preferred. These claims are prominently used in the venture capital industry (Sahlman 1990, Gompers 1996, and Kaplan and Strömberg 2003). The optimal financial contract can equivalently consist in a suitably chosen package of debt *and* equity for the financier.

The answer delivered by the model to the third question, raised by Gompers (p. 1467, 1995), and Hellmann and Puri (p. 195, 2002), is that in the United States banks could not play the value-enhancing role emphasized here since, until recently, the Glass-Steagall Act refrained them from holding equity stakes. The model shows that financiers holding pure debt face fewer incentives to support a firm than financiers holding a mix of debt and equity. It rationalizes why venture capitalists or business angels have emerged in the United States. In contrast, venture capital is more recent and far less developed in Europe or Japan, where banks often hold both debt and equity stakes, and accordingly, can play a supportive rule (for insightful discussions, see Allen and Gale (2000), Berglöf and Perotti (1994), Bhattacharya and Chiesa (1995), and Hellwig (1991)).

Overall, the model leads to the following testable empirical implications which are discussed at length later in the text:

- The entrepreneur's cash-flow rights in case of failure (respectively in case of success) of the project decrease (respectively increase) when entrepreneurial moral hazard rises.
- The entrepreneur's stake as a percentage of the cash flows increases with the outcome.
- The most profitable projects (or firms) are financed by financial intermediaries.
- The profitability of projects (or firms) is an increasing function of the percentage of common equity held by the financier.

Our emphasis on the supportive rule played by financiers differs from previous analyses which focused on monitoring. Thus, we analyze the optimal financial contract providing incentives to the entrepreneur and the financier, in a double-sided moral hazard context. It differs from papers where financiers play a passive role or where the financial contracts are not endogenized (Rajan (1992), Von Thadden (1995), Gertner and al. (1994), Burkart and al. (1997), and Pagano and Röell (1998)). Our comparison of tight relationships and loose relationships differentiates the present paper from Repullo and Suarez (1998), Casamatta (2003), and Schmidt (2003). These papers also investigate the design of entrepreneurs' and value-enhancing financiers' intertwined incentives through the means of optimal financial claims in the context of venture capital. Although these models highlight the incentive role of convertibles, they assume that the advisor-financier's participation to the project is always optimal at the start of the business venture. Thus, they do not investigate when tight relationships are desirable in the first place.

Previous research has analyzed the tightness of relationships between financiers and entrepreneurs concerned with too much intervention of the former (Aghion and Bolton 1992, Gertner and al. 1994, Burkart and al. 1997, Pagano and Röell 1998, and Marx 1998), monitoring costs to incur (Holmström and Tirole 1997), extraction of rents by informed banks (Hellwig 1991, Rajan 1992, Von Thadden 1995), leakage of information to competitors by informed banks (Yosha 1995) or expropriation of ideas by venture capitalists (Ueda 2004). However, these papers do not consider the supportive rule of financial intermediaries examined here, but instead focus on monitoring (with the exception of Gertner and al., 1994). Furthermore, they do not either investigate the above issues in a double-sided moral hazard context (Aghion and Bolton 1992, Rajan 1992, Marx 1998, and Ueda 2004), which amounts to ignoring that both agents must receive appropriate incentives. Or (sometimes and) they focus on the agency problems related to one type of financial claim (debt in Rajan (1992), Von Thadden (1995), and Gertner and al. (1994), or equity in Burkart and al. (1997), and Pagano and Röell (1998))[2], and do not allow incentives schemes to be designed efficiently through optimal financial claims. On the other hand, several recent papers (Repullo and Suarez 1998, and Schmidt 2003) investigate the design of entrepreneurs' and value-enhancing financiers' intertwined incentives through the means of optimal financial claims in the context of venture capital. Although these models highlight the incentive role of convertibles, they assume that the advisor-financier's participation to the project is always optimal at the start of the business venture. Thus, they do not investigate when tight relationships are desirable in the first place.

The paper proceeds as follows. Section 2 presents the model and a full-information benchmark. Section 3 determines what type of relationships maximizes the entrepreneur's utility when actions are not observable. Section 4 characterizes how these optimal relationships can be implemented with financial claims usually observed. 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 is endowed with liquid

[2] Holmström and Tirole (1997), and Ueda (2004), do not distinguish between different financial claims.

assets (or personal wealth) A. The entrepreneur makes an unobservable decision after the investment is sunk. This decision reduces to the following binary choice, which parallels Holmström and Tirole (1997). Maximizing the market value of the project yields $v \stackrel{d}{=} p_h R^S + (1 - p_h) R^F - I > 0$ in the absence of external advice, where R^S are the verifiable cash flows when the project succeeds, R^F are the verifiable cash flows when the project fails (with $R^S > I > R^F > 0$), and $p_h < 1$ is the probability of success of the project. In contrast, enjoying the private benefit $B > 0$ reduces the probability of success from p_h to $p_l < p_h$ so that the project is not profitable: $v - \delta p \Delta R \leq 0$[3], where $\delta p \stackrel{d}{=} p_h - p_l$ and $\Delta R \stackrel{d}{=} R^S - R^F$. The entrepreneur must raise external funds since $A < I$[4]. Thus, she sells financial claims to a financier, which determines the sharing rule of cash flows when the outcome occurs. Since there exists a continuum of financiers that compete to fund the project, the entrepreneur contracts with the financier that proposes the best financial conditions. The riskless interest rate is normalized to zero. Both the entrepreneur and the financier are risk-neutral and protected by limited liability in the sense that the only thing to be shared is the outcome of the project.

The model departs from Holmström and Tirole (1997) by allowing the financier to help the entrepreneur improve profits. Conditional on the entrepreneur abandoning B, the intrinsic value of the financier's advice depends on the costly and unobservable effort the financier exerts[5]. This effort E is a continuous choice variable in the interval $[0, 1]$ and costs $k\frac{E^2}{2}$. Exerting E increases the probability of success of the project from p_h to $p_h + E\ \alpha$, with $0 < \alpha \leq 1 - p_h$. The financier's effort is simultaneous with the entrepreneur's decision, after the sharing rule of cash flows was contractually agreed on, and the investment sunk. Requiring the financier's advice imposes an up-front fixed contracting cost C. Accordingly, C is saved if the entrepreneur does not require the financier's advice, i.e., the contracting cost of standard relationships is normalized to zero. To make the problem interesting, C is neither

[3] The entrepreneur undertakes a project if and only if the cash flows the project yields are strictly larger than the investment the project requires.

[4] The entrepreneur is allowed to raise more than $I - A$, that is, $I - A + t$ with $t > 0$. For the sake of concision, this case is mentioned in the text if t strictly increases the value of the project.

