DISCUSSION PAPER SERIES

No. 3462

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FINANCIAL ECONOMICS

Centre for Economic Policy Research

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ISSN 0265-8003

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Discussion Paper No. 3462
July 2002

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CEPR Discussion Paper No. 3462

July 2002

ABSTRACT

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

This Paper develops a theory of the joint allocation of control and cash-flow rights in venture capital deals. I argue that when the need for investor support calls for very high-powered outside claims, entrepreneurs should optimally retain control in order to avoid undue interference. Hence, I predict that risky claims should be negatively correlated to control rights, both along the life of a start-up and across deals. This challenges the idea that control should always be attached to more equity-like claims, and is in line with contractual terms used in venture capital, in corporate venturing and in partnerships between biotech start-ups and large corporations. The Paper also rationalizes the evidence, documented in Gompers (1999) and Kaplan and Stromberg (2000), that venture capital contracts include contingencies triggering both a reduction in VC control and the conversion of VC's preferred stock into common stock.

JEL Classification: G30
Keywords: control rights, corporate governance, security design and venture capital

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*This Paper is produced as part of a CEPR Research Network on 'Understanding Financial Architecture: Legal and Political Frameworks and Economic Efficiency', funded by the European Commission under the Research Training Network Programme (Contract No: HPRN-CT-2000-00064).

Submitted 05 July 2002

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 in their deals. Among other things, the interaction between cash-flow and control rights in venture capital is still far from being understood. This paper proposes an optimal contracting model to account for the *joint* pattern of control and cash-flow rights observed in venture capital deals.

Recent works on financial 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, 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. I 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 while VCs usually take *preferred* stock in the firms they fund, contractual covenants attach to VCs' preferred stock substantial control rights. Conversely, in many corporate venturing deals and in partnerships between biotech start-ups and big drug companies, the investor takes a majority equity stake in the start-up, but few or no seats on the board of directors. This evidence is striking, in that - contrary to common wisdom - *more equity-like claims seem to be associated to weaker control rights.* Unfortunately, existing financial contracting models cannot offer an explanation for this evidence: with the exceptions of Dewatripont and Tirole (1994) and Hellmann (1998) in most models control and cash-flow rights are not interrelated, as the focus is either on the allocation of control (Aghion and Bolton, 1992) or on the design of the investor's claim.[2] Trying to fill this gap, this paper addresses two questions on the optimal form of venture capital

[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] The list of financial contracting models deriving the optimal outside claims leaving aside control issues is too long to be reported here. I refer to Harris and Raviv (1991) or Kaplan and Strömberg's (2000) comprehensive bibliographies. See also section 1.1.

contracts: may it be desirable to attach substantial control rights to more debt-like claims such as preferred stock, and few control rights to more equity-like claims? If so, when are VCs more likely to take common stock with less than proportional control rights?

I 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 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*).

In the spirit of Aghion and Tirole (1997), I argue that the venture capitalist's *effective* control over project selection discourages entrepreneurial initiative. Hence, I delineate the following trade-off. 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*,[3] 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 business connections. On the other hand, entrepreneurs are unhappy with VCs who exercise too much control on their firms.[4]

I 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. The model predicts that in the optimal arrangement the venture capitalist will hold cash-flow rights that resemble either common or preferred stock. When VC support is costly to provide, the venture capitalist holds a class of common stock with no formal control, whereas the entrepreneur holds preferred stock and retains most

[3]There is a fundamental difference between *VC support* and *VC interference*. To interfere in the firm's decisions (e.g., impose a given direction to the R&D process, forbid scientific publications related to the start-up's R&D, replace the original founder with an outside CEO), a VC investor needs formal control. Conversely, an investor can provide support and advice even if she has no control rights.

[4]For instance, Hellmann and Puri (2002) and Kaplan and Strömberg (2002) identify two different roles for venture capitalists. A supporting role in activities like hiring key personnel or elaborating stock option plans, which is welcome by firm founders; and a controlling (or "adversarial") role, whereby the VC may forcefully replace the founder with an outside CEO.

control rights. When instead VC support is not very costly, the VC holds preferred stock but is given formal control. This result challenges the textbook assumption 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 covenants attaching substantial control to preferred stock.

