A Control Theory of Venture Capital Finance

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This article analyzes how an entrepreneur and an external investor allocate revenues and control among themselves in a venture capital relationship, given that they want to liquidate their holdings in the future. Within an incomplete contracting framework we generate contractual arrangements that closely resemble those observed in venture capital markets. In particular, we explain the predominance of preferred stock and convertible instruments.

1. Introduction

> The entrepreneur and the venture capitalist "live together" for 3 to 5 years, toward the mutual goal of a public offering or sale of the entrepreneur's business at a higher price than management or the venture capitalist paid. Occasionally, the process works smoothly.
>
> —David Silver, opening paragraph of *Venture Capital: The Complete Guide for Investors* (1985)

The possibility of a future sale of the firm is an important concern in any start-up, but particularly in venture capital arrangements.[1] Venture capitalists want to liquidate early, and many entrepreneurs specialize in starting up firms (for a discussion of entrepreneurship and business transfers, see Holmes and Schmitz, 1990). The average holding period for a venture capital investment is less than five years (Sahlman, 1990). Exit takes place either through an

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1. Based on a study of U.S. data, Pakes and Ericson (1988) claim that most sales of firms occur within the first three years after start-up.

initial public offering or, more commonly, through a trade sale of the company. Even if the parties agree ex ante to allow for a sale, they may disagree ex post; a sale can have considerable distributional consequences.

For example, an entrepreneur in a start-up firm often makes considerable firm-specific investments and derives sizeable private benefits from realizing his project. These benefits provide important incentives, but they are hard to specify in a contract. If an outsider can take over the firm and fire the entrepreneur without compensating him for these benefits, firm-specific investments may never be undertaken. Similarly, a venture capitalist worries about a new owner/manager taking out assets from the firm without paying their full market value (think, for example, of some customized computer software the value of which is hard to verify in court). In the absence of adequate protection of investments when ownership and management are transferred, venture capitalists will not contribute capital, or at least will demand much higher shares of revenues.

We demonstrate how the parties to venture capital arrangements can design the firm's capital structure to mitigate the distributional conflicts associated with a future sale of the firm. In particular, we explain a prevalent feature of the venture capitalist contract: the combined use of debt and equity or, more commonly, convertible preferred stock or convertible debt (Sahlman, 1990). Our claim is that the allocation of returns and control achieved by these instruments protects the initial contracting parties as much as possible against dilution and extracts from a future buyer of the firm. In particular, the parties make use of the right to sell control, which is itself a fundamental property right (Alchian and Demsetz, 1972).

In our model, allocation of the right to sell control determines who bargains with a new owner/manager. Once in control, the buyer takes over management from the entrepreneur and either increases the value of the claims of the noncontrolling party or dilutes them by stripping assets. The old controlling party is protected against dilution, but cannot free-ride on efficiency improvements brought about by a new owner/manager; the reverse is true for the old noncontrolling party. In particular, when the venture capitalist has control, she bargains with the buyer and makes sure her claims are paid in full; the new owner/manager then fires the entrepreneur without appropriate compensation. When the entrepreneur has control rights, he bargains with the buyer and will not sell unless he is fully compensated for his private benefits. The claims of the venture capitalist increase in value following efficiency improvements, and decrease in case of dilution.

These distributional conflicts—expropriation of managerial quasi-rents and asset stripping—are just examples, but they capture two generic state-contingent conflicts in venture capital finance: one relates to private benefits in good states of nature, and the other involves the value of the firm in bad states of nature. Private benefits are more valuable when the firm is doing well, while asset stripping is more likely when the firm's assets are worth more in alternative uses outside the firm. In general, there is a trade-off between, on

the one hand, having protection against dilution, and, on the other hand, free-riding on potential efficiency improvements by a buyer. Debt financing protects the parties to the venture capital arrangement against state-contingent dilution by transferring control from the entrepreneur to the venture capitalist in bad states of nature. The option to convert debt into minority equity (or minority equity into debt) further improves matters because it permits the venture capitalist to benefit from efficiency improvements brought about by a new owner/manager.

The situation discussed here belongs to a more general class of trilateral bargaining problems, those in which one party arrives after the others. If trading with the third party can improve the situation for both initial contracting parties, there is no conflict. Similarly, if both original parties are made worse off by trading with the latecomer, no conflicts arise; the initial contracting parties will not trade. However, if the third party can improve the situation for one party while worsening it for the other, there are potential conflicts; when there are constraints on ex post side contracting, the latecomer may collude with one of the initial contracting parties to extract surplus from the other. Our analysis demonstrates that these potential conflicts may be mitigated by allocating the decision to trade to the most vulnerable party. That distributional effects of sales of firms can be considerable is well illustrated in the business press and handbooks, which abound in stories of dilution in connection with sales of venture capital firms (see, for example, Silver, 1985).

It may seem that since the sale of the firm is a verifiable event, contracts could be made contingent on a sale. Many venture capital agreements also contain various restrictions, such as co-sale and "take me along" clauses, which require the consent of both parties before selling. However, since the parties' willingness to sell may be affected by the state of nature and the type of buyer, just making the contract contingent on the event of a sale is not sufficient. In any case, our framework allows us to analyse such clauses. We show that they are dominated by our first-best contract, the convertible contract.

Standard handbooks often explicitly recommend the use of convertible preferred shares (or convertible debt) to mitigate the problems associated with selling the firm (see, for example, Silver, 1985). In an exhaustive discussion of the structure of venture capital organizations, Sahlman (1990) views convertible preferred shares as the primary vehicle by which the parties can convert their illiquid holdings into cash. The fact that these instruments are converted at the time of sale also suggests that the possibility of a future sale is an important determinant of capital structure in venture capital firms.