[5] Relaxing this assumption by assuming that the financier's advice is simply less efficient when the entrepreneur does not abandon B would lead to qualitatively similar results.

trivial nor prohibitive, that is, $C \in \left]\underline{C}, \overline{C}\right[$ (see in Appendix). Imposing $v > \frac{\alpha^2 \Delta R^2}{2k}$ captures that the entrepreneur's managerial contribution to the project is more significant than the financier's managerial contribution to the project. Besides, maximizing the market value of the project creates more value than pursuing personal goals, B included, in the absence of external advice, i.e., $B \leq \delta p \Delta R$. Finally, the constant k, parametrizing the financier's cost of effort, verifies $k \geq max\left\{\alpha \Delta R, \frac{\alpha^2}{\delta p}\Delta R\right\}$.

2.2. First-best Case

Assuming that actions are contractible provides a benchmark. The entrepreneur must maximize profits. Otherwise, the net present value (NPV) of the project is negative so that obtaining funds is impossible. Thus, when the financier exerts E, the NPV is

$$V = (p_h + \alpha E)\, R^S + [1 - (p_h + \alpha E)]\, R^F - k\frac{E^2}{2} - (I + C), \tag{1}$$

since E increases the probability of success of the project from p_h to $p_h + E\ \alpha$, but costs $k\frac{E^2}{2}$. According to the first-order condition of the objective function given by (1), the financier's level of effort is

$$E^* = \frac{\alpha \Delta R}{k}. \tag{2}$$

Tight relationships (TR) are characterized by $E > 0$. In words, the financier supports the entrepreneur. Eq. (1) and Eq. (2) imply that the NPV yielded by TR is

$$V^* = v - C + \frac{\alpha^2 \Delta R^2}{2k}. \tag{3}$$

One can view v as the NPV of the project when the financier exerts no effort while no complex contract is written, which corresponds to loose relationships (LR). It is straightforward that TR are optimal in the first-best case if and only if $C < \frac{\alpha^2 \Delta R^2}{2k}$. Otherwise, LR create more value. Any sharing rule of the cash flows allows to implement the first-best solution provided that every party recoups the funds it invested. Hence, the financial claims issued have no impact on real decisions as postulated by Modigliani and Miller (1958). These conclusions do not hold under moral hazard as the next section shows.

3. Optimal Relationships

This section explores how the entrepreneur maximizes her revenue when there is moral hazard. The following conditions must be satisfied to have TR. First, TR imply that the financier exerts effort. Let the financier receive F in case of failure of the project and S in case of success of the project. Suppose the entrepreneur maximizes profits. Then, the financier chooses E so that

$$E \in \arg\max_{\widehat{E}} \left(p_h + \alpha \widehat{E}\right) S + \left[1 - \left(p_h + \alpha \widehat{E}\right)\right] F - k\frac{\widehat{E}^2}{2} - (I + C - A)\,, \tag{4}$$

where $(I + C - A)$ is the financier's financial input. I will refer to (4) as the financier's incentive compatibility constraint. The first-order condition leads to

$$E = \frac{\alpha\,(S - F)}{k}. \tag{5}$$

Next, the entrepreneur maximizes profits if and only if this policy yields a higher[6] revenue than pursuing private goals, which reduces to

$$\left(R^S - S\right) - \left(R^F - F\right) \geq \frac{B}{\delta p + E\alpha}. \tag{6}$$

In words, the difference between the entrepreneur's revenue in case of success of the project and the revenue in case of failure of the project must be sufficient. I will refer to (6) as the entrepreneur's incentive compatibility constraint. Observe that since the financier's advice rises the probability of success of the project by $E\alpha$, it renders the maximizing profits policy more attractive to the entrepreneur.

[6] The entrepreneur maximizes profits when indifferent between doing so and enjoying the private benefit.

Next, in order to accept to provide funds, the financier must at least break even. Hence, the financier's participation constraint[7] is

$$(p_h + \alpha E)\, S + [1 - (p_h + \alpha E)]\, F - k\frac{E^2}{2} - (I + C - A) \geq 0. \tag{7}$$

Finally, (F, S) must respect limited liability constraints, that is,

$$0 \leq F \leq R^F \tag{8}$$

$$0 \leq S \leq R^S. \tag{9}$$

The next proposition details the conditions under which TR are possible and the value they yield to the entrepreneur.

Proposition 1 *TR are possible if and only if* $B < \overline{B_T}$*.* $\overline{B_T}$ *increases in* A *up to* $\delta p \Delta R$ *(excluded). The entrepreneur earns* V*, the NPV of the project, which strictly decreases in* B *if* $B < \overline{B_T}$*.*

To get an intuition of these results, let us rewrite the NPV given by (1) as

$$V = v - C + \alpha \Delta R\, E - \frac{k}{2} E^2. \tag{10}$$

The entrepreneur naturally seeks to maximize V. It is shown below that this objective does not conflict with making TR feasible. Eq. (10) indicates that maximizing V requires to maximize E since V increases in E up to E^*. According to (5), it amounts to setting $S - F$ as high as possible while satisfying (6), (7), (8) and (9). First, the sharing rule of cash flows must ensure that the entrepreneur, whose participation is crucial to the realization of the project, abstains from pursuing personal goals. Then, *residual* incentives can be given to the financier. Combining (5) and (6), and solving for the

[7] As will become clear below, the entrepreneur recoups the NPV of the project since financiers are competitive. Hence, the entrepreneur's participation constraint is satisfied as long as the NPV is positive. This participation constraint is not mentioned in the text for the sake of brevity.

second-best level of effort in the absence of any other constraint leads to

$$S - F \leq \frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 kB}}{2\alpha^2}. \tag{11}$$

Eq. (11) shows that motivating the entrepreneur conflicts with motivating the financier. For example, granting the financier a large fraction of the cash flows when the project fails motivates the entrepreneur but automatically demotivates the financier. Similarly, granting the entrepreneur a large fraction of the cash flows when the project succeeds motivates the entrepreneur, but automatically demotivates the financier[8]. Thus, E, and in turn V, strictly decrease as the magnitude of entrepreneurial moral hazard rises when (11) is binding.

When $B = \overline{B_T}$, the entrepreneur's incentive problem is so serious that severely punishing the entrepreneur by allocating all cash flows in case of failure to the financier, i.e., setting $F = R^F$, is necessary. Then, the financier's participation constraint is binding. Suppose that $B > \overline{B_T}$. Motivating the entrepreneur would command either to increase F, which violates the entrepreneur's limited liability constraint, or to decrease S, which violates the financier's participation constraint. Hence, TR are impossible when $B > \overline{B_T}$. Personal wealth raises $\overline{B_T}$ since the larger A, the lower $I + C - A$. The entrepreneur must accordingly promise fewer cash flows to the financier when the project succeeds, which eventually facilitates the design of the entrepreneur's incentives. When $A \geq I + C - R^F$, the upper bound could reach $\delta p \Delta R$, for the financier receives $I + C - A$ whatever the outcome so that the entrepreneur captures any increase in the outcome, which has the required disciplining effect. However, when $B = \delta p \Delta R$, the financier's level of effort is zero so that relationships become endogenously loose. Hence, $\overline{B_T} < \delta p \Delta R$.

