Financial Contracting and the Specialization of Assets*

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Abstract

We analyze the nature of financial contracting when an entrepreneur can choose the specificity of investments and financial contracts are incomplete. Investing in project-specific assets increases productivity but decreases liquidation value. This creates a strategic incentive to specialize assets to decrease the bargaining power of the lender, which may make debt financing infeasible. By contrast, equity financing provided by a financier who contributes to the project, such as a VC, may be feasible because his contribution becomes more valuable as assets become more specialized. This helps persuade the entrepreneur to take the firm public, making cash flows contractible and allowing the financier to cash out. The entrepreneur faces a tension between going public, which is costly but induces the financier to exert effort, and remaining private, which limits the opportunities for contracting but allows the entrepreneur to divert cash flows. We predict that firms with greater opportunity to specialize will be mostly financed by equity, which results in optimal investment and exit decisions. Convertible contracts may also be used to ensure the feasibility of financing, but they increase the firm's likelihood of inefficiently going public.

Keywords: banks, venture capital, incomplete contracts, asset specificity, financial contracts.

JEL Classification: G21, G24, G32.

1 Introduction

Financial contracting takes many forms, and is a crucial feature of any investment decision which relies on external financiers as the primary source of funding. This is particularly true for firms where cash flows are not easily verifiable, as is likely the case for private firms and for startups. For such firms, where contracting is necessarily incomplete, the benefits of one particular form of financing, namely debt, has received much attention (see, e.g., Hart and Moore (1994, 1998)), where the focus has been on how to get firms to pay out cash to their financiers. At the heart of this argument lies the creditor's ability to force a firm to liquidate assets if the debt claim is not paid in a timely manner. However, while theory predicts the use of debt-based financing, it is not uncommon for such firms to be financed by equity, often backed by financiers such as venture capitalists (see, e.g., Schmidt (2003)).

In this paper, we argue that an important determinant of a firm's financial contracting opportunities is the scope for specializing the firm's assets. Our starting point is a simple model of investment and financial structure in a setting where cash flows and asset specificity are initially not verifiable and therefore cannot be contracted upon. Given the importance of the firm's liquidation value to contracting arrangements involving debt, we show that management may have a strategic incentive to take actions to reduce this value. Doing so lowers the credibility of the lender's liquidation threat, reducing the lender's bargaining power in any renegotiation. Asset specialization is one way of achieving this objective while maintaining or even enhancing efficiency: specific assets may be highly productive if used within the firm, but will have low value if used elsewhere (Williamson, 1988; Benmelech, Garmaise, and Moskowitz, 2005).[1] However, investments in project-specific assets introduce an inefficiency in financial contracting in that a creditor, anticipating that the firm's liquidation value will be low, may be unwilling to lend.

[1]Furthermore, the liquidation value of specialized assets could also be lower because the potential buyers of these assets, such as firms operating in the same industry, are more likely to be in financial distress at the same time as the borrowing firm (see Shleifer and Vishny (1992) and Acharya, Bharath, and Srinivasan (2007) for theoretical and empirical discussions of this issue).

One way of resolving such inefficiencies is to involve an equity investor who contributes to the success of the project by exerting effort and who stands to cash out if and when the firm goes public, an act that increases the verifiability of the firm's future cash flows and thus makes them contractible. We formalize this in the model by introducing a second financier that can, through some additional effort, improve the firm's prospects and add value. An example of such an "active" financier is a venture capitalist (VC), who can provide strategic, marketing, or distribution assistance.[2] This active financier does not rely on liquidation to extract value from his investment and is therefore not negatively affected by the entrepreneur's decision to specialize the assets. Indeed, specialization is likely to increase the marginal contribution of the financier's effort and further helps persuade the entrepreneur to take the firm public. We show that this kind of active financing becomes feasible when there is scope for making investments highly specific, which is exactly the instance when debt financing by a passive financier is a relatively poor option.

While active financing has a clear beneficial side, it is not always feasible. The optimal contract between the financier and the entrepreneur must balance the entrepreneur's incentive to divert the cash flows against the need to provide both parties with a stake sufficiently high that they are willing to contribute and follow through with an IPO. When there is little scope for specializing the assets, active financing adds little value to the firm. This reduces the entrepreneur's incentive to take the firm public and equity financing becomes infeasible. On the other hand, with low specialization the firm's assets have high liquidation value and debt financing is more likely to be feasible.

A key premise in our analysis is that a fundamental change occurs in the firm as a result of the process of going public in that, by being forced to file audited financial statements, increase disclosure, and improve transparency, a firm in essence makes at least some of its future cash flows contractible. This allows for equity claims that derive value from the

[2]Several papers provide evidence on the beneficial role of VC's in helping firms to succeed (Gorman and Sahlman, 1989; Megginson and Weiss, 1991; Hellmann and Puri, 2000, 2002; Baum and Silverman, 2004; Hsu, 2004), such as by helping to "professionalize" an entrepreneurial firm by bringing in professional management teams and shortening the time to IPO.

long term prospects of the firm. Importantly, while going public raises the possibility of contracting over future cash flows, such a prospect only arises if the entrepreneur finds it in his best interest to follow through with the IPO rather than to divert the firm's cash flows and claim that none materialized. There is thus a tension between having an IPO, which is costly both for the firm as well as privately for the entrepreneur, and keeping the firm private, which limits the opportunities for contracting but provides the entrepreneur with the ability to divert cash flows.

From the perspective of the financiers, this tension is reflected in the choice of financial contract that can be feasibly offered. A passive lender such as a bank, recognizing that it cannot help improve long term firm value, will always opt for a short term debt contract. An active financier such as a VC, by contrast, can help raise the return of the project but recognizes that the entrepreneur cannot commit ex ante to take the firm public. Any equity contract must therefore provide the entrepreneur with sufficient incentives to follow through with the IPO. The possibility of an IPO influences not just the source of financing that is feasible, but also the type of contract that should optimally be used, with both of these being affected by the scope for investing in specialized assets.

In our model, whenever equity financing is feasible it dominates any other contract, including a loan, since loans can result in a deadweight loss from inefficient liquidation. When equity is not feasible a convertible security sold to an active financier can be used to extend the region where financing is feasible. However, while this allows for the financing of projects with an intermediate level of asset-specificity, it increases the probability of liquidation, making it inferior to straight equity. Thus our paper contributes to the literature that explains the use of convertible contracts in venture capital (Dessi, 2005; Admati and Pfleiderer, 1994; Casamatta, 2003; Hellmann, 1998, 2006; Dessein, 2005). We also explain the commonly observed changes in the allocation of equity prior to the IPO, which arise in our model as part of the renegotiation between the entrepreneur and the financier to provide optimal incentives to invest for both parties.[3]

Our main empirical prediction is that projects with a large scope for specializing assets will be financed by active investors such as VC's, who contribute to the project and thus can persuade the entrepreneur to take the firm public. Conversely, projects that have no scope for specializing assets will be financed through debt, which should be supplied by lenders such as banks. Our model also provides a number of new testable predictions. We show that convertible contracts increase the entrepreneur's incentives to take the firm public, which results in suboptimal IPO decisions. We therefore expect firms that are largely financed by convertible securities to go public more often (or sooner) than firms that are largely financed by equity. Conversely, firms financed with equity held by an active financier have a higher probability of going public than do firms financed by debt.

We also show that, as the relative contribution of the active financier increases, the probability of exit through an IPO or acquisition increases and the entrepreneur chooses a higher level of asset specificity.[4] Finally, we argue that long term debt may be feasible when issued in conjunction with equity financing provided by an active financier since it can free-ride on the active financier's role in taking the firm public. Therefore we should see more long term debt in VC-backed companies compared to companies that rely primarily on the entrepreneur's own funds.

Our paper contributes to the financial contracting literature by explaining the feasibility of equity even without any control right considerations. In an incomplete contract framework, equity is generally not optimal or even feasible. Several papers that explain the feasibility of equity financing assume away the verification problem either fully or partially (Aghion and Bolton, 1992; Dewatripont and Tirole, 1994). Equity financing can also be feasible if it has unconditional control rights. For example, from the transaction cost perspective Williamson

[3]On the empirical front, a number of papers (Sahlman, 1990; Gompers, 1995; Kaplan and Stromberg, 2002, 2004) provide information about the role of VC's and the financial contracts that are used which are similar to the set of contracts we find to be optimal.

[4]Empirically, the reputation or network centrality of a VC (Hochberg, Ljungqvist, and Lu, 2005; Gompers and Lerner, 1999) could be used as a proxy for a VC's relative contribution.

