Venture Capital Meets Contract Theory: Risky Claims or Formal Control?*

Giacinta Cestone†

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Abstract

This paper develops a theory of the *joint* allocation of formal control and cash-flow rights in venture capital deals. We argue that when the need for investor support calls for very high-powered outside claims, entrepreneurs should optimally retain formal control in order to avoid excessive interference. Hence, we predict that risky claims should be be negatively correlated to control rights, both along the life of a start-up and across deals. This challenges the idea that risky claims should always be associated to more formal control, and is in line with contractual terms increasingly used in venture capital, in corporate venturing and in partnership deals between biotech start-ups and large drug companies. The paper provides a theoretical explanation to some puzzling evidence documented in Gompers (1997) and Kaplan and Strömberg (2000), namely the inclusion in venture capital contracts of contingencies that trigger both a reduction in VC control *and* the conversion of her preferred stocks into common stocks.

Keywords: Venture Capital, Control Rights, Security Design, Entrepreneurial Initiative

JEL Classification: G3

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†GREMAQ, Université de Toulouse and Institut d'Anàlisi Econòmica (CSIC), Barcelona.

1 Introduction

Although venture capital contracts have received considerable attention lately, there has been very little theoretical work trying to understand the particular terms that venture capitalists use. Among other things, the interaction between cash-flow and control rights in venture capital is still far from being understood. This paper proposes the first optimal contracting model to account for the *joint* pattern of control and cash-flow rights observed in venture capital contracts.

Recent works on venture capital contracting have pointed out that investors' control rights may well be allocated independently of cash-flow rights, through different sets of covenants.[1] One notable example is the widespread use, in venture capital deals, of several classes of common stock to which are attached very different voting, board and liquidation rights. Hence, the complex set of rights attributed to investors cannot be exhaustively described by standard securities like common stock, debt, or preferred stock. This suggests that venture capital contracting theory should focus on the allocation of different rights through contractual covenants rather than on the use of a particular security. We take this approach here.

Control and cash-flow rights seem to follow a joint pattern in real VC contracts, which suggests they are strongly interrelated. In their extensive study of venture capital agreements, Kaplan and Strömberg (2000) find that VCs' control is positively correlated to the performance sensitivity of the entrepreneur's cash-flow rights. Also, when VCs have voting control, their cash-flow rights are more likely to take the form of preferred stock. More generally, contractual terms increasingly adopted in the corporate world display similar characteristics. In corporate venturing deals and sophisticated partnership deals between biotech start-ups and big drug companies, the corporate investor typically takes a majority equity stake in the emerging start-up but few or no seats on the board of directors. This evidence is somehow puzzling, in that - contrary to common wisdom - *riskier claims are often associated to weak control rights*. Unfortunately, theoretical models of financial contracting cannot offer an explanation for this puzzle.[2]

We study the optimal contracting problem of an *early start-up* seeking venture capital finance and argue that two non-contractible factors are crucial for the start-up's success. First, at the seed stage, the entrepreneur must exert enough effort in pursuing research and

[1] For instance, Hellmann (1998) argues that "the separation of control rights from financial structure is important since for any given financial structure it is always possible to allocate control rights independently....if control emanates from holding the majority of the voting stock, then voting power can be attached to any financial instrument."

[2] With the exceptions of Dewatripont and Tirole (1994) and Hellmann (1998), in most models control and cash-flow rights are not interrelated: the focus is either on the allocation of control (Aghion-Bolton, 1992) or on the design of the investor's claim. The list of papers deriving the optimal outside claims leaving aside control issues is too long to be reported here. We refer to Harris and Raviv (1991) or Kaplan and Strömberg's (2000) comprehensive bibliographies.

analyzing the different projects available (*EN initiative*). At a later stage, after research has been carried out and a project has been selected by the controlling party, the venture capitalist must give professional advice in formulating the firm's strategy, provide introductions to potential customers and suppliers, help recruit key employees (*VC support*). Moreover, in the spirit of Aghion and Tirole (1997), we argue that the venture capitalist's *real* control over project selection discourages entrepreneurial initiative.

The central trade-off in our model is one between the entrepreneur's early incentives and the venture capitalist's late incentives.[3] To induce *VC support*, one would like to sell the venture capitalist a very risky claim. However - if VC is granted formal control over project selection - a risky claim induces excessive *VC interference*,[4] which in turn kills *EN initiative*. In other words, when a venture capitalist holds a risky claim, the cost of her formal control in terms of entrepreneurial initiative may become too high. This trade-off formalizes a typical entrepreneurial attitude towards venture capitalists: on the one hand, entrepreneurs like VC investors to support their firms with professional advice and connections. On the other hand, entrepreneurs are unhappy with VCs who exercise too much control on the firm.

We argue that an appropriate design of financial claims and control rights may enable entrepreneurs to induce VC support (the bright side of venture capital) while limiting VC interference (the dark side of venture capital). Intuitively, *when the need for VC support calls for very high-powered incentives to the investor, the entrepreneur should retain control,* thus avoiding any risk of interference. We predict that in the optimal arrangement the venture capitalist will hold cash-flow rights that resemble either common or preferred stock. When VC support matters, the venture capitalist holds a class of common stock with no formal control, whereas the entrepreneur holds preferred stock and retains control. When instead VC support is not very costly or not essential, the VC holds preferred stock but is given formal control. This result challenges the widespread idea that common stock should always be associated to more control rights with respect to preferred stock, and is in line with the use - in real-world VC contracts - of classes of common stock with very limited control rights attached.

This paper also provides a theoretical explanation to the striking evidence documented by Kaplan and Strömberg (2000), namely the inclusion in VC deals of contingencies that trigger both a reduction of VC formal control *and* the conversion of her preferred stock into common stock. Existing theories of contingent venture capital deals do not account for this joint evolution of control and cash-flow rights. In particular, it is not clear why after

[3] Conversely, many papers stressing the advising role of VC investors are concerned with the simultaneous, double-sided moral hazard problem arising when both the entrepreneur and the VC must support a project *after* it has been selected. See for instance Repullo and Suarez (1999) and Casamatta (2000).

[4] There is a fundamental difference between *VC support* and *VC interference*. To interfere in the firm's decisions (e.g., imposing a plan of action to the entrepreneur, reverting entrepreneurial decisions), a VC investor needs formal control. Conversely, an investor can provide support and advice even if she has no control rights.

attainment of good performance, *while VC's control rights are reduced, her claim becomes riskier* (from preferred equity to common equity). It is somehow puzzling that the investor's control rights are reduced when her claim (preferred stock) is converted in one (common stock) that in standard contracts is associated with *more* control (in the sense of more voting rights). We show that this contingent allocation of control and cash-flows may indeed be optimal in start-up financing.

The paper proceeds as follows. A review of the related literature is provided first. Then, Section 2 describes the model. Section 3 draws a distinction between formal and real control, and shows how a riskier financial claim increases the investor's real control. Moreover, it delineates the trade-off between inducing VC support and avoiding VC interference, showing that the latter discourages entrepreneurial initiative. Section 4 analyzes the benchmark case where VC support is contractible. It is shown that the optimal contract allocates formal control to VC but limits the riskiness of her financial claim, which then can be interpreted as preferred stock. Section 5 studies optimal control and cash-flow rights when VC support is not contractible. It is shown that when support is very costly, it is optimal to give the VC a very risky claim (common stock) but no control rights. Section 6 draws a simple extension of the model where an early signal of profitability accrues. The optimal contract is then very similar to the contingent control and cash-flow right allocations described in Kaplan and Strömberg (2000). Section 7 concludes.

1.1 Literature review

Dewatripont and Tirole (1994), hereafter referred to as DT, have been the first to point out that control and cash-flow rights are interrelated. They argue that, when monetary incentives are not sufficient to discipline managers, the optimal capital structure will allow for multiple claim-holders with contingent control rights: debt-holders (who prefer manager-unfriendly actions) should have control after bad performance, and equity-holders (whose preferences are more aligned with the manager's) should have control after good performance. Disliking debt-holders' intervention, the manager will have incentives to work in order to attain a good performance.

The present paper also studies the joint pattern of income rights and control rights. However, the focus is completely different. DT try to rationalize the existence of multiple claims, and to explain the observed correlation between control and cash-flow rights within *standard securities*, like debt or equity, used by traditional corporations. We focus on the more innovative venture capital arrangements, where studying the properties of standard securities does not make much sense. Secondly, the channel that links control rights and financial claims is also different. In DT, an outsider's claim works as an incentive scheme to take the appropriate course of action when she is in control.[5] Therefore, the design of a

[5]What the optimal course of action is depends in turn on the need to provide ex-ante incentives to the

claim determines *how* control is exercised by its holders. In our paper, the investor's claim determines *to which extent* she effectively exercises control (this is not the case in DT, where formal and effective control always coincide) in that a riskier claim makes the investor more eager to interfere in the firm's decisions.

Finally, our papers yield different predictions on the use of contingent contracts. DT's optimal contract can be implemented through a *contingent claim with uncontingent control:* a single controlling investor holding a debt-like claim when early profitability is low, and an equity-like claim when profitability is high. In contrast, we predict that a VC investor should hold a *contingent claim with contingent control rights*: after good signals of profitability, the investor's preferred stock is converted into common stock *and* control is transferred back to the entrepreneur. This prediction is more in line with existing evidence on venture capital agreements.