[8] Introducing a third party, for example, a passive financier entitled to all cash flows in case of failure of the project, and to no cash flow in case of success, would theoretically improve the design of incentives. Indeed, both the supportive financier 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 supportive financier and the entrepreneur are induced to collude when the project fails if the *origin* of cash flows is not verifiable: the wealthy supportive financier provides ΔR, and claims, along with the entrepreneur, that the venture has succeeded in order not to pay back the passive financier. Hence, the third party's reward must be non-decreasing in the outcome for robustness issues (see Innes (1990)), which eventually does not facilitate the design of incentives.

A couple of remarks are in order here. First, observe that maximizing E, or equivalently V, raises $\overline{B_T}$ since the financier's advice disciplines the entrepreneur. Second, making (11) bind in order to give as powerful incentives as possible to the financier implies that the financier earns a rent when (i) entrepreneurial moral hazard is sufficiently low and (ii) the financier contributes $I + C - A$ to the project. The entrepreneur recoups this rent, and thus earns the NPV of the project, by imposing on the financier to invest more than $I + C - A$, as in Rajan (1992). Third, one can directly relate the severity of entrepreneurial moral hazard to the compensation granted to the supportive financier, which extends the conclusions one can draw from (11): F increases in B while S decreases in B for incentive purposes (see the Proof of Proposition 1). Thus, one should empirically observe that:

- The entrepreneur's cash-flow rights in case of failure (respectively in case of success) of the project decrease (respectively increase) when entrepreneurial moral hazard rises.

It is not at odds with empirical evidence. When estimating the "liquidation" rights (i.e., the cash-flow rights when the project fails) of the founder of the firm, Kaplan and Strömberg (2003) find that the coefficient of "Industry R&D/sales" is negative although not significant[9]. This variable is a proxy for the severity of entrepreneurial moral hazard since it measures asset specificity which impacts the level of entrepreneurial discretion. Asset specificity can also be approximated by the ratio of R&D to firm value (see Barclay and Smith (1995)). An alternative potential measure of entrepreneurial discretion is the share of growth options in firm value measured by the market-to-book ratio (as suggested by Myers (1977), and used in empirical studies on leverage by Barclay and Smith (1995), and Rajan and Zingales (1995)).

LR are the alternative to TR. The next proposition characterizes the conditions under which LR are possible and the value they yield to the entrepreneur.

[9] See Table 4 in Kaplan and Strömberg (2003). Kaplan and Strömberg do not test the R&D/ Sales variable in their regression of cash-flow rights in the good state of nature. Their other measures of asymmetric information ("Repeat Entrepreneur" and "Months since the First Venture Capital Round") are more related to adverse selection issues rather than to moral hazard issues.

Proposition 2 *LR are possible if and only if $B < \overline{B_L}$. $\overline{B_L}$ increases in A up to $\delta p \Delta R$ (included). The entrepreneur earns v, the NPV of the project which is independent of B if $B < \overline{B_L}$.*

The intuitions for these results are the following. When LR are possible, the NPV of the project is v and does not depend on B since the financier is passive. When LR are impossible, the NPV of the project is 0. The financier's participation constraint is optimally binding since leaving a rent to the financier makes it more difficult to motivate the entrepreneur, all else equal. Hence, the entrepreneur captures v. When $B > \overline{B_L}$, entrepreneurial moral hazard is so severe that when the project succeeds the entrepreneur should be promised a fraction of cash flows that does not allow the financier to break even. It is straightforward that $\overline{B_L}$ increases in A (for the same reason as in the case of $\overline{B_T}$). The upper bound $\overline{B_L}$ reaches $\delta p \Delta R$ (included) when A is sufficient, i.e., $A \geq I - R^F$. In such a case, the financier always receives $I - A$ so that the entrepreneur captures any increase in the outcome, which has the required disciplining effect as long as $B \leq \delta p \Delta R$.

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

Proposition 3 *Optimal relationships are:*

(i) If $C < \frac{\alpha^2 \Delta R^2}{2k}$,
- *TR when $B \in \left]0, \underline{B}\right]$, $\forall A$;*
- *LR when $B \in \left]\underline{B}, \overline{B_L}\right]$, $\forall A$;*
- *TR when $B \in \left]\overline{B_L}, \overline{B_T}\right]$ if $A \leq \overline{A}$.*

(ii) If $C \geq \frac{\alpha^2 \Delta R^2}{2k}$,
- *LR when $B \in \left]0, \overline{B_L}\right]$, $\forall A$;*
- *TR when $B \in \left]\overline{B_L}, \overline{B_T}\right]$ if $A \leq \overline{A}$.*

First, suppose that C, the cost of TR, is bounded above by $\frac{\alpha^2 \Delta R^2}{2k}$ so that TR are optimal in the first-best case (see Figure 1). Part (i) of Proposition 3 first states that the entrepreneur prefers LR rather than TR if C is not offset by the net increase in expected revenue resulting from the financier's advice. The entrepreneur opts for LR when $B > \underline{B}$ since V strictly decreases in B (Proposition 1) while v is independent of B (Proposition 2)[10].

Interestingly, part (i) of Proposition 3 however states that TR are feasible for higher values of B than LR as long as the entrepreneur's wealth is limited to $\overline{A}$. Undertaking the project then requires a supportive financier. Indeed, (6) shows that TR facilitate the design of the entrepreneur's incentives since the financier's advice is valuable only if the entrepreneur maximizes profits. This effect does more than balancing the fact that TR imply a larger investment (i.e., $I+C$) which imposes an additional restraint on the design of the entrepreneur's incentives[11]. Thus, even though LR are more profitable than TR when $B > \underline{B}$, they are not feasible for higher values of B, that is, $B \in \left]\overline{B_L}, \overline{B_T}\right]$, contrary to TR. To get an illustration of this result, imagine that $A = 0$, and $C = \frac{\alpha^2 \Delta R^2}{2k}$ contrary to the above assumption. Then, $V^* = v$. In words, TR and LR have the same *potential* NPV. However, $\overline{B_L} < \overline{B_T}$. Furthermore, under moral hazard, $E < E^*$ and in turn $V < v$. Hence, although TR yield a lower *real* NPV than LR would potentially do, they are feasible when entrepreneurial moral hazard is more severe.