Previous analyses have attempted to explain convertible instruments and the reason why the conversion option would ever be exercised prior to maturity (Lewis, 1991). Most explanations have focused on the fact that these instruments are relatively insensitive to variations in the riskiness of the underlying assets. Thus, Brennan and Kraus (1987) and Brennan and

Schwartz (1988) point to the usefulness of convertibles when it is difficult to estimate asset risk. Green (1984) and Chiesa (1991) invoke incentive explanations for the existence of convertible securities.[2] Costantinides and Grundy (1990) and Stein (1992) show how these instruments can mitigate problems associated with ex ante information asymmetries. This article focuses on the control aspect of convertible instruments and on their use in venture capital finance. We argue that in venture capital finance control and incentives cannot be separated; the entrepreneur's private benefits form an important part of his incentive scheme, and assets are often hard to protect in contracts. A state-contingent allocation of control protects these incentives. As in Chiesa (1991), the option to convert allows the parties to contract on nonverifiable but observable information (the state of nature).

Our findings are related to those of Aghion and Bolton (1992), who demonstrate that when an entrepreneur faces private costs in liquidating his firm, he may lower the cost of outside finance by agreeing to give up control when the firm is doing poorly.[3] Grossman and Hart (1988) also analyze how the prospect of a future sale affects capital structure—in their case, the allocation of votes among equityholders of a widely held firm. In work parallel to ours, Zingales (1991) has extended the model of Grossman and Hart to the decision about whether to go public and how many of the shares to sell off to outside investors; the optimal allocation of control between inside and outside shareholders is determined by the trade-off between protecting private benefits and free-riding. All these models generate capital structures with only one type of financial instrument: either all-equity or all-debt. We show here that the standard instruments may be combined, or equipped with conversion privileges to reduce the costs of external finance.[4]

Section 2 presents a model where an entrepreneur and a venture capitalist design their contractual arrangement knowing that in the future an outside owner/manager is interested in taking over control over the firm. In Section 3 we compare six venture capital contracts: five combinations of the standard financial contracts and one convertible debt contract. Section 4 analyzes the results, and Section 5 concludes.

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2. A related literature has focused on the prevalence of staged financing in venture capital agreements (see, e.g., Hansen, 1991; and Admati and Pfleiderer, 1991). Here the emphasis is on the first stage, that is, the allocation of control and return streams in the initial contract between the entrepreneur and the venture capitalist.

3. Aghion and Bolton (1992) allow for contracts to be renegotiated. As in our model, it is the incompleteness of the initial contract in combination with the entrepreneur's wealth constraint that lend importance to the allocation of control; in the absence of wealth constraints, conflicts could be mitigated through ex post side contracting.

4. Aghion, Dewatripont, and Rey (1990) also generate a capital structure where debt and equity have complementary roles. Equity allows for efficiency-enhancing takeovers, while debt reduces managerial compensation in bad states of nature by requiring a fixed payment. Furthermore, standard debt limits management's possibilities to invest in various forms of takeover defenses. In a setting similar to that of Aghion and Bolton (1992), Zender (1991) endogenously generates an optimal capital structure containing two instruments resembling debt and equity.

2. The Basic Model

A risk-neutral entrepreneur (E) with no funds of his own needs outside capital C for a project.[5] He turns to a risk-neutral venture capitalist (I) in a market where there are many investors but few entrepreneurs with ideas worth investing in. Consequently, the entrepreneur is assumed to have all the bargaining power. He offers the venture capitalist a contract, knowing that in the future, with some probability, a new manager (B) will offer to buy control of the firm. The entrepreneur chooses between the two standard contracts, equity and debt, alone or in combination, or with a conversion option. The return and control rights associated with these contracts will be specified in detail later, but they affect how much a new owner/manager has to pay for the firm. The entrepreneur proposes the contract that extracts the most from the future buyer provided that the venture capitalist breaks even—that is, that she receives the market rate of return, which is equivalent to the discount rate and assumed to be zero. Once a contract is signed, the entrepreneur cannot receive additional capital in the market, at least not when the firm is doing poorly. In such bad states of nature, outside investors know that, by assumption, the optimal decision is to liquidate the firm, and they will not provide new funds, at least not without getting control.

The entrepreneur's idea is economically viable for at most two periods: a short period before the parties receive a signal about the profitability of the project, and then a longer period representing the entire life of the project. At the beginning of period 1, a contract is signed and production starts. The project may be abandoned at the end of period 1 or, at the latest, at the end of period 2. Upon shutdown, the firm's assets are liquidated and the proceeds distributed. The timing of events is depicted in Figure 1.

The operation yields revenues (net operating income) y_1 and y_2 in periods 1 and 2, respectively, where y_1 is small compared to y_2 and to input C. (If y_1 were larger than C, everything could be paid back in the first period and the problem of long-term finance would disappear.) Both y_1 and y_2 are observable, but they become verifiable by a court only when the firm is liquidated. First-period revenues depend on the state of nature, Θ, a summary statistic for a change in any of a broad set of circumstances relevant to the project's outcome. For simplicity, there are only two states of nature, good and bad, $\{\Theta_g;\Theta_b\}$, occurring with probabilities q and $1 - q$, respectively. The bad state of nature implies low first-period revenues, and the good state implies high. Second-period revenues are a function of both the state of nature and an action taken at $t = 1$. The party in control chooses among three actions: continuation (c) of the firm under the entrepreneur, a sale (s) of the firm to a new owner/manager, and liquidation (l). Once first-period revenues and the state of nature are revealed, the parties know also the second-period revenues for the various actions. Since y_1 is assumed to be negligible, the subscript can be

5. Risk neutrality is perhaps not an attractive assumption in entrepreneurial firms, but the introduction of limited amounts of risk aversion is unlikely to change our main results.

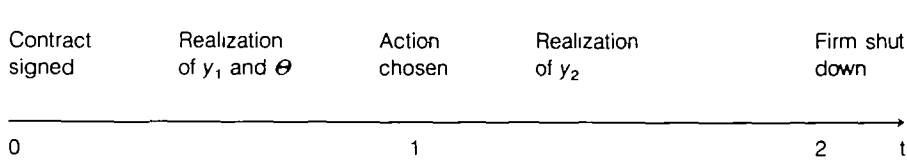

Figure 1 Timing of events in venture capital finance model.

dropped from the payoff calculations. We let y_{gi} denote second-period revenues in the good state given that action i is undertaken, and y_{bj} these revenues in the bad state when action j is implemented.