The paper also proposes a theoretical explanation to the striking evidence documented by Gompers (1999) and Kaplan and Strömberg (2000), namely the inclusion in VC deals of contingencies that trigger both a reduction of the investor's control rights *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 attainment of good performance, *while VC's control rights are reduced, her claim becomes riskier*. It is somehow puzzling that the investor's control rights are reduced when her claim (preferred stock) is converted into one (common stock) that in standard contracts is associated with *more* control. In a simple extension of the model, I 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 delineates the trade-off between VC support and VC interference. 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 (e.g., common stock) but no control rights. Section 6 draws a simple extension of the model where an early signal of profitability accrues, and derives the optimal contingent control and cash-flow right allocation. Section 7 is a discussion of empirical predictions and evidence. Section 8 concludes. Appendices A and B collect most of the proofs.

1.1 Literature review

Dewatripont and Tirole (1994) 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. Dewatripont and Tirole (1994) rationalize the existence of multiple financial claims, and explain the observed correlation between control and cash-flow rights within *standard securities* like debt or equity, used by traditional corporations. I 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 Dewatripont and Tirole (1994), 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 claim determines *how* control is exercised by its holders. In my paper, the investor's claim determines *to which extent* she effectively exercises control. Finally, our papers yield different predictions on the use of contingent contracts. Dewatripont and Tirole'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, I 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) 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 positive or zero), no

[5] What the optimal course of action is depends in turn on the need to provide ex-ante incentives to the 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 (1998), 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. 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 Burkart et al., ownership concentration inevitably leads to excess intervention, as large equity stakes always come with formal control.

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 my 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 solution envisioned in Burkart, Gromb and Panunzi (1997) for large, publicly traded firms.

My work also relates to a series of papers stressing the advising/supporting role of venture capitalists within a double sided moral hazard framework, such as Repullo and Suarez (1999), Schmidt (1999), Casamatta (2000), Renucci (2000), Inderst and Müller (2001). These models focus on the optimal design of cash flow rights but do not endogenize control allocation. Also, none of them points to excessive interference as the "dark side" of venture capital, with the exception of Renucci (2000). There, investors' interference can only be avoided by reducing her incentives for information gathering, thus at the cost of receiving less advice. By contrast, in my paper two different contractual instruments - claim design and control allocation - can be used to spur investors' advice while forgoing undue 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 give 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 affected once one allows control to spur entrepreneurial initiative as well, as the present paper does. Hellmann's prediction that VCs should ask superior control rights does account for some but not all the stylized facts of venture capital. In particular, it leaves unexplained a common practice in corporate venturing, whereby corporate investors do not seek board seats in portfolio companies.[7]

[7] Other papers analyzing the allocation of control rights between entrepreneurs and venture capitalists obtain predictions that contrast with the evidence cited here. Chan, Siegel and Thakor (1990) predict that VCs should bear all cash-flow risk when in control, while in Kirilenko (2001) the VC demands control rights that are disproportionately large compared to the size of her equity.

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.

Projects

When the contract is signed, an entrepreneurial idea already exists, but it is still vague (for instance, there may be alternative discoveries or patents to pursue).[8] I define each potential course of action as a project. The start-up faces N+1 a priori identical projects, $k \in \{0, 1, 2, ..., N\}$. 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 non-verifiable 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 both. Two projects, indexed $N-1$ and N, have the following probabilities of success and private costs to EN:

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

where $p + \tau \in (0; 1)$. λ is the probability that the most profitable project $(N-1)$ is also the least costly for EN. Following Aghion and Tirole (1997), λ measures the congruence of interests between EN and VC.

Assume:

$$\lambda \in (0, 1) \qquad \text{(A1)}$$

[8] For instance, when a biotech start-up is financed, it is typically still unknown which therapeutic products it will pursue and in which order. Only after financing, the management of clinical trials determines which of several therapeutic uses of a drug will seek regulatory approval (see Lerner and Merges, 1998).

and:

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

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.