Part (i) of Proposition 3, along with Proposition 2 which states that $\overline{B_L}$ increases in A, further implies that personal wealth allows the entrepreneur to avoid the cost of contracting with a supportive financier, which is worthwhile when $B > \underline{B}$. Observe that LR even become feasible where TR are not feasible if the entrepreneur's wealth is sufficient, that is, $A > \overline{A}$. The positive effect of advice on incentives when relationships are tight is then offset by the restraint imposed by the larger investment TR require. To have an intuition for this result, observe that the entrepreneur captures any increase in the outcome, which is best for incentive purposes, provided that $A \geq I - R^F$ if relationships are loose, whereas the same result only holds for $A \geq I + C - R^F$ if relationships are tight.

Next, suppose that $C \geq \frac{\alpha^2 \Delta R^2}{2k}$ so that LR represent the first best (see Figure 2 and observe that $\underline{B} \leq 0$). It implies that, under moral hazard, LR are optimal whenever feasible, i.e., when $B \leq \overline{B_L}$. Part (ii) of Proposition 3 states that if $A \leq \overline{A}$, TR are feasible for a higher level of entrepreneurial moral

[10] Since $C > \underline{C}$, that is, the fixed cost of TR is not trivial, $\underline{B} < \overline{B_L}$.

[11] Observe that E does not depend on I, $I + C$ or A when the entrepreneur's and the financier's incentive compatibility constraints are binding.

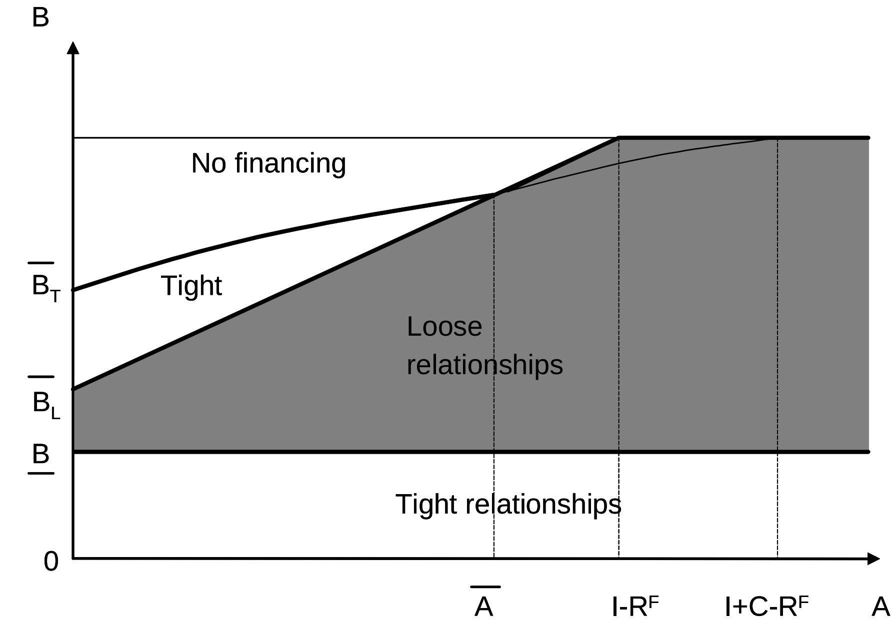

Figure 1: Optimal relationships as a function of the moral hazard problem B and personal resources A of the entrepreneur when contracting costs C are limited.

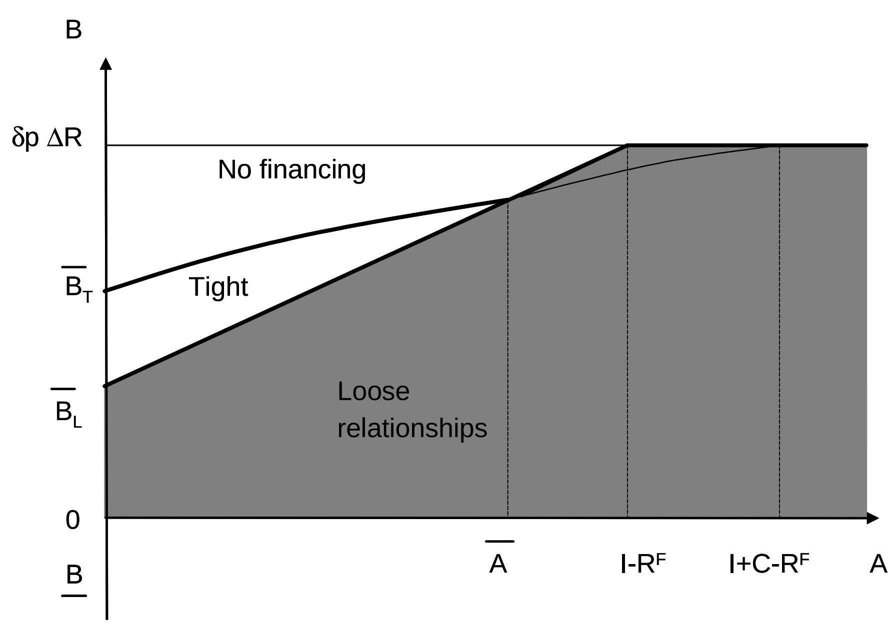

Figure 2: Optimal relationships as a function of the moral hazard problem B and personal resources A of the entrepreneur when contracting costs C are significant.

hazard thanks to the disciplining effect so that TR are optimal when $B \in \left]\overline{B_L}, \overline{B_T}\right]$. If $A > \overline{A}$, $\overline{B_L} > \overline{B_T}$ so that LR are optimal whatever the magnitude of the entrepreneurial moral hazard problem[12].

Finally, Proposition 3, along with Proposition 1 (respectively Proposition 2) which states that $\overline{B_T}$ (respectively $\overline{B_L}$) increases in A, implies that personal wealth (or internal cash flows in a dynamic framework) relaxes financing constraints, which is consistent with empirical evidence (e.g., Gilchrist and Himmelberg 1995, and Fazzari and al. 1988).

It is possible to relate the profitability of projects and the level of initial wealth of entrepreneurs to the type of relationships they have with financiers. Recall that, overall, the NPV weakly decreases in B (combine Proposition 1 and Proposition 2), and in C. Thus, Proposition 3 implies that one should observe that:

- The most profitable projects (or firms) are financed by financial intermediaries.

This result cannot be obtained in a traditional model of financial intermediation. For instance, Holmström and Tirole (1997) find that for a given size of the private benefit, rich entrepreneurs are better off directly dealing with uninformed investors in order to avoid costly monitoring by financial intermediaries. Hence, they obtain a positive correlation between profitability and the absence of financial intermediaries. The difference stems from the fact that we consider two types of financial intermediaries' intervention, very different in essence. In Holmström and Tirole (1997), the financier *directly* impacts the entrepreneur's incentives by reducing the private benefit (i.e., the financier monitors the entrepreneur), whereas here, the financier *indirectly* impacts the entrepreneur's incentives by increasing the probability of success of the project (i.e., the financier supports the entrepreneur). Hence, in the first-best, entrepreneurs contract with advisors-financiers in the present paper if contracting costs are low, whereas they always avoid costly funding via financial intermediaries in their framework.