Managing the firm also confers private, nonverifiable benefits (z). We think of these benefits as a reputation that the entrepreneur may use in other business situations. To highlight our conflicts, we assume that private benefits accrue only in good states of nature; there is no positive reputational value for an entrepreneur in running a poorly performing company. Private benefits are also affected by the choice of action; they disappear when the firm is liquidated. In addition, if the firm is sold (action s) when the entrepreneur does not have control, he is not compensated for his private benefits (his managerial quasi-rents are expropriated).

After first-period revenues and the state of nature have become known, an outside manager (B) offers to buy the firm. The buyer makes a take-it-or-leave-it offer to the party with the right to sell control.[6] If the new owner/manager gets control, he increases second-period revenues (in good states of nature, through improved management; in bad states, through superior liquidation). In addition, he transfers a nonverifiable asset Φ to himself in connection with liquidation (asset stripping). We assume that incentives to strip assets are stronger in bad states of nature when the firm's assets are more likely to be better used elsewhere (for simplicity, $\Phi(\Theta_g) = 0$). To ensure that the buyer can always pay the entrepreneur's reservation price, we also assume that in good states the buyer enjoys larger private benefits z_B than the entrepreneur ($z_B > z_E$).

The utility functions can now be written as

$$U_E = M + z_E \qquad z_E(\Theta_b) = 0$$
$$U_I = M$$
$$U_B = M + z_B + \Phi \qquad z_B(\Theta_b) = 0; \qquad \Phi(\Theta_g) = 0,$$

6. This assumption provides the buyer with all the bargaining power (first-mover advantage); since everything is observable, the buyer knows the seller's reservation price and offers that plus a small amount, thus realizing the entire surplus from the bargain. This may seem unrealistic in a competitive market; in most cases, the seller is likely to enjoy some of the surplus. However, to make the bid, the buyer must get some surplus. (An alternative split where the seller and the buyer share equally in the surplus would not change our main results.)

where M represents verifiable money income. The venture capitalist (I) cannot manage the firm herself, only sell or liquidate it, and therefore she never enjoys any private benefits. Since the venture capitalist and the entrepreneur, by assumption, cannot extract the buyer's private benefits (z_B), the size of these benefits will not affect their choice of contract. To simplify notations, we drop the subscript and let z denote the entrepreneur's private benefits.

If a perfectly contingent contract could be written, a first-best solution would be possible. Such a contract would state which action to implement (or would stipulate the payoffs) in each state contingent on the event of a sale. To capture the difficulties involved in writing such comprehensive contracts, we assume that even though the state of nature Θ is perfectly observable, it is not verifiable by a public court (for a discussion of verifiability, see Tirole, 1986). When actions and payoffs cannot be made contingent directly on the state of nature, contracting parties can avoid costly ex post bargaining by allocating control over strategic decisions to one of the parties (Grossman and Hart, 1986). The parties' returns will increase if they can make this allocation contingent on some verifiable variable correlated with the state of nature (Aghion and Bolton, 1992). We evaluate the different control and revenue allocations that the parties can achieve through the use of the standard financial contracts debt and equity.

3. Choice of Contracts

A contract allocates control rights (the right to choose an action at $t = 1$) and rights to return streams, and may also allow a party to convert debt into equity (or equity into debt). We examine six venture capital contracts: non-voting (or minority) equity (NVE), voting (or majority) equity (VE), joint ownership (EE), standard (or all)-debt (SD), a combination of standard debt and non-voting equity (DE), or convertible debt (CD).

The entrepreneur offers the contract that maximizes his payoffs provided that the venture capitalist breaks even. However, before analyzing the choice of contract we must specify our assumptions about the relative values of second-period revenues and the entrepreneur's private benefits in order to generate the previously described state-contingent conflicts:

(i) $y_{gc} + z > y_{gs} > y_{gc} > y_{gl}$

(ii) $y_{bs} > y_{bl} > y_{bc} > y_{bs} - \Phi$.

If there is no buyer, conditions (i) and (ii) stipulate that the entrepreneur and the external investor both prefer action plan {c,l}—that is, to continue in good states and to liquidate in bad states. This action plan is a constrained first-best, the first-best plan when the initial contract prevents the firm from being sold (or when there is no buyer). In this case, the choice of capital structure is irrelevant. The entrepreneur's expected payoffs π are independent of the allocation of control and revenues (due to risk neutrality), that is,

$$\pi_{NVE} = \pi_{VE} = \pi_{EE} = \pi_{SD} = \pi_{DE} = \pi_{CD} = q(y_{gc} + z) + (1 - q)y_{bl} - C,$$

where C denotes the venture capitalist's reservation utility (her initial capital contribution).

When a buyer appears, the choice of capital structure is no longer irrelevant; by stipulation, the party with control always sells (undertakes action plan {s,s}). The controlling party receives what he or she would get in the absence of a sale, that is, if the original entrepreneur continued to manage the firm (action plan {c,l}). The controlling party has protection against potential dilution in the bad state ($y_{bl} > y_{bs} - \Phi$), but does not enjoy the benefits of efficiency improvements brought about by the buyer in the good state ($y_{gs} > y_{gc}$). Depending on the sharing rule in the contract (linear share or fixed payment), the noncontrolling party, on the other hand, may benefit from efficiency improvements but be vulnerable to expropriation of private benefits or asset stripping. The allocation of control and the right to sell control, and the design of sharing rules, influence the compensation to the initial contracting parties and how much they can extract from a potential buyer. We start by analyzing different all-equity structures, and then introduce debt financing and the option to convert debt into equity.

