The allocation of control rights

in venture capital contracts

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Venture capitalists often hold extensive control rights over entrepreneurial companies, including the right to fire entrepreneurs. This paper examines why, and under what circumstances, entrepreneurs would voluntarily relinquish control. Control rights protect the venture capitalists from hold-up by the entrepreneurs. This provides the correct incentives for the venture capitalists to search for a superior management team. Wealth-constrained entrepreneurs may give up control even if the change in management imposes a greater loss of private benefit to them than a monetary gain to the company. The model also explains why entrepreneurs accept vesting of their stock and low severance.

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1. Introduction

In recent years much attention has focused on the possibility that suppliers of capital provide more to firms than just money. The venture capital industry is a particularly good example of an institution that prides itself on 'nursing' companies, rather than just financing them. Venture capitalists add value to their companies by providing a variety of services: they help shape strategies, provide technical and commercial advice and attract key personnel (Byers (1997); Bygrave and Timmons (1992); Gorman and Sahlman (1989); Sapienza (1992)). For many of these activities the investors and the founders (entrepreneurs) have reasonably well-aligned objectives of increasing the company's profitability. But a closer look at the venture capital business reveals that divergent interests can also create a lot of tension between entrepreneurs and venture capitalists.

Probably the most contentious issue is the composition of top management, especially whether a founder should (at some point) resign from his or her position as the CEO. Venture capitalists typically argue that professional top management adds value to the company, and that founders are prone to pursue actions that are in their personal interest, as opposed to the company's interest. Entrepreneurs, on the other hand, typically do not want to leave. They may have developed a personal attachment to the company, may consider a replacement humiliating, and may worry about their professional credibility.

The transition from founder CEOs to professional management received considerable attention in some of the most successful start-up companies, such as Apple Computers, Cisco Systems and Silicon Graphics. The replacement of a founder CEO is a widespread phenomena. In a study of entrepreneurial companies in Silicon Valley, Hannan, Burton and Baron (1996) find that in the first 20 months of a company's life, the likelihood that a non-founder is appointed as CEO is around 10%; this likelihood increases to about 40% after 40 months and over 80% after 80 months. While Hannan, Burton and Baron's study does not distinguish between voluntary and involuntary changes of CEO, Gorman and Sahlman (1989) argue that venture capitalists frequently use their control of the board of directors to replace the original founders from the position of the CEO, and that this transition is considered "traumatic" to all parties.

Venture capitalists thus play a key role in the potentially contentious appointment of a new CEO. They hold effective control over the board, typically through a voting majority, and sometimes through explicit contractual agreements. See Clark (1987), Fenn, Liang and Prowse (1995), Fried and Hisrich (1995), Gompers (1995), Lerner (1995), Rosenstein (1988) and Sahlman (1990, 1991) for accounts about the venture capitalist's role on the board. Crosswhite and Vesper (1981), Roberts (1993) and Sahlman

(1988) document case studies that feature venture capitalists with significant control rights.[1] When venture capitalists perceive problems with the founding CEO, they typically engage in an extensive search for a new CEO. Once a suitable candidate has been identified, they will exercise their control over the board to appoint the new CEO and force the founder out of the company.[2]

A surprising stylized fact is that entrepreneurs have little protection in case of termination. A typical venture capital deal includes the shareholder agreement and the employment agreement (Testa (1997); Timmons (1994)). The shareholder agreement specifies the shares that are held by the investors and the founding team. The entrepreneurs' shares typically 'vest' over a fairly long horizon (often up to five years), and fired entrepreneurs forfeit their claims on stock that has not vested.[3] Moreover, it is not unusual to find a clause that specifies that all the shares that have already vested are automatically repurchased by the company *at cost*. Since the value of stock typically rises significantly in the early years of a company, and since the founders receive their stock at the very beginning, the repurchase value of the stock is a small fraction of its true value. The employment agreement, on the other hand, specifies the terms of employment of entrepreneurs. While it could in principle specify a generous severance package, this is essentially unheard of in venture capital.

In this paper I provide a theory that explains these stylized facts. A natural question to ask is why entrepreneurs choose contractual arrangements that give venture capitalists such strong control rights and afford little protection. The answer is simple for those cases where entrepreneurs have no choice but to accept these extreme terms. If venture capitalists cannot achieve the required rate of return without the option to replace the founders, then the founders can only refuse the financing, or accept the financing and relinquish control rights. But many companies do have some choice concerning the financial terms. They may have the option to raise funds with private investors who typically lack the expertise to exert control (Ehrlich et. al. (1994); Fiet and Hellriegel (1995); Wetzel (1983)). Even if they only seek funds from venture capitalists, the entrepreneur may have some bargaining power, especially if the proposed venture appeals to more than one venture capitalist. As a consequence many entrepreneurs may be able to negotiate terms with the venture capitalist (Hoffmann and Blakey (1987)). *The main question I therefore ask in this paper is why, and under what circumstances, do entrepreneurs voluntarily relinquish control rights to venture capitalists?*

To answer this question I derive a theoretical model that looks specifically at the right to appoint the CEO. I begin by explaining the conflict of interest in a transition to professional management. In running the company entrepreneurs realize a private benefit that cannot be transferred to another party. A change of management involves a conflict of interest, since entrepreneurs want to protect their own private benefit while venture capitalists want to maximize their financial return. The level of private benefit is also endogenous, because entrepreneurs take non-verifiable actions that involve a trade-off between the financial performance of the firm and their private benefit. This reflects the above-mentioned problem that entrepreneurs may not always act solely in the interest of the company.[4] A natural way to resolve this problem is to give entrepreneurs an equity stake in the company. But since entrepreneurs are wealth constrained - otherwise they would not need to approach investors in the first place - their equity stakes will in general not be sufficiently large to provide first-best incentives.

For the venture capitalists I examine the incentives to search for a professional management team.[5] I show that venture capitalists need control rights to have sufficient incentives to engage in an executive search. Suppose the entrepreneur is in control. If the net benefit of a change in management - defined as the change in the sum of the venture capitalists' and entrepreneurs' utilities (including private benefit) - is negative, entrepreneurs will simply refuse to leave. In this case the venture capitalists' search effort are futile. If the net benefit is positive, entrepreneurs can hold up the decision to appoint the new CEO and extract significant rents in a renegotiation. In this case I show that the venture capitalists always benefit too little from their search activities. Anticipating this, venture capitalists' would exercise insufficient search effort.

I derive the optimal (second-best) contract that specifies the entrepreneur's base wage, his or her equity share, a severance package (that includes the terms of vesting) and the allocation of control rights. The base wage is shown to be always set at zero. If the net benefit of a change of management is positive, entrepreneurs will always want to relinquish control to preserve the venture capitalists' incentives to engage in a value-increasing search. I show that the optimal contract induces not only a positive, but also an 'excessive' rate of replacement, where 'excessive' is defined relative to the first-best. Moreover, the optimal contract specifies a severance package that never fully compensates entrepreneurs for being replaced.

If the net benefit of a change of management is negative it would seem that entrepreneurs would want to retain control rights to ensure that no change of management occurs. I show that while this intuition is true for some parameter values, there exist other parameter values where entrepreneurs would want to relinquish control rights. The reason is that entrepreneurs trade off either giving venture capitalists more favorable financial terms or more favorable control terms. Offering more favorable financial terms means that entrepreneurs give up more equity. But this increases the agency costs associated with the entrepreneurs' non-contractible actions. Offering more favorable control terms, on the other hand, means that there is a higher likelihood of a change of management with negative net benefit. The optimal contract trades off these two costs.

Since this trade-off is not concave, I use the theorems of supermodularity to examine the comparative statics of this model. I show that venture capital control is more likely, and a change of management more frequent, (1) if professional managers are more productive, (2) if entrepreneurs are less productive, (3) if the entrepreneurs' private benefit is lower, and (4) if venture capitalists have greater bargaining power.

In terms of the literature, this paper builds on the hold-up problem in incomplete contracts (Williamson (1985); Grossman and Hart (1986); Hart (1995)). Control rights matter either because they allow one party to make a decision in the presence of conflict of interest, or because they affect the threat points in any renegotiation. Control is important since it affects the non-contractible behavior of the two contracting parties. I examine a new type of non-contractible behavior, namely the VC's effort to find a professional manager. Moreover, in this model the control decision can be specified in advance. As a consequence, the contract I consider is slightly richer. Depending on the control action (replace the entrepreneur or not) two different payments to the entrepreneur can be specified (labeled 'severance' and 'equity' respectively).

The model closest to this one is probably Aghion and Bolton (1992). They too are concerned with devising optimal contracts when an entrepreneur is wealth-constrained and wants to preserve some private benefit. In their model the entrepreneur would always like to retain control rights, but the requirement to provide investors a minimum expected return on their investment forces him or her to relinquish control rights. Aghion and Bolton are primarily concerned with deriving the conditions under which the entrepreneur would relinquish 'contingent control', where investors obtain control only in some states of the world (see also Aoki (1994) and Dewatripont and Tirole (1994)). I examine the case where the entrepreneur *can* provide investors the required rate of return on their investment without relinquishing control. By introducing a non-contractible action of the investor, I show that the entrepreneur may *voluntarily* yield control rights. Having control rights assures the venture capitalist that after spending the effort to search a professional manager she will not be held up by the entrepreneur.