Observe that, whatever the supportive financier's cost of effort k, TR would always be optimal in

[12] Note that if, contrary to the maintained assumption, $C \geq \overline{C}$, TR can yield a negative NPV in the second-best case which leaves no alternative to LR.

the absence of C, even in the second best. This strict optimality of TR does not fit with empirical evidence (see Gompers and Lerner (1999) p. 14, Table 1.3) that in the United States, outside the Silicon Valley, Texas, route 128 in Massachusetts, and a limited number of other areas where value-enhancing financiers such as venture capitalists are concentrated, and k and C are presumably the lowest, resorting to supportive financing is infrequent.

Finally, let us compare the first-best case to the second-best case. Under moral hazard, both the entrepreneur and the financier must be induced to maximize profits so that one can never promise $(S - F) = \Delta R$ to the financier since $B > 0$. And the higher B, the larger the deviation of E from E^*. Since there is less value-enhancement by the financier than in the first-best case, the entrepreneur prefers LR where she avoids C when entrepreneurial moral hazard is severe enough, although TR would be optimal in the first-best case if C is limited. Conversely, if C is large, LR would be optimal in the first-best case. However, they are not feasible in the second-best case when the entrepreneur's wealth is limited and B is sufficiently large. Then, TR can be the only solution available. Another difference is that some projects are not financed in the second-best case. Finally, whatever the contracting costs, the sharing rule of cash flows now matters. It implies that every financial claim cannot allow the entrepreneur to implement the second best, as shown in the next section.

4. Implementation

The purpose of this section is to present how the relationships obtained above in an abstract way can be implemented with contractual tools observed in the real world.

Proposition 4 *The optimal financial contract entails:*

(i) Issuing straight debt when relationships are loose;

(ii) Issuing convertible preferred equity, participating convertible preferred, or a mix of debt and equity for the financier, when $B \in \left[\underline{B_T}\ , \overline{B_T}\right]$ *and relationships are tight;*

(iii) Selling (possibly out) the project to the provider of funds while undertaking it and being compensated by a fixed salary and a bonus, when $B \in \left]0, \underline{B_T}\right[$ *and relationships are tight.*

As stated in the first part of Proposition 4, straight debt allows the entrepreneur to implement loose relationships, whereby the incentive problem is one-dimensional because only the entrepreneur is active. Issuing debt with face value S deprives the entrepreneur from all cash flows when the project fails, which has the required disciplining effect. According to the widely held view, debt fosters incentives, as residual claimants are severely punished when things go awry. However, the received analyses mostly rely on the costly state verification paradigm initiated by Townsend (1979), Diamond (1984), and Gale and Hellwig (1985), or on the inalienability of human capital approach developed by Hart and Moore (1994)[13]. In contrast, I consider a model where cash flows are contractible, which is not at odd with business practice, and obtain straight debt as an optimal claim. This result, reminiscent of Innes (1990), corresponds to bank financing (or to the entrepreneur issuing bonds) in the United States.

The second part of Proposition 4 states that selling a mix of debt and equity to the financier achieves the dual objective of inducing the entrepreneur to maximize the cash–flows and the financier to work as much as possible, when entrepreneurial moral hazard is not trivial, i.e., $B \in \left[\underline{B_T}\ , \overline{B_T}\right]$. Denote d as the face value of debt, and θ as the dilution. The role of θ is to make the financier benefit from the upside potential of the project, which is good for incentive purposes, while the role of d is to satisfy the financier's participation constraint. It is worth noting that implementing the optimal contract with pure debt is only possible when $B = \overline{B_T}$[14]. In any other cases, debt *and* equity prove necessary. Banks often have both debt and equity stakes in France, Germany and Japan, up to some limit (Allen and Gale 2000). For instance, "[T]he keiretsu main bank holds from 2 to 5 percent [of the group's companies]" according to Berglöf and Perotti (1994). This pattern is consistent with the supportive role banks (or their subsidiaries) play or used to play in these countries, whether facilitating the coordination of investment and production decisions within Japanese financial Keiretsus or in Continental Europe

[13] The costly state verification paradigm however does not preclude outside equity as an optimal claim as subsequently demonstrated by Fluck (1998), provided that equity has unlimited life.

[14] Pure equity is only possible when $B = \underline{B_T}$.

(see Hellwig (1991) for a discussion), or advising their clients since banks' diversified portfolios of investments grant them access to privileged information (Bhattacharya and Chiesa 1995). The fact that financiers need to hold both debt and equity in order to have a supportive role can explain why venture capitalists emerged in the United States, where the Glass-Steagall Act until recently refrained banks from holding equity stakes.

In fact, venture capitalists usually buy convertibles which give rise to the same sharing rule of cash flows as a mix of debt and equity in the framework adopted in this paper. Participating convertible preferred is a straightforward example, for it is characterized by the financier receiving both the principal amount of the preferred (like the face value of debt in the above case), and the common stock promised under the conversion terms. Participating convertible preferred are often used in venture capital contracts. For example, they appear in 38,5% of the 213 financing rounds examined by Kaplan and Strömberg (2003). The mix of debt and equity can also be replicated by convertible preferred equity which is again widely used in the venture capital industry (Sahlman 1990, Gompers 1996, and Kaplan and Strömberg 2003). It appears in 95,7% of the financing rounds investigated by Kaplan and Strömberg (2003). Denote r as the minimum pay-off guarantied by convertible preferred equity, and δ as the fraction of equity the financier gets when converting the claim into common stocks. Setting $r < \delta R^S$ ensures that conversion occurs if the project succeeds, which fosters the financier's incentives. Note that this paper is by no means the only one to examine the claims that are optimal in a double-sided moral hazard context. However, in Repullo and Suarez (1998), and in Schmidt (2003), convertible preferred equity or participating convertible preferred do not solve the problem considered.

Whatever the kind of claim is considered, one should empirically observe that:

- The profitability of projects (or firms) is an increasing function of the percentage of common equity held by the financier.

The intuition is the following. For incentive purposes on the entrepreneur's side, the financier's stake in the upside potential of the project (θ in the case of debt and equity, and δ in the case of convertibles) decreases when entrepreneurial moral hazard rises. It diminishes the financier's incentives to work ($E = \frac{\alpha}{k}\theta\Delta R$ in the case of debt and equity while $E = \frac{\alpha}{k}(\delta R^S - r)$ in the case of convertibles), and, eventually, the profitability of the project. Next,

- The entrepreneur's stake as a percentage of the cash flows increases with the outcome.