3.1 All-equity Financing

The entrepreneur manages the firm in the first period. We are concerned with control over the second-period action decision and in particular with the right to sell control.[7] When only equity has been issued one party holds (or both parties share) control in *all* states of nature. The parties may decide to share control (joint ownership) or to allocate control and the right to sell control to the entrepreneur (issue non-voting, or minority, equity) or to the venture capitalist (issue voting equity). These contracts give the entrepreneur the right to a share—s_{EE}, s_{NVE}, and s_{VE}, respectively—of verifiable revenues.[8] Table 1

7. For simplicity, and because of the analytical problems associated with trilateral bargaining, we assume that the allocation of control cannot be renegotiated once a buyer has appeared. However, allowing renegotiation is unlikely to change our qualitative results. To prevent a takeover, the party vulnerable to dilution may attempt to prevent a sale by offering a small amount t_0 to the party with control rights who is indifferent between selling and not selling. Since the entrepreneur is liquidity constrained, only the external investor can make such an offer, that is, renegotiation is feasible only in bad states of nature when non-voting equity has been issued. In this case, the outcome of bilateral renegotiation (ruling out transfers from the buyer) depends on the relative bargaining power of the entrepreneur and the external investor. The entrepreneur may be willing to accept a small transfer, but he could also insist on a large sum, up to the reservation price of the investor. If both parties have some bargaining power, the external investor will have to carry some of the costs of potential dilution even though a sales never takes place. To reiterate a crucial point: it is the entrepreneur's wealth constraint that lends significance to the allocation of control.

8. These shares may be interpreted as wages related to verifiable revenues or as a share in the equity capital of the firm; the entrepreneur's share of verifiable revenues is small relative to his private benefits. Since revenues in the first period are not verifiable, a separate linear sharing rule in this period is not meaningful, dividends may or may not be paid out, but they are not specified

Table 1. Allocation of Control and Revenues for Different Forms of Financing

	θ_g		θ_b	
	Party in Control	Venture Capitalist's Payoff	Party in Control	Venture Capitalist's Payoff
Non-voting equity (NVE)	E	$(1 - s_{NVE})y$	E	$(1 - s_{NVE})y$
Voting equity (VE)	I	$(1 - s_{VE})y$	I	$(1 - s_{VE})y$
Joint ownership (EE)	E/I	$(1 - s_{EE})y + z/2$	E/I	$(1 - s_{EE})y + z/2$
Tall-debt (SD)	E	D	I	y
Convertible debt (CD)	E	$(1 - s_{CD})y$	I	y
Mixed (DE) [αNVE + $(1 - \alpha)$ SD]	E	$\alpha(1 - s_{DE})y + (1 - \alpha)D$	I	y

summarizes, for the two states of nature, the allocation of control and returns associated with the contracts considered in the analysis. Under all-equity finance the allocation of control is not contingent on the state of nature. The three equity contracts all represent different control allocations: under non-voting (or minority) equity the entrepreneur is in control, under voting equity the venture capitalist has control, and under joint ownership they share control. The venture capitalist receives a share $(1 - s)$ of verifiable revenues, with the size of s depending on the choice of contract. In case of joint ownership, the venture capitalist also can extract some of the entrepreneur's private benefits. The contracts containing debt are specified in more detail later, but they all have state-contingent control: the entrepreneur has control in the good state and the venture capitalist in the bad state. Debt contracts also stipulate a fixed repayment or, if verifiable revenues are not sufficient, all such revenues remaining. Mixed debt and equity finance, with a share α of equity and $(1 - \alpha)$ of debt, is the general case with standard debt and convertible debt as special cases ($\alpha = 0$ and $\alpha = 1$, respectively). Since the entrepreneur is assumed to have all the bargaining power, the shares of revenues, debt repayments, and extracted private benefits must sum up to the initial capital contribution C.

We first compare voting and non-voting equity, and these contracts and joint ownership. Then three contracts including debt financing are considered.

3.1.1 Non-Voting vs. Voting Equity. When non-voting equity has been issued and a buyer appears, the entrepreneur is indifferent to a takeover, that is, the

in the initial contract. Liability is limited so that the entrepreneur cannot be forced to pay more than his initial capital contribution—that is, $s \in [0,1]$. Personal collateral is not uncommon in venture capital arrangements. However, we assume that such collateral is not sufficient; for simplicity, the entrepreneur has no assets. Handbooks on venture capital warn against using personal collateral since it mixes up the firm and the entrepreneur's private economy (Silver, 1985).

entrepreneur is compensated as if action plan {c,l} were implemented. The venture capitalist enjoys the benefits of efficiency improvements in good states of nature, but is subject to asset stripping in bad states. To calculate the entrepreneur's expected payoffs under non-voting equity (π_{NVE}), we set his share of revenues s_{NVE} so as to maximize his expected payoffs (i.e., his reservation price when he sells control):

$$\pi_{NVE} \equiv \underset{s_{NVE}}{\text{Max}}\ q(s_{NVE}y_{gc} + z) + (1 - q)s_{NVE}y_{bl},$$

subject to the venture capitalist's individual rationality (IR) constraint,

$$q(1 - s_{NVE})y_{gs} + (1 - q)(1 - s_{NVE})(y_{bs} - \Phi) \geq C.$$

Under voting equity, the buyer makes his take-it-or-leave-it offer to the venture capitalist. Since the investor knows that no more offers will be made, she accepts as long as the price is equivalent to what she would get in the absence of a buyer. The entrepreneur loses his job but retains his equity holdings; consequently, he shares in potential value-increasing actions, but his managerial quasi-rents are expropriated in good states of nature and, in addition, assets are syphoned off in bad states.

The entrepreneur maximizes his expected payoffs under voting equity π_{VE} by offering the sharing rule s_{VE} that solves the following problem:

$$\pi_{VE} \equiv \underset{s_{VE}}{\text{Max}}\ qs_{VE}y_{gs} + (1 - q)s_{VE}(y_{bs} - \Phi),$$

subject to the individual rationality constraint for the venture capitalist,

$$q(1 - s_{VE})y_{gc} + (1 - q)(1 - s_{VE})y_{bl} \geq C.$$

We can now compare the two contracts. Since the entrepreneur is assumed to have all the bargaining power, the individual rationality constraints are binding; we solve for the entrepreneur's expected payoffs. The following proposition evaluates the two capital structures for a particular case.