Gertner, Scharfstein and Stein (1994) examine the importance of control in an investor - manager context and show that the investor may want to have control in order to better add value. In their case the investor wants to preserve the liquidation value of an asset. They interpret 'managerial control' as an 'external capital market' and 'investor control' as an 'internal capital market.' This paper examines a different set of investor activities and a richer set of contracts. I would also emphasize that in the context of venture capital, 'investor control' can be meaningfully provided by an 'external' provider of capital.[6]

Berglöf (1994) also looks at venture capital contracts and derives the optimality of convertible debt.

In his model the allocation of control rights matters in determining the bargaining strength of the company vis-à-vis an acquirer. I emphasize the importance of control rights in the bargaining between venture capitalists and entrepreneurs.[7]

The structure of the paper is as follows. In section 2 I introduce the basic model. Section 3 derives the optimal contract when there is no renegotiation. Section 4 allows for renegotiation and discusses the role of control rights. In section 5 I further consider the effect of replacements on the entrepreneur's incentives. In Section 6 I examine the importance of wealth constraints for the professional manager. A brief conclusion follows. All proofs are relegated to the appendix.

2. The basic model

In this model there exists an entrepreneur (EN) who possesses a project idea, and a venture capitalist (VC) that has funds to finance the project.[8] The project can either succeed, providing a payoff that is normalized at 1, or fail, providing no return. I assume that both parties are risk neutral. I denote the expected utility of the EN and the VC by U_{EN} and U_{VC} respectively. The EN's reservation utility is given by UEN. All values are expressed in time 0 present values. The EN must offer a contract that provides the VC with an expected utility of at least Q. Q is the total required return of the VC, which is a function of the amount invested and any market power that the VC may have.

Throughout the model I assume symmetric information. At the outset, there is a question about the EN's ability to manage. In particular, the VC is aware that at the end of the first period, she may be able to locate a professional manager (PM) with superior management skills. I assume that the EN has a success probability p, while the PM has a success probability of ϕ. In the basic model I treat ϕ as a constant. In section 6 I model the identity of the professional manager to make ϕ endogenous. In order to locate a PM, the VC needs to engage in a costly search. The probability of finding a PM will be given by m, and the private, non-verifiable search costs are given by c(m). For simplicity I use a quadratic cost specification, i.e., $c(m) = 0.5Mm^2$, where M is a strictly positive constant. Throughout the paper I assume that M is sufficiently large to ensure that the optimal choice of m is strictly smaller than 1.

The EN not only hopes to derive some monetary benefit from a successful project, but also derives utility from running the project. I denote the monetary equivalent of this private benefit by B. This utility can be thought of as the psychic return of running the entrepreneurial venture, the increased human capital that the EN derives from managing it, or any on-the-job-consumption. The EN has some control over the amount of private benefit. In particular he can make a non-contractible decision that increases his private benefit at the expense of expected profits.[9] I represent this trade-off by assuming that $B = b_0 + b_1$ and $p = p_0 + p_1(b_1)$ with $p_B \equiv \frac{\partial p_1}{\partial b_1} < 0$. The parameters b_0 and p_0 represent the fixed components, while b_1 and p_1 are affected by the EN's choice. The important distinction between private benefit and monetary benefit is that the private benefit is not transferable, so it is lost whenever the EN is replaced by a PM. I define $\Gamma \equiv \phi - p - B$ as the net benefit of replacing the EN with a PM.[10]

The EN and the VC write a contract at the beginning of the first period. I use the general 'mechanism design' specification where the VC gets all of the return from the project (namely 1 in case of success and 0 in case of failure) and makes a payment to the EN that depends on the (verifiable) state of the world. The contract specifies the allocation of control rights, as well as the payments that the EN receives under each verifiable outcome.

In this model there are two verifiable events (replacement or not) and two possible final outcomes (success or failure). If there is no replacement the payment of the VC to the EN is given by α_0 if the outcome is failure and α_1 if the outcome is success. If there is replacement the payment of the VC to the EN is given by S_0 if the outcome is failure and S_1 if the outcome is success. In addition there may be an ex-ante transfer payment, denoted by t, that the VC can make to the EN. The EN is assumed to be wealth constrained, and I denote the EN's wealth by $W_{EN} \geq 0$. While the transfer payment can be negative, it is constrained by the condition $W_{EN} + t \geq 0$. W.l.o.g. $\alpha_0, \alpha_1, S_0, S_1$ are all non-negative.

The above is a 'mechanism design' specification, but the payments to the EN also have a simple 'financial contracting' interpretation. Define $\alpha \equiv \alpha_1 - \alpha_0$, then α is the incremental return the EN gets from success in the venture. Since the return in case of success is normalized at 1, this can be thought of as the EN's equity stake in the company (provided that $\alpha_1 \geq \alpha_0$ which will always be the case).[11] α_0 is the return that the EN receives irrespective of the success of the company. This may be thought of as the wage compensation of the entrepreneur. (S_1-S_0) is the incremental return that the EN gets if the PM achieves success. It can be thought of as the amount of stock already vested by EN at the time of replacement (provided $S_1 \geq S_0$). S_0 can then be thought of as the fixed severance pay. It is also useful to define $S \equiv \phi S_1 + (1-\phi)S_0$ which is the EN's expected return in case of replacement. I call S the 'severance package.'

I define control rights independently of the financial structure. Control resides either with the EN, in which case we say $\gamma = 0$, or with the VC, in which case we say $\gamma = 1$.[12] 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 resides with the board of directors, then the contract between the VC and the EN may directly determine the board structure. And if control emanates from holding the majority of the voting stock, then voting power can be attached to any financial instrument.[13]

The timing of the game is as follows. The EN and the VC write a contract, specifying $\{\alpha_0,\alpha_1,S_0,S_1,t,\gamma\}$. At the end of the first period the VC may engage in a search for a PM. If no PM is located, the EN stays on and chooses his optimal level of private benefit B. In the model of section 3 I will assume that the VC has the control rights. If a PM is located, the VC may replace the EN with the PM, and the VC can commit not to renegotiate. In section 4 I will assume that whether or not the EN is replaced by the PM depends on the outcome of a possible renegotiation (which in turn depends on the allocation of control rights). At the end of the second period the project is either a success or a failure. Depending on the verifiable outcome of the game, the VC pays the EN α_0,α_1,S_0 or S_1.

3. The optimal contract without renegotiation

In this section I discuss the optimal contract between the EN and the VC. The expected utilities of the EN and the VC are given by

$$U_{EN} = m[\phi S_1+(1-\phi)S_0] + (1-m)[B+p(B)\alpha_1+(1-p(B))\alpha_0] + t$$

$$U_{VC} = m[\phi(1-S_1)+(1-\phi)(1-S_0)] + (1-m)[p(B)(1-\alpha_1)+(1-p(B))(-\alpha_0)] - c(m) - t$$

If ϕ is a constant, then we can use $S = \phi S_1 + (1-\phi)S_0$ in the above: the overall size of the severance package matters, but the composition is irrelevant.

The EN's optimal choice of B satisfies[14]

(1) $$1 + \alpha p_B = 0$$

The VC's optimal choice of m is given by m = Max[0,m'] where m' solves

(2) $$Mm' - [\phi - S - (p(B)(1-\alpha)-\alpha_0)] = 0$$

Before deriving the optimal contract, it is worth briefly identifying the first-best values of B and m. Maximizing the total utility $U_{VC} + U_{EN}$ w.r.t. B yields the first order condition $p_B = -1$. This would only be achieved if $\alpha = 1$, i.e., if the EN owned all of the equity. Maximizing $U_{VC} + U_{EN}$ w.r.t. m yields m =

$\text{Max}[0, \frac{\Gamma}{M}]$. Suppose for the moment that $\alpha_0 = 0$, which I will show is optimal. Define

$$S^{FC}(\alpha) \equiv B + \alpha p \text{ and } \quad S^{NR}(\alpha) \equiv \phi - (1-\alpha)p(\alpha),$$

where FC stands for 'full compensation' and NR for 'no replacement.' If $\Gamma > 0$ then it is easy to verify that a severance package of $S = S^{FC}$ would implement the first-best replacement rate.[15] This severance package fully compensates the EN for his losses in a termination. If $\Gamma \leq 0$, the optimal replacement rate is 0, and any $S \geq S^{NR}(\alpha)$ would implement this.

I now examine the optimal (second-best) contract and compare it to the first-best outcome. The optimal contract maximizes the following Lagrangian w.r.t. $\{\alpha_0,\alpha_1,S_0,S_1,t\}$:

$$L = U_{EN} + \lambda_0(U_{EN}\text{-UEN}) + \lambda_1(U_{VC}\text{-Q}) + \lambda_2(W_{EN}+t) + \lambda_3(-\alpha p_B-1) + \lambda_4(Mm-\phi+S+(p(B)(1-\alpha)-\alpha_0)) + \lambda_5 m$$

A critical assumption of the model is that the wealth constraint of the EN is binding. If it wasn't satisfied the EN would not be seeking funding from the VC in the first place. With this the optimal contract always has $\alpha_0 = 0$ and $t = -W_{EN}$. The reason is that it is always better to give the EN equity, which provides incentives, rather than giving him a base wage, or letting him keep his wealth, neither of which increase his incentives.