This result is driven by the fact that the entrepreneur, contrary to the financier, is crucial to the project. Accordingly, the financier only receives residual incentives. This pattern is in line with what Kaplan and Strömberg (2003) find in the case of venture capital.

Venture capitalists are viewed as financial intermediaries especially efficient when agency problems are significant. In contrast, consider the case where entrepreneurial moral hazard is limited, i.e., $B \in \left]0, \underline{B_T}\right[$, which corresponds to the third part of Proposition 4. Inducing the initiator of the project to maximize profits is then easier. The point is to design the most powerful incentive scheme for the provider of funds. A solution is to sell (possibly out) 100% of the cash flows to the provider of funds in exchange for the investment[15]. A suitably chosen package consisting of a base salary $(R^F - F)$ and a bonus $\left[(R^S - S) - (R^F - F)\right]$ when the project succeeds induces the initiator of the project to behave properly. As F increases in B, the higher the private benefit is, the smaller the base salary is. Conversely, as $(S - F)$ decreases in B, the higher B is, the bigger the bonus is. Murphy (1998) confirms the incentive role of bonuses in compensation packages.

5. Conclusions

In this paper, I investigate the choice of entrepreneurs to have tight relationships with value-enhancing financiers or loose relationships with non-supportive providers of funds. For this purpose, I develop a model that relates the kind of relationships and the firm's financial structure to the interaction of agency problems on the financiers' and entrepreneurs' sides. A first result is that tight relationships

[15] Observe that the model does not distinguish between projects that are realized internally and projects that are sold out. It is not rare to have founders of companies selling out their businesses, and thereafter still working therein. For instance, the Forbes Magazine (1999) points out the cases of firms ranked in their "Top 200 best small companies": Scotsman Industries (food equipment maker, supplier of McDonald's) acquired by Berisford Plc., ABRInformation Services bought out by Ceridian Corp. and Automobile Protector Corp. acquired by Ford Motor Co.

create more value than loose relationships when entrepreneurial moral hazard and contracting costs are limited. The reason is that financiers which are not crucial to the success of the project only face residual incentives to exert effort. These residual incentives decline as entrepreneurial moral hazard rises. A second result is that tight relationships discipline entrepreneurs more easily than loose relationships, provided that the entrepreneur's personal wealth is limited, since maximizing profits is more attractive to the entrepreneur when the financier is supportive. In that case, tight relationships are feasible for a higher degree of entrepreneurial moral hazard. A third result is that the entrepreneurs' financial contributions to the projects allow them to contract with passive financiers when loose relationships, if feasible, create more value than tight ones. A fourth result is that implementing tight relationships commands more complex arrangements (a mix of debt and equity or convertibles for the financier, or selling the project to the financier) than implementing loose relationships (straight debt). Original testable empirical implications regarding the determinants of both profitability and the cash-flow rights of the entrepreneur are derived from the model. While this paper emphasizes the supporting role of financiers, future research should investigate the link between supporting and monitoring functions.

Appendix

Contracting costs of TR are characterized by $C \in \left]\underline{C}, \overline{C}\right[$. $\underline{C}$ is given below by (18). $\overline{C} \overset{d}{=} \min\left\{C_{\overline{B_T}/\overline{B_L}}, v\right\}$. $C_{\overline{B_T}/\overline{B_L}}$ is given below by (19)[16].

[16] The proof of Proposition 3 makes it clear that $\underline{C} < C_{\overline{B_T}/\overline{B_L}}$. Provided that I is not too large, $C < v$ is compatible with $C > \underline{C}$.

Proof of Proposition 1. As a first step, rewrite the maximization program as

$$\max_{S,F} (S-F)$$

$$\begin{aligned}
s.t. \qquad & (IC)_e : \quad S - F \leq \frac{\alpha^2 \Delta R - k\delta p + \sqrt{\left(\alpha^2 \Delta R + k\delta p\right)^2 - 4\alpha^2 kB}}{2\alpha^2} \\
& (PC)_f : \quad p_h S + (1-p_h) F + \frac{\alpha^2 (S-F)^2}{2k} - (I+C) + A \geq 0 \\
& (LL)_F : \quad 0 \leq F \leq R^F \\
& (TR) : \quad S > F.
\end{aligned}$$

Indeed, observe that the financier's effort, given by the FOC of (4), is $E = \frac{\alpha(S-F)}{k}$. The financier's utility function is concave since $k > 0$ so that E is the maximum. Then, note that:

- TR require $E > 0$, which imposes $S > F$, condition referred to above as (TR).

- Replacing E by its value into (6) leads to $\alpha^2(S-F)^2 - \left(\alpha^2 \Delta R - k\delta p\right)(S-F) - k\left(\delta p \Delta R - B\right) \leq 0$. Let $X \overset{d}{=} S-F$, and rewrite the LHS of the former inequality as the polynomial $P(X)$. $P(X)$ has 2 roots, denoted $\underline{X}$ and $\overline{X}$ ($> \underline{X}$) since $B \leq \delta p \Delta R$ implies $B < 1/2 \left[\delta p \Delta R + \frac{\left(\alpha^2 \Delta R\right)^2 + (k\delta p)^2}{2\alpha^2 k}\right]$, so that the determinant is positive. The entrepreneur maximizes profits if $\underline{X} \leq S-F \leq \overline{X}$. Observe that $\underline{X}$ is irrelevant to the program since $k \geq \frac{\alpha^2 \Delta R}{\delta p}$ implies $\underline{X} \leq 0$ while (TR) must hold. It leads to $(IC)_e$[17]. Note that $\overline{X} > 0$, which is necessary because of (TR), is equivalent to $B < \delta p \Delta R$.

- Substituting $E = \frac{\alpha(S-F)}{k}$ into (7) leads to $(PC)_f$.

- Similarly, substituting E into the objective function given by (1) leads to $V = v - C + \frac{\alpha^2(S-F)\Delta R}{k} - \frac{\alpha^2(S-F)^2}{2k}$. Maximizing V with respect to S and F is equivalent to maximizing $(S-F)$ which becomes the objective function of the program. Indeed, V is strictly increasing in $(S-F)$ on $[0, \Delta R]$ since (i) v and C depend neither on S nor on F, (ii) $(S-F) < \Delta R$ according to $(IC)_e$

[17] For the sake of brevity, (IC) hereafter stands for incentive compatibility constraint, (PC) stands for participation constraint, and (LL) for limited liability constraint. The subscript e refers to the entrepreneur; the subscript f refers to the financier, and the subscript F refers to failure.

when $B > 0$, while (iii) $k > 0$ and $\alpha > 0$.