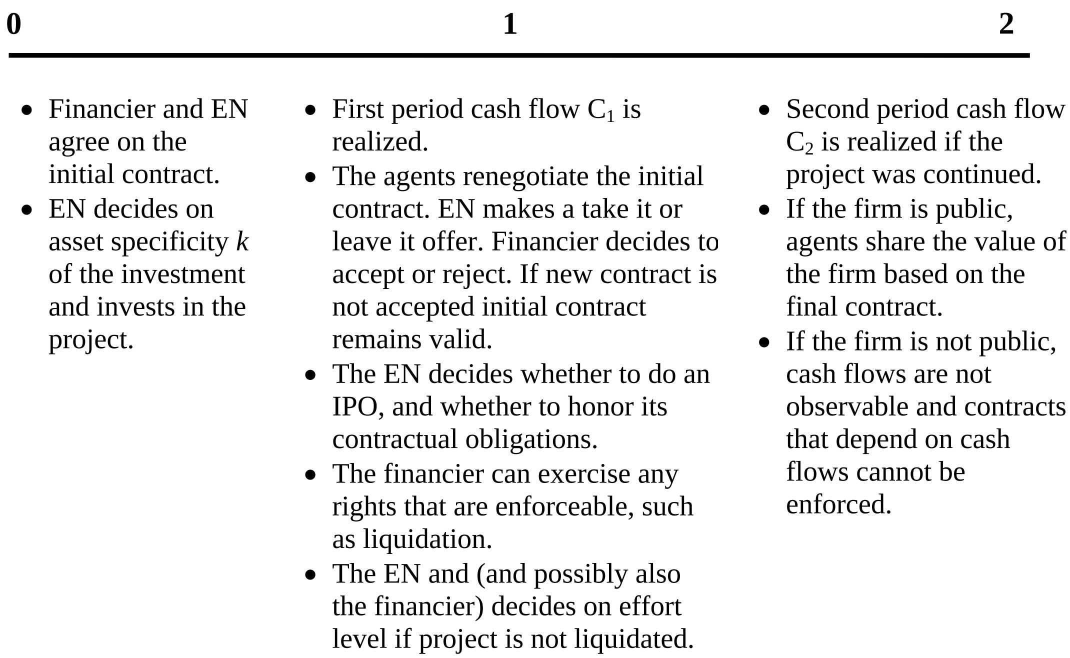
(1988) argues that assets with limited redeployability are more likely to be financed with equity if equityholders have control of the board and have the power to replace management. Similarly, Fluck (1998) shows that outside equity can be optimal when it has unconditional control rights and can credibly threaten to dismiss managers. Our innovation is to show that when the financier can contribute to the success of the project, outside equity can be feasible (and optimal) in a framework where contracts are incomplete at the time of financing even if equity does not provide any control rights. We show that the entrepreneur may endogenously choose to make the cash flows verifiable, which enables the active financier to cash out without having any decision rights. This is also consistent with the argument and empirical evidence that the allocation of cash flow and control rights can be separated through the use of covenants (Hellmann, 1998; Kaplan and Stromberg, 2002; Schmidt, 2003).

Ueda (2004) and Winton and Yerramilli (2007) also study an entrepreneur's choice between bank and VC financing. Ueda (2004) argues that VC's have a superior ability to evaluate projects than banks but at the same time have the potential to steal the entrepreneur's idea. Winton and Yerramilli (2007) proposes that venture capitalists can monitor more intensively the continuation strategies of investors but at the same time face a higher cost of capital. We contribute to this literature by emphasizing the role of asset-specificity as a determinant of firms' choice of financing source.

2 The Model

An entrepreneur (EN) is endowed with a two-period project which requires an initial investment of I and returns a cash flow C_t in each of the subsequent periods, $t = 1, 2$. These cash flows are observable by the entrepreneur and the financier but are unverifiable by courts so cannot be contracted upon. The entrepreneur has capital of $W \leq I$ and needs to raise the remaining amount $I - W$ from either a passive (e.g., bank) or an active (e.g., VC) financier. The entrepreneur chooses the type of financing from the menu of contracts provided by the financier. The timeline of actions is provided in Figure 1.

Figure 1: Timeline



The entrepreneur has some flexibility in how to use the capital and may decide, once he has obtained financing, to invest in general (redeployable) assets, or in assets that are specifically tailored for the proposed project. Specialization, denoted by $k \geq 1$, is costly, with the cost given by $g(k)$, which is increasing and convex. Although the financier observes k, third parties cannot enforce contracts that depend on k. As k gets higher the value of assets under alternative use decreases, but the return from the project increases. Specifically, we assume that the investment's liquidation value at $t = 1$ is equal to $L = \frac{\gamma_i I}{k}$, where $\gamma_i \in (0, 1)$ and $i \in \{passive, active\}$. Partial liquidation of assets is not possible. The liquidation value of the assets decreases over time, and for simplicity we assume that it is equal to zero at time 2.[5] We assume that the passive investor is better than the active investor at extracting value under liquidation, i.e., $\gamma_{passive} > \gamma_{active}$. This captures the idea that financiers such as banks generally have much larger portfolios which allow them to have departments specialized in liquidating non-performing loans.

At $t = 1$, the cash flow C_1 is realized, which is random and has probability density function $f(C)$ with support in $[C_0, \infty)$, $C_0 > 0$. After C_1 is realized, the entrepreneur decides whether to honor his contractual obligations. If he chooses not to follow through with his obligations, he can either divert the cash for his personal consumption, or he can propose an alternative contract to the financier. At time 1 he must also decide how much effort e_{EN} to exert in producing long term ($t = 2$) cash flows.

We assume that the entrepreneur retains ownership and control of the project unless the financier is explicitly granted liquidation rights in case of non-payment. If the project is continued, the $t = 2$ cash flow C_2 depends on the realization of C_1, the level of asset-specificity k, the total effort levels of the entrepreneur and the financier (if any), and any payment P_1 made in the first period, since those are deducted from the cash available to continue the project. The cash available for investment is denoted by $\widetilde{C}_1 = (C_1 - P_1)$. A payment can also be made at time 2, denoted by P_2.

Passive investors lack the personnel and experience to help the entrepreneur manage the company, so they cannot help to increase the $t = 2$ cash flow. Therefore, if the entrepreneur borrows from a passive investor, time 2 cash flows are given by $C_2 = \widetilde{C}_1 k e_{EN}$, where e_{EN} is the effort level of the EN. On the other hand, active investors are specialized in helping firms to succeed. For instance, VC firms may provide portfolio companies with strategic advice, help them professionalize their management, and attract better resources, business partners and human capital. As in Hellmann (2006), we formalize this by assuming that an active investor (a VC) can exert effort e_{VC} at time 1 that increases the time 2 cash flows,

[5] In a similar setting, Hart and Moore (1998) show that only short term debt is feasible because the financier can only exit with the threat of liquidating assets.

$C_2 = \widetilde{C}_1 k(e_{EN} + \phi e_{VC})$, where $\phi > 0$ measures the relative contribution of the active investor. The cost of effort is equal to $c(e) = \frac{1}{2}e^2$ for both the entrepreneur and the active investor.

The value of the firm at time 2 is YC_2, where Y is an exogenously given multiplier of the time 2 cash flows, such as the P/E ratio. We assume that $Y \geq \sqrt{\frac{2I}{C_0} + 2}$, which implies that it is always socially optimal to continue the project even if the entrepreneur invests alone. While the firm's cash flow and value cannot initially be contracted upon, we assume that it becomes verifiable in period 2 only if the entrepreneur decides in the first period to take the firm public, an action to which he cannot commit ex ante. Undertaking an IPO requires paying a fixed cost of T. Once the IPO process starts, the entrepreneur can no longer divert the cash since several market participants monitor the cash flows of the firm.[6] In our model, there is no difference between exit through IPO or through acquisition. In both cases the value of the firm becomes observable by third parties.

After signing the contract at time 0, agents can renegotiate the contract at time 1. For simplicity, we give all bargaining power to the entrepreneur: the entrepreneur can make a take it or leave it offer to the financier after the realization of the time 1 cash flows.[7] If the financier rejects the EN's proposal the initial contract remains valid.

3 Passive Financing

We begin by analyzing a debt-like contract where the entrepreneur promises to pay an amount P_t at time t in exchange for receiving $I - W$ from a passive financier such as a bank (we will use the terms "lender" and "bank" interchangeably). Later, we will show that an equity-like contract is not feasible when the financier cannot contribute to the project.

We solve by backward induction. At time 2, the firm has either gone public or not. If

[6]This captures the notion that filing for an initial public offering leads not only to greater scrutiny by regulatory agencies (i.e., the SEC), but also forces the firm to more carefully track its accounts by certifying its financial statements, hiring independent auditors, etc. All of these decrease the ability of the entrepreneur to steal the cash from the firm by pretending no cash flow was realized.

[7]The results can be extended to the case where both the financier and the entrepreneur have some bargaining power.

the firm did not go public, cash flows are not verifiable at time 2. If, on the other hand, the firm is public at time 2, the bank can force the EN to make the promised payment, if any, by going to court. However, if the only required payment to the bank is at time 2 (i.e., $P_1 = 0$, $P_2 > 0$), the EN at time 1 will prefer not to take the firm public, and will instead keep the firm private and appropriate all the cash flows. The intuition is that when the entrepreneur decides not to go public, the bank has no power in ex-post bargaining because the liquidation value of the assets is zero at time 2 and the firm's cash flow and value is not verifiable by a third party. Thus having only long term debt to be repaid at time 2 is not feasible, since the bank would never be repaid in equilibrium. Anticipating this, the bank would refuse to lend at time 0. We can now state the following.