Result 1: If $\Gamma > 0$, the optimal severance package is given by some S^* that never fully compensates the EN, i.e., $S^* < S^{FC}$. Moreover, the optimal replacement rate m^* is always higher than the first-best rate.

The intuition for this result is that the EN has a fundamental choice between giving the VC a greater financial stake (through a lower α) or making it easier for the VC to bring in a PM (through a lower S). At the first-best level of replacement (where $m = \frac{\Gamma}{M}$ and $S = B + \alpha p$) the benefit of giving utility to the VC through ease of replacing management just equals the cost, which comprises the VC's marginal search cost as well as the EN's loss of utility. Transferring one unit of utility to the VC through a lower S costs the EN exactly one unit of utility. Transferring utility to the VC through lower α, however, costs the EN one unit of utility plus the marginal agency cost. It is therefore worth it for the EN to choose a lower severance. This in turn induces a higher replacement rate.

Result 2: If $\Gamma \leq 0$, then there exist parameters for which $S^* \geq S^{NR}$ and the EN is never replaced ($m^* = 0$), and there also exist parameters for which $S^* \varepsilon [0,S^{NR})$ and the EN is replaced with a positive probability $m^* > 0$. Any replacement decreases total utility and the EN is never fully compensated in case of replacement.

To prove this result we only need to find an example for each case. In the appendix I develop cases 1 to 3 to show that the optimal severance package may be $S^* = 0$, $S^* \varepsilon (0,S^{NR})$ or $S^* = S^{NR}$.

The significance of this result is to establish the *possibility* that the EN would choose a contract with replacement, even if the net gains of replacement are negative. The intuition is that the EN is willing to channel utility to the VC through lower severance, even if there is a net loss in the transmission, in order to retain more equity and thus reduce agency costs.

Result 2 begs the question of *when* the EN chooses a positive replacement rate with $\Gamma \leq 0$. For this we need to look at the comparative statics of the model. Since L is not necessarily concave I use the monotone comparative statics tools of Milgrom and Roberts (1990) and Milgrom and Shannon (1994).

Result 3: The optimal replacement rate m is a (weakly) decreasing function of b_0 and p_0, and a (weakly) increasing function of Q and ϕ. The optimal severance package is a (weakly) increasing function of b_0, and a (weakly) decreasing function of Q. Its relationship to p_0 and ϕ is ambiguous.

The intuition for these results are as follows. Higher private benefit b_0 make replacing the EN more costly in terms of the utility lost by the EN. The optimal contract will specify a higher severance package to induce a lower replacement rate. A higher fund requirement Q will decrease the EN's equity stake, and thus increase the agency cost associated with the EN's choice of B. The EN will want to rely more on reductions in S to avoid further reductions in α that would generate high agency costs. As a consequence the EN is more willing to accept a higher replacement rate. A better-skilled PM (a higher value of ϕ) or a less able EN (a lower value of p_0) make replacement more worthwhile.[16]

Result 3 applies equally to the cases $\Gamma > 0$ and $\Gamma \leq 0$. I noted before that the natural question from result 2 was to ask when does the EN accept or refuse replacement? The following corollary addresses this question directly.

Corollary to Result 3: There exists a critical value b_0^c such that for all $b > b_0^c$ the EN will choose $S^* = S^{NR}$, and no replacement occurs. The critical value is a function of all other parameters in the model. The same holds for a critical value p_0^c and $p > p_0^c$, for a critical value ϕ^c and $\phi < \phi^c$, and for a critical value Q^c and $Q < Q^c()$.

This corollary is based on the simple observation that the choice between $S = S^{NR}$ and $S < S^{NR}$ (i.e., m=0 and m>0) is an issue of monotone comparative statics. For example, if m = 0 is optimal for some b_0, then it must also be optimal for some higher b_0. For a lower b_0, however, it *may* be that m > 0 is optimal.

4. Renegotiation and the allocation of control rights

In this section I relax the assumption that the EN and the VC cannot renegotiate at the time of replacement. This allows us to examine the allocation of control rights. The owner of control rights decides whether the EN is replaced by the PM. If no renegotiation occurs, control rights determine the outcome directly. Even if there is renegotiation, control rights still matter since bargaining occurs in the shadow of threat points that depend on control rights. I assume that the two parties can always achieve efficient bargaining, so that I can use the generalized Nash bargaining solution. I denote the EN's bargaining power by θ. For the allocation of control rights I distinguish between EN control and VC control. I also make a distinction between the cases of $\Gamma > 0$ and $\Gamma \leq 0$. The only variables of interest in the original contract are α and S. I denote their renegotiated values by α^R and/or S^R.

EN control with $\Gamma > 0$

If $S < S^{FC}$: In the absence of renegotiation the EN is worse off with replacement. The EN can thus credibly threaten not to accept replacement. The threat points (i.e., the returns in the absence of renegotiation) are given by $\underline{uen} = B + \alpha p$ and $\underline{uvc} = (1-\alpha)p$. The EN can agree to be replaced after renegotiation. The total gains from renegotiation are given by Γ, so that the returns after renegotiation are $uen^* = \underline{uen} + \theta\Gamma$ and $uvc^* = \underline{uvc} + (1-\theta)\Gamma$. The EN is replaced and is paid a severance package $S^R = B + \alpha p + \theta\Gamma = (1-\theta)S^{FC} + \theta S^{NR}$

If $S \geq S^{FC}$: In this case the EN cannot credibly threaten to refuse a replacement. No renegotiation occurs, and the EN is replaced for a severance package S.

EN control with $\Gamma \leq 0$

If $S < S^{FC}$: The EN prefers not to be replaced. No renegotiation occurs.

If $S \geq S^{FC}$: The EN prefers to be replaced. Since the VC is indifferent between replacing or not at

S^{NR}, and since $S \geq S^{FC} = S^{NR} - \Gamma \geq S^{NR}$, the VC prefers not have the replacement at such a high severance. She can offer renegotiation. The threat points are given by $\underline{uen} = S$ and $\underline{uvc} = \phi - S$. The total gains from renegotiation are given by $(-\Gamma)$, so that the returns after renegotiation are $uen^* = \underline{uen} + \theta(-\Gamma)$ and $uvc^* = \underline{uvc} + (1-\theta)(-\Gamma)$. The EN is not replaced and is given equity α^R that satisfies $\alpha^R p(\alpha^R) = S + \theta(-\Gamma)$.

VC control with $\Gamma > 0$

If $S \leq S^{NR}$: The VC can credibly commit to replacing the EN. No renegotiation occurs, and the VC replaces the EN for a severance package S.

If $S > S^{NR}$: In the absence of renegotiation the VC would not want to replace the EN. The threat points are given by $\underline{uen} = B + \alpha p$ and $\underline{uvc} = (1-\alpha)p$. The total gains from renegotiation are given Γ, so that the returns after renegotiation are $uen^* = \underline{uen} + \theta\Gamma$ and $uvc^* = \underline{uvc} + (1-\theta)\Gamma$. The EN is replaced and is paid a severance package $S^R = B + \alpha p + \theta\Gamma = (1-\theta)S^{FC} + \theta S^{NR}$.

VC control with $\Gamma \leq 0$

Define $S^{RC} \equiv \phi - (1-\underline{\alpha})p(\underline{\alpha})$, where 'RC' stands for 'renegotiated continuation.'

If $S < S^{RC}$: The VC would want to replace the EN in the absence of renegotiation. The VC could offer to renegotiate the equity ownership of the EN in order to retain him. The threat points are given by $\underline{uen} = S$ and $\underline{uvc} = \phi - S$, and the total gains from renegotiation are given $(-\Gamma)$. Because of the EN's wealth constraint, however, there is a problem in transferring enough of the gains from renegotiation to the VC. The EN's equity stake cannot fall below $\underline{\alpha}$ (if he isn't replaced), and the EN has no wealth to make any side payment. The VC will accept any renegotiation outcome if and only if $(1-\alpha^R)p(\alpha^R) \geq \phi - S$. It follows that renegotiation is only feasible if $S \geq \phi - (1-\underline{\alpha})p(\underline{\alpha})$. For $S < \phi - (1-\underline{\alpha})p(\underline{\alpha}) = S^{RC}$ no renegotiation can succeed, and the VC replaces the EN for S.[17]

If $S^{NR} > S \geq S^{RC}$: Renegotiation is feasible. The threat points are given by $\underline{uen} = S$ and $\underline{uvc} = \phi - S$. After renegotiation the EN receives an equity stake $\alpha^R = \text{Max}[\underline{\alpha}, \alpha(\theta)]$, where $\alpha(\theta)$ satisfies $\alpha(\theta)p(\alpha(\theta)) + B = S + \theta(-\Gamma)$.

If $S \geq S^{NR}$: In the absence of renegotiation the VC would not want to replace the EN. There are no net gains to be made from renegotiation, so no replacement occurs.