- Given that $(S - F) < \Delta R$ when $B > 0$, $F \leq R^F \Rightarrow S < R^S$. Furthermore, $F \geq 0 \Rightarrow S > 0$ since (TR) holds. Thus, (8) implies (9), and limited liability constraints reduce to $(LL)_F$.

As a second step, solve the program. Making $(IC)_e$ bind is the best potential solution. $(PC)_f$ must be satisfied. Two cases arise.

- $(PC)_f$ **is binding.** Combining $(IC)_e$ and $(PC)_f$, both binding, leads to

$$\begin{aligned} F &= I - A + C - p_h \left[\frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 kB}}{2\alpha^2} \right] \\ &\quad - \frac{\alpha^2}{2k} \left[\frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 kB}}{2\alpha^2} \right]^2 \quad (12) \\ S &= F + \left[\frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 kB}}{2\alpha^2} \right], \quad (13) \end{aligned}$$

so that (TR) is verified since $B > 0$. It is straightforward that F strictly increases in B. Conversely, S strictly decreases in B. Indeed, $\frac{\partial S}{\partial B} = \frac{1}{2} \left[1 - \frac{2k - (\alpha^2 \Delta R + k(p_h + p_l))}{\sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 kB}} \right] < 0$ is equivalent to $B > (1 - p_l) \left[\Delta R - \frac{k(1-p_h)}{\alpha^2} \right]$, which is verified. The reason is that, on the one hand, (i) $k \geq \alpha \Delta R$, (ii) $1 - p_h \geq \alpha$, and (iii) $p_l < 1$, imply that $(1 - p_l) \left[\Delta R - \frac{k(1-p_h)}{\alpha^2} \right] \leq 0$. On the other hand, $B > 0$.

Now consider $(LL)_F$. When the project fails, the entrepreneur is protected by limited liability if $F \leq R^F$. Besides, $S > F \Rightarrow B < \delta p \Delta R$ as shown above. Combine these two conditions as

$$\begin{aligned} & B \leq \delta p \Delta R - 2 \left(I + C - A - R^F \right) \\ & + \left[\alpha^2 \Delta R + k \left(p_h + p_l \right) \right] \left[\frac{-p_h k + \sqrt{(p_h k)^2 + 2\alpha^2 k (I + C - A - R^F)}}{\alpha^2 k} \right] \\ & \text{if } A < I + C - R^F, \text{and} \\ & B < \delta p \Delta R \text{ if } A \geq I + C - R^F. \quad (14) \end{aligned}$$

Denote this upper bound $\overline{B_T}$. Observe that (i) if $A < I+C-R^F$, $\frac{\delta \overline{B_T}}{\delta A} = 2 - \frac{\alpha^2 \Delta R + k(p_h+p_l)}{\sqrt{(p_h k)^2 + 2\alpha^2 k(I+C-A-R^F)}}$, and (ii) $\frac{\delta \overline{B_T}}{\delta A} > 0$ if $A < I + C - R^F + \vartheta$, where $\vartheta \overset{d}{=} \frac{(2p_h k)^2 - (\alpha^2 \Delta R + k(p_h+p_l))^2}{8\alpha^2 k} \geq 0$ since $k \geq \frac{\alpha^2}{\delta p}\Delta R$. Thus, $\overline{B_T}$ overall increases in A.

When the project fails, the financier is protected by limited liability if $F \geq 0$ or

$$\begin{aligned} B \quad \geq \quad & \underline{\underline{B_T}} \overset{d}{=} \delta p \Delta R - 2(I + C - A) \\ & + \left[\alpha^2 \Delta R + k\left(p_h + p_l\right)\right] \left[\frac{-p_h k + \sqrt{(p_h k)^2 + 2\alpha^2 k(I + C - A)}}{\alpha^2 k}\right]. \end{aligned} \tag{15}$$

Thus, $(LL)_F$ and (TR) are compatible with $(PC)_f$ and $(IC)_e$ both binding on $\left[\underline{\underline{B_T}}, \overline{B_T}\right]$.

- $(PC)_f$ **is not binding.** Now, consider $\left]0, \underline{\underline{B_T}}\right[$. Suppose $(IC)_e$ is kept binding so that $(S - F)$ is maximized. As shown above, $F \geq 0$ is incompatible with the financier just breaking even. Denote the financier's net gain t, where $t > 0$ implies that $(PC)_f$ is verified. Then, setting $F = 0$ is consistent with $(LL)_F$ and implies, because $(IC)_e$ is binding, that $S = \frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 k B}}{2\alpha^2}$, which satisfies (TR). Imposing, since financiers are competitive, an up-front transfer t from the financier to the entrepreneur allows the latter to capture V even on $\left]0, \underline{\underline{B_T}}\right[$.

As a final step, note that, on $\left]0, \overline{B_T}\right]$, given F and S,

$$E = \frac{\alpha^2 \Delta R - k\delta p + \sqrt{(\alpha^2 \Delta R + k\delta p)^2 - 4\alpha^2 k B}}{2\alpha k}. \tag{16}$$

It is straightforward that E, and in turn V, strictly decrease in B. Observe that the entrepreneur's participation constraint which was not mentioned until now for the sake of conciseness is satisfied since $v - C > 0$ ensures that the NPV, captured by the entrepreneur, is strictly positive.

Proof of Proposition 2. Suppose first that $A \leq I - R^F$. Setting $F = R^F$ relaxes both (6) and (7), given that $E = 0$ by definition. Making (7) bind implies that $S = R^F + \frac{I - R^F - A}{p_h}$. It is straightforward that (8) is verified, while (9) is verified since $v > 0$. Thus, LR are feasible when $B \leq \delta p \Delta R - \frac{\delta p}{p_h}(I - A - R^F)$ if $A \leq I - R^F$. This upper bound increases in A up to $\delta p \Delta R$ when $A = I - R^F$. Suppose next that $A > I - R^F$. Setting $S = F = I - A$ satisfies (6) and implies that (7) binds. It also satisfies (8) and (9). Thus, LR are feasible $\forall B \leq \delta p \Delta R$ if $A > I - R^F$. Overall, LR are feasible when $B \leq \overline{B_L} \stackrel{d}{=} \min\{\delta p \Delta R, \delta p \Delta R - \frac{\delta p}{p_h}(I - A - R^F)\}$. The entrepreneur captures the NPV, v, since (7) is binding.