Lemma 1. *Any equilibrium debt contract at time 0 always requires the EN to pay at time 1: $P_1 > 0$.*

Although the terms of the debt contract can be renegotiated at time 1, the bank always initially requires the EN to promise a payment at time 1. Consider therefore the case where the EN has committed to pay $P_1 > 0$ at time 1. The entrepreneur may at time 1 make the payment to the lender and keep running the project, or he may decide to divert the cash flow. In the latter case, the lender will liquidate the assets of the firm in order to secure at least some repayment, thus terminating the EN's ability to continue the project. Alternatively, the entrepreneur may propose to go public, but asks to defer the payment P_1 in exchange for a time 2 payment of P_2. The bank can either accept or reject the EN's offer. If the bank rejects the EN's offer the original contract remains in place and either the original payment P_1 must be made or the bank can liquidate the assets.

At time 1, the EN decides whether to: (1) undertake the IPO and defer payment to time 2; (2) pay P_1 but not go public; or (3) divert the cash flows C_1 but face the prospect of liquidation. First, we need to solve the optimal effort levels to calculate the payoff of the EN for each case. If the EN chooses not to divert the time 1 cash, he must decide on his effort level by solving one of the following optimization problems:

$$\text{no IPO} : \max_e Yk(C_1 - P_1)e_{EN} - \frac{1}{2}e^2 \quad (1)$$

$$\text{IPO} : \max_e YkC_1 e_{EN} - \frac{1}{2}e^2 - T - P_2 \quad (2)$$

In case (1), the EN makes a payment P_1 to the bank at time 1 in order to avoid liquidation. This payment reduces the amount of cash available for continuing the project and thus reduces his ability to generate time 2 cash flows, $C_2 = k(C_1 - P_1)e_{EN}$. Case (2) reflects the fact that when the EN commits to do the IPO all time 1 cash flows are invested. Solving (1) and (2) yields the EN's optimal effort level as $e_{EN}^I = YkC_1$ and $e_{EN}^{NI} = Yk(C_1 - P)$ for the IPO and No IPO cases, respectively.

The EN compares payoffs from the three different strategies discussed above and chooses the one that has the highest payoff. These payoffs are summarized as follows.

$$\text{IPO and pay } P_2 : \frac{1}{2}Y^2k^2{C_1}^2 - T - P_2 \quad (3)$$

$$\text{Pay } P_1 \text{ but no IPO} : \frac{1}{2}Y^2k^2(C_1 - P_1)^2 \quad (4)$$

$$\text{Don't pay} : C_1 + max\{L - P_1, 0\} \quad (5)$$

Recall that after C_1 is realized, agents renegotiate the terms of the contract that they signed at time 0. Since the EN makes a take it or leave it offer, it will never be optimal for him to offer to pay more than the minimum of either the promised repayment in the first period, P_1, or the liquidation value L: $P_2 \leq \min\{P_1, L\}$. At the same time, the bank need never accept an offer less than $\min\{P_1, L\}$. Hence, $P_2 = \min\{P_1, L\}$. The payoff of the bank is therefore not affected by the decision of the entrepreneur at time 1 because the renegotiation process makes the bank indifferent between all possible outcomes.

Lemma 2. *The bank always receives the minimum of either the initially promised repayment P_1 or the liquidation value L.*

Having resolved the time 1 renegotiation and continuation decision, we now turn to the initial stage. At time 0, after receiving financing, the entrepreneur chooses the level of specificity k of the investment. As the value of k increases, the productivity of assets increases. At the same time, however, the assets' value for use outside of the project decreases.

The payoff to the entrepreneur from bank financing is equal to:

$$\begin{aligned}\Pi_{EN}^{bank} &= -W + \int_{C_0}^{C_a} (C + \max\{L - P_1, 0\}) f(C) dC \\ &+ \int_{C_a}^{C_b} \frac{1}{2} k^2 Y^2 (C - \min\{L, P_1\})^2 f(C) dC \\ &+ \int_{C_b}^{\infty} \left(\frac{1}{2} k^2 Y^2 C^2 - T - \min\{L, P_2\} \right) f(C) dC - g(k),\end{aligned} \tag{6}$$

where

$$\begin{aligned}C_a \quad &\text{solves} \quad \frac{1}{2} k^2 Y^2 (C - \min\{L, P_1\})^2 = C + \max\{L - P_1, 0\} \\ C_b \quad &\text{solves} \quad \frac{1}{2} k^2 Y^2 (C - \min\{L, P_1\})^2 = \frac{1}{2} k^2 Y^2 C^2 - T - \min\{L, P_2\}.\end{aligned}$$

Equation (6) illustrates that the entrepreneur can divert the time 1 cash flow (and face liquidation), pay back the loan at time 1 but not go public, or go public and renegotiate the repayment until time 2. The payoff to the entrepreneur in these cases is $C_1 + \max\{L - P_1, 0\}$, $\frac{1}{2} k^2 Y^2 (C_1 - \min\{L, P_1\})^2$ and $\frac{1}{2} k^2 Y^2 C_1^2 - F - \min\{L, P_2\}$, respectively. C_a represents the level of cash flows for which the first and second expression are equal; C_b is the level of cash flows for which the second and third expressions are equal. We note that renegotiating the loan to extend maturity (and committing to take the firm public) may or may not dominate simply repaying the loan. Here, we write the payoff to the entrepreneur from bank financing assuming that a region exists where paying off the loan at time 1 dominates extending the maturity. In the appendix, we provide the condition for the existence of this region.

The entrepreneur determines the optimal level of specialization k^* from the following first order condition which is discussed in more detail in the appendix:

$$\begin{aligned}\frac{\partial \Pi_{EN}}{\partial k} &= \int_{C_0}^{C_a} \frac{\partial \max\{L-P_1,0\}}{\partial k} f(C)dC \\ &+ \int_{C_a}^{C_b} Y^2 \left[k(C-\min\{L,P_1\})^2 - \frac{1}{2}k^2 \frac{\partial \min\{L,P_1\}}{\partial k} \right] f(C)dC \\ &+ \int_{C_b}^{\infty} \left(kY^2C^2 - \frac{\partial \min\{L,P_2\}}{\partial k} \right) f(C)dC - \frac{\partial g(k)}{\partial k} = 0,\end{aligned} \tag{7}$$

Equation (7) highlights an important issue related to debt-based financing in that firms financed through loans consider the effect of specialization on their bargaining power with the lender in addition to any increase in productivity. When the firm is not financially constrained, so that $I-W < L$, the entrepreneur balances the marginal cost of specialization with the marginal benefit resulting from the increased productivity of assets. However, when the firm is financially constrained, i.e., when P_1 is equal to or very close to L, there is also a strategic incentive to specialize the assets. This can be seen from noting that when the firm is financially constrained, $\frac{\partial \min\{L,P_1\}}{\partial k}$ is negative and $\frac{\partial \max\{L-P_1,0\}}{\partial k}$ is positive or zero; these terms increase the equilibrium level of specialization. When the firm is not constrained, $\frac{\partial \min\{L,P_1\}}{\partial k}$ is equal to zero and $\frac{\partial \max\{L-P_1,0\}}{\partial k}$ is negative, which establishes that an unconstrained firm specializes less than a constrained firm.

Lemma 3. *With short-term debt financing, constrained firms specialize assets not only to improve productivity but also to decrease the bargaining power of the financier. As a result, financially constrained firms specialize their assets more than non-constrained firms do.*

Proof: See the appendix. □

In equilibrium, the bank should correctly anticipate the entrepreneur's choice of asset-specificity. Therefore, the bank will agree to lend only if the expected payment is more than or equal to the loan amount. The participation constraint of the bank can therefore be stated as:

$$I - W \leq \min\{L, P_1\} = \min\left\{\frac{\gamma_{bank} I}{k^*}, P_1\right\} \tag{8}$$

Assuming that the banking industry is competitive, (8) will hold with equality.[8] If the wealth of the entrepreneur is less than the difference between the liquidation value and the amount of investment, a bank loan will not be feasible. Therefore, companies with an opportunity to significantly specialize their assets once they have obtained financing may never receive funding from banks in the first place, even if the projects are highly productive. We summarize this in the following simple result, which characterizes the possibilities for bank financing.

Proposition 1. *Define* $k_h \equiv \frac{\gamma_{bank} I}{I-W}$. *Bank debt financing is feasible if and only if* $k^* < k_h$.

Combined with Lemma 3, a corollary to this finding is that as a result of the strategic desire to reduce the liquidation value of assets, firms with large needs for financing may find it increasingly more difficult to obtain debt financing. Put differently, the feasibility constraint in Proposition 1 is affected by the desire of the entrepreneur to reduce its lender's incentive to liquidate the firm's assets.