Burkart, Gromb and Panunzi (1997), hereafter BGP, have already argued that investors' high-powered claims are detrimental to entrepreneurial initiative, in that they turn formal control into effective interference. In their model, this implies that outside *voting equity* should not be concentrated in the hands of a few shareholders.[6] The focus of their paper is the (over-interference) cost of ownership concentration, and not the simultaneous design of control rights and financial claims: first, due to the structure of payoffs (either R or zero), no prediction can be drawn on the impact of *security design* on real control and entrepreneurial initiative. Secondly, the allocation of formal control is not endogenously derived; rather, it is assumed that a large equity stake always comes with formal control.

The concern that excess interference kills entrepreneurial initiative is definitely relevant to venture capital. However, for young and innovative firms, the venture capitalist's support matters at least as much as entrepreneurial initiative. The novel point of our paper is that venture capital contracts should take into account *both sides of the coin*, that is, try to induce the investor's support while limiting her interference. Solving this trade-off requires a more innovative design of cash-flow and control rights with respect to the contractual solution envisioned in BGP for large, publicly traded firms.

In Renucci (2000), investors' advice directly enhances profit maximization but may require entrepreneurs to forgo their private benefits. Hence, having an investor-advisor (a "tight relationship" with the investor) has both benefits and costs. When entrepreneurial private benefits are large, it is better not to have investors make recommendations; as a

manager. As investors' incentives are instrumental to curb managerial moral hazard, they do not necessarily induce ex-post maximization of the firm's value.

[6]This result parallels that obtained by Pagano and Röell (1995), who predict that the founder of a company may want to go public in order to temper the involvement of outside shareholders by limiting their stakes. In that paper, the cost of excess monitoring comes from the fact that the initial owner cares not only about the market value of the company but also about his future private benefits as manager of the firm. As in BGP, ownership concentration inevitably leads to excess intervention, as large equity stakes always come with formal control in those two papers.

consequence, it is optimal to issue dispersed equity. Conversely, when private benefits are small, entrepreneurs do want investors' advice. In this case, the design of cash-flow rights trades-off the investor's incentives with the entrepreneur's incentives: the lower the private benefit (the milder entrepreneurial moral hazard), the riskier is the investor's claim. In stark contrast with our work, control rights are not explicitly analyzed in that paper. Hence, investors' interference can only be avoided by reducing her incentives for information gathering, thus forgoing the benefits of advice. In our paper, two different contractual instruments - claims design and control allocation - can be used to spur investors' advice and support while forgoing excessive interference.

Hellmann (1998) defines control rights independently of financial claims, so that a high equity stake is not necessarily associated with control. In his paper, a specific control right, the right to appoint the CEO, is relinquished to the venture capitalist to provide her sufficient incentives to engage in an executive search. Providing such incentives by raising the investor's equity-stake would require giving the entrepreneur a low-powered claim, thus reducing his effort. Hellmann's point is thus that VC's incentives are better provided through control rights while cash-flow rights (equity) should take care of entrepreneurial incentives. This result is severely affected once one allows control to spur entrepreneurial initiative as well, as the present paper does. Although Hellmann's results are consistent with some stylized facts of venture capital, namely the allocation of voting control to VCs at the early stage of financings, they do not account for the evidence that control is shifted to *entrepreneurs* at the late financing stage and in general after good short-term performance. Hellmann's prediction that venture capitalists should ask superior control rights is also at odds with the common practice in corporate venturing, whereby corporate investors do not seek board seats in portfolio companies.[7]

2 The model

An entrepreneur has one idea which requires external financing. To turn his idea into a real business, the entrepreneur has to pay a set up cost I, but he has no money. To raise the amount I, the entrepreneur (EN) makes a take-it-or-leave-it contract offer to a venture capitalist (VC) and, if needed, to passive outside investors as well. Passive investors play no role in the firm's management; they just need to break even to participate in the firm's financing. Investors behave competitively in the market for funds.

[7]Furthermore, in contrast to the present work, the paper does not make any security design prediction on whether VC's cash-flow rights should resemble common stock, preferred stock or convertible debt.

Projects

The start-up faces N+1 a priori identical projects,[8] $k \in \{0, 1, 2, ..., N\}$. All projects may fail (yield income $R^L > 0$) or succeed (yield income $R^H = R^L + \Delta R$), but they differ in their probability of success and the nonverifiable private cost they engender for EN. Although the project choice is observable by informed parties, it is not verifiable.

The status-quo project (project 0) is known: it succeeds with probability p and imposes a private cost $\gamma > 0$ on the entrepreneur. The payoffs attached to the N other projects are *not* known unless further investigation is carried out. It is known that $(N-2)$ projects are worse than project 0 for both VC and EN, and at least one of them has disastrous consequences for the firm, in that it brings the probability of success to zero and imposes a cost $\gamma_k = -\infty$ on EN. Two projects, indexed $N-1$ and N, have the following probabilities of success and private costs:

0	$N-1$	N	probability
p, γ	$p+\tau, 0$	p, γ	λ
p, γ	$p+\tau, \gamma$	$p, 0$	$1-\lambda$

where $p + \tau \in (0; 1)$.

Following Aghion and Tirole (1997), λ measures the congruence of interests between EN and VC. We assume:

(A1) $\lambda \in (0, 1)$

Moreover, we assume:

(A2) $\tau \Delta R > \gamma > \tau \frac{B}{p}$

Where, as it will be clear later, $\frac{B}{p}$ is the entrepreneur's additional utility when high rather than low profits are realized. Project $N-1$ is the most efficient one. However, with probability $(1-\lambda)$ the entrepreneur prefers project N, whereas the venture capitalist always prefers project $N-1$. The assumptions $\lambda < 1$ and $\gamma > \tau \frac{B}{p}$ ensure that EN and VC's preferences over projects are not always aligned, and thus control allocation matters. The assumption $\lambda > 0$ ensures that EN sometimes has the same objectives as VC. Thus, the latter may want to adopt EN's proposed project even when EN has no formal authority to impose it.

The Information Gathering Stage

After paying the set up cost I, the entrepreneur exerts a nonverifiable effort $e \in [0, 1]$ to screen among different projects. At a private cost $\frac{e^2}{2}$ he learns the payoff of all candidate

[8] When the contract is signed, an entrepreneurial idea already exists, but it is still vague: there may be different variants of the same product to choose among, or different business plans to follow to market and sell the product. We define each of these options as a project.

projects with probability e. This effort could be interpreted as additional research pursued to produce a well-defined business plan (prototype building, product tests, etc.). Simultaneously, the venture capitalist can exert a nonverifiable effort $E \in [0,1]$ at a cost $\frac{E^2}{2}$, to monitor the entrepreneur's research activity. VC can only become informed if the entrepreneur is: if EN learns the project payoffs, VC also learns them with probability E, and does not learn with probability $(1-E)$.

Project selection

The formal authority to choose a project can be allocated either to the entrepreneur or the venture capitalist. Under *VC-formal control*, the entrepreneur can make a project proposal; the venture capitalist may then adopt the entrepreneur's proposal or choose another project. She does so only if she is informed about the project payoffs and the proposal is not congruent with her objectives. Otherwise, she optimally rubber-stamps EN's recommendation, since with probability $\lambda > 0$ EN's favorite project is also VC's favorite project. Under *EN-formal control*, the entrepreneur has the right to choose his preferred project. The existence of "disastrous projects" ensures that, when uninformed about the projects' payoffs, both EN and VC optimally adopt the status quo project (project 0).

The Moral Hazard Stage

After a project is selected, both EN and VC have to spend effort on its implementation. Their efforts are unverifiable and complementary:[9] if both parties "behave",[10] the probability of success is $p > 0$. If either the investor or the entrepreneur "misbehaves", the probability of success is zero. When the entrepreneur misbehaves, he enjoys a private benefit $B > 0$; when the venture capitalist misbehaves, she enjoys a private benefit $c > 0$. We assume that the start-up is worth funding only if the contractual arrangement induces both EN and VC to behave.[11] When this is the case, even the status-quo project (project 0) has a positive value:

(A3) $$p\Delta R + R^L - I - \gamma > 0$$

Preferences

Venture capitalists and passive investors are risk-neutral. The entrepreneur's expected utility for project k is:

$$U_k(R^L_{en}, R^H_{en}) = \begin{cases} R^L_{en} + (p+\tau_k)(R^H_{en} - R^L_{en}) - \gamma_k & \text{when } R^H_{en} - R^L_{en} < \frac{B}{p} \\ R^L_{en} + (p+\tau_k)\frac{B}{p} - \gamma_k & \text{when } R^H_{en} - R^L_{en} \geq \frac{B}{p} \end{cases}$$

where $\tau_k \in \{0;\tau\}$, $\gamma_k \in \{0;\gamma\}$, and R^L_{en} (R^H_{en}) is the monetary payment he receives after low (high) profits are realized. The entrepreneur's utility is a concave function of money. This

[9] Complementarity between efforts is not crucial to our results. It is assumed here only to simplify the notation.