Proof of Proposition 3. As a first step, let us characterize the thresholds $\underline{B}$, $\underline{C}$ and $C_{\overline{B_T}/\overline{B_L}}$. Combining (10) and (16), and rearranging leads to

$$v > V \Leftrightarrow B > \underline{B} \stackrel{d}{=} \frac{2kC - (\alpha \Delta R)^2 + \left(\frac{\alpha^2 \Delta R + k \delta p}{\alpha}\right)\sqrt{(\alpha \Delta R)^2 - 2kC}}{k}. \tag{17}$$

Besides,

$$\begin{aligned} \overline{B_L} &> \underline{B} \Leftrightarrow C > \underline{C} \stackrel{d}{=} -\frac{\delta p}{2p_h}(I - R^F) \\ &+ \frac{(\alpha^2 \Delta R + k \delta p)}{4\alpha^2 k}\left[\alpha^2 \Delta R - k \delta p + \sqrt{(\alpha^2 \Delta R - k \delta p)^2 + 4\alpha^2 k \frac{\delta p}{p_h}(I - R^F)}\right]. \end{aligned} \tag{18}$$

Note that $\underline{C} < \frac{\alpha^2 \Delta R^2}{2k}$. Next,

$$\begin{aligned} \overline{B_T} &> \overline{B_L} \Leftrightarrow C < C_{\overline{B_T}/\overline{B_L}} \stackrel{d}{=} -\left(\frac{p_h + p_l}{2p_h}\right)(I - R^F) \\ &+ \left[\frac{\alpha^2 \Delta R + k(p_h + p_l)}{4\alpha^2 k}\right]\left[\alpha^2 \Delta R - k \delta p + \sqrt{(\alpha^2 \Delta R - k \delta p)^2 + 4\alpha^2 k \frac{\delta p}{p_h}(I - R^F)}\right]. \end{aligned} \tag{19}$$

Note that $C_{\overline{B_T}/\overline{B_L}} > \frac{\alpha^2 \Delta R^2}{2k}$.

As a second step, suppose that $C < \frac{\alpha^2 \Delta R^2}{2k}$. Eq. (18) and Eq. (19) imply that $C \in \left]\underline{C}, \frac{\alpha^2 \Delta R^2}{2k}\right[$

ensures $\overline{B_T}_{|A=0} > \overline{B_L}_{|A=0} > \underline{B}_{|A=0}$. Besides,

$$\begin{aligned}
A &\geq \overline{A} \overset{d}{=} I - R^F - \frac{p_h \Delta R + \frac{\alpha^2 \Delta R^2}{k}\left(\frac{p_h}{p_h+p_l}\right) + 2C}{\frac{p_h+p_l}{p_h}} \\
&+ \frac{\sqrt{\left[p_h \Delta R + \frac{\alpha^2 \Delta R^2}{k}\left(\frac{p_h}{p_h+p_l}\right) + 2C\right]^2 - 2C\left[2C - \frac{(\alpha^2 \Delta R + k(p_h+p_l))^2}{\alpha^2 k} + 2p_h\left(\frac{\alpha^2 \Delta R + k(p_h+p_l)}{\alpha^2}\right)\right]}}{\frac{p_h+p_l}{p_h}} \\
&\Rightarrow \overline{B_L} \geq \overline{B_T}. \qquad (20)
\end{aligned}$$

Thus, relationships are tight when $B \in \left]0, \underline{B}\right]$ $\forall A$, loose when $B \in \left]\underline{B}, \overline{B_L}\right]$ $\forall A$, tight again when $B \in \left]\overline{B_L}, \overline{B_T}\right]$ if $A < \overline{A}$.

As a third step, suppose that $C \geq \frac{\alpha^2 \Delta R^2}{2k}$. It implies that $\underline{B} < 0$. Since $C < C_{\overline{B_T}/\overline{B_L}}$ (recall that $C < \overline{C}$), $\overline{B_T}_{|A=0} > \overline{B_L}_{|A=0}$. Thus, relationships are loose when $B \in \left]0, \overline{B_L}\right]$ $\forall A$, and tight when $B \in \left]\overline{B_L}, \overline{B_T}\right]$ if $A < \overline{A}$.

Proof of Proposition 4. Denote

$$\begin{aligned}
\underline{B_T} &\overset{d}{=} \delta p \Delta R - 2\left(I + C - A\right) + \left[\Delta R\left(\alpha^2 \Delta R + k\left(p_h + p_l\right)\right) + 2kR^F\right] \\
&\times \left[\frac{-k\left[p_h R^S + (1-p_h)R^F\right] + \sqrt{\left[\left(p_h R^S + (1-p_h)R^F\right)k\right]^2 + 2k\alpha^2 \Delta R^2\left(I + C - A\right)}}{k\alpha^2 \Delta R^2}\right]. \qquad (21)
\end{aligned}$$

The case where $B \in \left]0, \underline{B_T}\right[$ is directly analyzed in the text. Consider the case where $B \in \left[\underline{B_T}, \overline{B_T}\right]$. F and S are given by (12) and (13), respectively. The optimal sharing rule of cash flows can be implemented in the following two ways.

Mix of debt and equity. Since $B \leq \overline{B_T} \Rightarrow F \leq R^F$, thus $d \leq R^F$. Hence, (d, θ) is characterized by (i) $d + \theta(R^F - d) = F$, (ii) $d + \theta(R^S - d) = S$, (iii) $0 \leq d \leq R^F$, and (iv) $0 \leq \theta \leq 1$. Solving for d and θ leads to $d = \frac{F \times R^S - R^F \times S}{\Delta R - (S - F)}$ and $\theta = \frac{S-F}{\Delta R}$. Observe that $B \geq \underline{B_T} \Rightarrow F \times R^S - R^F \times S \geq 0$. It implies that $d \geq 0$ since $0 < S - F < \Delta R$. Thus $0 \leq d \leq R^F$ is verified. It is easy to check $0 \leq \theta \leq 1$ from $0 < S - F < \Delta R$. Hence, a mix of debt and equity implements the optimal sharing rule of cash flows.

Convertibles. For simplicity, conversion does not trigger any issuance of new claims. Instead, the entrepreneur releases some of the existing claims to the financier. Convertible preferred equity is feasible if there exists r and δ such that (i) $r = F$, (ii) $\delta R^S = S$, (iii) $\delta R^F \leq r < \delta R^S$, (iv) $0 \leq r \leq R^F$, and (v) $0 < \delta \leq 1$. Note that $r = F$ ensures that $0 \leq r \leq R^F$ is verified since $(LL)_F$ holds. It follows from (a) $r = F$, (b) $F < S$ and (c) $S = \delta R^S$ that $r < \delta R^S$ is verified. Furthermore, $r \geq \delta R^F$ is also verified since $F \geq \delta R^F \Leftrightarrow F \times R^S - S \times R^F \geq 0$ is satisfied (because $B \geq \underline{B_T}$) and $r = F$. It is straightforward that $0 < \delta \leq 1$ holds since $\delta = \frac{S}{R^S}$ and $0 < S < R^S$ (implied by $(LL)_F$). Hence, convertible preferred equity implements the optimal sharing rule of cash flows.

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