Proposition 1. When expected private benefits are nonnegligible and the net effect on expected revenues of a buyer appearing is zero, non-voting equity dominates voting equity. In general, there always exists a z^* above which non-voting equity dominates voting equity.

Proof. We compare the entrepreneur's expected payoffs for the two contracts. Setting $\pi_{NVE} - \pi_{VE} > 0$ yields the following inequality:

$$(a - b)\left[1 - \frac{C(a + b)}{ab}\right] < qz$$

where

$$a = qy_{gs} + (1 - q)(y_{bs} - \Phi) \qquad \text{and} \qquad b = qy_{gc} + (1 - q)y_{bl},$$

a and b denoting, respectively, the expected value of verifiable revenues under the buyer and in the absence of a buyer. The left-hand side of the inequality compares the effect on expected verifiable second-period revenues of the two contracts, and the right-hand side is the expected value of private benefits. Domination may go either way, but when the net effect on expected verifiable revenues ($a - b$) is zero, and expected private benefits are positive (a specific case that we discuss later), non-voting equity dominates voting equity. The inequality also proves our general result that a level of benefits exists above which non-voting equity dominates voting equity. Q.E.D.

The economics underlying the result in Proposition 1 is more complicated than it may appear at first. What matters to the initial contracting parties is how much they can extract from the buyer given that the venture capitalist receives her capital contribution in expectation; we have assumed that all the surplus goes to the entrepreneur. Since the buyer makes a take-it-or-leave-it offer to the party in control, the buyer can push the controlling party to his or her reservation valuation; the choice of contract affects the size of a party's reservation valuation and which party's reservation valuation matters. When the entrepreneur has control—that is, when non-voting equity has been issued—the value of the private benefits and $(1 - s_{NVE})$ of efficiency improvements are extracted from the buyer in good states of nature $(1 - s_{NVE})$; the larger the venture capitalist's share, the more value is extracted from the buyer. However, in bad states net dilution increases, and the value extracted from the buyer decreases, in the external investor's share. Correspondingly, under voting equity the amount extracted from the buyer decreases (increases) in the venture capitalist's share in good (bad) states. The value of the entrepreneur's private benefits is not extracted, since these benefits do not enter into the venture capitalist's reservation valuation.

Under non-voting equity, assets are stripped from the firm in conjunction with liquidation in bad states of nature ($y_{bl} > y_{bs} - \Phi$). Voting equity results in Pareto-inferior actions in both good and bad states of nature; the managerial quasi-rents are expropriated and the entrepreneur's claims to the firm's assets diluted, respectively ($y_{gc} + z > y_{gs}$; and $y_{bl} > y_{bs} - \Phi$). The ranking over the two allocations of control depends on the relative size of these two forms of dilution and on the size of initial capital requirements. However, it is important to note that, even in the absence of dilution, the payoffs from voting and non-voting equity are not equivalent; whereas the controlling party gets his or her reservation price, the noncontrolling party can free-ride on the efficiency improvements brought about by the buyer.

To ensure that the entrepreneur is properly compensated for his private benefits, voting equity could be combined with a payout triggered by a sale of the firm (a golden parachute); such a clause would extract more from the

buyer. However, the entrepreneur should not be compensated in bad states of nature, where he enjoys no private benefits; compensation would have to be contingent on the state of nature, which is assumed not to be verifiable. If the entrepreneur is allowed to promise payouts out of future cash flows, the liquidity constraint is removed; the entrepreneur pays the venture capitalist not to sell in good states. Voting equity may then dominate non-voting equity and yield payoffs equivalent to those of joint ownership or all-debt financing.

3 1 2 Joint Ownership and Unanimity Rules. As an alternative to unilateral allocations of control, the entrepreneur and the venture capitalist could agree to share control over the firm and bargain over the price at which to sell once the buyer has appeared. Alternatively, they may require that a decision to sell must be unanimous, or that the firm can be sold only in its entirety. The venture capitalist, who has a lower reservation utility, can then extract some of the value of the private benefits from the entrepreneur before consenting to a sale (since the entrepreneur is liquidity-constrained, this transfer comes from the proceeds of the sale). For simplicity, we assume that the parties split the value of private benefits equally (this is the Nash bargaining solution; an alternative specification would not affect our main results). However, since the entrepreneur suggests the contract, the venture capitalist's possibility to extract private benefits in case of a sale merely leads the entrepreneur to offer the venture capitalist a lower share of verifiable revenues ($1 - s_{EE}$). The buyer knows the reservation utilities of the parties and offers $y_{gc} + z$ in good states of nature and y_{bl} in bad states.

We now have the optimization problem for joint ownership. The entrepreneur proposes a sharing rule s_{EE} maximizing his expected payoffs:

$$\pi_{EE} \equiv \underset{s_{EE}}{\text{Max}}\ q(s_{EE}y_{gc} + z/2) + (1 - q)s_{EE}y_{bl},$$

subject to the venture capitalist's individual rationality constraint,

$$q[(1 - s_{EE})y_{gc} + z/2] + (1 - q)(1 - s_{EE})y_{bl} \geq C.$$

The following proposition compares joint ownership and non-voting equity.

Proposition 2. Joint ownership dominates non-voting equity when the expected net dilution resulting from a sale in bad states of nature is larger than expected efficiency improvements brought about by the buyer in good states.

Proof. We want to show when $\pi_{EE} > \pi_{NVE}$. Setting $\pi_{EE} - \pi_{NVE} > 0$ gives us the following expression:

$$(1 - q)[y_{bl} - (y_{bs} - \Phi)] > q(y_{gs} - y_{gc})$$

Q.E.D.

The left-hand side of this inequality represents the benefits of joint ownership—that is, the expected value of avoiding dilution in bad states of nature. The right-hand side corresponds to the costs of this arrangement, which are the gains forgone from efficiency improvements brought about by the new owner/manager in good states. For the special case investigated in Proposition 1—that is, when the net effect of a buyer appearing is zero—the contracting parties are indifferent between the two contracts. Under our assumption that the buyer has all the bargaining power, a joint ownership contract or a unanimity rule ensures the initial contracting parties a compensation equivalent to what they would get in the absence of a buyer. This contract protects them against dilution by a buyer but does not allow them to benefit from potential efficiency improvements. When the expected net effect on verifiable revenues of a future sale is negative, it may seem that parties should agree not to sell the firm under any condition. However, the entrepreneur may still wish to convert his private benefits into cash.