A similar backward induction analysis reveals that bank equity is never feasible. Equity does not provide the bank with the right to liquidate the assets. In addition, at time 1, the entrepreneur has no incentive to take the firm public since the bank contributes nothing to the success of the project. As a result, the bank cannot receive any payment from the entrepreneur for its equity investment.

4 Active Financing

In this section we consider the role of a financier who plays an active part in helping to develop the project and thus contributes to its success. A primary example of such a financier is a

[8] Note that P_1 is somewhat indeterminate as any $P_1 > L$ will always be renegotiated down to a payment no greater than L. Without loss of generality we can therefore restrict our analysis to cases where $P_1 \leq L$.

venture capitalist, and we will use the terms "VC" and "active financier" interchangeably. Since the VC has no advantage in lending relative to a bank, a loan will always be cheaper from a bank than from a VC.[9] Therefore, we limit our analysis to equity contracts in this section.

We again use backwards induction. The entrepreneur agrees at time 0 to give an equity stake β to the financier, which corresponds to a fraction β of the time 2 value, YC_2, in return for receiving the required funds $I - W$. At time 2, if the firm has gone public the cash flows become verifiable. The VC can then liquidate its equity share at the market value. If the firm is not public, cash flows are not verifiable, and the entrepreneur can appropriate the entire value of the company by claiming that no cash flows were realized. Equity does not provide liquidation rights or control rights to the VC, so that the VC's payoff is equal to zero if the EN does not take the firm public.

At time 1, after observing the realization of the cash flow C_1, the EN and the VC can renegotiate the terms of the initial contract. As with debt financing, the EN makes a take it or leave it offer. If the offer is rejected, the original contract (i.e., the equity share β) remains in place. The outcome of the renegotiation process will clearly depend on agents' outside options. We therefore first calculate agent's payoffs under the initial sharing rule β.

As in the previous section, the effort level of the entrepreneur when he decides on an IPO is denoted by e_{EN}^{I} and when he decides to keep the firm private is denoted by e_{EN}^{NI}. If the entrepreneur takes the firm public, he shares the future cash flows with the VC, who may also exert effort and thus help increase the value of the firm. The effort level of the

[9] It may be that VCs in some instances can obtain higher value for the firm's assets than what a bank can achieve. In general, we have in mind liquidation that arises as a result of default, a function that banks are often well-equiped to perform since it represents their primary way of obtaining recovery in default states. Nevertheless, including the possibility that VCs may sometimes be better at finding an alternative use for the assets does not qualitatively change our results concerning the nature of the financing provided. If VC's are better liquidator than banks for certain firms, a bank loan will be dominated by a VC loan for these firms.

entrepreneur when he decides to do the IPO is obtained from the following problem:

$$\max_e (1-\beta)[kYC_1(e+\phi e_{VC})-T]-\frac{1}{2}e^2, \tag{9}$$

which in equilibrium yields $e_{EN}^I = (1-\beta)kYC_1$.

Likewise, the effort level of the VC when the entrepreneur commits to do the IPO is obtained by maximizing:

$$\max_e \beta[kYC_1(e_{EN}+\phi e)-T]-\frac{1}{2}e^2. \tag{10}$$

The solution to this problem yields $e_{VC} = \phi\beta kYC_1$.

On the other hand, the effort level of the entrepreneur when he decides not to take the firm public is obtained from:

$$\max_e kYC_1 e - \frac{1}{2}e^2. \tag{11}$$

The solution is $e_{EN}^{NI} = kYC_1$.

Note that the level of effort of the EN is larger when he rejects the IPO, $e_{EN}^{NI} > e_{EN}^I$. This is because, by not taking the firm public, he avoids sharing the future proceeds of the project with the VC and therefore he is willing to put in more effort, as summarized in the following result.

Lemma 4. *If the entrepreneur decides to take the firm public, the effort levels of the entrepreneur and the VC are sub-optimal because of the double-sided moral hazard problem (Holmstrom, 1982). However, if the entrepreneur decides not to go public, the entrepreneur captures all of the value and exerts a higher level of effort.*

While the lemma establishes that the EN will exert a higher level of effort by not going public, it does not imply that going public is never optimal. The overall increase in project value depends also on the effort of the VC, which is only undertaken if the EN commits to take the firm public. These effort levels depend on how the cash flow of the firm is shared, and both agents' incentives to exert effort increase with their share of the cash flows. However, the sharing rule that agents agree on at time 0 may not be optimal because the VC's equity share β is set to satisfy his ex ante participation constraint, which may not coincide with the optimal provision of incentives. Therefore, agents should renegotiate the sharing rule at time 1, once C_1 is known, so as to increase the joint payoff. The following result establishes that renegotiation will always lead to the sharing rule that maximizes total value.

Proposition 2. *The optimal sharing rule β^* is determined by the relative contribution of the VC with respect to the entrepreneur, ϕ. This sharing rule is given by:*

$$\beta^* = \frac{\phi^2}{1+\phi^2}. \tag{12}$$

If necessary, agents agree on fixed transfers P_{VC} and P_{EN} from the time 2 cash flows for the VC and the entrepreneur, respectively, to satisfy their incentive compatibility constraints and implement the sharing rule β^*. The transfers are feasible if it is optimal to do the IPO under the sharing rule β^*, i.e., $P_{VC} + P_{EN} \leq YC_2 - T$.

Proof: See the appendix. □

The proposition establishes that whenever the initial contract does not lead to ex post maximization of surplus, the entrepreneur can always propose a different contract that will maximize joint profit (similar to Hellmann (2006)). If this optimal sharing rule makes one of the agents worse off, his incentive compatibility (IC) constraint can always be satisfied by making a fixed transfer to him from the cash flow at time 2, which becomes observable if the firm goes public. It is worthwhile noting that such a process resembles the granting of additional stock options to either the entrepreneur or to the VC. As a result of renegotiation, one party's stake is likely to increase. However, in order to obtain this increase, that party may have to make a fixed payment at $t = 2$, which can be interpreted as the payment for conversion of the options that increase this party's stake. Therefore, from now on we assume that at time 1 agents will agree on the sharing rule that maximizes the joint payoff regardless of the sharing rule agreed on at time 0.

The renegotiation between the VC and the EN depends on whether the EN is willing to undertake the IPO under the initial sharing rule β. For the entrepreneur, the cost of taking the firm public is not just the fixed cost T of the IPO, but also the lost opportunity to divert future cash flows since these become verifiable once the firm is public. This creates a tension for the entrepreneur between committing to take the firm public so as to benefit from the VC's expertise, and diverting all cash flows and running the project himself. If the IC constraint that ensures the EN will prefer to take the firm public is satisfied under the initial sharing rule β, the outside option of the VC is equal to the payoff from going public under the initial sharing rule. The VC's IC constraint can then be stated as:

$$\begin{aligned} &\beta^*[kYC_1(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*) - T - P_{VC} - P_{EN}] + P_{VC} - \frac{1}{2}e^2_{VC}(\beta^*) \geq \\ &\beta[kYC_1(e^I_{EN}(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}e^2_{VC}(\beta). \end{aligned} \tag{13}$$

If the IC constraint of the entrepreneur is not satisfied under the initial sharing rule, the outside option of the VC is equal to zero since the EN's option to reject the IPO and run the firm privately is credible. Recognizing this, it will be optimal for the VC to accept any offer that provides him a net payoff of zero or more.

Lemma 5. *The incentive compatibility constraint of the entrepreneur for doing the IPO under the initial sharing rule β is satisfied if the realized cash flow at time 1, C_1, is greater than C_{high}, where*

$$C_{high} = \sqrt{\frac{T(1-\beta)}{[\frac{1}{2}(1-\beta)^2 + (1-\beta)\beta\phi^2 - \frac{1}{2}]k^2Y^2}}. \tag{14}$$

The entrepreneur always takes the firm public if C_1 is greater than C_{low}, where

$$C_{low} = \sqrt{\frac{T}{(\frac{\phi^4 - 2\phi^2}{2+2\phi^2})k^2Y^2}}. \tag{15}$$

Proof: See the appendix. □

Lemma 5 establishes that the outcome of the time 1 renegotiation depends on the realization of first period cash flows, C_1. If these cash flows are sufficiently low ($C_1 < C_{low}$), the entrepreneur prefers not to bear the cost of taking the company public, and the VC's payoff is equal to zero. If cash flows are at an intermediate level ($C_{low} < C_1 < C_{high}$), the entrepreneur finds it optimal to commit to do the IPO, but only under the optimal sharing rule β^*. Under the initial sharing rule β, the entrepreneur would prefer to keep the firm private and run the project himself. In this case, renegotiation leads both agents to agree on the optimal sharing rule, with the entrepreneur capturing all the surplus, and the VC again getting zero because of the entrepreneur's credible threat to keep the firm private. Finally, if cash flows are high ($C_1 > C_{high}$), the entrepreneur decides to take the firm public and agents agree on the optimal sharing rule. The VC receives his outside option, which is determined by the initial sharing rule and yields a value greater than zero. In summary, although agents always agree on the optimal sharing rule, the initial sharing rule is still relevant because it determines the VC's outside option under renegotiation.[10]