Information Gathering

After paying the set up cost I, the entrepreneur exerts a non-verifiable 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 projects with probability e. This effort could be interpreted as additional research pursued to come up with a well-defined product (prototype building, product tests, etc.). Simultaneously, the venture capitalist can exert a non-verifiable 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).

Moral Hazard

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", project

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

k's probability of success is $p + \tau_k > 0$ (with $\tau_k \in \{0; \tau\}$). If either the investor or the entrepreneur "misbehaves", the probability of success is τ_k.[10] When the entrepreneur misbehaves, he enjoys a private benefit $B > 0$; when the venture capitalist misbehaves, she enjoys a private benefit $c > 0$. I 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:

$$p\Delta R + R^L - I - \gamma > 0 \tag{A3}$$

Preferences

Venture capitalists and passive investors are risk-neutral. The entrepreneur's expected utility for project k ($k = 0, N-1, N$) 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 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 e.

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 $I_{vc} \leq I$ when outside 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 $R^H_{en} \geq 0$. Let me define the variable

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

[10] 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).

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

as the power of VC's incentives, or the riskiness of VC's 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:

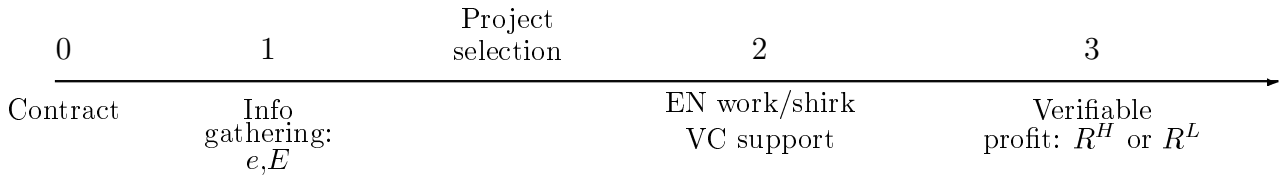

Figure 1: Time line

At $t = 0$ the entrepreneur receives seed finance from a venture capitalist, in exchange for cash-flow and control rights in the firm. At the *information gathering stage* ($t = 1$), 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 course of action is selected by the party in control, its implementation requires further efforts from both the venture capitalist and the entrepreneur. The *implementation stage* ($t = 2$) has more to do with bringing the product to market. Hence, the venture capitalist's support becomes crucial at this stage. The assumption that the VC provides support after basic research has been carried out is *not* crucial to the paper's results. Indeed, even if the timing was reversed the basic trade-off between VC support and VC interference would still be there.[12] The timing assumed here is more suited to the companies I am trying to model, namely R&D start-ups (such as biotech firms) that are still far from bringing a product to market.

[12]Whether VCs provide more support at an earlier or later stage is largely an empirical question on which the evidence is mixed. See for instance Sapienza (1992) and Kaplan and Strömberg (2002).

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

My model captures what I 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 $t = 1$, 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 $t = 2$. Hence, 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 T=2: The "moral hazard" stage

As in much of the literature on venture capital finance, I assume that the investor plays an active role in determining a start-up's success. It is a well documented fact that venture capitalists are actively engaged in managing the firms they fund.[13] Venture capitalists help recruit key personnel, advise the entrepreneur on strategic decisions, provide introductions to potential customers and suppliers. I 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 reduces the firm's probability of success by an amount p. The fear of idea expropriation is indeed a relevant concern for innovative entrepreneurs.[14]

In order that the entrepreneur works and the venture capitalist supports the start-up,

[13] See for instance Gorman and Sahlman (1989), Sahlman (1990) and more recently Hellmann and Puri (2002).

[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 (2002) 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 (2002) a financial contract is designed so as to commit the investor not to fund a competing firm.

the cash-flow rights have to satisfy the following incentive compatibility constraints:

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

and

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

I assume that $\Delta R = R^H - R^L \geq \frac{B}{p} + \frac{c}{p}$, that is I abstract from any potential tension between second period incentives. The relevant tension here is between VC's incentives to support the start-up and VC's excessive interference. Indeed, the need for VC support 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 project selection. I show this in the following subsection.