When offering the initial contract, the EN and the VC anticipate the outcomes of renegotiation. The EN has to choose whether or not to give the VC control rights. Consider the case of $\Gamma > 0$. We have already seen that $m^* > 0$ and $S^* < S^{FC}$. Suppose that the EN was in control, and $S = S^*$ from result 1. Once the VC has found a PM, the EN could credibly threaten not to resign. In a renegotiation the EN would offer to resign in exchange for $S^R = (1-\theta)S^{FC} + \theta S^{NR}$. The benefit of the VC's search is $\phi - (1-\alpha)p - S^R = (1-\theta)\Gamma$. Although the EN eventually resigns, he successfully holds up the VC. In anticipation of being held up, the VC spends less effort on locating a PM. While the optimal level of search effort is given by $m^* = \frac{\phi - (1-\alpha)p - S^*}{M}$, under EN control the actual level of search effort is given by $m^R = \frac{\phi - (1-\alpha)p - S^R}{M} < m^*$ since $S^R \geq S^{FC} > S^*$. There are too few replacements as long as the EN is in control.

Suppose now that the VC was in control, and $S = S^*$. Since $S^* < S^{FC} \leq S^{NR}$, the VC can credibly commit to replace the EN at S^*, and thus maintain the efficient amount of search effort m^*. I have shown that:

Result 4: If $\Gamma > 0$, the optimal contract always gives the VC the control rights. The optimal severance package is given by S^* from result 1.

It is worth stressing the intuition behind result 4. If the VC can increase the value of the company by searching for a PM, she must be given the appropriate incentives. Because the EN may credibly hold up the benefit if in control, giving the VC control rights is necessary to preserve her incentives to add value.

Consider next the case of $\Gamma \leq 0$. If the EN was in control, he would always refuse any replacement. If the VC was in control, and if $S < S^{NR}$, then I distinguish two cases. If $S^* < S^{RC}$, the VC can commit to replace the EN. If $S^{RC} \leq S^* < S^{NR}$, the VC would not replace the EN, but only use the PM to get the EN to concede some of his equity ownership. In order to get this concession the VC incurs socially wasteful search costs. As a consequence, any contract with $S^{RC} \leq S^* < S^{NR}$ is dominated by another contract that gives the VC the same utility, but induces no search by setting $S \geq S^{NR}$. The optimal contract therefore either gives the EN control, or it gives the VC control and sets $S < S^{RC}$.[18]

The comparison of VC control and EN control is thus similar to the choice of $m = 0$ versus $m > 0$ of result 2. Whenever $m^* = 0$ in result 2, we now have that EN control is optimal. Whenever $m^* > 0$ and $S^* < S^{RC}$ in result 2, VC control is now optimal with the same S^*. From case 1 in the appendix we know that this case may occur. Finally, if $m^* > 0$ and $S^{RC} \leq S < S^{NR}$ then either EN or VC control with $S < S^{RC}$ can be optimal. I have shown the following:

Result 5: If $\Gamma \leq 0$, then two cases may occur: either EN control is optimal, and the EN is never replaced, or VC control is optimal with $S^* \varepsilon [0,S^{RC})$, so that the VC replaces the EN with a positive probability.

Result 4 and 5 provide the general description of the optimal allocation of control rights. We can apply result 3, and its corollary, to examine the comparative statics of the optimal control rights. Remember that γ denotes the allocation of control, with $\gamma = 0$ signifying EN control, and $\gamma = 1$ signifying VC control.

Result 6: γ is a (weakly) decreasing function of b_0 and p_0, and a (weakly) increasing function of Q and ϕ.

Result 6 has an important and intuitive interpretation. The decision to give the VC control rights is a function of the benefit of replacing the EN. The larger the private benefit accruing to the EN (high b_0), the less desirable is VC control. The optimal allocation of control also depends on the abilities of the EN and the PM. If the EN has a high ability (a high value of p_0), VC control becomes less desirable. If the PM has a high ability (a high value of ϕ), the more desirable VC control becomes. Finally, the higher Q, the more VC control becomes important. We should think of a higher Q as representing any situation where the VC takes a larger stake in the company. This could be the result of a number of factors, including a larger fund requirement, greater market power of the VC or lower return prospects by the EN.

5. The incentive effect of replacement

So far I have assumed that the EN chooses his level of private benefit after the replacement decision. This implies that the replacement decision had no effect on the EN's choice of private benefit. If the EN consumes a private benefit prior to a replacement decision, however, the allocation of control rights may influence the EN's choice of private benefit. A natural conjecture is that the fear of being replaced induces the EN to put greater emphasis on financial return. In this section I show that this intuition is valid but incomplete. In particular, there exists a second effect that works in the opposite direction: the uncertainty that the EN may be replaced makes financial return less attractive than the certain consumption of private benefit. For most parameter ranges the results of section 2 to 4 are not affected if we take into account these additional incentive effects.

Let A denote the private benefit consumed before any replacement decision may occur, and B denote the additional private benefit consumed if no replacement occurred. We write $U_{EN} = A + mS + (1-m)(B+\alpha p)$. The analysis of sections 2 to 4 assumed that there is a tradeoff between B and p, i.e., it implicitly assumed that A is a constant.[19] Consider now an alternative model where there is a trade-off between A and p, i.e., p(A) with $p_A < 0$. For simplicity I assume that B is now a constant.

The VC's search effort is now given by $m = \frac{\phi - (1-\alpha)p(A) - S}{M}$, so that a higher level of A increases the VC's effort to search for a PM. The EN's optimal choice of A is given by:[20]

(3) $$1 + \alpha p_A - m\alpha p_A + \frac{\partial m}{\partial A}(S - B - \alpha p) = 0$$ 1

The first two terms in (3) correspond to our previous analysis, where the EN trades off private benefit and expected financial return. The third term shows that the probability of replacement exerts a negative influence on the EN's incentive to increase firm value. If private benefit is consumed before the replacement decision, the EN is not certain to benefit from increases in the firm value, while he is certain to benefit from increases in his private benefit A. As a consequence the EN's desire to extract private benefit increases. The fourth term concerns the EN's influence on the VC's search intensity. Whenever $S < B + \alpha p$, the EN wants to reduce the VC's search intensity: this induces the EN to reduce his private benefit A. If, however, $S > B + \alpha p$, the EN increases his private benefit in order to increase the VC's search.

In the appendix I derive the optimal contract for this model. The most interesting question is whether the results of sections 2 to 4 continue to hold. An interesting first result is that $\frac{\partial A}{\partial S} > (<)\ 0$ if $\alpha <$ (>) 0.5. A higher severance package S lowers the EN's zeal to reduce the VC's search intensity m, which induces a higher level of A. But a higher S also reduces m, and thus decreases the EN's desire for private benefit A. The first effect dominates the second effect if and only if $\alpha < 0.5$. This is then a sufficient (but not necessary) condition to obtain our previous result that $S^* < S^{FC}$, and all other results continue to hold too. Similarly, $\Gamma < 0$ is also a sufficient condition for this. If $\alpha > 0.5$ and $\Gamma > 0$, however, it may be that $S^* > S^{FC}$. For $\alpha > 0.5$ a higher severance (and thus a lower replacement) induces the EN to choose a lower level of private benefit. If this effect dominates the standard effect that severance takes away from the EN's equity, then it may be possible that the optimal contract involves fewer replacements than in a first-best world. In such a world it may be that the optimal contract has no replacements, even though $\Gamma > 0$.

A closely-related extension of this model is to allow the EN's choice of A to affect the productivity of the PM. If prior to the replacement the EN neglects to take some actions that would benefit the company but hurt his private benefit, then we might expect that this also impacts the success probability of the company once a PM takes over the company. Put differently, there may be some irreversibly good or harm that the EN can do to the company prior to being replaced. The simplest way of modeling this is to assume that ϕ is an increasing function of p, i.e., $\phi(p)$ with $\frac{\partial\phi}{\partial p} > 0$. The interesting implication of this is that the composition of the severance package now matters. This can be seen from examining the EN's choice of A, which is now given by

$$(3') \quad 1 + \alpha p_A - m\alpha p_A + \frac{\partial m}{\partial A}(S - B - \alpha p) + m(S_1 - S_0)\frac{\partial \phi}{\partial p} p_A = 0 \, 2$$

The larger the difference between S_1 and S_0, the lower the EN's choice of A. By making the severance package more sensitive to the final success of the venture, the EN is more concerned about financial return even if the company is run by a PM. It follows that whenever the EN chooses an excessive private benefit it is optimal to set $S_0 = 0$ and $S_1 = \frac{S^*}{\phi}$.

I have thus shown that vesting may be superior to an outright severance payment. This result relates well to the empirical fact that venture capital contracts typically do not specify any severance pay. The financial return of a fired founder come mainly from the stock that has already vested at the time of firing.

6. The role of wealth constraints for the professional manager

So far I have not modeled the identity of the PM. In this section I show that as long as the PM is wealth-constrained, the analysis of sections 2 to 4 continues to hold. If the PM faces no wealth constraint, however, the VC may want to replace the EN for additional reasons.