3.2 Debt Financing

When there are potential state-contingent conflicts associated with a sale of the firm, all-equity financing may not be optimal. Since the two conflicts discussed here occur in different states of nature and between different parties, the parties may be able to extract more from a buyer by making the allocation of control contingent on the state of nature through debt financing. When a buyer appears in the good state, the entrepreneur who is vulnerable to expropriation of his private benefits holds the control rights and thus the right to tender these rights. If the buyer shows up following the realization of the bad state of nature and assets can be stripped, control is allocated to the external investor, who cares most about firm value. We here consider three contracts involving debt financing: all-debt financing; combined debt and equity financing; and convertible debt (or equity). Before discussing these contracts we describe the mechanism for transferring control.

Debt specifies repayments D_1 and D_2 in periods 1 and 2, respectively. First-period debt repayment is set so that when the bad state of nature has occurred, first-period revenues y_1 are not sufficient to meet the obligations. The liquidity-constrained entrepreneur must then default, in which case control is transferred to the venture capitalist. The first-period debt repayment D_1 is assumed to be negligible in relationship to second-period revenues; it serves only as a signal of the state of nature. To facilitate notation, we now drop the subscript and let D represent the second-period repayment. If this payment is not met, the external investor receives all verifiable second-period revenues (min (D,y)). We also assume that $y_{gi} > D > y_{bj}$, that is, that second-period revenues are larger than debt repayments (otherwise the entrepreneur would not enter into the agreement), and debt is risky.

The three debt contracts all share this state-contingent control allocation. We analyze all-debt financing and convertible debt as special cases of a more general optimization problem describing the combined use of debt and equity. This problem has the following objective function:

$$\pi_{DE} \equiv \underset{s_{DE},\alpha,D}{\text{Max}}\ q[\alpha s_{DE}(y_{gc} - D) + (1 - \alpha)(y_{gc} - D) + z],$$

subject to the following constraints:

$$q[\alpha(1 - s_{DE})y_{gs} + (1 - \alpha)D] + (1 - q)y_{bl} \geq C \qquad \text{and} \qquad 0 < \alpha < 1,$$

where α denotes the share of equity and $1 - \alpha$ the share of debt in the venture capitalist's holding in the firm. The sharing rule s_{DE} denotes the share of second-period revenues accruing to the entrepreneur. In other words, the venture capitalist gets a share $\alpha(1 - s_{DE})$ of verifiable revenues from her equity holdings and $(1 - \alpha)D$ from her holdings of debt in good states of nature. (For notational consistency we distinguish between the share of equity in the venture capitalist's portfolio α and the sharing rule s_{DE} denoting the share of revenues accruing to the entrepreneur; ceteris paribus an increase in α implies a decrease in s_{DE}.) Since debt is assumed to be risky, the venture capitalist receives all verifiable revenues. All-debt financing here represents the case where $\alpha = 0$, and convertible debt the case where $\alpha = 1$ (and $D = 0$). We proceed first by analyzing these extreme cases and then draw the implications for contracts combining debt and equity.

3 2 1 All-debt Financing. All-debt financing, or standard debt, transfers control to the venture capitalist if the first-period debt repayment is not met and gives the entrepreneur all second-period revenues remaining after debt obligations have been fulfilled. The entrepreneur maximizes his expected payoffs by suggesting a fixed second-period repayment D which solves

$$\pi_{SD} \equiv \underset{D}{\text{Max}}\ q(y_{gc} + z - D),$$

subject to the external investor's individual rationality (IR) constraint

$$(IR)\ qD + (1 - q)y_{bl} \geq C.$$

We derive the following proposition:

Proposition 3. All-debt external financing dominates non-voting equity only when the expected net dilution resulting from a sale in bad states of nature is larger than the expected efficiency improvements brought about by the buyer in good states.

Proof. We want to show when $\pi_{SD} > \pi_{NVE}$. Setting $\pi_{SD} - \pi_{NVE} > 0$ gives us

$$(1 - q)[y_{bl} - (y_{bs} - \Phi)] > q(y_{gs} - y_{gc})$$

Q.E.D.

This inequality is identical to that in the proof of Proposition 2 comparing joint ownership and non-voting equity. This equivalence, however, is not general but a result of the particular conflicts studied here. Shared ownership gives the parties their joint reservation price in both states of nature. All-debt external financing ensures the entrepreneur his reservation price in good states, and the venture capitalist hers in bad states. If, for example, the buyer is less efficient than the entrepreneur in good states ($y_{gc} > y_{gs}$), joint ownership would extract more from the buyer. Of course, there may be considerable costs associated with unconstrained ex post bargaining, in which case all-debt financing is more attractive. The problem with all-debt external financing is that while control is optimally allocated, the allocation of rights to revenues is such that the initial contracting parties do not benefit from efficiency improvements brought about by a buyer in good states of nature. If they could combine the protection against asset stripping offered by debt with the possibility to enjoy the benefits of a buyer through issuing equity, the contracting parties may be able to extract more from the buyer than under all-equity or all-debt financing.[9]

3.2.2 Convertible Debt. Convertible debt ($\alpha = 1$) protects the venture capitalist against dilution in bad states by ensuring her the liquidation value of the firm under the original entrepreneur. In good states of nature, when asset stripping is not a problem, debt is converted into (non-voting) equity, and the venture capitalist receives $(1 - s_{CD})$ of second-period revenues. Figure 2 illustrates the payoffs to the external investor associated with this convertible debt contract. For now we assume that the optimal strategy is to utilize the conversion option in good but not in bad states of nature. We later discuss the optimality of this conversion strategy.