3.2 T=1: 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 my 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:

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

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

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

[15] For a general analysis of formal versus real authority in organizations, we refer the reader to Aghion and Tirole's (1997) seminal paper. See also Dessein (2001).

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, the income that can be credibly pledged to VC under such arrangement must be larger than the funds provided. Hence, I assume throughout:

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

- 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.

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 my implicitly ruling out option contracts of the following type. The initial contract assigns VC a convertible claim. Conversion must occur after project selection, and gives the right to an increase of the 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 even if EN has all formal control. 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, such an option is not a feasible contract for many parameter configurations.

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. Combining the parties' first order conditions, and assuming interior solutions, one obtains 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

I 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. I proceed deriving first the optimal cash-

[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 my 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.

flow rights under, respectively, *EN-formal control* and *VC-formal control*. I 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 never interferes in the project selection even if she holds an arbitrarily risky claim in the start-up. At the optimum, the risk-averse entrepreneur leaves VC with most of the risk:[20]

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

Proof. See Appendix A. ■

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

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

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:

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

[20] Indeed this contract is not uniquely optimal. Equivalently, one could set $\delta_{vc} < \Delta R - B/p$ and have passive outside investors co-finance the firm to bear the residual risk $\Delta R - B/p - \delta_{vc}$. However, this is no longer true in a general model with continuous VC support, as I show in Appendix B. In that case it is uniquely optimal to give VC the riskiest claim compatible with EN's incentives, so as to maximize VC's advising effort.

s.t.:

$$
\begin{aligned}
&(IC_{en}) \qquad R^H_{en} - R^L_{en} \geq \tfrac{B}{p} \\
&(IR_{vc}) \qquad R^L_{vc} + p\delta_{vc} + e[\lambda + E(1-\lambda)]\tau\delta_{vc} - \tfrac{E^2}{2} \geq I_{vc} \\
&(IR_{ou}) \qquad \{p + e[\lambda + E(1-\lambda)]\tau\} \left(\Delta R - \tfrac{B}{p} - \delta_{vc}\right) = I - I_{vc} \\
&(LL_{en}) \qquad R^H_{en} \geq 0;\ R^L_{en} \geq 0 \\
&\text{where: } e = e^{VC}(\delta_{vc}) \qquad E = E^{VC}(\delta_{vc})
\end{aligned}
$$

(IC_{en}) is the entrepreneur's incentive constraint for stage-2 effort. (IR_{vc}) is the venture capitalist's participation constraint; (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 1 *When the venture capitalist is granted formal control rights over the start-up, it is optimal to limit the riskiness of her claim. The optimal level of δ_{vc} under VC control is given by $\delta^{VC}_{vc} < \Delta R - \frac{B}{p} \equiv \delta^{EN}_{vc}$.*

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 $\Delta R - \frac{B}{p}$ 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 Appendix A 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 the textbook corporate finance assumption that riskier claims, like common equity, should

be always associated to more control. I have proved that this need not be the case: *when entrepreneurial initiative is essential*, riskier financial claims (e.g. common equity) should be granted *fewer* control rights, while substantial control can be attached to safer claims (e.g. preferred equity).[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 give control to VC as the latter 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 2 *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 (i.e., set* $\delta_{vc} < \Delta R - B/p$*).*

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 support is contractible, 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 1 predicts. See Appendix A 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 my model, ex-post efficiency requires that project $N-1$ is selected, 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

[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 control rights (voting rights, seats on the board, authority to appoint the C.E.O., etc.) contribute to determine the extent of formal control enjoyed by investors. My point is then that the *overall formal control* enjoyed by an investor and the riskiness of her claim should be negatively correlated.

[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 my paper, formal control over project selection is conferred to VC simply because she will always choose the efficient project.

[23] Remember that EN's limited 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.

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

Let me 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 an important 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:

Proposition 3 – ***Risky Claims or Formal Control ?*** – *When VC support is costly to provide, 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 prescribes:*

- *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 Appendix A. ■

Figure 2 graphically shows the intuition of Proposition 3. 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, $\widehat{c} = 0.21$.