[10] For a description of the role of VC's effort at this stage, see section 3.1.

[11] For this, it is sufficient to assume that $R^L + \tau\Delta R - I + B + c < 0$.

particular utility function captures in a very simple way the idea that monetary incentives have a limited impact on the entrepreneur's provision of research effort.

Contracts

The entrepreneur makes a take-it-or-leave-it contract offer to the venture capitalist specifying the parties' cash-flow rights and control-rights. The contract must also specify VC's outlay $I_{vc} \leq I$ whenever passive investors are present; otherwise, VC's outlay is equal to I. Due to the non-verifiability of projects, cash-flow rights can be contingent on the final outcome, but not on the project choice. Hence, cash-flow rights specify VC and EN's payoff in case of failure (R^L_{vc} and R^L_{en}) and success (R^H_{vc} and R^H_{en}). When present, passive investors receive $(R^L - R^L_{vc} - R^L_{en})$ or $(R^H - R^H_{vc} - R^H_{en})$. Entrepreneurs are protected by limited liability: $R^L_{en} \geq 0$ and $R^H_{en} \geq 0$. We define the variable

$$\delta_{vc} = R^H_{vc} - R^L_{vc}$$

as the power of VC's incentives, or the riskiness of the financial claim. As projects cannot be described and contracted upon ex ante, the contract must also allocate to either EN or VC the formal control over project selection.

Timing

The timing of events is summarized in the following figure:

Contract stage	Information stage		Moral hazard stage	Outcome stage
I	Efforts e,E	**Project selected**	EN work/shirk VC support/not	Verifiable profit: R^H or R^L

Figure 1: Time line

There are typically four stages in the life of an innovative start-up, before a verifiable signal of success or failure occurs. At the *contracting stage*, the entrepreneur receives seed finance[12] from a venture capitalist, in exchange for cash-flow and control rights in the firm. At the *information gathering stage*, research is carried out to redefine the entrepreneurial idea and turn it into a real project. Both VC and EN are actively involved in this stage; however, as research requires specialized technological skills, the entrepreneur's role is crucial. After a

[12]Seed finance "allows a business idea to be developed, perhaps involving the production of a business plan, prototypes and additional research, prior to bringing a product to market and commencing large-scale manufacturing" (*A Guide to Venture Capital*, British Venture Capital Association, page 16).

business plan is selected by the party in control, its implementation requires further efforts from both the venture capitalist and the entrepreneur. The *implementation stage* has more to do with bringing the product to market. Hence, the venture capitalist's support becomes crucial at this stage.

3 The trade-off between VC's support and excess interference

Our model captures what we believe are two main phenomena in innovative, venture-funded start-ups. First, start-ups face *multiple moral hazard problems* at different stages of their life. At the information gathering stage (stage 1), the main issue is to induce EN and VC to exert the optimal amount of research in order to pick the best available project. However, even when the "right" project is adopted, its value can be jeopardized if VC does not support its implementation at stage 2. At that stage, providing incentives to the venture capitalist is crucial. Secondly, entrepreneurs dislike excessive interference, and thus are willing to limit VC's *effective control* through an appropriate design of her claim. An optimal venture capital deal should ideally induce VC support while limiting VC interference.

3.1 The moral hazard stage

As in much of the literature on venture capital finance, we assume that the investor plays an active role in determining a start-up's success.[13] It is a well documented fact that venture capitalists are actively engaged in managing the firms they fund. Venture capitalists help recruit key personnel, advice the entrepreneur on strategic decisions, provide introductions to potential customers and suppliers. We define all these activities as *VC support*; c is then the private cost borne by VC when providing support. An alternative interpretation for VC's moral hazard is the following. The venture capitalist may "cannibalize" the project, for instance, by stealing the entrepreneurial idea and using it to fund a new, competing venture. In this case, she gains c but drives the firm's probability of success to zero. The fear of idea expropriation is indeed a relevant concern for innovative entrepreneurs.[14]

[13] Gorman and Sahlman (1989) provide extensive evidence on the time venture capitalists devote to support portfolio companies. For models stressing the advising/supporting role of venture capitalists, see Repullo and Suarez (1999), Schmidt (1999), Casamatta (2000), and Renucci (2000). In these models, as well as in our model, the venture capitalist's effort *directly* increases the profitability of a project. Hence, she is more an advisor than a monitor à la Holmström and Tirole (1997).

[14] The risk of value-destroying actions is perceived as very strong in the venture capital world (see also the discussion in section 7). For instance, here is Silver's (1984) advice to new entrepreneurs approaching a corporation's venture capital arm: "beware of corporate officers disguised as venture capitalists! Many are the corporations who attempt to kill new companies whose products may become competitive." Hellmann (1998) trades off this cost with the benefits of corporate venture capital financing. In Ueda (2000), the dark side of venture capital is the threat that the investor duplicate the project when intellectual property rights are weak. Finally, in Cestone and White (2000) a venture capital contract is designed so as to commit the

At stage 2, in order that the entrepreneur works and the venture capitalist supports the start-up, the cash-flow rights have to satisfy the following incentive compatibility constraints:

$$p(R_{en}^H - R_{en}^L) \geq B$$

or

$$(R_{en}^H - R_{en}^L) \geq \frac{B}{p} \qquad (IC_{en})$$

and:

$$p(R_{vc}^H - R_{vc}^L) \geq c$$

or

$$\delta_{vc} \geq \frac{c}{p} \qquad (IC_{vc})$$

We assume that $\Delta R = R^H - R^L \geq \frac{B}{p} + \frac{c}{p}$, that is, there is no tension between second period incentives. The relevant tension here is between VC's *early* and *late* incentives. Indeed, VC *late* moral hazard imposes an important constraint on the structure of the financial arrangement: the venture capitalist must be given *a sufficiently risky financial claim* for the project to be worth funding. However, a very risky claim may induce VC to gather too much information and over-interfere with the firm's decisions at stage 1. We show this in the following subsection.

3.2 Formal versus effective control

The allocation of formal control in a venture capital arrangement does not describe *per se* who will take the relevant decisions in the start-up's life. Indeed, formal control rights turn into *effective control* only when the controlling party has enough information to exercise them.[15] In our model, an uninformed VC (EN) never dares choosing (proposing) a project without being informed on payoffs. Moreover, EN's preferences are sometimes congruent with VC's ($\lambda > 0$). Hence, an uninformed VC will not exercise her control but rather adopt EN's proposal, whenever there is one.

- Under *EN-Formal Control*, the utility functions of EN and VC are:

VC not to fund a competing firm.

[15]For a general analysis of formal versus real authority in organizations, we refer the reader to Aghion and Tirole's (1997) seminal paper.

$$U_{en}^{EN} = R_{en}^{L} + p\frac{B}{p} + e\lambda\tau\frac{B}{p} - (1-e)\gamma - \frac{e^2}{2}$$

$$U_{vc}^{EN} = R_{vc}^{L} + p\delta_{vc} + e\lambda\tau\delta_{vc} - \frac{E^2}{2}$$

As VC can only be informed if EN is, VC never has any real control under this arrangement. If EN is informed, he selects his favorite project, which is also the value-enhancing project with probability λ.[16] Otherwise, he adopts the status-quo project. When EN is in control, information gathering efforts at stage 1 are:

$$e^{EN} = \lambda\tau\frac{B}{p} + \gamma \qquad \text{and} \qquad E^{EN} = 0$$

Note that effort levels do not depend on the shape of VC's claim.[17]

For *EN-Control* to be feasible, we need to assume that the income that can be credibly pledged to VC under such arrangement is larger than the funds provided. Hence, we will assume throughout:

(A4) $$R^L + [p + e^{EN}\lambda\tau]\left(\Delta R - \frac{B}{p}\right) > I$$

- Under *VC-Formal Control*, the utility functions of EN and VC are:

$$U_{en}^{VC} = R_{en}^{L} + p\frac{B}{p} + e[E + (1-E)\lambda]\tau\frac{B}{p} - eE(1-\lambda)\gamma - (1-e)\gamma - \frac{e^2}{2}$$

$$U_{vc}^{VC} = R_{vc}^{L} + p\delta_{vc} + e[E + (1-E)\lambda]\tau\delta_{vc} - \frac{E^2}{2}$$

With probability eE, VC has real control: she picks the value-enhancing project, that imposes an expected cost $(1-\lambda)\gamma$ on EN. However, with probability $e(1-E)$, EN has *effective* control: VC rubber-stamps EN's proposal, which has probability λ of being the value-enhancing project. Finally, when the parties are uninformed (with probability $(1-e)$), the status-quo project is adopted.

In this case, the reaction functions in information gathering for EN and VC are:

$$e = \left[\lambda\tau\frac{B}{p} + \gamma\right] - \left(\gamma - \tau\frac{B}{p}\right)(1-\lambda)E$$

and

$$E = \tau\delta_{vc}(1-\lambda)e.$$

[16] Owing to the non-verifiability of project choice, no contract may ensure that an informed entrepreneur always chooses the value-enhancing project. See however the next footnote.