The entrepreneur maximizes his expected payoffs π_{CD} by suggesting a sharing rule s_{CD} that solves

$$\pi_{CD} \equiv \underset{s_{CD}}{\text{Max}}\ q(s_{CD}y_{gc} + z),$$

subject to the external investor's individual rationality constraint

(IR) $q(1 - s_{CD})y_{gs} + (1 - q)y_{bl} \geq C$. (When the assumed conversion strategy is followed, the second-period debt repayment D never enters into the problem.)

9. This article focuses on distributional issues arising from dilution of minority stakes. However, the venture capitalist could extract more from a new owner/manager by buying the whole firm at $t = 0$ or, equivalently, could make an initial transfer T in excess of capital requirements C. In principle, such a transfer would relax the individual rationality constraint and allow debt repayments D to be raised sufficiently high to achieve the first-best. Besides defining away the problem of minority dilution, such a transfer would have to be set at a level where the entrepreneur would be better off, or at least as well off, just walking away with the transfer.

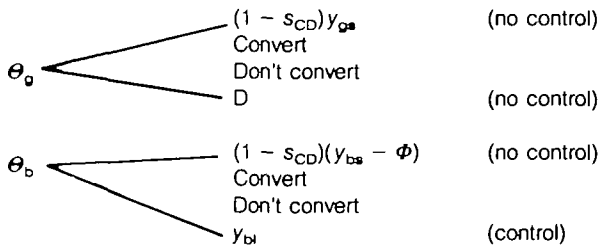

Figure 2. The external investor's payoffs in a convertible debt contract.

We derive the following proposition:

Proposition 4. A debt contract that provides the external investor with an option to convert it into non-voting equity dominates any combination of debt and equity financing.

Proof. Obvious (set $\alpha = 1$ or $D = 0$). Q.E.D.

The convertible debt contract mitigates the moral hazard problem by using observable but nonverifiable information (about the state of nature). Under our assumption of symmetric information about the state of nature, a non-voting (or minority) equity contract convertible into standard debt would be equivalent; the venture capitalist always converts in bad states of nature. (A contract convertible into voting (or majority) equity would be equivalent to pure voting equity—these two contracts would both give control to the venture capitalist). However, if the entrepreneur had private information about the state, the signal provided by a fixed debt repayment in the first period would be valuable.

3.2.3 Combined Debt-Equity Financing. Convertible preferred shares and convertible debt are the most common forms of contractual arrangements in venture capital finance. However, we also observe venture capitalists holding both debt and equity in the same firm. We here study a specific mixed contract that entitles the entrepreneur to a share s_{DE} and an exogenously fixed level of debt ensuring that control is transferred in bad states of nature and all second-period revenues in these states go to the debtholder. From the master program for debt financing and our analysis of the two extreme cases, the following proposition regarding combined debt and equity finance ($0 < \alpha < 1$) can be established.

Proposition 5. A combination of debt and equity financing where the entrepreneur has control in good states and the external investor in bad states always dominates pure debt financing and may also dominate pure equity

financing where the entrepreneur has control (non-voting equity). However, combined debt-equity financing is always inferior to convertible debt.

Proof. We know that convertible debt is the first-best contract and that the master debt program is monotonically increasing in α. Q.E.D.

Compared to all-debt financing and joint ownership, the mixed contract allows the venture capitalist to benefit from the efficiency improvements brought about in the good state of nature. Unlike non-voting and voting equity, mixed financing protects the initial contracting parties against asset stripping, but it may extract less of the efficiency improvements in good states. As a result, the mixed contract may dominate pure equity and debt financing even though the contract is not optimal.

4. A Numerical Example

To provide further intuition, we present a numerical example. In Table 2 we assign numbers to the relevant parameters and calculate the expected profits from each type of contractual arrangement. We then analyze how their relative ranking is affected by changes in some of these parameters. Under the payoff assumptions made earlier we know that convertible debt should always dominate any combination of debt and equity finance (Proposition 4). Furthermore, the expected profits from all-debt financing (SD) and joint ownership (EE) are the same as when there is no sale (Propositions 2 and 3)—the parties are protected against dilution in bad states but cannot enjoy the efficiency improvements brought about in good states. We call this benchmark case π^*. Consequently, the perturbations in the numerical example affect only the relative rankings of non-voting equity, voting equity, and π^*.

For the parameter values in the base case (Case A) the expected verifiable revenues are the same as when there is no sale (the special case in Proposition 1). All contracts yield positive expected profits—with non-voting equity, all-debt financing, joint ownership, and the case where there is no sale having the same expected profits. Convertible debt yields more and voting equity less. If the initial capital requirements are higher (Case B), the ranking is preserved, but only the expected profits from convertible debt are positive. Voting equity has negative expected profits and the other contracts simply break even. Cases C and D illustrate, respectively, that as asset stripping possibilities increase (decrease), non-voting equity becomes less (more) attractive relative to π^*. In both cases, voting equity is still the least attractive contract.

When private benefits are small and dilution in bad states is large (Case E), voting equity dominates non-voting equity. However, for this case the expected profits under voting equity are negative and smaller than π^*; the parties are better off with all-debt financing or joint ownership. Given the payoff assumptions, it is hard to find parameter constellations for which voting equity is the second-best contract. Of course, if the payoffs from particular actions are altered (e.g., private benefits are made very small), voting equity may

Table 2 A Numerical Example of Alternative Venture Capital Contracts

Case	Parameter Values	Alternative Contract Payoffs[a] π^*	π_{NVE}	π_{VE}	π_{CD}	Ranking of Contracts
Case A (base case)	$y_{gs} = 120\ y_{bs} = 50$ $y_{gc} = 100\ y_{bl} = 40$ $z = 40\ \Phi = 30$ $q = .5\ C = 50$ $a = qy_{gs} + (1 - q)(y_{bs} - \Phi)$ $b = qy_{gc} + (1 - q)\ y_{bl}$	40	40	20	45	$\pi_{CD} > \pi_{NVE} = \pi^* > \pi_{VE}$
Case B	$C = 90$	0	0	−20	28.7	$\pi_{CD} > \pi_{NVE} = \pi^* > \pi_{VE}$
Case C	$\Phi = 50$	40	31.7	17.2	45	$\pi_{CD} > \pi^* > \pi_{NVE} > \pi_{VE}$
Case D	$\Phi = 20$	40	43.3	21.4	45	$\pi_{CD} > \pi_{NVE} > \pi^* > \pi_{VE}$
Case E	$z = 30$ $\Phi = 50$ $C = 85$	0	−14.1	−11.4	11.7	$\pi_{CD} > \pi^* > \pi_{VE} > \pi_{NVE}$