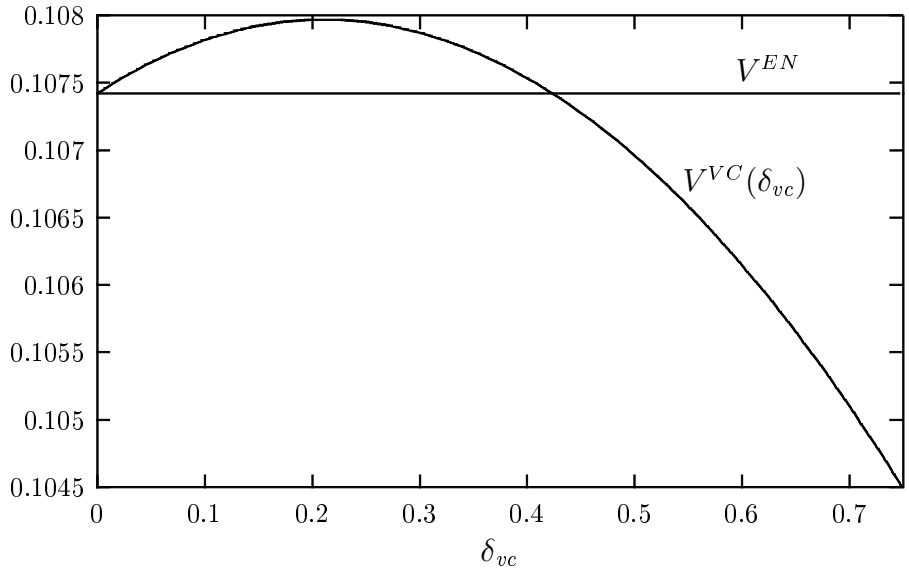

Figure 2: Plot of $V^{VC}(\delta_{vc})$ and V^{EN}

Remark 1 – Continuous VC support – In Appendix B, I show that similar intuitions hold for the more general case where VC support is a continuous variable, i.e. VC provides a level of support $c \in [0;1]$ at private cost $\frac{c^2}{2}$, which induces a probability of success $cp+\tau_k$ for project k. Under VC-control, when δ_{vc} is increased *a trade-off between early entrepreneurial initiative and VC support* arises. One the one hand, VC's support is increased, which enhances the probability of success. This is the benefit of a riskier claim. One the other hand, increasing δ_{vc} destroys value by inducing excessive real control and reduced initiative at $t=1$. This is the cost of a riskier claim. Conversely, under EN-control, only the support effect is present. Hence, VC is given the riskiest claim compatible with EN's incentives, as in Lemma 1. One can then conclude that the optimal level of δ_{vc} is lower under VC-control than under EN-control.

5.1 Security design

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

5.1.1 Case 1: c "large"

In this case, the optimal contract allocates control to EN and gives VC a very risky claim: $\delta_{vc} = \Delta R - B/p$ and $R^L_{vc} = I - \left[p + e^{EN}\lambda\tau\right](\Delta R - B/p)$. The entrepreneur's payoffs are: $R^L_{en} = R^L - R^L_{vc} > 0$ and $R^H_{en} = R^L_{en} + B/p$. As VC grabs most of ΔR, her payment in the low state must be 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 $r > (1-\alpha)R^L$ (i.e., $R^L_{vc} = R^L - r < \alpha R^L$), otherwise preferred and common stock do not differ *de facto*. To implement the optimal contract, it is sufficient to set:

$$r = R^L_{en} \qquad \text{and} \qquad \alpha R^H = R^L_{vc} + \delta^{EN}_{vc}$$

which implies $\alpha = \left(R^L_{vc} + \Delta R - \frac{B}{p}\right)/R^H$. The pair $\{r, \alpha\}$ satisfies the condition $r > (1-\alpha)\,R^L$ whenever $I - \left[p + e^{EN}\lambda\tau\right](\Delta R - B/p) < \frac{R^L}{\Delta R}(\Delta R - B/p)$, that is, whenever I is sufficiently low, or ΔR is sufficiently large.