At time zero, after raising financing, the EN decides on the optimal level of specialization. The entrepreneur's payoff from VC financing, Π_{EN}^{VC}, can now be stated as

$$\begin{aligned}\Pi_{EN}^{VC} = & -W + \int_{C_0}^{C_{low}} \frac{1}{2} Y^2 k^2 C^2 f(C) dC \\ & + \int_{C_{low}}^{C_{high}} [V(\beta^*) - c_{EN}(\beta^*) - c_{VC}(\beta^*)] f(C) dC \\ & + \int_{C_{high}}^{\infty} [V(\beta^*) - \beta V(\beta) + c_{VC}(\beta) - c_{EN}(\beta^*) - c_{VC}(\beta^*)] f(C) dC - g(k),\end{aligned} \tag{16}$$

[10]Note that assuming that C_{low} and C_{high} exist implicitly imposes a constraint on ϕ, the relative contribution of the VC. Essentially, it must be that the VC's contribution is sufficiently large for VC financing to be feasible. Throughout, we assume that this is the case.

where

$$V(\beta) = k^2 Y^2 C_1^2 \left((1-\beta) + \beta\phi^2\right) - T,$$
$$c_{EN}(\beta) = \frac{1}{2}(1-\beta)^2 k^2 Y^2 C_1^2,$$
$$c_{VC}(\beta) = \frac{1}{2}\beta^2 k^2 Y^2 C_1^2 \phi^2.$$

The term $V(\beta)$ denotes the value generated by the VC and the EN when the firm goes public and the VC has an equity share of β. The variables $c_{VC}(\beta)$ and $c_{EN}(\beta)$ denote the equilibrium costs of effort for the VC and the EN, respectively, under the sharing rule β. We can now take the derivative of the entrepreneur's profit with respect to k to determine the optimal level of specialization, which, after some simplification, yields:

$$\begin{aligned}
\frac{\partial \Pi_{EN}^{VC}}{\partial k} &= \int_{C_0}^{C_{low}} kY^2C^2 f(C)dC \\
&+ \int_{C_{low}}^{C_{high}} kY^2C^2 \left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) f(C)dC \\
&+ \int_{C_{high}}^{\infty} kY^2C^2 \left[\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) - 2\left(\beta(1-\beta) + \frac{1}{2}\beta^2\phi^2\right)\right] f(C)dC - \frac{\partial g}{\partial k} = 0.
\end{aligned} \tag{17}$$

The EN's optimal level of specialization can be solved from the above equation. Note that this time the EN specializes assets only to increase productivity and has no incentive to decrease liquidation value. The entrepreneur has an incentive to specialize more when the relative contribution of the VC, ϕ, is higher in order to benefit more from the VC's effort.

Lemma 6. *The EN specializes assets more when the relative contribution of the VC's effort to the project is higher.*

Proof: See appendix. □

We now calculate the payoff of the VC from financing the project. The VC captures surplus only when the entrepreneur's IC constraint is satisfied at time 1 under the initial sharing rule β. The VC's surplus is equal to his share of the cash flows according to the initial sharing rule minus the cost of his effort. Since we assume that the VC industry is competitive, the expected payoff of the VC must be equal to zero:

$$-(I-W)+\int_{C_{high}}^{\infty}\left(k^2Y^2C^2\left(\beta(1-\beta)+\frac{1}{2}\beta^2\phi^2\right)-\beta T\right)f(C)dC=0. \qquad (18)$$

The initial share of the VC can now be determined from this equation. As long as a $0<\beta<1$ exists that satisfies (18), the entrepreneur can raise funds from the VC. Note that specializing the assets increases the payoff of the VC. Unlike the bank, the VC prefers projects with highly specialized assets because as the specificity of the assets increases, the VC's effort becomes more valuable, and the entrepreneur is more likely to take the firm public. We summarize this discussion in the following result.

Proposition 3. *The initial share of the VC, β, is decreasing in the expected level of specialization of the assets. There exists a minimum value $\underline{k}$ such that VC equity financing is feasible only for $k^* \geq \underline{k}$, i.e., the participation constraint of the VC at time zero is satisfied by $0<\beta<1$.*

5 Active versus Passive Financing

Both the passive and the active financiers evaluate the entrepreneur's project and propose financial contracts if financing the investment is feasible. Passive financing has a higher chance of being feasible when the liquidation value of the assets is high, i.e., when the entrepreneur's opportunity to specialize the assets is low. On the other hand, active financing has a higher chance of being feasible when the marginal productivity of assets is high, i.e., when the entrepreneur's opportunity to specialize the assets is high. However, it may also be possible for both types of financing to be feasible at the same time. We analyze the entrepreneur's choice between the two types of financing assuming that both are feasible.

The optimality of one form of financing versus the other is obtained from comparing (6), which represents the entrepreneur's payoff if financing through a bank loan, with (16), the entrepreneur's payoff when financed with VC equity. When both VC and bank financing are feasible at the same time, the EN prefers the financial contract that maximizes his payoff. Since we assume that financial markets are competitive, the payoffs of the bank and the VC are equal to zero. Therefore, the entrepreneur's payoff is maximized when total output is maximized.

Note that the levels of specialization in bank and VC financing are different. Therefore comparing the total payoff in bank and VC financing is not straightforward. Let's first assume that the level of specialization in VC equity financing is equal to the level of specialization in bank debt financing. If both forms of financing are feasible, VC equity financing always dominates bank debt financing because bank financing may result in inefficient outcomes - liquidation and under investment - due to the existence of the promised short term debt payments. VC equity financing, by contrast, never results in an inefficient outcome: even when cash flows are sufficiently low that the firm does not become public and there is no scope for the VC to put in effort to help the firm, VC financing is still optimal as it avoids the possibility of inefficient liquidation. Therefore for the same level of specialization, VC financing is always preferred by the entrepreneur. When we allow the EN to choose the level of specialization k under VC financing, the EN chooses a different level of specialization, which increases the total payoff further. Therefore if both a bank loan and VC equity are feasible, VC equity always dominates the bank loan.

Proposition 4. *If both a bank loan and VC equity are feasible, the entrepreneur always chooses VC equity over a bank loan.*

Proof: See the appendix. □

We note that although pure VC equity financing is always preferred, it is not uniquely optimal. There may be other linear and non-linear contracts that can achieve the same outcome. For example, a financial contract with an initial sharing rule $\beta = \frac{\phi^2}{1+\phi^2}$ plus a fixed transfer in case the firm goes public can satisfy the participation constraint of the

VC at time zero and implement the same outcome. This contract does not eliminate the need for renegotiation given that the fixed transfer would need to be adjusted based on the realization of the first period cash flow. Moreover, its existence depends on the assumption that the relative contribution of the VC is known with certainty at time zero. Our focus is on explaining the feasibility and optimality of common contracts. However, we do not attempt to examine or rule out all other possible contracts.

We can use the same method as above to compare a bank loan to a VC loan. The entrepreneur will choose the loan that maximizes the total payoff from the project. When the EN is constrained ($L = P_1$) with the bank loan, a VC loan is not feasible. We want to consider the case when both loans are feasible, i.e., when the EN is not financially constrained when raising capital from the bank. In this case, given that banks have superior liquidation ability, borrowing from them minimizes the dead-weight loss from liquidation. Therefore the loan is cheaper when the entrepreneur borrows from a bank instead of borrowing from a VC. The following simple result summarizes this observation.

Lemma 7. *If both a bank and a VC loan are feasible, the entrepreneur prefers the bank loan.*

6 The Role of Convertible Securities

Up to now, we have considered only pure debt and equity contracts. However, in practice financial contracts that can convert from debt into equity are often used. This is particularly true with VC financing, where the financier is seen as playing a large role in contributing to the success of the project. Here, we analyze the effect of allowing for such contracts.

Assume that the financier and the EN agree at time 0 on a convertible contract, which we define as a contract that gives the financier a debt contract with a payment P_1 at time 1, but which can be converted into equity at any time. If converted, the financier receives an equity stake equal to a fraction β of the time 2 value, but gives up the fixed payment P_1. As usual, we allow for renegotiation to occur at time 1 by letting the EN offer a new contract after the realization of the cash flows at time 1. The financier can either accept or reject the new contract. If the financier rejects the new contract, the initial convertible contract remains valid.