To model the identity of the PM I assume that he too has a trade-off between expected financial return ϕ and private benefit, which I denote by B_m.[21] Suppose first that the PM has no wealth of his own. In the appendix I show that for a large class of models the VC can always bargain the PM down to his reservation utility.[22] The VC compensates the PM with a payment of α_m in case of success. α_m is either equal to zero, is chosen to satisfy the PM's participation constraint, or may include a moral hazard premium that the VC prefers to pay in order to increase the likelihood of success.[23] If the PM succeeds, the VC has a return of $(1-\alpha_m)$ so that the net benefit of replacing the EN is now given by $\phi(1-\alpha_m) - p(1-\alpha) - S$, and the net benefit to the initial contracting parties is given by $\Gamma = \phi(1-\alpha_m) - p - B$. Subject to these modifications the analysis of sections 2 to 4 remains unchanged.

Consider now the effect of relaxing the assumption that the PM has no wealth. Indeed, suppose that the PM has a sufficiently 'large' amount of wealth that his wealth constraint is never binding. Because of the moral hazard of choosing a private benefit, the PM would always acquire all equity, i.e., $\alpha_m = 1$. For this the PM would pay the VC an amount $t_m = \phi + B_m$. Using this, we have $\Gamma = \phi + B_m - p(\alpha) - B(\alpha)$.

If the PM has identical preferences and abilities to the EN, i.e., $B(\alpha) = B_m(\alpha) \Leftrightarrow \phi(\alpha) = p(\alpha)$ for all α, then we have $\Gamma = p(1) + B(1) - p(\alpha) + B(\alpha) > 0$. From the analysis of sections 2 to 4 we know that under these circumstances the optimal contract allows for a positive replacement rate. The reason that the VC wants to replace the EN in the first example is not that the PM is necessarily better, but that the PM has more wealth. This allows for a better resolution of the moral hazard problem.

If the PM is actually better, the VC will be even more keen to replace the EN. Consider, however the case where the PM is less eager and less able than the EN. In particular suppose that $B_m(1) = B(\alpha) - \varepsilon_1$ with $\varepsilon_1 > 0$ and $\phi(1) = p(\alpha) - \varepsilon_2$ with $\varepsilon_2 > 0$. In this case $\Gamma = -(\varepsilon_1 + \varepsilon_2)$. For small enough ε_1 and ε_2 the analysis of sections 2 to 4 shows that VC control with $m^* > 0$ may still be optimal. To understand why the VC gets to replace the EN with a less able and less eager PM remember that the wealth-constrained EN would like to convert his private benefit into transferable utility to reduce agency costs. The sale of the company to the PM achieves this. The PM is able to pay the VC for his consumption of private benefit. By owning the control rights the VC effectively receives an indirect payment of private benefit with probability m. In return she grants the EN a higher equity share.

If the PM is not wealth constrained, we can think of the PM as a company that is making an acquisition. The acquirer may want to dismiss the original entrepreneur and use the entrepreneurial company for its own strategic purpose. The private benefit can be thought of as the synergistic benefit that the acquisition has on the acquiring company's existing businesses.[24] In this case the control rights of the VC pertain not so much to the replacement of the entrepreneur, but rather to the financial exit strategy of the company.

There are some empirical observations that match this aspect of the model. Venture capitalists typically control the exit decision of their investment companies, and a financial exit strategy is typically part of the term sheet (Fenn, Liang and Prowse (1995); Sahlman (1991); Testa (1997)). Blackburn, Hellmann, Kozinsky and Murphy (1996) also document how a particular acquiring company repeatedly faced conflicts with the founding entrepreneurs in the process of acquiring entrepreneurial companies. In this case study founders of the entrepreneurial companies typically left after a clash with the acquiring company.

7. Conclusion

This paper examines the relationship between venture capitalists and entrepreneurs from the perspective of corporate control. I ask why, and under what circumstances, entrepreneurs voluntarily relinquish the right to appoint the CEO. I show that when venture capitalists have control, they provide greater effort in finding professional managers that increase the value of the company. Wealth-constrained entrepreneurs may relinquish control, even if the replacement decision hurts the entrepreneur more than it benefits the venture capitalists. By examining the optimal contract, I provide rationale for the stylized facts that venture capitalists tend to control the boards of the companies they invest in, and that entrepreneurs commonly accept 'vesting' of their stock and modest severance packages.

The comparative statics of the model lead to a number of interesting and empirically testable predictions. The model predicts that the smaller the entrepreneur's equity stake and the more wealth constrained the entrepreneur, the more likely is investor control. It also predicts that investor control should be more frequent the less 'able' the founder is as a manager. The founder's level of business experience may serve as a proxy for this, with less experience implying more investor control. Finally, the higher the expected quality of professional managers, or the greater their availability, the more we should expect investor control. The quality and availability of professional managers is difficult to measure directly, although it may be argued that professional managers are more readily available in more mature industries.

One challenge for testing these hypotheses is finding good measures of investor control. The model, however, provides some guidance. First one may try to measure 'ex-ante' control of the investor by analyzing board representation and voting control. Second, one may look at 'ex-post' control in terms of replacement rates for entrepreneurs.

Another issue for testing this model is defining an appropriate sample. The model interprets the choice of control structure as a contractual problem that the entrepreneur and the venture capitalist face at the time of funding. The model then explains why control by the venture capitalist is to be expected under a certain range of parameters. An alternative interpretation of the model is that some investors, such as venture capitalists, specialize in developing investment expertise in the area of corporate governance. Other investors, such as most private investors, do not develop such an expertise. Entrepreneurs then self-select: only those willing to yield control rights choose venture capitalists, while the others seek financing with private investors or other more passive sources of funds. With this interpretation of the model in mind, a good sampling method would be to consider a set of entrepreneurs that choose between venture capital and other sources of funds, rather than a set of entrepreneurs that have already chosen to seek venture capital finance.

Appendix

The appendix contains the proofs for all the results in the main text, as well as some technical proofs that the main text alluded to.

Proof of result 1

The Lagrangian is given by:

$L = U_{EN} + \lambda_0(U_{EN}\text{-}UEN) + \lambda_1(U_{VC}\text{-}Q) + \lambda_2(W_{EN}+t) + \lambda_3(-\alpha p_B\text{-}1) + \lambda_4(Mm\text{-}\phi+S+(p(B)(1\text{-}\alpha)\text{-}\alpha_0)) + \lambda_5 m$

where we are maximizing w.r.t. $\{\alpha_0,\alpha_1,S_0,S_1,t\}$. Taking the derivative w.r.t. t we have $\frac{\partial L}{\partial t} = 1 - \lambda_1 + \lambda_2$ 3. I am interested in the case where the wealth constraint is binding, i.e., $\lambda_2 > 0$. This implies $t = - W_{EN}$ and $\lambda_1 > 1$. The Lagrangian has a solution only if $\lambda_0 > 0$, i.e., if not only the VC's but also the EN's participation constraint is satisfied. This requires that UEN is not too large, which I assume. I also need to ensure that the participation of the VC is satisfied. There exists Q_0, so that for $Q > Q_0$, the EN cannot get the project financed, even at the most favorable terms to the VC. Moreover, there exists $Q_1 < Q_0$ so that for all $Q \in [Q_1,Q_0]$ the EN needs to give up control in order to allow the VC to make the required return. The loss of control rights is involuntary from the EN's perspective, since the project cannot be financed otherwise. I am interested in the question of when the entrepreneur yields control rights voluntarily. I therefore assume that $Q < Q_1$. (For $t=-W_{EN}$ and $\alpha_0=0$, Q_0 and Q_1 are given by $Q_0 = U_{VC}(S=0,\alpha=\underline{\alpha})$ and $Q_1 = (1\text{-}\underline{\alpha})p(\underline{\alpha}) + W_{EN}$.)

Examining the above Lagrangian it is immediate that S_0 and S_1 appear only in the form of $S = \phi S_1+(1\text{-}\phi)S_0$. This means that the total size of the severance package matters, but that the composition of the severance package does not matter. To see that $\alpha_0 = 0$ is optimal use $\lambda_3 \geq 0$ and $\lambda_4 \geq 0$ in $\frac{\partial L}{\partial \alpha_0} = 1 - \lambda_1 + \lambda_3 p_B - \lambda_4(1\text{-}p) < 0$ 4. The intuition is that the wealth constrained entrepreneur should be given maximal incentives to focus on the financial return of the venture rather than his private benefit. This is best achieved by compensating the EN with stock rather than a base wage.

From equation (1) in the main text p is a function of α, with $\frac{\partial p}{\partial \alpha} = -\frac{1}{\alpha p_{BB}} > 0$. Because of this the VC might not want to take all the equity. Indeed there may exist a minimal equity level $\underline{\alpha}$ below which the VC would not want to go. Formally we have $\frac{\partial(1-\alpha)p}{\partial \alpha} = \eta - p$, where $\eta = (1-\alpha)\frac{\partial p}{\partial \alpha} = -\frac{(1-\alpha)}{\alpha^3 p_{BB}} \geq 0$. Assuming that p_{BBB} is not too negative ($p_{BBB} > -\frac{(2\alpha+\alpha^2)(p_{BB})^2}{(1-\alpha)}$), $\frac{\partial \eta}{\partial \alpha} < 0$, so that $(1\text{-}\alpha)p$ is concave in α. Either we have $\eta > p$ at $\alpha = 0$ (we say $\underline{\alpha} = 0$), or there exists $\underline{\alpha} > 0$ so that $\eta = p$, and for all $\alpha > \underline{\alpha}$ we have $\eta - p > 0$. $\underline{\alpha}$ is thus the minimal equity that the VC would always give to the EN.