5.1.2 Case 2: 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: $\delta_{vc} = \delta^{VC}_{vc} < \Delta R - B/p$ 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*.[24] 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:

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

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

[24] Here I am arguing that an appropriate use of common stock and preferred stock may implement the optimal cash-flow rights. Notice however that the same cash-flow splitting rule can be achieved by selling a combination of standard debt and equity to VC. Multiple security design interpretations of the optimal contract are standard when the distribution of returns has a two-point support (a feature shared by many models of VC contracting). Yet in venture capital deals, preferred stock, rather than a debt-equity mix, seems to be the most common financial instrument to give a party a debt-like claim.

6 Contingent venture capital deals

Venture capital deals make an extensive use of contingencies. Gompers (1999) 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, the VC usually enjoys control. If the company performs poorly, VC obtains full control; but as early performance milestones are attained, VC loses her superior voting, board and liquidation rights. Also, upon attainment of performance targets, the VC's preferred stock is converted into common stock.[25]

According to existing theories, it is not clear why the venture capitalist should lose her superior control rights exactly at the time when her preferred stock can (or must) be converted into common stock.[26] In this section, I argue that this contingent allocation of cash-flow and control rights can be rationalized in an extension of my basic model.

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 (the "interim action") represents all further decisions that may enhance profitability. The timing is as follows (see also figure 3). After the start-up's financing, research is carried out ($t = 1$) and a project is chosen as in the basic model. Then, an early signal accrues about the profitability of the project adopted. The signal is verifiable. At $t = 2$ (after signal realization) VC provides support to

[25] 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 occurs in 38% of the contracts in Gomper's sample. Conversion is contingent on profit or sales benchmarks, as well as on an initial public offering. See however Kaplan and Strömberg (2000), who argue that automatic conversion contingent on profits or sales is indeed rare.

[26] Several papers have provided a rationale for the use of convertible securities. Yet, in a first set of papers, control allocation is neglected, and convertibles implement a contingent allocation of cash-flows. Green (1984) and Biais and Casamatta (1999) show how convertible debt induces entrepreneurial effort while limiting excessive risk-taking. In Schmidt (1999), convertible debt strictly outperforms any mixture of debt and equity in providing incentives to both VC and EN. Cornelli and Yosha (1997) find that convertible debt may reduce entrepreneurial incentives for "window dressing" in a model of stage financing. In other models, convertibles serve to allocate contingent control rights to the parties (see Berglöf 1994, Kalai and Zender 1997); however, conversion of a debt-like claim into equity is always associated to an *increase* in control.

the start-up. Simultaneously, both VC and EN gather information about the interim action; then, the action is selected. Finally, monetary profits R^H or R^L are realized. I define the period between the initial financing and the signal realization as the *seed stage*; the *start-up stage* takes place after the signal occurs and until the firm's profits are realized.[27] I assume that VC support is a continuous variable as in Remark 1. To simplify matters, there is no entrepreneurial moral hazard at $t = 2$, and the entrepreneur is not responsive to monetary incentives.[28]

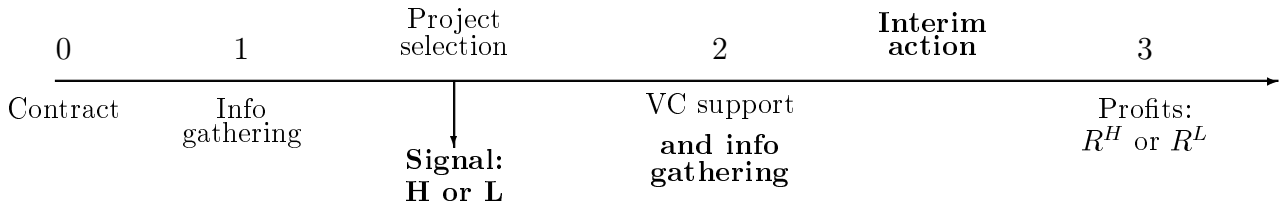

Figure 3: Time line

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 the 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 paper's bottom line implies that the optimal claim to be held by the venture capitalist