[17] The result that VC never has any real control and thus does not gather information under EN's formal control depends on our implicitely ruling out option contracts. Suppose the initial contract assigns VC a convertible claim. Conversion must occur after project selection, and gives the right to a higher share of profits in the failure state. If the conversion rate is appropriately designed, whenever VC is informed about project payoffs, she will convert her claim after observing that project N has been selected, and not convert after project $N-1$ has been selected. This option then gives VC incentives to gather information about projects. The threat of conversion may induce EN to choose project $N-1$, so that finally VC does enjoy some real control. However, as EN must be given an incompressible stake $\frac{B}{p}$ in the firm's upside, but on the other hand cannot bear too much risk, it may not be possible to design such an option.

The entrepreneur's research effort or *initiative* is spurred by the prospect of having real control. Information gathering (E), and increased interference, by the venture capitalist can only inhibit such initiative. On the other hand, when VC's financial claim is riskier (e.g., δ_{vc} is larger), she invests more in information gathering and thus interferes more often in the start-up's life. Combining the parties' FOCs, and assuming interior solutions, we obtain the equilibrium values of e and E under *VC-Formal Control*:

$$e^{VC}(\delta_{vc}) = \frac{\lambda\tau\frac{B}{p}+\gamma}{1+\left(\gamma-\tau\frac{B}{p}\right)(1-\lambda)^2\tau\delta_{vc}} \quad \text{and} \quad E^{VC}(\delta_{vc}) = \frac{\left(\lambda\tau\frac{B}{p}+\gamma\right)(1-\lambda)\delta_{vc}}{1+\left(\gamma-\tau\frac{B}{p}\right)(1-\lambda)^2\tau\delta_{vc}}.$$

It is immediate to observe that:

$$\frac{\partial E}{\partial \delta_{vc}} > 0 \qquad \text{and} \qquad \frac{\partial e}{\partial \delta_{vc}} < 0$$

The extent to which a venture capitalist turns her control rights into real control depends on the riskiness of her claim (δ_{vc}). A riskier claim makes VC more eager to interfere in the project selection process. This in turn reduces entrepreneurial autonomy, hence discouraging initiative.[18]

3.3 The trade-off

The above analysis shows that - whenever VC is granted control rights over project selection - a trade-off between VC support and excess interference arises. Two crucial factors contribute to turn an entrepreneurial idea into a successful firm. First, the entrepreneur must devote enough effort to analyzing the different projects available, before one is selected (*EN's initiative*).[19] Second, the venture capitalist must provide sufficient advice and support when the project is implemented (*VC's support*). The design of the venture capitalist's claim has two effects. On the one hand, it may spur VC's support to the project, which makes a risky claim desirable. On the other hand, it determines her incentives to gather information. The latter must be calibrated so as to avoid an "interference-kills-initiative" effect. In this sense, a very risky claim may be suboptimal.

4 The benchmark: Contractible VC support

We now study the optimal venture capital deal when the degree of VC's support at stage 2 is verifiable and thus can be contracted upon. We proceed in the following way: we derive the optimal cash-flow rights under, respectively, *EN-Formal Control* and *VC-Formal*

[18] This is a straightforward extension of Burkart, Gromb and Panunzi's (1997) result that initiative is inhibited when *voting* equity is concentrated in the hands of a large shareholder. Section 1.1 drew the major differences between their paper and our contribution.

[19] Note that at this stage the investor's information-gathering effort cannot make up for insufficient entrepreneurial initiative, as VC can become informed only if EN is.

Control. We then compare the surplus generated by the venture under the two arrangements to determine the optimal control rights allocation.

4.1 Cash-flow rights under *EN-control*

When the entrepreneur has formal control, information gathering efforts do not depend on the shape of the investor's claim. Hence, VC will never interfere in the project selection even if she holds an arbitrarily risky claim in the start-up. This will be the case at the optimum, as the risk-averse entrepreneur will leave VC with most of the risk:[20]

Lemma 1 *Under EN-Control, the optimal contract gives VC the riskiest claim compatible with entrepreneurial incentives:* $\delta_{vc}^{EN} = \Delta R - \frac{B}{p}$ *and* $R_{vc}^{L} = I - \left[p + e^{EN}\lambda\tau\right]\left(\Delta R - \frac{B}{p}\right) < R^{L}$.

Proof. See the Appendix. ■

Note that under EN-Control the value of the venture does not depend on δ_{vc}^{EN}:

$$V^{EN} = \left\{R^{L} + p\Delta R - \gamma - I\right\} + e^{EN}\left[\lambda\tau\Delta R + \gamma\right] - \frac{(e^{EN})^2}{2}$$

4.2 Cash-flow rights under *VC-control*

When VC has formal control on the project selection, the shape of her financial claim has a crucial impact on the extent of *real* control she exercises, and thus on entrepreneurial initiative. In this case, the value of the venture is:

$$V^{VC}(\delta_{vc}) = \left\{R^{L} + p\Delta R - \gamma - I\right\} + e^{VC}\left[\lambda\tau\Delta R + \gamma\right] + e^{VC}E^{VC}(1-\lambda)\left[\tau\Delta R - \gamma\right] - \frac{(e^{VC})^2}{2} - \frac{(E^{VC})^2}{2}$$

with $e^{VC} = e^{VC}(\delta_{vc})$ and $E^{VC} = E^{VC}(\delta_{vc})$. The optimal cash-flow rights then solve:

$$Max_{R_{vc}^{L},\delta_{vc},I_{vc}} \quad V^{VC}(\delta_{vc})$$

s.t.:

$$(IC_{en}) \quad R_{en}^{H} - R_{en}^{L} \geq \frac{B}{p}$$

$$(IR_{vc}) \quad R_{vc}^{L} + p\delta_{vc} + e[\lambda + E(1-\lambda)]\tau\delta_{vc} - \frac{E^2}{2} \geq I_{vc}$$

$$(IR_{ou}) \quad \{p + e[\lambda + E(1-\lambda)]\tau\}\left(\Delta R - \frac{B}{p} - \delta_{vc}\right) = I - I_{vc}$$

$$(LL_{en}) \quad R_{en}^{H} \geq 0;\ R_{en}^{L} \geq 0$$

where: $e = e^{VC}(\delta_{vc}) \qquad E = E^{VC}(\delta_{vc})$

[20] One may argue that this contract is not unique. Equivalently, one could set $\delta_{vc} < \Delta R - \frac{B}{p}$ and have passive outside investors co-finance the firm and bear the residual risk $\Delta R - \frac{B}{p} - \delta_{vc}$. However, this is no longer true in the general model with continuous support: as we show in the appendix, in that case it is uniquely optimal to give VC the riskiest claim compatible with EN's incentives.

(IC_{en}) is the entrepreneur's incentive constraint for stage-2 effort and (IR_{vc}) is the venture capitalist's participation constraint and (IR_{ou}) is the outside investors' participation constraint. (LL_{en}) ensures limited liability for the entrepreneur, while $e^{VC}(\delta_{vc})$ and $E^{VC}(\delta_{vc})$ are defined in section 3.2. The following proposition shows that - under VC-Control - the venture capitalist must hold a safer financial claim than under EN-Control:

Proposition 2 *When the venture capitalist is granted formal control rights over the start-up, it is optimal to limit the riskiness of her claim:* $\delta_{vc}^{VC} < \Delta R - \frac{B}{p} = \delta_{vc}^{EN}$.

Proof. Following the lines of Burkart-Gromb-Panunzi (1997), the optimal level of δ_{vc} is determined by solving:

$$\frac{dV^{VC}}{d\delta_{vc}} = \frac{\partial V^{VC}}{\partial e}\frac{de}{d\delta_{vc}} + \frac{\partial V^{VC}}{\partial E}\frac{dE}{d\delta_{vc}} = 0$$

where the first term represents the "initiative effect" and is always negative due to $\frac{de}{d\delta_{vc}} < 0$. The second term is the "control effect", which is negative for $\delta_{vc} = \Delta R - \frac{B}{p}$. It follows that $\delta_{vc} = \Delta R - \frac{B}{p}$ cannot be an optimum. Note that, as $\delta_{vc} < \Delta R - \frac{B}{p}$, passive investors are brought in so as to bear the residual risk $\left(\Delta R - \frac{B}{p} - \delta_{vc}\right)$. See the Appendix for a detailed proof. ■

The intuition is straightforward: when investors hold risky financial claims, they have stronger incentives to become informed about the firm's prospects and interfere in its decisions. As a consequence, their formal control rights turn into *excessive real control*, or over-interference. Entrepreneurial initiative is then discouraged. In other words, when investors hold equity-like claims, the cost of control in terms of entrepreneurial initiative becomes too high. Hence, *entrepreneurs granting control rights to venture capitalists should sell them a financial claim that is not too sensitive to the firm's profits.* The above result challenges a widespread view in textbook corporate finance, namely, the idea that risky claims, like common equity, should be always associated to more control. We have proved that this need not be the case: *when entrepreneurial initiative is essential*, riskier financial claims (e.g. common equity) should be granted *less* control rights.[21]

4.3 Optimal control allocation

Assumption (A4) guarantees that *EN-Formal Control* is a feasible arrangement: the entrepreneur is not obliged to relinquish formal control to the venture capitalist in order to obtain funding. Yet, the entrepreneur may voluntarily relinquish control to VC as the latter