To simplify the Lagrangian we can thus think of p as a function of α with $\alpha \in [\underline{\alpha},1]$, thus replacing the λ_3 condition. From equation (2) in the main text we can also think of m as a function of α and S, thus replacing the λ_4 condition. By limiting S to its relevant range $S \in [0,S^{NR}(\alpha)]$ we can also dispose of the λ_5 condition.

With all these results we can simplify our Lagrangian to $L = U_{EN} + \lambda(U_{VC}\text{-}Q)$. Taking derivatives w.r.t. α and S we have $\frac{\partial L}{\partial \alpha} = (1-m)p - \lambda(1-m)(p-\eta) - \frac{B+\alpha p - S}{M}(p-\eta)$ 5 and $\frac{\partial L}{\partial S} = \frac{B+\alpha p - S}{M} - (\lambda - 1)m$ 6. From $\frac{\partial L}{\partial \alpha} = 0$ we obtain $\lambda = \frac{p}{p-\eta} - \frac{B+\alpha p - S}{(1-m)M}$ 7, which we use to substitute in $\frac{\partial L}{\partial S}$ to obtain $\frac{\partial L}{\partial S} = \frac{B+\alpha p - S}{(1-m)M} - \frac{m\eta}{p-\eta}$ 8. The Lagrangian is not necessarily concave, and I take account of that in deriving the optimal contract. I first examine whether the EN would want to increase the replacement rate from zero by a small amount. Evaluating $\frac{\partial L}{\partial S}$ at $S = S^{NR}(\alpha)$ (where m = 0) we get $\frac{\partial L}{\partial S} = -\frac{\Gamma}{M}$ .9 We immediately see that decreasing S from S^{NR} is beneficial whenever $\Gamma > 0$. For any $S < S^{NR}$ we have m > 0. Whenever the net benefit of bringing in a PM is positive, the optimal contract will have a positive replacement rate. The optimal severance package S^* is thus either equal to zero, or it is the interior. In the latter case we set $\frac{\partial L}{\partial S} = 0$ to obtain $S^{IO} = B + \alpha p - m^*(1-m^*)M\frac{\eta}{p-\eta}$ 10 where 'IO' stands for an interior optimum. I have already shown that $m^* > 0$. It follows that $S^* < \alpha p + B = S^{FC}$. Using S^{IO} in (1) we have $m^* = \frac{\Gamma}{M} + m^*(1-m^*)\frac{\eta}{p-\eta} > \frac{\Gamma}{M}$ 11. The optimal replacement rate exceeds the first-best level. Obviously, if S = 0 we also have $S < S^{FC}$ and again the optimal replacement rate exceeds the first-best level.

Proof of result 2

To prove result 2 I develop numerical examples. Let $B = b_0 - b_2 - b$ and $p = p_0 + \sqrt{2D(b_2 - b)}$ 12, where b_2 equals some positive constant. It is straightforward to show that $B + \alpha p = p_0 + b_0 + 0.5D\alpha^2$ and $(1-\alpha)p = (1-\alpha)p_0 + \alpha(1-\alpha)D$. Using this we can solve $U_{VC} = Q$ for α and substitute into U_{EN}. This allows us to directly identify the optimal choice S. I use the following assumptions: $\phi = 0.8$, $p_0 = 0$, Q = 0.124, M = 25, D = 0.5. The three cases will vary only in their value for b_0, taking the values $b_0 = 0.7$, $b_0 = 1$ and $b_0 = 1.4$ respectively. All the calculations were performed in Mathematica and are available upon request.

Table 1 summarizes the main numerical results. As can be seen from Figures 1 to 3 (which show U_{EN} as a function of S over the interval $[0,S^{NR}]$), cases 1 to 3 show the possibility of an equilibrium with $S^* = 0$, $S^* \in (0,S^{NR})$ and $S^* = S^{NR}$ respectively. Figure 2 is particularly interesting, as it shows that U_{EN} is not concave everywhere, and that it is increasing in S near S^{NR}.

While we are interested in these examples mainly for their qualitative result, it is worth mentioning that the values in table 2 represent intuitive concepts. Their numerical values, however, are sensitive to the choice of parameters and should not be over-interpreted. For example, in the optimal contract of case 1 the EN retains 64.42% of the equity. He is replaced with a probability of 2.74%. His probability of success is 32.21%, compared to 80% with the PM. For the columns 100Γ and $100U_{EN}$, suppose that the project were to return \$100 if successful. The net loss to replacing the EN is then given by \$11.58 and the expected utility for the EN is given by \$77.90.

Proof of result 3

In order to examine the comparative statics of this model, it is convenient to apply the following transformation of variable. Let $\sigma \equiv \phi$ - (1-α)p - S. We can rewrite (2) as Mm = σ. Applying this, we obtain $U_{EN} = B + \alpha p - \frac{\sigma(\Gamma - \sigma)}{M}$ and $U_{VC} = (1-\alpha)p - \frac{\sigma^2}{2M}$. We write the Lagrangian as L = U_{EN} + λ(U_{VC}-Q), which is now a function of α and σ. The range over which we maximize is given by α ε [$\underline{\alpha}$,1] and σ ε [0,σ_1], where $\sigma_1 \equiv \phi$ - (1-α)p. We solve this Lagrangian as before. We have $\frac{\partial L}{\partial \alpha} = p - \frac{\sigma\eta}{M} - \lambda(p-\eta)$ and $\frac{\partial L}{\partial \sigma} = \frac{\Gamma - \sigma}{M} + (\lambda - 1)\frac{\sigma}{M}$. Setting $\frac{\partial L}{\partial \alpha} = 0$, we get $\lambda = 1 + \frac{(1-\sigma)\eta}{(p-\eta)M}$. We therefore have $\frac{\partial L}{\partial \sigma} = \frac{\Gamma - \sigma}{M} + \frac{\sigma(1-\sigma)\eta}{(p-\eta)M^2}$. We can now verify whether L is supermodular, and whether the constraint set is increasing in a particular parameter. If both of these conditions are satisfied, we know from Milgrom and Roberts (1990) and Milgrom and Shannon (1994) that σ is (weakly) increasing in the particular parameter.

Changes in ϕ: $\frac{\partial^2 L}{\partial \sigma \partial \phi} = \frac{1}{M} > 0$. Moreover $\frac{\partial \sigma_1}{\partial \phi} = 1 > 0$. It follows that σ is (weakly) increasing in ϕ. The effect on S = ϕ - (1-α)p - σ is ambiguous, since a higher ϕ increases S through the first term, but decreases S through the last term.

Changes in p_0: $\frac{\partial^2 L}{\partial \sigma \partial(-p_0)} = \frac{1}{M} + \frac{\sigma(1-\sigma)\eta}{(p-\eta)^2 M^2} > 0$. Moreover $\frac{\partial \sigma_1}{\partial(-p_0)} = 1 - \alpha \geq 0$. It follows that σ is (weakly) increasing in (-p_0), thus (weakly) decreasing in p_0. The effect on S = ϕ - (1-α)p - σ is ambiguous, since a higher p_0 decreases S through the second term, but increases S through the last term.

Changes in b_0: $\frac{\partial^2 L}{\partial \sigma \partial(-b_0)} = \frac{1}{M}$. Moreover $\frac{\partial \sigma_1}{\partial(-b_0)} = 0$. It follows that σ is (weakly) increasing in (-b_0), thus (weakly) decreasing in b_0. Moreover, increases in b_0 (weakly) increase S = ϕ - (1-α)p - σ through the last term.

Changes in Q: In this case we have $\frac{\partial L}{\partial Q} = -\lambda$, so that $\frac{\partial^2 L}{\partial \sigma \partial Q} = \frac{\eta}{(p-\eta)} \geq 0$. Moreover $\frac{\partial \sigma_1}{\partial Q} = 0$. It follows that σ is (weakly) increasing in Q. Moreover, increases in Q (weakly) decrease S = ϕ - (1-α)p - σ through the last term.

Joint Control

If Γ > 0, the EN will only accept replacement if S $\geq$ S^{FC}, and the VC will only accept replacement if S $\leq$ S^{NR}. If S $\leq$ S^{FC} then the VC and the EN can renegotiate. The threat points are given by $\underline{uen}$ = B + αp and $\underline{uvc}$ = (1-α)p, and the total gains from renegotiation are given by Γ. The returns after renegotiation are uen^* = $\underline{uen}$ + $\theta\Gamma$ and uvc^* = $\underline{uvc}$ + (1-θ)Γ. The EN is replaced and is paid a severance package S^R = B + αp + $\theta\Gamma$ = (1-θ)S^{FC}+ θS^{NR}. If $S^{FC} \leq S \leq S^{NR}$ the parties agree to replace the EN for S. If S $\geq$ S^{NR} the VC and the

EN can renegotiate. The threat points are given by $\underline{uen} = B + \alpha p$ and $\underline{uvc} = (1-\alpha)p$, and the total gains from renegotiation are given by Γ. The returns after renegotiation are $uen^* = \underline{uen} + \theta\Gamma$ and $uvc^* = \underline{uvc} + (1-\theta)\Gamma$. The EN is replaced and is paid a severance package $S^R = B + \alpha p + \theta\Gamma = (1-\theta)S^{FC} + \theta S^{NR}$.