[27] The British Venture Capital Association identifies four crucial stages in a company's development. At 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..." The *start-up stage* is "to develop the company's products and fund their initial marketing." In a *further early stage* the company may "initiate commercial manufacturing and sales...but may not yet be generating profits." Finally, at the *expansion stage*, the VC may provide finance "to grow and expand an established company." (*A Guide to Venture Capital*, page 16-17). Usually, these early stages are followed by an exit stage where the firm is brought to the market through an IPO. For a complete description of the venture capital process, from investment to exit, see also Gompers and Lerner (1999). I do not explicitly model exit as this lies beyond the scope of the paper. Hence, my model cannot provide a theory for the use of contingencies like the outcome or the timing of an IPO. See Aghion, Bolton and Tirole (2000) for an optimal contracting model analyzing exit provisions in venture capital financing.

[28] One may reasonably assume that EN enjoys a large private benefit from running the firm, and thus is willing to start a venture even if he has to bear the costs of information gathering and of project implementation.

depends on who has formal control on the interim action (see Appendix B). Under EN-control, it is optimal that VC holds a risky claim so as to induce maximal support. Under VC-control, a trade off arises between VC support and VC interference at $t = 2$. Hence, it is optimal to limit the riskiness of VC's claim so as to preserve EN's incentives to gather information at $t = 2$. This implies the following: *if control over the interim action is contingent upon the signal, cash-flow rights should be made contingent as well.*

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.

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 me 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 at $t = 1$. 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":[29] 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*

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

can ensure that EN - when informed - never proposes project $(N-2)$ at the seed stage.[30] This is the case if:

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

or:

$$U_{en}^{EN} - U_{en}^{VC} \geq \frac{b}{\xi}$$

which holds whenever entrepreneurial benefits of control over the interim action are large enough relative to the benefits of control over project selection. 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 $t = 1$.

The following Proposition describes how the contingent allocation of control and cash-flow rights delineated so far can be implemented:

Proposition 4 *In the optimal contingent contract the venture capitalist holds superior control rights at the close of the financing and takes convertible preferred equity in the firm. When an early signal of profitability is observed, control is shifted back to the founder, and VC's preferred stock is converted into common. If a bad signal is observed, VC keeps control over the firm and her preferred stock is not converted.*

The particular terms of this contract are similar to those observed in the venture capital world.

7 Empirical predictions and evidence

I argued that start-ups where VC's advice and EN's initiative are both essential inputs for success should sell the investor a high-powered claim but reduce the latter's control. A recent paper by Hellmann and Puri (2002) provides indirect evidence that this is indeed the case. Using data on Silicon Valley start-ups, Hellmann and Puri contrast VC's support and VC's "adversarial role".[31] They find that VC support tends to be larger in firms which do not experience a controversial CEO turnover, suggesting that control and support are inversely

[30] I am 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.

[31] 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's adversarial role is proxied by the frequency of *forced* founder replacement with outside CEOs.

related. Another implication of my paper is that VCs holding large equity stakes may not have the right to impose decisions against the will of the entrepreneur, while even VCs with few board seats may largely support the firm provided they have high-powered claims. This is consistent with Kaplan and Strömberg's (2002) finding that a VC's equity stake does not explain intervention in management, while board control does not explain the extent of VC support. Finally, my theory is also endorsed by recent findings on European venture capital deals: in line with Proposition 3, Cummings (2002) finds that "VCs typically have fewer control rights with common equity, and more control rights when mixes of preferred and common are used."

The paper predicts that high-powered monetary incentives and weak control rights should be common among 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). A widespread perception in the business community is that corporate venture funds display these characteristics to a larger extent than independent venture capital houses. On the one hand, both entrepreneurs and independent VCs recognize the added value of having a corporate investor as a partner in a deal.[32] On the other hand, corporate investors are not trusted as much as independent venture capitalists when it comes to confidentiality over new ideas: once the internal plans 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 (see Hellmann 2002). This explains why many entrepreneurs express concerns about confidentiality when dealing with corporate VCs and why they fear corporate control. In line with my theory, many corporate venturing programs have adopted an "hands-off approach" to protect entrepreneurs. 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."[33] Gompers and Lerner (1999) also document that corporate VCs do not take board seats in portfolio firms.