We first analyze the effect of a convertible contract on financing by an active investor. The outcome of renegotiation at time 1 depends on the outside option of the financier, which is determined by the initial contract. If the EN commits to do the IPO, the investor can either convert to equity or he can demand repayment of the loan by threatening to liquidate. If the project is liquidated, no subsequent investment is possible. If the EN does not commit to the IPO, the optimal action for the investor is to require payment P_1 (since converting is clearly not optimal). The EN may then divert the cash flows, which will force the investor to liquidate, or he can make the payment. Therefore, the EN compares four different outcomes with the following payoffs.

$$\begin{aligned} \text{Divert cash flows} &: \; C_1 + max\{L - P_1, 0\} \\ \text{Pay loan but no IPO} &: \; \frac{1}{2}Y^2k^2(C_1 - P_1)^2 \\ \text{IPO and investor converts} &: \; (1-\beta)[kYC_1(e_{EN}^I(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}(e_{EN}^I(\beta))^2 \\ \text{IPO and investor liquidates} &: \; C_1 + max\{L - P_1, 0\} \end{aligned} \tag{19}$$

The outside option of the VC is determined by the action of the EN under the initial contract.

$$\begin{aligned} \text{Divert cash flows} &: \; min\{L, P_1\} \\ \text{Pay loan but no IPO} &: \; P_1 \\ \text{IPO and investor converts} &: \; \beta[kYC_1(e_{EN}^I(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}(e_{VC}(\beta))^2 \\ \text{IPO and investor liquidates} &: \; min\{L, P_1\} \end{aligned} \tag{20}$$

When the EN offers a new contract to the VC after the realization of the time 1 cash flow, he cannot propose a payment less than the outside option of the VC. With the IC constraint of the VC in mind, the EN tries to maximize the total surplus. The convertible contract helps the VC receive payment in states of the world with low cash flow realizations by threatening to liquidate the project. Therefore, a convertible security enlarges the region of investment specificity where active financing is feasible.

Proposition 5. *A convertible contract decreases the minimum value of k for which active financing becomes feasible. However, if active financing is feasible with both a convertible contract and an equity contract, the EN always chooses the equity contract.*

Proof: See the appendix. □

Although the convertible security increases the region where active financing is feasible, it also introduces the possibility of liquidation and early (i.e., time 1) payment, which are both socially inefficient. The optimal security under active financing is equity; however, equity financing is only feasible for projects with sufficiently highly specialized assets. The convertible contract is thus socially optimal only when equity financing is not feasible.

The convertible contract also provides different incentives to take the firm public compared to the pure equity contract. With the convertible contract the EN has to pay P_1 if he decides not to do an IPO but wants to continue investing. He also pays the minimum of P_1 or the liquidation value when he diverts the cash flows. However, with pure equity, when the EN rejects the IPO he does not have to pay anything to the VC. Therefore, for a given level of asset specificity k, the convertible contract decreases the minimum level of time 1 cash flow at which going public becomes optimal for the EN. This establishes that firms financed by convertible security are more likely to follow through quickly with an IPO than firms financed by simple equity.

Lemma 8. *For a given level of asset specificity k, a convertible contract decreases the minimum cash flow at which committing to an IPO becomes optimal compared to pure equity financing.*

Note that several combinations of (P_1, β) can be feasible when agents agree on a convertible contract. As P_1 increases, the inefficiencies introduced by the convertible contract compared to a pure equity contract increase. Therefore, the EN prefers the contract that minimizes the inefficiencies.

Lemma 9. *The optimal convertible contract is the contract with the lowest P_1 that makes the convertible contract feasible.*

As a final point, we note that a convertible bank contract (i.e., for a passive financier) may also increase the region where bank financing becomes feasible, but only if there is a possibility that the EN prefers to do an IPO with the initial convertible contract and the amount received by the bank after conversion is larger than P_1. In this case, a convertible bank contract increases the region where financing becomes feasible because it allows the bank to capture some of the surplus in the states of the world with high time 1 cash flows. However, it can be shown that the convertible bank contract is never converted to equity, and will in fact always be negotiated to a time 2 debt contract (with no further conversion rights) if the EN decides to do the IPO. This provides maximal incentives for the EN to exert effort to improve future cash flows since he knows he will not have to share marginal cash flows with the lender.

7 Imposing Restrictions on Asset Specificity

In our analysis, we focus on investments that are not contractible, including the entrepreneur's choice of how much to specialize the assets. In this section, we briefly study the case where costly contracts can be written that restrict the investment choice of the entrepreneur. In particular, the financier can impose restrictions that limit the asset specificity of investments by imposing a cost to the entrepreneur when he specializes the assets.

Assume that the cost of specialization for the entrepreneur is given by $\alpha g(k)$, where α measures the tightness of covenants that restricts asset specificity. The value of α is determined by the financier at a cost that is increasing and convex in α.

The analysis of bank and venture capital financing does not change once the entrepreneur decides on the level of specialization. As long as bank or VC financing is feasible there is no need to introduce costly restrictions on asset specificity because these restrictions decrease social welfare. Moreover, with VC equity financing, imposing a restriction decreases the probability of going public and the payoff of the VC in this case. Therefore, introducing restrictions on asset specificity cannot increase the feasibility of VC equity financing, so the VC would never impose such restrictions.

On the other hand, a bank may impose restrictions on how much the assets can be specialized. Restrictions on asset specificity increase the region where the assets are liquidated; however, they also increase the liquidation value of assets. The bank's payoff is limited to the liquidation value of assets regardless of whether liquidation happens or not. Therefore, the bank prefers to increase the value under liquidation even if this increases the probability of liquidation.

The feasible region for bank financing increases as the bank restricts the firm's ability to specialize the assets. At the same time, the feasible region decreases as the cost of imposing restrictions increases. Given that the costs of restrictions are increasing and convex, there is an upper limit on how much the specialization of assets can be restricted. Since the bank loan market is competitive and restrictions decrease the total payoff, the equilibrium contract should impose the fewest restrictions possible to guarantee the feasibility of the loan.

Lemma 10. *Imposing restrictions on the asset specificity is socially sub-optimal. A VC never imposes restrictions on the asset specificity. A bank may impose restrictions on the specialization of assets up to the level at which a bank loan just becomes feasible.*

8 Cost of Financing and the Possibility of Long Term Debt

We have assumed that there is no difference in the costs associated with either bank or VC financing. In practice, differences in the cost of one kind of financing versus the other may exist, and in particular may be higher for VC financing to reflect the greater level of involvement with the firm. For instance, suppose that the opportunity cost of providing financing for both the bank and the VC are increasing and convex in the amount of financing provided by each, but that it is higher for the VC than for the bank (this is as in Winton and Yerramilli (2007)). It is straightforward now to see that the optimal capital structure for the firm should involve balancing the increasing costs of each kind of financing, but minimizing as much as possible on VC equity due to its higher cost. The possibility of debt and equity financing simultaneously may also affect the characteristics of debt financing, as follows.

We have shown that a bank will be willing to lend only on a short term basis because the liquidation value of assets at time 2 is zero. Consider the case of long term debt where a bank jointly finances the project with a VC. A long term loan does not provide the bank with liquidation rights at time 1, but it does entitle the bank to receive repayment at time 2. This payment can be enforced if the entrepreneur agrees to take the company public. While the entrepreneur will never take the firm public if financed solely with long term debt, he may be willing to do an IPO if he also raises funds from an active investor. Thus, a long term bank loan can be viable by "piggy-backing" on the VC's role in helping to take the firm public.

To formalize how long term debt arises in our framework, assume now that the entrepreneur raises a fraction ω of the amount of financing necessary from a VC and obtains the rest, $(1-\omega)(I-W)$, as a long term loan from a bank. In return the VC receives a share β of residual cash flows from the firm, while the bank receives a promise of repayment equal to P_2 at time 2.

At time 2, if the firm has gone public the EN pays the bank P_2 and the rest of the cash flows are shared between the VC and the EN. If the firm is not public, the payoffs of both the bank and the VC are zero. The bank relies on the VC's ability to convince the EN to take the firm public. At time 1, agents can renegotiate the initial financial agreements. As usual, the EN makes a take it or leave it offer, this time to both the bank and the VC. If the EN is willing to follow through with the IPO even under the initial financing terms, then the bank and the VC can capture a positive payoff determined by their initial contract. However, if the EN is not willing to take the firm public under the initial contracts, then the EN captures the surplus by offering a payoff equal to the outside options of the financiers. Since the long term loan does not give any liquidation rights to the bank at time 1, the bank's outside option in this case is equal to zero. In equilibrium, of course, the bank will correctly conjecture that it will be paid only when the EN is willing to do the IPO under the initial financial contracts. We can therefore write down the expected payoff of the bank at time zero as

$$\text{Bank's} \quad \text{Payoff:} \quad -(1-\omega)(I-W) + \int_{C_r}^{\infty} P_2 f(C) dC, \tag{21}$$

where

$$C_r \quad \text{solves} \quad \frac{1}{2} Y^2 k^2 C_1^2 = (1-\beta)(V(\beta) - P_2) - c_{EN}(\beta),$$

and $V(\beta)$ is as defined earlier and represents the value generated by the VC and the EN when the firm goes public. As can be easily seen from the formula above, as the size of the long term loan increases, the region where the bank captures a positive payoff decreases.

Long term debt is feasible if there exist values for ω, β, and P_2 which satisfy the participation constraint of the bank and the VC simultaneously. It is obvious that for some set of parameters long term debt will be feasible. Long term debt does not introduce any inefficiency in the liquidation decision since the bank does not have the right to liquidate assets at time 1. Therefore, long term debt can coexist with VC equity financing. This prediction is consistent with the findings of Hellmann, Lindsey, and Puri (2007) that making venture capital investments in a specific company increases a bank's chance of subsequently making a loan to that company.