If $\Gamma \leq 0$, under a joint control arrangement, both the EN and the VC must agree to the replacement. The EN will only accept replacement if $S \geq S^{FC}$, and the VC will only accept replacement if $S \leq S^{NR}$. Since $S^{FC} \geq S^{NR}$ no agreement to replace the EN can ever be reached.

We immediately see that joint control is identical to EN control for $\Gamma \leq 0$. For $\Gamma > 0$ any outcome under joint control can also be achieved with EN control (but not vice versa). Joint control is thus weakly dominated by EN control.

Proof of result 6

The proof of result 6 is analogous to the proof of result 3, except that the range for σ is given by $\sigma \in \{0\} \cup (\sigma_0, \sigma_1]$, where $\sigma_0 \equiv (1-\underline{\alpha})p(\underline{\alpha}) - (1-\alpha)p(\alpha)$. We verify that $\frac{\partial\sigma_0}{\partial\phi} = 0$, $\frac{\partial\sigma_0}{\partial(-p_0)} = \alpha - \underline{\alpha} \geq 0$, $\frac{\partial\sigma_0}{\partial(-b_0)} = 0$ and $\frac{\partial\sigma_0}{\partial Q} = 0$. The constraint set remains non-decreasing in the parameters of change, so that the analysis of result 3 continues to hold.

Generality of the assumption that the PM has no bargaining power

The assumption that the PM never has any bargaining power may seem restrictive, but it turns out that this can be derived in a general way. Consider a game where there is sequential bargaining: After writing the initial contract, and after identifying a PM, the VC may renegotiate with the EN and then she may negotiate with the PM. I will show that this contract can always be written in a way to commit the VC to only accept a bargaining with the PM that extracts all rents (other than efficiency-rents) from the PM.

Consider α_m as derived in the main text. This leaves the PM with no rents other than maybe some efficiency rents (due to the moral hazard problem). If the EN and the VC write a simple contract with some (α, S) then the PM may be able to extract some surplus (i.e., achieve a higher compensation than α_m) whenever his bargaining power is sufficiently large. But the EN and the VC can write an alternative contract that specifies (α, S) if the VC obtains a deal of α_m from the PM (which is a verifiable event) and (α, S') if she obtains any $\alpha_m' \neq \alpha_m$, where $S' = (1-\alpha_m')\phi - (1-\alpha)p + \varepsilon$, $\varepsilon > 0$. With such a contract the VC either obtains α_m from the PM, or else she has to pay a severance package S' that leaves her with a negative net benefit for replacing the EN. As a consequence, the VC is contractually pre-committed when bargaining with the PM in a way that the only acceptable bargaining outcome is α_m.

One may think that this result depends on the fact the bargaining between the PM and the VC happens last. This is, however, not the case. Consider the game where the VC bargains first with the PM, and then has an opportunity to renegotiate with the EN. The VC can again contractually pre-commit to only accept α_m in the bargaining with the PM. For this the initial contract between the EN and the VC specifies the same contingent structure as above. In addition the contract specifies that the VC only has the right to replace the EN if she obtains a deal of α_m from the PM. If $\Gamma \geq 0$, then the VC is better off not replacing the EN than having the PM with some deal $\alpha_m' \neq \alpha_m$. If $\Gamma < 0$, then any deal $\alpha_m' \neq \alpha_m$ is as good as no deal, since the EN will refuse to be replaced. This shows that what matters is not who bargains last, but rather who bargains first. Because the EN and the VC have a natural 'first-mover advantage' they can always extract all rents from the PM. Indeed, similar reasoning to the above also shows that letting the EN, rather than the VC negotiate does not affect the result that the PM cannot extract any rents.

Note that this proof differs from the analysis of Berglöf (1994) which is restricted to debt and equity contracts. I allow for more general contracts that depend on the bargaining outcome with the third party (i.e., the PM).

Analysis of the model with the alternative timing assumption

The EN's choice of A is determined by $1 + \alpha p_A - m\alpha p_A + \frac{\partial m}{\partial A}(S - B - \alpha p) = 0$ 13.

The second order condition is given by $\Delta \equiv \frac{2(1-\alpha)\alpha(p_A)^2}{M} + [(1-m)\alpha - \frac{(1-\alpha)(S-B-\alpha p)}{M}]\, p_{AA}$ 14, which is satisfied provided that p_{AA} sufficiently negative and M sufficiently large.

We obtain $\frac{\partial A}{\partial \alpha} = \frac{-p_A}{-\Delta}[-(1-m) + \frac{B+\alpha p - S}{M} - \frac{(1-2\alpha)p}{M}] < 0$ 15 provided M sufficiently large: a larger equity stake induces the EN to reduce his private benefit. Moreover $\frac{\partial A}{\partial S} = \frac{-p_A}{-\Delta}\frac{(1-2\alpha)}{M}$ 16. We have already discussed this derivative in the main text.

Maximizing the Lagrangian L = U_{EN} + λ(U_{VC}-Q) w.r.t. S we get $\frac{\partial L}{\partial S} = m + \frac{B+\alpha p - S}{M} + \lambda[-m + (1-m)(1-\alpha)\, p_A \frac{\partial A}{\partial S}]$ 17. Using the same reasoning as before, we have $\lambda > 1$ whenever the wealth constraint is binding. Using $\frac{\partial L}{\partial S} = 0$ to solve for λ and using $\lambda > 1$ we have $S < B + \alpha p + (1-m)M(1-\alpha)(p_A)\frac{\partial A}{\partial S}$ 18. In order to get the result that $S^* < \alpha p + B$, a sufficient (but not necessary) condition is that $\alpha < 0.5$. In this case the analysis of sections 2 to 4 continues to hold.

If $\alpha > 0.5$ it may still be true that $S^* < \alpha p + B$ but different outcomes may too arise. In particular, it may be that the optimal contract has too little replacement relative to the first-best. If $\Gamma < 0$ we have $S^{NR} < S^{FC}$, so that $S^* \leq S^{NR} < S^{FC}$: the analysis of sections 2 to 4 continues to hold. Suppose now that $\Gamma > 0$. Evaluating $\frac{\partial L}{\partial S}$ at $S = S^{FC}$ we get $\frac{\partial L}{\partial S} = -(\lambda - 1)m + \lambda \frac{(1-m)(p_A)^2(1-\alpha)(2\alpha-1)}{(-\Delta)M}$ 19. There are two effects to increasing S. First, there is the usual negative effect that giving higher severance implies less equity for the EN which induces him to choose a higher level of private benefit. Now, however, there is a second effect that a higher severance also reduces the VC's search intensity, which induces the EN to choose a *lower* level of private benefit. Whenever this second effect dominates the first effect, the optimal contract has a replacement rate m^* that is smaller than the first-best replacement rate.

It may even be the case that $m^* = 0$, even though replacements are ex-post efficient (i.e., $\Gamma > 0$). To see this evaluate $\frac{\partial L}{\partial S}$ at $S = S^{NR}$. We have $\frac{\partial L}{\partial S} = -\frac{\Gamma}{M} - \lambda \frac{(p_A)^2(1-\alpha)(1-2\alpha)}{(-\Delta)M}$ 20. For $\alpha > 0.5$ and Γ sufficiently small but positive, $\frac{\partial L}{\partial S} > 0$ at $S = S^{NR}$, so that the optimal replacement rate becomes $m^* = 0$. In this case it is not worth it to have even a small amount of replacement. In order to have a small incentive for the VC to replace the EN, we must have S close to S^{NR}, so that $S > S^{FC}$. But with such a high S, the EN strictly prefers to be replaced. He will therefore increase his private benefit to increase the likelihood of being replaced. This creates an inefficiency that may outweigh the efficiency benefit of replacement.