[21] It is true in general that common equity receives more voting rights than, say, preferred equity. But - in sophisticated financial contracts like VC deals - many other control rights (ex., seats on the board, authority to appoint the C.E.O.) contribute to determine the extent of formal control enjoyed by investors. Our point is then that the *overall formal control* enjoyed by an investor and the riskiness of her claim should be negatively correlated.

will choose the efficient project more often than EN himself would do.[22] However, to prevent excessive control from destroying EN's initiative, VC's *real* control is limited by reducing her incentives for information-gathering. This result is stated in:

Proposition 3 *When VC's support is contractible, it is always optimal to release formal control to VC, and give her a relatively safe financial claim in the start-up.*

Proof. Assumption (A4) ensures that under both EN-Control and VC-Control the investor's pledgeable income is larger than the financial need I. Therefore, the optimal control allocation is simply the one that maximizes the value of the venture. When VC's claim can be freely designed, VC-Control can do at least as well as EN-Control, as $Max_{\delta_{vc}} V^{VC}(\delta_{vc}) \geq V^{EN}$. Therefore, VC is granted formal control, and her claim is made "relatively" safe as Proposition 2 predicts. See the Appendix for a detailed proof. ■

Following Hart (1995), the optimal allocation of authority in a venture trades off ex-ante incentives with ex-post efficiency. In our model, ex-post efficiency requires that project $N-1$ is selected at stage 1, as $\tau \Delta R > \gamma$. When VC is in control, she always chooses the efficient project, whereas EN may choose a suboptimal project when *he* is in control.[23] This makes VC control desirable. On the other hand, VC's control on project selection may destroy EN's incentives to gather information on available projects, thus reducing the value of the venture. This effect is stronger when VC's claim is riskier and thus she exerts too much *real* control. The solution is then to allocate *formal* control rights to VC and appropriately shape VC's financial claim so as to induce the ex-ante optimal level of *real* control.

5 Optimal control and cash-flow rights when VC support is not contractible

We now turn to the case where VC's support to the venture is not observable. In this case, the need to provide incentives to VC imposes a relevant constraint on the contract: the riskiness of the claim, δ_{vc}, cannot be smaller than $\frac{c}{p}$. Under *VC-Formal Control*, this constraint may bind if c is very large: then, VC has excessive incentives to monitor the start-up and has too much real control. This in turn reduces EN's initiative and the value of the venture V^{VC}. The above reasoning suggests that - when c is large - the cost of VC-Control in terms of entrepreneurial initiative may become too high. Hence, it may be optimal to give EN the formal control over project selection. This intuition lies behind the following result:

[22] Hellmann (1998) also shows that, even when they are not credit rationed, entrepreneurs may *voluntarily* relinquish some control rights to venture capitalists. In his paper, the right to appoint the C.E.O. provides the venture capitalist with ex-ante incentives to engage in an executive search. In our paper, formal control over project selection is conferred to VC simply because she will always choose the efficient project.

[23] Remember that EN's lack of responsiveness to monetary incentives precludes the possibility to bribe him when he is in control, so as to induce him to select the efficient project.

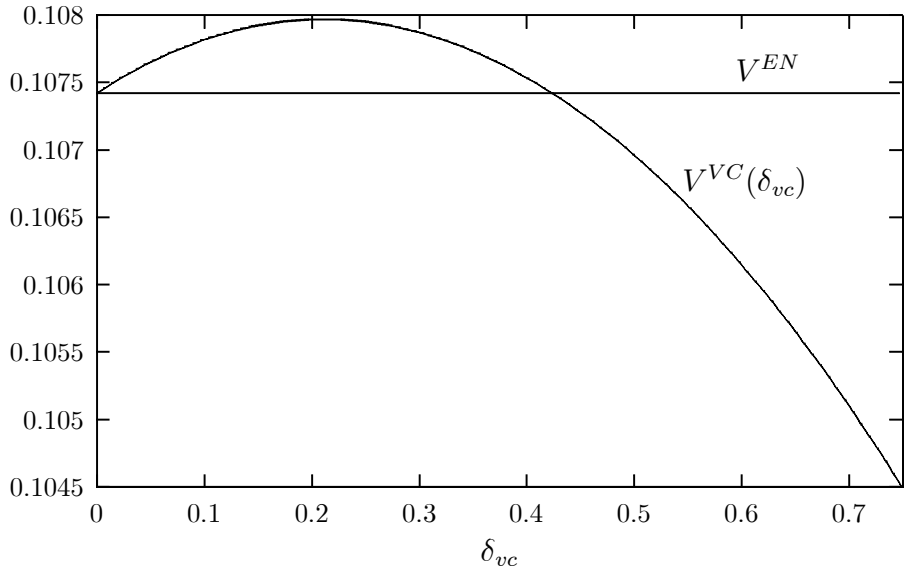

Figure 2: Plot of $V^{VC}(\delta_{vc})$ and V^{EN}

Proposition 4 *When the extent of VC moral hazard is large, it is optimal to grant formal control to EN. Formally, there exists a threshold value* $\widehat{c} \in (0; p\Delta R - B)$ *such that the optimal financial contract sets:*

- *if* $c \leq \widehat{c}$*: VC has formal control, and* $\delta_{vc}^* < \Delta R - \frac{B}{p}$
- *if* $c > \widehat{c}$*: EN has formal control and* $\delta_{vc}^* = \Delta R - \frac{B}{p}$

Proof. See the Appendix. ■

Figure 2 graphically shows the intuition of Proposition 4. It displays the functions $V^{VC}(\delta_{vc})$ and V^{EN} for the following values of the parameters: $\Delta R = 1$, $\frac{B}{p} = 0.25$, $\tau = 0.5$, $\gamma = 0.25$, $\lambda = 0.5$, $p = 0.5$. Accordingly, the power of VC's claim, δ_{vc}, varies between 0 and 0.75. The intersection of the two curves defines the threshold $\widehat{\delta}_{vc} \equiv \frac{\widehat{c}}{p}$, which takes here the value 0.42. When $\delta_{vc} > 0.42$, entrepreneurial control does better than VC's control. Hence, $\widehat{c} = 0.21$.

Remark on continuous support – In the appendix we show that similar intuitions hold for the case where the venture capitalist can provide different levels of support at increasing costs, so that a riskier claim induces more support. Hence, when δ_{vc} is increased, *a trade-off between early entrepreneurial initiative and late venture capital's support* arises. One the one hand, VC's support is increased, which enhances the probability of success. This is the benefit of a risky claim. One the other hand, increasing δ_{vc} destroys value by inducing excessive real control and reduced initiative at stage 1. This is the cost of a risky claim.

When EN has Formal Control, only the support effect is present. Hence, VC is given the riskiest claim compatible with EN's incentives, as in Lemma 1. Conversely, under VC-Formal Control, giving VC a risky claim has a cost as well as a benefit. Hence, the optimal level of δ_{vc} is lower than under EN-Control.

5.1 Security design

The optimal contracts we just solved for consisted of a cash-flow splitting rule $\left\{\delta_{vc}, R^L_{vc}\right\}$ and a formal control allocation. Here we illustrate how the above cash-flow rights can be implemented through financial instruments commonly observed in venture capital deals. To simplify matters, we restrict our analysis to the extreme cases where VC support is very costly ($c \cong p\Delta R - B$) and VC support has a low cost ($c \leq p\delta^{VC}_{vc}$).

c "large"

In this case, the optimal contract allocates control to EN and gives VC a very risky claim: $\delta_{vc} = \Delta R - \frac{B}{p}$ and $R^L_{vc} = I - \left[p + e^{EN}\lambda\tau\right]\left(\Delta R - \frac{B}{p}\right)$. Conversely, $R^L_{en} = R^L - R^L_{vc} > 0$ and $R^H_{en} = R^L_{en} + \frac{B}{p}$. As VC gains most of ΔR, her payment in the low state is reduced so as to ensure that EN appropriates all the surplus from the venture. These cash-flow rights can be implemented by giving *common stock to VC and preferred stock to the entrepreneur*. Let r be the minimum revenue to be paid to preferred stock-holders, and $(1-\alpha)$ the fraction of preferred stock held by EN. α is the fraction of common stock issued to VC. Preferred stock to EN has a role in that - by promising a minimum dividend to EN - ensures that a VC holding common stock is not paid much in the low state. Obviously, this is the case if and only if $(1-\alpha)R^L < r$ (e.g., $R^L_{vc} = R^L - r < \alpha R^L$). To implement the optimal contract, it is sufficient to set:

$r^* = R^L_{en}$ and $\alpha^* R^H = R^L_{vc} + \delta^{EN}_{vc}$, which implies $\alpha^* = \frac{R^L_{vc} + \Delta R - \frac{B}{p}}{R^H}$.[24]

c "small"

When c is smaller than $c_0 \equiv p\delta^{VC}_{vc}$, the optimal contract gives VC formal control over the venture and a relatively safe financial claim: $\delta_{vc} = \delta^{VC}_{vc} < \Delta R - \frac{B}{p}$ and $R^L_{vc} = I - \left[p + e^{EN}\lambda\tau\right]\delta^{VC}_{vc}$. As VC captures a small part of the surplus from success ΔR, she must receive an adequate compensation in case of failure in order that she is willing to fund the firm. This can be done by giving *preferred stock to VC and common stock to the entrepreneur*. Let r be the minimum revenue to be paid to preferred stock and α VC's equity share. This contract implements the optimal cash-flow rights if it satisfies:[25]

$r^* = R^L_{vc}$ and $\alpha^* R^H = R^L_{vc} + \delta^{VC}_{vc}$.