Partnership deals between biotech start-ups and big drug companies are plagued by similar problems. Leading drug firms may be helpful financiers when it comes to advising biotech research, or even performing the costly stages of testing and manufacturing a newly

[32] For instance, David Barry of Asset Alternatives Inc. argues that "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." See *The Corporate Venturing Directory & Yearbook* (2000), page 9.

[33] See *The Corporate Venturing Directory & Yearbook* (2000), page 12.

discovered drug. However, as I 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 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 - "it demanded only two of Genentech's 13 board sits".

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. My 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 my 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 the riskiness of claims. My theory also explains the use - documented in Gompers (1999) 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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9 Appendix A

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.:

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

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

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

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

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 1

To simplify calculations, let us define the following variables:

$$X = \tau\Delta R - \gamma$$
$$F = \gamma - \tau\frac{B}{p}$$
$$G = \lambda\tau\Delta R + \gamma$$

The value of the venture under VC-control can be re-written 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 me first prove a preliminary result:*

Lemma 2 *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}, I 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 $e(E) = e^{EN} - F(1-\lambda)E$, one obtains:

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

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

The second derivative is then:

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

- *I now study the optimal level of E*

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

$$\frac{dV^{VC}}{dE} = \frac{\partial V^{VC}}{\partial E} + \frac{\partial V^{VC}}{\partial e}\frac{de}{dE} = 0. \tag{1}$$

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.

- *I am 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 first order condition, it is: $E = \overline{E} \equiv e(1-\lambda)\tau\left(\Delta R - \frac{B}{p}\right)$. 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 2

Setting $\delta_{vc} = 0$ under VC-control 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), one obtains:

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

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, it is optimal to give control to the investor, as her objectives are more in line with those of the venture.

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

Lemma 3 *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, one obtains:

$(V^{VC} - V^{EN}) - (Pl.Inc^{VC} - Pl.Inc^{EN}) =$

$= -(1-\lambda)\left(\gamma - \frac{B}{p}\right)E^{VC}(e^{VC} + e^{EN}) < 0$

Thus, $V^{VC} > V^{EN} \Longrightarrow Pl.Inc^{VC} > Pl.Inc^{EN} > I$
by (A4)

Q.E.D. ■

Proof of Proposition 3

First, 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 to be larger than V^{EN} (from Proposition 2).

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 $\widehat{\delta}_{vc}$ 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 preferred to VC-control.

10 Appendix B: Continuous VC support

I analyze here the case where the venture capitalist can provide different levels of support. At $t = 2$, she exerts a non-verifiable 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 $cp + \tau_k$ for project k. The first best level of support is then equal to $p\Delta R$. The venture capitalist's first order condition for c is:

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

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

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

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

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

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

$\frac{\partial V^{EN}}{\partial c}\frac{dc}{d\delta_{vc}}$ 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:

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

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

Differentiating with respect to δ_{vc}:

$$\frac{dV^{VC}}{d\delta_{vc}} = \underset{(+)}{\frac{\partial V^{VC}}{\partial c}\frac{dc}{d\delta_{vc}}} + \underset{(-)}{\frac{\partial V^{VC}}{\partial e}\frac{de}{d\delta_{vc}}} + \underset{(?)}{\frac{\partial V^{VC}}{\partial E}\frac{dE}{d\delta_{vc}}} \tag{3}$$

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). The support effect is the same as in (2), and the initiative effect is of course negative. When δ_{vc} is set equal to $\Delta R - \frac{B}{p}$, the control effect is also negative. It follows that VC's optimal claim must be safer than under EN-control:

Proposition 5 *With continuous, non-contractible VC support, the optimal cash flow rights associated to VC control are such that* $\delta_{vc} < \Delta R - \frac{B}{p}$. *Conversely, under EN control it is:* $\delta_{vc} = \Delta R - \frac{B}{p}$.