9 Conclusion

We study how the scope for specializing assets affects a firm's financing choices. An entrepreneur's inability to credibly commit on the specificity of investments creates a conflict between the entrepreneur and a potential lender. In general, lenders would like investments with non-specific assets and therefore high liquidation value. By contrast, entrepreneurs prefer to invest in projects that, while profitable, also make use of highly specialized assets as a way of reducing the lender's ex-post bargaining power. This tension implies there are some profitable projects that cannot be undertaken using loan financing when contracts are incomplete and the entrepreneur cannot commit to invest only in assets with high liquidation value.

On the other hand, a financier that benefits from the upside potential of a project may be able to get around this problem by taking equity in the firm. This will be particularly true if the financier can exert effort to increase the value of the firm's investments, which is greatest when the firm employs relatively specialized assets. Such financing provides an incentive for the entrepreneur to take the firm public as a way of benefiting from the expertise of the financier. The decision to ease the limits to contracting thus becomes endogenous and is embodied in the entrepreneur's decision to take the firm public. In this context, the design of financial contracts, along with the source of financing, determine whether the entrepreneur is likely to follow through in making cash flows contractible.

Our model explains the use of either short term (e.g., bank) debt financing for firms with assets with a low degree of specialization, as well as equity-like (e.g., VC) financing for firms with highly specialized assets. We also show, consistent with recent empirical findings, that convertible contracts are useful for making VC financing feasible in instances when such financing would not be possible with equity only. Moreover, the use of a convertible contract increases the likelihood of an IPO relative to an all-equity contract. Our model also implies that long term debt can be feasible when used in conjunction with VC (equity) financing by piggy-backing on the VC's incentives to help take the firm public.

An issue not studied here is whether the possibility of additional cash infusions from outsiders at the time of the IPO decision ($t = 1$) can improve investment decisions and ease financing constraints. To the extent that going public is not contractible at the time the firm first seeks financing (i.e., at $t = 0$), it is unlikely that such considerations should change the qualitative nature of our results, which rely primarily on the tension between ensuring repayment to investors and improving efficiency through the use of claims that do not involve liquidation of the firm's assets. However, we leave the detailed analysis of this issue for future research.

10 Appendix

Proof of Lemma 3: The payoff to the EN under bank financing is given by (6). The derivative of (6) with respect to k can be calculated as:

$$
\begin{aligned}
\frac{\partial \Pi_{EN}}{\partial k} = & \int_{C_0}^{C_a} \frac{\partial \max\{L-P_1,0\}}{\partial k} f(C)dC + (C_a + \max\{L-P_1,0\} f(C_a) \frac{\partial C_a}{\partial k} \\
& + \int_{C_a}^{C_b} Y^2 \left[k(C-\min\{L,P_1\})^2 - \frac{1}{2}k^2 \frac{\partial \min\{L,P_1\}}{\partial k} \right] f(C)dC \\
& + \frac{1}{2}k^2Y^2(C_b-\min\{L,P_1\})^2 f(C_b)\frac{\partial C_b}{\partial k} - \frac{1}{2}k^2Y^2(C_a-\min\{L,P_1\})^2 f(C_a)\frac{\partial C_a}{\partial k} \\
& + \int_{C_b}^{\infty} \left(kY^2C^2 - \frac{\partial \min\{L,P_2\}}{\partial k} \right) f(C)dC - \left(\frac{1}{2}k^2C_b^2 - F - \min\{L,P_2\} \right) f(C_b)\frac{\partial C_b}{\partial k} \\
& - \frac{\partial g(k)}{\partial k},
\end{aligned} \tag{22}
$$

where, as defined above,

$$
\begin{aligned}
C_a \quad & \text{solves} \quad \frac{1}{2}k^2Y^2(C_a-\min\{L,P_1\})^2 = C_a + \max\{L-P_1,0\} \\
C_b \quad & \text{solves} \quad \frac{1}{2}k^2Y^2(C_b-\min\{L,P_1\})^2 = \frac{1}{2}k^2Y^2C_b^2 - T - \min\{L,P_2\}.
\end{aligned}
$$

Note that all terms related to the boundaries of the integral cancel out, leaving only (7):

$$
\begin{aligned}
\frac{\partial \Pi_{EN}}{\partial k} = & \int_{C_0}^{C_a} \frac{\partial \max\{L-P_1,0\}}{\partial k} f(C)dC \\
& + \int_{C_a}^{C_b} Y^2 \left[k(C-\min\{L,P_1\})^2 - \frac{1}{2}k^2 \frac{\partial \min\{L,P_1\}}{\partial k} \right] f(C)dC \\
& + \int_{C_b}^{\infty} \left(kY^2C^2 - \frac{\partial \min\{L,P_1\}}{\partial k} \right) f(C)dC - \frac{\partial g(k)}{\partial k}.
\end{aligned} \tag{23}
$$

Setting this equal to zero determines k^*, the optimal degree of specialization. From here, we see that for $L = P_1$, $\frac{\partial \min\{L,P_1\}}{\partial k} < 0$, so that k^* will be greater for financially constrained firms.

Finally, it is clear that for both constrained and unconstrained firms, an increase in $\frac{\partial g(k)}{\partial k}$

for all k leads to a decrease in k^*. $\square$

Proof of Proposition 2: We want to maximize the joint payoff, which is obtained from substituting the equilibrium levels of effort, $e_{EN}^I(\beta)$ and $e_{VC}(\beta)$, into the total payoff function, $kYC_1\left(e_{EN}^I(\beta)+\phi e_{VC}(\beta)\right)-\frac{1}{2}\left(e_{EN}^I(\beta)\right)^2-\frac{1}{2}\left(e_{VC}(\beta)\right)^2$. This yields

$$(kYC_1)^2\left((1-\beta)+\phi^2\beta-\frac{1}{2}(1-\beta)^2-\frac{1}{2}\phi^2\beta^2\right). \tag{24}$$

Maximizing (24) with respect to β yields

$$\beta^*=\frac{\phi^2}{1+\phi^2}. \tag{25}$$

The second order condition is $-(kYC_1)^2(1+\phi)<0$, so that the solution above is indeed the maximum.

We need to show now that agents can always agree on the optimal sharing rule β^* when they agree on the IPO. Let's assume that the initial sharing rule is $\beta\neq\beta^*$. We need to show that positive and feasible side payments P_{VC} and P_{EN} exist such that both agents prefer to renegotiate to the optimal sharing rule β^*. The IC constraint of the VC is

$$\begin{aligned}&\beta^*[kYC_1(e_{EN}^I(\beta^*)+\phi e_{VC}(\beta^*))-T-P_{VC}-P_{EN}]+P_{VC}-\frac{1}{2}e_{VC}^2(\beta^*)\geq\\&\beta[kYC_1(e_{EN}^I(\beta)+\phi e_{VC}(\beta))-T]-\frac{1}{2}e_{VC}^2(\beta).\end{aligned} \tag{26}$$

For the EN, his IC constraint is

$$\begin{aligned}&(1-\beta^*)[kYC_1(e_{EN}^I(\beta^*)+\phi e_{VC}(\beta^*))-T-P_{VC}-P_{EN}]+P_{EN}-\frac{1}{2}\left(e_{EN}^I(\beta^*)\right)^2\geq\\&(1-\beta)[kYC_1(e_{EN}^I(\beta)+\phi e_{VC}(\beta))-T]-\frac{1}{2}\left(e_{EN}^I(\beta)\right)^2.\end{aligned} \tag{27}$$

Adding up these constraints we get the joint payoff on the left hand side when the sharing rule is β^* and the joint payoff on the right hand side when the sharing rule is β. Since β^*

maximizes the joint payoff it is always possible to simultaneously satisfy both constraints. It is important to note that the fixed payments do not affect the first order conditions and therefore the effort levels of the agents.

We also need to show that the side payments are feasible:

$$P_{VC} + P_{EN} \leq kYC_1 \left(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*) \right) - T$$

We show that side payments are feasible for the two possible cases: Assuming that there are no side payments, by switching from β to β^* either one agent is better off or both of them are better off. When we consider side payments, the EN must always be better off because he has the bargaining power and he captures the surplus by making the VC indifferent among the sharing rules.