[24] $\{r^*, \alpha^*\}$ represents indeed preferred stock provided $(1-\alpha^*)R^L < r$. The above is true whenever $I - \left[p + e^{EN}\lambda\tau\right]\left(\Delta R - \frac{B}{p}\right) < \frac{R^L}{\Delta R}\left(\Delta R - \frac{B}{p}\right)$, that is, whenever I is sufficiently low, or ΔR is sufficiently large.

[25] This represents indeed preferred stock provided $\alpha^* R^L < r^*$, that is: $\frac{R^L_{vc} + \delta^{VC}_{vc}}{R^H} R^L < R^L_{vc}$.

6 Contingent venture capital deals

Venture capital deals make an extensive use of contingencies. Gompers (1997) and Kaplan and Strömberg (2000) report that cash-flow rights, control rights and disbursements of additional finance are made contingent upon observable measures of performance. Performance milestones are both financial (e.g. the attainment of a minimum level of short term earnings or net worth) and non-financial (patent approval, Federal Drug Administration approval for new drugs). Along the life of a start-up, the parties' rights typically evolve in the following way. At the initial stage of financing, VCs usually enjoy control. If the company performs poorly, VCs obtain full control; but as early performance milestones are attained, VCs lose their superior voting, board and liquidation rights. This occurs when the VCs' preferred stock converts into common stock.[26]

According to existing theories, it is not clear why the venture capitalist should lose her superior control rights exactly when her preferred stock can (or must) be converted into common stock. It is puzzling that after good short-term performance VC control is reduced and simultaneously her claim is made riskier, which in standard securities is associated with *more* control. Applying our model to a multi-period setting may provide a theoretical explanation for this contingent allocation of cash-flow and control rights.

6.1 Early profitability signals and contingent control

Assume that during the start-up's life two non-contractible actions must be taken in sequence. The first consists in selecting a project; the second represents all further strategic decisions that may enhance the firm's profitability. The timing is as follows (see also figure 3). After the start-up's financing, research is carried out and a project is chosen. Then, an early signal accrues about the profitability of the project adopted. The signal is verifiable. After signal realization, the start-up's life proceeds exactly as in the basic model:[27] information gathering takes place over the second action; the controlling party selects the action; VC provides a level of support $c \in [0;1]$ at private cost $\frac{c^2}{2}$. This induces a probability of success cp. Finally, monetary profits are realized. We define the period between the initial financing and the signal realization as the *seed stage*; the *second round*, or *start-up stage*,[28] takes place

[26] In a significant number of cases, such conversion occurs automatically once the performance milestone is attained, and thus it is *not* just an option offered to the venture capitalist. Automatic conversion occurred in 38% of the VC deals in Gomper's sample. According to Kaplan and Strömberg, 73% of the financing rounds in their sample included automatic conversion provisions.

[27] To simplify matters, there is no entrepreneurial moral hazard on project implementation.

[28] The British Venture Capital Association identifies four crucial stages in a company's development. A the *seed stage*, VC finance "allows a business idea to be developed, perhaps involving the production of a business plan, prototypes and additional research, prior to bringing a product to market and commencing large-scale manufacturing." The *start-up stage* is "to develop the company's products and fund their initial marketing. Companies may be in the process of being set up or may have been trading for a short time, but not have sold their product commercially." In a *further early stage* the company may "initiate commercial manufacturing

after the signal occurs and until the firm's profits are realized. Usually, these early stages are followed by an exit stage where the firm is brought to the market through an IPO. We do not explicitly model exit as this lies beyond the scope of the paper.[29] To simplify matters, we also assume that the entrepreneur is not responsive at all to monetary incentives.[30]

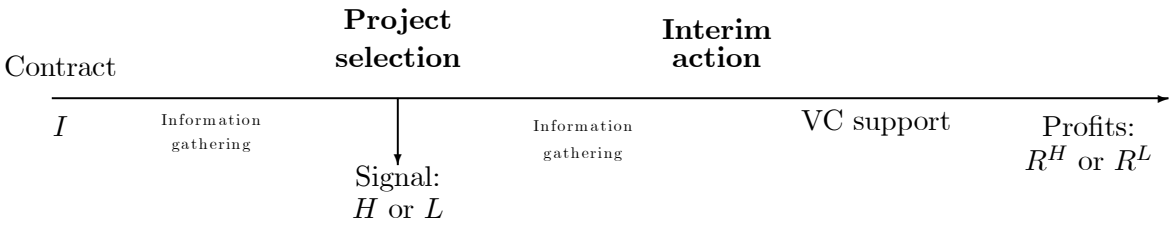

Figure 3: Time line

The initial contract must allocate control rights over both actions, as well as cash-flow rights over the final profit. Both the cash-flow rights and formal control over the second action can be made contingent upon the verifiable signal of project profitability. At the seed stage, incentives for information gathering and for project selection crucially depend on how control and cash-flow rights change upon attainment of a good (bad) signal.

The start-up stage

The events occurring after signal realization are described by our basic model with continuous VC support. As we argue in section 5 (and formally show in the appendix), the optimal claim to be held by the venture capitalist depends on who has formal control on the second-period action: under EN-Control, it is optimal that VC holds a risky claim so as to induce maximal support. Under VC-Control, it is optimal to limit the riskiness of VC's claim so as to preserve EN's second-round initiative. Define U_{en}^{EN} the entrepreneur's second-round utility when he has formal control on the second action, and U_{en}^{VC} the entrepreneur's second-round utility when VC has formal control.

and sales...but may not yet be generating profits." Finally, at the *expansion stage*, the venture capitalist may provide finance "to grow and expand an established company." (*A Guide to Venture Capital*, page 16-17). The final and crucial stage in the venture capital cycle is the *exit stage*. For a complete description of the venture capital process, from investment to exit, see Gompers and Lerner (1999).

[29] See Aghion, Bolton and Tirole (2000) for an optimal contracting model analyzing exit provisions in venture capital financing.

[30] We may reasonably assume that EN enjoys a fixed private benefit B from running the firm, and thus is willing to start a firm even if he will have to bear the costs of information gathering and of project implementation.

The seed stage

Project selection takes place at the seed stage and is not reversible at a later stage. The $N+1$ available projects have different probabilities of success $(p+\tau_k)$ and private costs (γ_k) for the entrepreneur. Let us slightly generalize the basic model by assuming that one project $(N-2)$ has disastrous consequences for the firm $(\tau_{N-2}=-p)$ but gives a private benefit b to the entrepreneur $(\gamma_{N-2}=-b)$. When project $(N-2)$ is available, EN's and VC's preferences over projects are never congruent, as EN invariably prefers project $(N-2)$ to any other project. Hence, *VC should have formal control at the seed stage*, as she always chooses the profit-enhancing project while EN never does.

There is a problem, though. Suppose VC has formal control at the seed stage. Should she ever rubber-stamp the entrepreneur's proposal when uninformed? Obviously not: if EN proposes a project, this must be his favorite one, namely, the value-destroying project $(N-2)$. As his proposal will never be accepted, EN has no incentive to gather information ex ante. This lack of initiative impounds on the firm's value, in that it will always stick to the status quo project. To put it in other words, "the key to entrepreneurial real control (and initiative!) is congruence":[31] if EN's preferences are never congruent with the investor's objectives, his proposals are never rubber-stamped, which completely kills initiative as a result. To partially realign EN's preferences over projects with the objective of profit maximization, a contingent control allocation in the second round may be called for.

Assume that early performance variables realized at the end of the seed stage signal whether a value-destroying project was chosen: if $(N-2)$ is selected, a bad signal (L) accrues. If any other project is selected, signal L only accrues with probability $(1-\xi)$, while with probability $\xi>0$ a good signal (H) accrues. A contract allocating *second-round control to the entrepreneur if the early signal is good and to the venture capitalist if the signal is bad* can ensure that EN - when informed - never proposes project $(N-2)$ at the seed stage.[32] This is the case if:

$$\xi U_{en}^{EN}+(1-\xi)U_{en}^{VC}\geq b$$

which holds whenever entrepreneurial benefits of control in the second round are large enough. By realigning EN's preferences with VC's, contingent second-round control allows to grant seed-stage control to the venture capitalist (as is efficient), and yet preserve entrepreneurial initiative at that stage. As showed in our basic model, it is optimal to tie to

[31] A discussion of these issues can be found in Tirole (2000).