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Table 1:

Assumptions	ϕ	b_0	Q	M	D	p_0
Case 1	0.8	0.7	0.124	25	0.5	0
Case 2	0.8	1	0.124	25	0.5	0
Case 3	0.8	1.4	0.124	25	0.5	0
Case 4	1	1.4	0.124	25	0.5	0
Case 5	0.24	0.3	0.1249	5	0.5	0

Table 2:

Results	α	M	p	100Γ	$100U_{EN}$
Case 1: S = 0	64.42%	2.74%	32.21%	-11.84	78.17
Case 1: $S = S^{NR}$	54.47%	0%	27.24%	-9.82	77.42
Case 2: S = 0	64.42%	2.74%	32.21%	-41.84	107.35
Case 2: $S = S^{*}$	60.35%	1.87%	30.17%	-41.07	107.47
Case 2: $S = S^{NR}$	54.47%	0%	27.24%	-39.82	107.42
Case 3: S = 0	64.42%	2.74%	32.21%	-83.84	146.25
Case 3: $S = S^{NR}$	54.47%	0%	27.24%	-79.82	147.42
Case 4: S = 0	68.39%	3.57%	34.20%	-62.50	146.28
Case 4: $S = S^{NR}$	54.47%	0%	27.24%	-59.82	147.42
Case 5: S = 0	55.40%	2.33%	27.70%	-26.03	36.79
Case 5: $S = S^{NR}$	51.41%	0%	25.71%	-25.10	36.61

Figure 1:

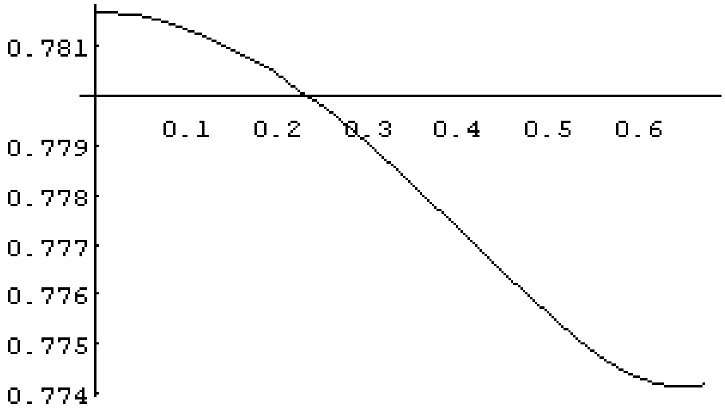


Figure 2:

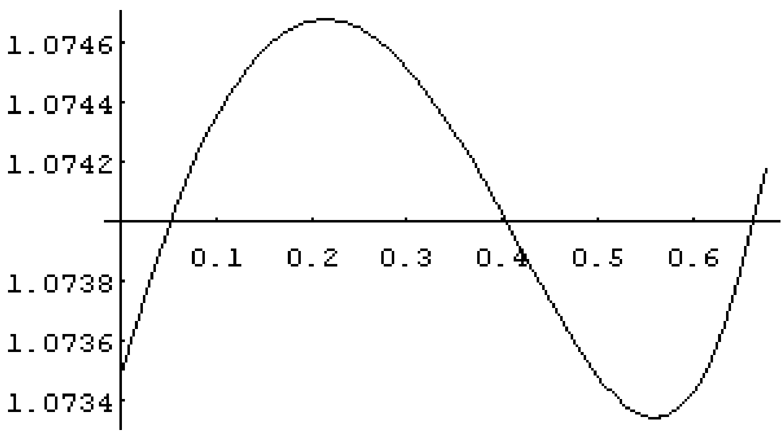
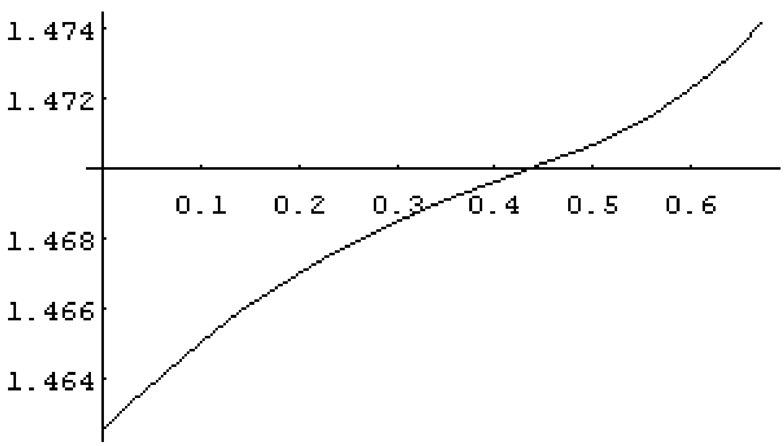


Figure 3:



[1] Some of the literature notes that control may not always be defined as clearly as suggested in the model of this paper. The important point to note is that *the founding entrepreneurs do not have control*.

[2] In some cases the change in management involves no conflict, notably if founders want to leave anyway, or if they prefer to stay as board members or functional vice-presidents (such as the COO). Still, in many cases entrepreneurs resent the professional managers (and vice versa!), and the founders leave the company, either at or shortly after the appointment of a new CEO.

[3] "Vesting" is a legal arrangement where the entrepreneurs' shares are originally held by the company. Entrepreneurs receive title to these shares according to some contractually specified schedule.

[4] Demsetz and Lehn (1985) find some evidence that owners of closely-held firms may be concerned with consuming a private benefit at the expense of their company. They cite the dramatic stock price increases at Disney after the death of the dominant founder as a suggestive example.

[5] It is worth pointing out that there is a significant difference between the activities of venture capitalists and the typical role of directors in large public companies. In large companies, directors evaluate and vote on takeover proposals. But since there is no market for corporate control in start-up companies, venture capitalists essentially substitute for this market through direct search.

[6] This paper views the entrepreneur and the venture capitalist as forming a partnership, where each party can take private actions that affect a joint value. Based on the work of Crampton, Gibbons and Klemperer (1987), Minehart and Neeman (1996) also examine efficient control rules in a model with private actions taken by both members of the partnership. Their model is different, however, since they are concerned with a very different control problem, namely the resolution of the partnership where one party needs to buy out the other.

[7] Chan, Siegel and Thakor (1990) use a model with moral hazard to explain the existence of performance requirements and the allocation of control rights in venture capital contracts. In their model control means making actual production decisions. They assume that venture capitalists can replace entrepreneurs and run the companies themselves. I argue instead that venture capitalists are instrumental for finding professional managers.

[8] I formulate the model in the context of venture capital, where the issue of control is particularly prominent, but the analysis can be applied more generally to the financing of closely-held firms.

[9] Technically this is similar to the standard effort problem in a principal-agent setting.

[10] This net benefit measures the unweighted sum of utilities of the EN and the VC. It excludes any utility of the PM, which the VC and the EN would not take into account in their bargaining.

[11] The interpretation of α as equity is natural in the context of venture capital (see also Admati and Pfleiderer (1994)). It is straightforward to extend the model to allow for a general distribution of returns (as opposed to just success or failure). All the insights of the model continue to apply if we define α as the expected value of the EN's financial stake in the project. This financial stake could consist of any nonlinear function of the return, i.e., any type of financial securities that satisfies some mild regularity conditions.

[12] In the appendix I consider the possibility of joint control, where the EN and the VC must agree on a decision to bring in the PM. I show that joint control is weakly dominated by EN control, justifying its omission in the main body of the paper.

[13] Indeed, creating a financial structure consisting of several classes of stock with differential voting power is common practice in venture capital contracts (Fenn, Liang and Prowse (1995); Testa (1997)).

[14] I assume that $p_{BB} = \frac{\partial^2 p_1}{\partial b_1{}^2} < 0$ so that the second-order condition is always satisfied.
[15] Throughout the paper, when I use the conditions $\Gamma > 0$ and $\Gamma \leq 0$, Γ will be evaluated at m = 0.
[16] The ambiguous effect of ϕ and p_0 on S can be understood as follows. A higher ϕ (or a lower p_0) calls for a higher m. At a given S, a higher ϕ (lower p_0) already increases the VC's incentive to search. The change in S is therefore only intended to adjust the VC's search incentive, which may have overshot or undershot its optimal level in direct response to the change in ϕ (p_0).
[17] This renegotiation outcome is inefficient in the sense that the EN's wealth constraint prevents joint utility maximization. If the VC were to make an ex-ante transfer to the EN, then this inefficiency would disappear and no replacement would occur. This is, however, never optimal. The no replacement outcome can also be obtained from EN control. Moreover, the ex-ante transfer would reduce the EN's equity stake, thus increasing agency costs.
[18] EN control is formally identical to VC control with $S \geq S^{NR}$. The latter, however, is a counter-intuitive arrangement, where the VC is given control rights, but the high severance prevents her from exercising them. We can ignore this arrangement, especially given that this would clearly be an inefficient arrangement if there is even a small probability that the EN wants to leave for exogenous reasons.
[19] A only has an effect on the participation constraint which I assume is satisfied.
[20] The second-order condition is negative provided p_{AA} is sufficiently negative and M is sufficiently large, which I assume.
[21] It is useful to define B = B(p) and $B_m(\phi)$ as the inverse functions of p(B) and $\phi(B_m)$. If $-B_m'(\phi) < (>) -B'(p)$ for all $p=\phi$, then the marginal loss of private benefit is always lower (higher) for the PM than for the EN when increasing the success probability. This immediately implies that for every α, $\phi(\alpha) > (<) p(\alpha)$. Note that this depends only on the derivatives of B(p) and $B_m(\phi)$, but not their absolute values.
[22] Through the appropriate choice of B_m I normalize the PM's reservation utility at 0.
[23] Formally, we have $\alpha_m = \text{Max}[0,\alpha_{m0},\alpha_{m1}]$, where α_{m0} is the lowest α satisfying $\frac{\partial(1-\alpha_m)\phi}{\partial\alpha_m} \geq 0$ and α_{m1} satisfies $B_m(\phi) + \alpha_{m1}\phi = 0$ (where ϕ is chosen to maximize the left-hand side expression).
[24] Obviously, it can also be interpreted as the private benefit of the managers in the acquiring company, or a combination of these two effects.