[a] Calculations for Case A payoffs are shown below:
$\pi^* = \pi_{SD} = \pi_{EE} = q(y_{gc} + z) + (1 - q)y_{bl} - C = .5(140 + 40) - 50 = 40$
$\pi_{NVE} = (1 - C/a)b + qz = (1 - 50/70)\ 70 + 20 = 40$
$\pi_{VE} = (1 - C/b)a = (1 - 50/70)\ 70 = 20$
$\pi_{CD} = (y_{gc}/y_{gs})(qy_{gs} + (1 - q)y_{bl} - C) + qz = 100/120\ (.5(120 + 40) - 50) + 20 = 45$

dominate other contractual arrangements. Indeed, if the venture capitalist rather than the entrepreneur enjoys private benefits,[10] then voting equity may implement the first-best action plan.

5. Analysis of Results

Our model discusses how the possibility of a future sale of control affects the initial choice of contract. The main result is that convertible debt always dominates pure debt or pure equity financing or any arrangement combining these instruments (Proposition 4). If a conversion option is very costly, or for some other reason not feasible, then the ranking of the other contracts also matters. We show that when the expected gains from potential efficiency improvements brought about by a buyer exceed the expected costs from potential dilution, non-voting equity then dominates all-debt external financing (Proposition 3). In addition, we show that our mixed contract always dominates all-debt external financing (Proposition 5). When the expected net dilution in bad states of nature is larger than expected efficiency improvements in good states, the mixed contract dominates non-voting equity (Propositions 3 and 5). Furthermore, in the special case where the expected net effect on verifiable revenues of a buyer appearing is zero, the mixed contract dominates non-voting equity, which in turn generates expected payoffs equivalent to those under joint ownership or all-debt external financing and larger than those under voting equity (Propositions 1, 2, 3, and 5).

If asset stripping is not state-contingent—that is, if a buyer reduces firm value in both good and bad states of nature—then all-debt financing (or a convertible debt instrument which is never converted) dominates. When the entrepreneur enjoys private benefits in both good and bad states, non-voting equity (or convertible debt which is always converted) will become relatively more attractive. When conflicts are not state-contingent, the net effect depends on the relative size of asset stripping and managerial quasi-rents and on initial capital requirements, but in general all-equity structures become more attractive. If the control transfer associated with debt is costly—for example, because a failure to meet debt repayments is an imperfect signal of the bad state of nature—the parties may prefer pure equity to debt financing (Berglöf, 1991). Furthermore, the relative costs of the errors (transferring control when it should not be transferred or not transferring when it should be transferred) should affect the determination of the first-period debt repayment—that is, when control is transferred.

Caution is warranted in interpreting these results. A number of restrictions have been imposed on the contracting problem. Most important, to simplify the model we have focused on the case where the probability of a buyer occurring is exogenous (and set to one); the choice of capital structure has no effect on the likelihood of a buyer appearing. This is clearly unsatisfactory, because the allocation of control affects the price a buyer has to pay for the

10. For example, as suggested by Demsetz and Lehn (1985), owning a newspaper or a baseball franchise may convey such benefits to a controlling owner.

firm; the parties may use this allocation to discriminate ex ante between diluting takeovers and takeovers that enhance efficiency. However, making the probability of takeovers contingent on the choice of contract would only reinforce the complementarity of debt and equity financing; debt financing reduces the likelihood of diluting takeovers in bad states of nature.

To limit the analysis to standard debt and equity contracts may also seem restrictive. However, from a much wider class of contracts Aghion and Bolton (1992) generate optimal contracts that resemble our standard financial instruments. Furthermore, the predominance of these instruments in corporate finance suggests that considerable gains arise from standardization. Our task has not been to explain why these standards evolved but to determine how such contracts may be used. We are certain that our results also hold for a more general class of contracts. In particular, as demonstrated, they hold for a more general debt contract with a linear, second-period sharing rule (convertible debt) and for equity contracts with unanimity rules or unconstrained ex post bargaining.

6. Concluding Remarks

Standard debt and equity have been shown to have complementary roles in mitigating potential conflicts associated with a sale of the firm and in extracting surplus from a buyer. Whereas both standard debt and non-voting equity compensate the entrepreneur for his private benefits in good states of nature, these contracts have different effects on the expected payoffs to the contracting parties. A standard debt contract provides protection against value-decreasing actions in bad states of nature by shifting control, and the right to sell control, among the initial contracting parties. Non-voting, or minority, equity financing allows the contracting parties to enjoy some of the benefits of efficiency improvements in good states by shifting control to a third party, an outside buyer. In general, the two mechanisms for control transfer associated with debt and equity contracts—bankruptcy and takeover—also serve as complements. Bankruptcy optimizes among the insiders to the firm, while a takeover optimizes between insiders and outsiders.

Venture capital agreements typically allow for the possibility that the firm will be widely held in the future. They often stipulate procedures for initial public offerings (e.g., demand registration, whereby the venture capitalist can ask for a public offering and select an underwriter of such an issue). This possibility should also affect the design of financial instruments in the closely held entrepreneurial firm. For example, all the capital structures considered here potentially can be used to constrain managerial consumption. In fact, their disciplinary effects complement or reinforce each other. Voting equity allows the external investor to sell to a buyer without compensating the entrepreneur for his private benefits. Non-voting equity in the form of a minority holding of shares with voting power could potentially be transformed into majority equity if the firm has to return to the capital market in the future. In addition, in certain situations the threat of liquidation inherent in standard debt may be used to affect the behavior of the entrepreneur or the buyer. This

model should be extended to consider also the widely held firm and the disciplinary role of capital structure.

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