[32] We are not the first to propose this "carrot-and-stick" view of contingent control. Dewatripont and Tirole (1994) argue for instance that shifting control to tough investors after bad performance is a way to discipline managers when monetary incentives are costly to provide. Note that monetary incentives need not be completely ruled out in order to derive the optimality of contingent control. It can be argued that late moral hazard may significantly reduce the effectiveness of monetary incentives. For instance, in our setting, if EN must hold an incompressible stake $\frac{B}{p}$ in the firm's upside (as it is the case in the basic model), he cannot be severely punished in monetary terms after a bad signal accrues.

each control allocation an appropriate design of cash-flow rights, so as to give a relatively safe claim to the party in control. Hence, cash-flow rights should as well be contingent upon the early signal. This suggests that the following contract may deal appropriately with the multiple incentive problems affecting the firm: the venture capitalist holds superior voting and board rights at the close of the financing and takes convertible preferred equity in the firm. When an early performance milestone is attained, control is shifted back to the founder, and VC's preferred stock is converted into common. The particular terms of this contract are similar to those observed in the venture capital world.

7 Evidence from the corporate world

We argued that there exists a trade-off between giving a venture capitalist the incentive to support a start-up with professional advice and business connections, and limiting her taste for excess interference (real control). Hence, when the firm requires a large support from its venture capital investor, it is optimal to reduce the latter's control rights. A recent paper by Hellmann and Puri (2000) provides indirect evidence that this is indeed the case. Using data on Silicon Valley start-up companies, Hellmann and Puri construct a measure for venture capital support, what they call the "soft side of venture capital". They find that the latter is negatively correlated with VC's control rights (the "hard side of venture capital").[33] They also show that "the role of venture capital is state contingent, focussing more on control in the bad state and more on support in the good state". This second piece of evidence is in line with the results in section 6, whereby after a good short-term signal the investor's incentives are tightened and her control rights reduced.

We proved that holders of risky claims should be assigned less control rights than holders of safe claims. However, we do not claim that common equity and control should always be negatively correlated. As the analysis focuses on those firms where entrepreneurial initiative is an essential input for success, our predictions are likely to hold in the case of high-tech, early start-ups. The way cash-flow and control rights evolve *along the life of a start-up* (documented by both Gompers, 1997 and Kaplan and Strömberg, 2000) confirms our predictions. Cross-sectional results also seem to support our theory: Kaplan and Strömberg (2000) find that in first-round investments the degree of VC control is positively correlated with the performance sensitivity of the *founder*'s claim.[34] This suggests that the degree of VC control is negatively correlated with the performance sensitivity of the *venture capitalist*'s claim (unfortunately, this correlation is not directly measured in their paper).

[33] More specifically, the paper focuses on VC support to "team building" (recruitment process, design of human resource policies and of stock option plans for key employees), while VC control is measured by the right to replace the founders with outside CEOs.

[34] In their sample, when the VC has (voting) control, about thirty percent of the founder's equity stake is contingent on performance versus a three percent when the founder has control.

According to Proposition 4, investors who can substantially contribute to success of a portfolio company, but have a high opportunity cost of doing so (e.g. have a high c), should hold high-powered monetary incentives and weak control rights. A widespread perception in the business community is that corporate venture funds display these characteristics to a larger extent than independent venture capital houses. Corporate investors are playing an increasing role in the venture capital arena: leading firms like Intel Corporation, Lucent Technologies, NBC, Oracle have all created their own corporate venturing programs in the past few years. On the one hand, both entrepreneurs and independent VCs recognize the added value of having a corporate investor as a partner in a deal. According to David Barry of Asset Alternatives Inc., "an investment from a corporate powerhouse like Intel Corp., Lucent Technologies, NBC, or even Amazon.com Inc. may determine whether a technology, telecom or internet start-up succeeds or fails."[35] On the other hand, corporate investors are not as trusted as independent venture capitalists are when it comes to confidentiality over new ideas: once the internal plans and developments of an emerging company have been learned by the corporate venture capitalist, the latter may have very poor incentives to favor the start-up's success, and rather let the technological information be exploited by her parent house. This explains why many entrepreneurs express concerns about confidentiality when leading with corporate VCs and why they fear corporate control. In line with our theory, the most successful corporate venturing programs have adopted clear-cut policies to protect entrepreneurs. The most effective is probably to keep an hands-off approach: Gene Franz, senior director of the venture arm of Oracle Corporation, declares for instance that "Oracle Venture Partners generally doesn't seek a board seat, or attempt to dictate the running of portfolio companies." Gompers and Lerner (1999) also document that corporate VCs do not take board seats in portfolio firms; moreover, compared to independent VCs, they are much more likely to invest in late financing rounds, e.g. when research effort and entrepreneurial initiative have already been exerted.

Other casual evidence in the corporate world supports our view that risky claims (for instance, large equity stakes) need not necessarily be associated with control. Indeed, the same phenomena that determine the terms of corporate venture capital deals lie behind the sophisticated partnership deals between biotech start-ups and big drug companies. Biotech entrepreneurs often finance their research by raising funds from leading drug firms. These may be helpful financiers when it comes to advising biotech research, or even performing the costly stages of testing and manufacturing a newly discovered drug. However, as we already argued, a *controlling* corporate partner willing to keep an eye on new discoveries may be tempted to appropriate the good ones (or destroy the ones that compete with its leading drugs). Apparently, scared by excess interference and the risk of cannibalization, biotech

[35] Except where indicated otherwise, all quotations in this section are drawn from *The Corporate Venturing Directory & Yearbook* (2000).

start-ups are becoming more and more cautious when writing such "window-on-technology" deals. As reported in *The Economist* (August 29th, 1992), "...when a big drug firm buys a controlling stake in a biotech firm, it is usually careful to let the firm's founders continue to run it". One striking example: when Hoffmann-La Roche bought a 60% stake in Genentech - an American biotech lab - in 1990, "it demanded only two of Genentech's 13 board sits".

As is the case for many moral hazard models, the existence of reputational mechanisms would obviously temper the results in our paper. If a venture capitalist is concerned about being known to treat entrepreneurs fairly, he will be reluctant to expropriate entrepreneurial ideas or over-interfere in the firm's management at the expense of entrepreneurial private benefits of control. Our prediction is then that contractual terms like the ones described here should be more common when there are doubts about whether the (corporate) investor is a long-term player in the venture capital market.

8 Concluding remarks

Although cash-flows and control rights are strongly interrelated in venture capital deals, financial contracting models focus on one mechanism in isolation. This paper develops an optimal contracting model where cash-flow rights and control rights are allocated independently, and yet are shown to follow a joint pattern. Our theory challenges the common idea that risky claims (e.g. common stock) should always be associated to more control rights, as it used to be the case in standard securities. In line with our results, venture capital contracts, corporate venturing deals, and sophisticated partnership deals between biotech start-ups and big drug companies often display a negative correlation between control rights and riskiness of claims. Our theory also explains the use - documented in Gompers (1997) and Kaplan and Strömberg (2000) - of contingent contracts where the investor's superior control rights are reduced and her claim is converted into a riskier one upon attainment of early performance milestones. These features of innovative financial deals have never been rationalized in earlier theoretical work.

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Appendix

Proof of Lemma 1

The optimal cash-flow splitting rule solves:

$Max_{R^L_{vc},\delta_{vc}} \quad \left[(R^L - R^L_{vc}) + (p + e^{EN}\lambda\tau)\frac{B}{p} - (1 - e^{EN})\gamma - \frac{(e^{EN})^2}{2}\right]$

s.t.:

$(IC_{en}) \qquad (R^H_{en} - R^L_{en}) \geq \frac{B}{p}$

$(IR_{vc}) \qquad R^L_{vc} + \left[p + e^{EN}\lambda\tau\right]\delta_{vc} \geq I$

$R^L_{en} = R^L - R^L_{vc}$ and $(R^H_{en} - R^L_{en}) = \Delta R - \delta_{vc}$

$e^{EN} = \lambda\tau\frac{B}{p} + \gamma$

Note first that, as EN is risk-averse, it is optimal to set (IC_{en}) binding. Secondly, as under EN-Control information gathering efforts are independent of δ_{vc}, δ_{vc} can be set arbitrarily large without inducing "excess interference" of VC. Hence, it is optimal to increase the risky payment δ_{vc} up to $\Delta R - \frac{B}{p}$ and reduce R^L_{vc} so as to keep for EN most of the "safe" return. Obviously, R^L_{vc} is set so as to keep (IR_{vc}) binding:

$$R^L_{vc} = I - \left[p + e^{EN}\lambda\tau\right]\left(\Delta R - \frac{B}{p}\right) < R^L$$
by (A4)

Proof of Proposition 2

To simplify calculations, let us define the following variables:

$X = \tau\Delta R - \gamma$

$F = \gamma - \tau\frac{B}{p}$

$G = \lambda\tau\Delta R + \gamma$

We can then re-write the value of the venture under VC-Control as:

$$V^{VC}(e, E) = [R^L + p\Delta R - \gamma - I] + eG + eE(1 - \lambda)X - \frac{e^2}{2} - \frac{E^2}{2}$$

The net marginal benefit of EN's initiative is:

$\frac{\partial V^{VC}}{\partial e} = G + (1 - \lambda)EX - e$

while the net marginal benefit of VC's monitoring is:

$\frac{\partial V^{VC}}{\partial E} = e(1 - \lambda)X - E$

- *Let us first prove a preliminary result:*

Lemma 5 *The value of the venture $V^{VC}(\delta_{vc})$ under VC-Formal Control is concave in δ_{vc}.*

Proof. As $E(\delta_{vc})$ is monotonically increasing in δ_{vc}, we can as well study $V^{VC}(E)$, where e has been replaced with the best reply $e(E)$. Differentiating w.r.t. E :

$\frac{dV^{VC}}{dE} = \frac{\partial V^{VC}}{\partial E} + \frac{\partial V^{VC}}{\partial e}\frac{de}{dE} =$

$= [e(E)(1-\lambda)X - E] + [G + (1-\lambda)EX - e(E)]\,[-F(1-\lambda)]$

And as $e(E) = e^{EN} - F(1-\lambda)E$, we obtain:

(1) $\frac{dV^{VC}}{dE} = e^{EN}(1-\lambda)X - F(1-\lambda)^2XE - E - F(1-\lambda)G$

$-F(1-\lambda)^2XE + e^{EN}F(1-\lambda) - F^2(1-\lambda)^2E$

The second derivative is then:

(2) $\frac{d^2V^{VC}}{dE^2} = -2F(1-\lambda)^2X - F^2(1-\lambda)^2 - 1 < 0$ ■

- *We now study the optimal level of E*

As $V(E)$ is concave, the optimal level of E is determined by the first order condition:

$$\frac{dV^{VC}}{dE} = \frac{\partial V^{VC}}{\partial E} + \frac{\partial V^{VC}}{\partial e}\frac{de}{dE} = 0$$

The first term represents the *control effect*. Under VC-Control, increasing E (e.g. real control) benefits the venture in that VC imposes the value-enhancing project more often. However, monitoring has a cost. Therefore, the control effect is positive provided $e(1-\lambda)X - E > 0$. The second term represents the *initiative effect*. This effect is always negative: increased monitoring and interference discourage EN's information-gathering effort (initiative), which is the engine for discovering value-enhancing projects.

- *We are left to prove that $\delta_{vc}^{VC} < \Delta R - \frac{B}{p}$*

Suppose not. Then $\delta_{vc}^{VC} = \Delta R - \frac{B}{p}$ and from VC's F.O.C. for effort E we have: $E = \overline{E} = e(1-\lambda)\tau\left(\Delta R - \frac{B}{p}\right)$. But then, as $e(1-\lambda)X - \overline{E} < 0$, the *control effect* is negative and so is $\frac{dV^{VC}}{dE}$. Hence, δ_{vc}^{VC} should optimally be reduced below $\Delta R - \frac{B}{p}$. Q.E.D.

Proof of Proposition 3

Setting $\delta_{vc} = 0$ one obtains $E^{VC} = 0$, $e^{VC} = e^{EN}$ and:

$V^{VC}(0) = [R^L + p\Delta R - \gamma - I] + e^{EN}G - \frac{(e^{EN})^2}{2} = V^{EN}$.

Whatever is achieved with EN-Control can always be achieved by granting formal control to VC and giving her a safe claim ($\delta_{vc} = 0$) so that VC never has any real control. Hence, *VC-Control does weakly better than EN-Control*. Indeed, under some mild condition, VC-Control is *strictly* preferred to EN-Control. This is the case whenever:

$$\frac{dV^{VC}}{dE}(E=0) > 0$$

that is, it is optimal to have VC exercise "some" real control. Substituting $E = 0$ in (1), we obtain:

$$\frac{dV^{VC}}{dE}(0) = e^{EN}(1-\lambda)X - F(1-\lambda)G + e^{EN}F(1-\lambda) =$$
$$\lambda\tau^2\Delta R\frac{B}{p} + \lambda\tau^2\frac{B}{p}(\Delta R - \frac{B}{p}) + \gamma\left[(1-\lambda)\tau\Delta R - \gamma\right]$$

Note that $\lambda < 1 - \frac{\gamma}{\tau\Delta R}$ is a sufficient (but not necessary) condition for the above expression to be positive: when the congruence of interests between the parties is low and initiative is maximal ($e = e^{EN}$), it is optimal to give control to the investor, as her objectives are more in line with those of the venture.

For completeness we show below that VC's participation constraint never binds. Therefore, value-maximization is the only criterion determining the allocation of control.

Lemma 6 *Whenever the value of the venture is larger under VC-Control (e.g., $V^{VC} > V^{EN}$), the investor's pledgeable income also is. This, and assumption (A4), imply that VC-Control is feasible.*

Proof. After tedious calculations, we obtain:

$$(V^{VC} - V^{EN}) - (Pl.Inc^{VC} - Pl.Inc^{EN}) =$$
$$= -(1-\lambda)\left(\gamma - \frac{B}{p}\right)E^{VC}(e^{VC} + e^{EN}) < 0$$
Thus, $V^{VC} > V^{EN} \Longrightarrow Pl.Inc^{VC} > Pl.Inc^{EN} > I$
by (A4)

Q.E.D. ■

Proof of Proposition 4

First, let us define $c_0 \equiv p\delta_{vc}^{VC}$ (where δ_{vc}^{VC} is the optimal riskiness of VC claim when VC support is contractible). Clearly, when VC has formal control and $c \leq c_0$, the constraint $\delta_{vc} \geq \frac{c}{p}$ does *not* bind. Thus, the shape of the investor's claim does not depend on the extent of VC's moral hazard c, and is determined as in section 4.2. The value of the venture is then: $Max_{\delta_{vc}} \quad V^{VC}(\delta_{vc})$, which we know is larger than V^{EN}.

When $c > c_0$, (IC_{vc}) binds and VC's claim can no longer be shaped so as to induce the optimal amount of *real* control. Then, $\delta_{vc} = \frac{c}{p}$ and the value of the venture, $V^{VC}(\frac{c}{p})$, is monotonically decreasing in c. Define as $\widehat{\delta}_{vc}$ the value of δ_{vc} such that: $V^{VC}(\widehat{\delta}_{vc}) = V^{EN}$. This value satisfies $\widehat{\delta}_{vc} < \Delta R - \frac{B}{p}$. Then, $V^{VC}(\delta_{vc}) < V^{EN}$ for $\delta_{vc} > \widehat{\delta}_{vc}$. Therefore, for any $c > \widehat{c} \equiv \widehat{\delta}_{vc}p$, EN-Control is to be preferred to VC-Control.

Continuous VC support

We analyze here the case where the venture capitalist can provide different levels of support. At stage 2, she exerts a nonverifiable effort $c \in [0;1]$ at a private cost $\frac{c^2}{2}$. Provided the entrepreneur works at this stage, this induces a probability of success cp. The first best level of support is then equal to $p\Delta R$. The venture capitalist's first order condition for c is:

$$p\delta_{vc} = c \qquad (IC_{vc})$$

As expected, VC's support is increasing in the riskiness of her claim. We can now study the optimal design of the claim under EN-Control and VC-Control.

Under *EN-Control*, the value of the venture is:

$$V^{EN} = \left\{R^L - \gamma - I\right\} + e^{EN}\left[\lambda\tau\Delta R + \gamma\right] - \tfrac{(e^{EN})^2}{2} + pc\Delta R - \tfrac{c^2}{2}$$

where c is given by (IC_{vc}). Taking the derivative with respect to δ_{vc} yields:

$$\frac{dV^{EN}}{d\delta_{vc}} = \frac{\partial V^{EN}}{\partial c}\frac{dc}{d\delta_{vc}} = p^2\left[\Delta R - \delta_{vc}\right] > 0$$

$\frac{\partial V^{EN}}{\partial c}\frac{dc}{d\delta_{vc}}$ is the *support effect*: a riskier claim benefits a start-up by increasing VC's incentives to provide support at stage 2. As this effect is always positive, Lemma 1's result carries through: under EN-Control it is optimal to give VC the riskiest possible claim: $\delta_{vc}^{EN} = \Delta R - \frac{B}{p}$. Under *VC-Control*, the value of the venture is:

$$V^{VC} = \left\{R^L - \gamma - I\right\} + e^{VC}\left[\lambda\tau\Delta R + \gamma\right] + e^{VC}E^{VC}(1-\lambda)\left[\tau\Delta R - \gamma\right]$$
$$-\tfrac{(e^{VC})^2}{2} - \tfrac{(E^{VC})^2}{2} + pc\Delta R - \tfrac{c^2}{2}$$

where $c = p\delta_{vc}$, $e = e^{VC}(\delta_{vc})$ and $E = E^{VC}(\delta_{vc})$.

Differentiating with respect to δ_{vc}:

$$\frac{dV^{VC}}{d\delta_{vc}} = \underset{(+)}{\frac{\partial V^{VC}}{\partial c}\frac{dc}{d\delta_{vc}}} + \underset{(-)}{\frac{\partial V^{VC}}{\partial e}\frac{de}{d\delta_{vc}}} + \underset{(?)}{\frac{\partial V^{VC}}{\partial E}\frac{dE}{d\delta_{vc}}}$$

where the support effect (the first term) is to be balanced with the *initiative effect* (the second term) and the *control effect* (the third term). If we set $\delta_{vc} = \Delta R - \frac{B}{p}$, the control effect is negative. It follows that VC's optimal claim must be safer than under EN-Control. Proposition 2 then extends to the case of continuous support.