Without side payments, if both parties are better off or if the VC is better off then there exists a solution to both IC constraints such that $P_{VC} = 0$ and $P_{EN} > 0$. P_{EN} can be found from satisfying the VC's IC constraint with equality. It is obvious from the VC's IC constraint that P_{EN} is feasible (given that doing the IPO is the socially optimal action). If the EN is better off but the VC is not, then there exists a solution to both IC constraints such that $P_{VC} > 0$ and $P_{EN} = 0$. P_{VC} can again be found from satisfying the VC's IC constraint with equality. This time, it is not clear whether P_{VC} is feasible, i.e., whether $kYC_1(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*)) - F - P_{VC} \geq 0$. For P_{VC} to be feasible we need:

$$\beta[kYC_1(e^I_{EN}(\beta) + \phi^2 \beta kYC_1) - T] - \frac{1}{2}e^2_{VC}(\beta) - P_{VC} + \frac{1}{2}e^2_{VC}(\beta^*) \geq 0. \tag{28}$$

We can solve the value of P_{VC} from the IC constraint of the VC and replace it in (28). After simplifying, (28) becomes:

$$\begin{aligned} &[kYC_1(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*)) - T] - \frac{1}{2}e^2_{VC}(\beta^*) \geq \\ &\beta[kYC_1(e^I_{EN}(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}e^2_{VC}(\beta). \end{aligned} \tag{29}$$

Given that total cash flow is larger with the optimal sharing rule, the optimal share of the VC, β^*, has to be lower than the initial share of the VC, β, to make the VC worse off (without side payments). The VC exerts lower effort at a lower cost when her share of cash flows is lower. Therefore, $\frac{1}{2}e^2_{VC}(\beta^*) \leq \frac{1}{2}e^2_{VC}(\beta)$. On the other hand, we know that $kYC_1(e^I_{EN}(\beta^*)+\phi e_{VC}(\beta^*))-T > \beta[kYC_1(e^I_{EN}(\beta)+\phi e_{VC}(\beta))-T]$ given that doing the IPO is socially optimal. Therefore, condition (28) holds, which shows that the P_{VC} is feasible. □

Proof of Lemma 5: The expressions for C_{high} and C_{low} are deduced from the EN's incentive compatibility constraint for doing an IPO. C_{high} solves:

$$\frac{1}{2}Y^2k^2{C_1}^2 = (1-\beta)[kYC_1(e^I_{EN}(\beta)+\phi e_{VC}(\beta))-T] - \frac{1}{2}(e^I_{EN}(\beta))^2.$$

C_{low} solves the equation above when $\beta = \frac{\phi^2}{1+\phi^2}$. □

Proof of Lemma 6: Using the participation condition for the VC, given by (18), we can rewrite the first order condition for maximization of Π^{VC}_{EN} with respect to k, given in (17), as

$$\begin{aligned}\frac{\partial \Pi^{VC}_{EN}}{\partial k} &= \int_{C_0}^{C_{low}} kY^2C^2 f(C)dC \\ &+ \int_{C_{low}}^{\infty} kY^2C^2\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) f(C)dC \\ &-\frac{2}{k}\int_{C_{high}}^{\infty} \beta T f(C)dC - \frac{2(I-W)}{k} - \frac{\partial g}{\partial k} = 0.\end{aligned} \tag{30}$$

We can now differentiate this first order condition with respect to the VC's relative contribution parameter ϕ. The first term is clearly invariant with respect to ϕ, although we note that $\frac{\partial C_{low}}{\partial \phi} < 0$ for $C_{low} < \infty$. The second term is clearly increasing in ϕ. Moreover, since $\frac{\partial C_{low}}{\partial \phi} < 0$, differentiating $\frac{\partial \Pi^{VC}_{EN}}{\partial k}$ with respect to ϕ shifts weight from the first term to the second term, which is larger since $\frac{\phi^4+\phi^2+1}{1+\phi^2} > 1$. Finally, note that the derivative of

$-\frac{2}{k}\int_{C_{high}}^{\infty}\beta T f(C)dC$ with respect to ϕ can be written as

$$\frac{\partial}{\partial\phi}\left(-\frac{2}{k}\int_{C_{high}}^{\infty}\beta T f(C)dC\right) = -\frac{2}{k}\int_{C_{high}}^{\infty}\frac{\partial\beta}{\partial\phi}T f(C)dC - \frac{\partial C_{high}}{\partial\phi}\frac{2}{k}\beta T f(C_{high}).$$

Since $\frac{\partial\beta}{\partial\phi} < 0$ from equation (18) and $\frac{\partial C_{high}}{\partial\phi} < 0$, both terms must be positive. Therefore, the derivative of $\frac{\partial\Pi_{EN}^{VC}}{\partial k}$ with respect to ϕ is positive, implying a higher first order condition and therefore a large equilibrium value of specialization, k^*. □

Proof of Proposition 4: Let's first assume that the level of specialization is equal to the level that is optimal under bank financing. Given that $Y \geq \sqrt{\frac{2I}{C_0}+2}$, it is always socially optimal to continue the project at time 1. However, in the case of bank financing if the cash flows are between C_0 and C_a the EN chooses to divert the cash flows at time 1. When cash flows are between C_a and C_b the EN makes the payment, reducing the funds available for investment. The EN may decide to do the IPO (and therefore invests all cash flows) if $C_1 > C_b$; however there is a fixed cost T of doing the IPO, which is a social waste. Therefore, in bank financing either the investment is lower than what is socially optimal or there is a social waste. Consider the following sub-optimal strategy for an EN financed by a VC: never do the IPO regardless of the realization of first period cash-flows. This strategy profile dominates the optimal strategy profile that the EN can follow with bank financing because there is no social waste and all cash flows are invested. While following this strategy would not be feasible since the VC would then refuse to offer financing, we note that the strategy of choosing optimally when to do the IPO is in fact feasible does better for the EN. Furthermore, optimally choosing when to do the IPO induces the VC to exert effort when necessary. Therefore, when both forms of financing are feasible, VC financing always dominates bank financing, even if they involve different levels of specialization. □

Proof of Proposition 5 and Lemma 8 : Define C_u, C_v, C_x, C_y, and C_z as the minimum cash flow levels from the perspective of the EN when paying P_1 dominates diverting the cash flows (and being liquidated) under the initial contract, an IPO dominates paying P_1 under the initial contract, an IPO dominates diverting the cash flows under the initial contract, an IPO dominates paying P_1 under the optimal sharing rule, and an IPO dominates diverting cash flows under the optimal sharing rule, respectively. The ordering of C_1 with respect to C_u, C_v, C_x, C_y, and C_z determines the action of the EN and the outside option of the financier. These cash flows are defined as follows.

$$\begin{aligned}
C_u \text{ solves } &: C_1 + max(L - P_1, 0) = \frac{1}{2}Y^2k^2(C_1 - P_1)^2 \qquad (31)\\
C_v \text{ solves } &: \frac{1}{2}Y^2k^2(C_1 - P_1)^2 = (1-\beta)[kYC_1(e^I_{EN}(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}(e^I_{EN}(\beta))^2\\
C_x \text{ solves } &: C_1 + max(L - P_1, 0) = (1-\beta)[kYC_1(e^I_{EN}(\beta) + \phi e_{VC}(\beta)) - T] - \frac{1}{2}(e^I_{EN}(\beta))^2\\
C_y \text{ solves } &: \frac{1}{2}Y^2k^2(C_1 - P_1)^2 = (1-\beta^*)[kYC_1(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*)) - T] - \frac{1}{2}(e^I_{EN}(\beta^*))^2\\
C_z \text{ solves } &: C_1 + max(L - P_1, 0) = (1-\beta^*)[kYC_1(e^I_{EN}(\beta^*) + \phi e_{VC}(\beta^*)) - T] - \frac{1}{2}(e^I_{EN}(\beta^*))^2
\end{aligned}$$

In the case of an IPO, possible fixed transfers between agents are omitted in the formulas.

Since financing is competitive, the investor's payoff from accepting the convertible contract must be equal to zero:

$$\begin{aligned}
0 = -(I - W) \quad + & \quad \int_{C_0}^{C_u} \min\{P_1, \frac{\gamma_{VC}I}{k}\}f(C)dC + \int_{C_u}^{C_v} P_1 f(C)dC\\
& + \int_{C_v}^{\infty}\left(k^2Y^2C^2\left(\beta(1-\beta) + \frac{1}{2}\beta^2\phi^2\right) - \beta T\right)f(C)dC.
\end{aligned}$$

Financing is feasible if we can find a pair P_1 and $\beta < 1$ that satisfies the above equation. On the other hand, the feasibility of financing with an equity-only contract is determined by

$$-(I - W) + \int_{C_{high}}^{\infty}\left(k^2Y^2C^2\left(\beta(1-\beta) + \frac{1}{2}\beta^2\phi^2\right) - \beta T\right)f(C)dC = 0.$$

It is clear that $C_v < C_{high}$: ceteris paribus, with a convertible contract the EN decides to do the IPO at a lower realization of time 1 cash flow (this completes the proof of Lemma 8).

Now assume that both the convertible contract and the equity contract are feasible. With both contracts the payoff of the investor in expectation is equal to $I - W$. Therefore, the

EN prefers the contract that maximizes the total surplus. In the all-equity case, the total output is equal to:

$$\begin{aligned} -I \quad &+ \quad \int_{C_0}^{C_{low}} \frac{1}{2}(kYC)^2 f(C)dC \\ &+ \quad \int_{C_{high}}^{\infty} \left(\frac{1}{2}((e_{EN}^{I}(\beta^*))^2 + (\phi e_{VC}(\beta^*))^2) - T \right) f(C)dC - g(k) \end{aligned}$$

With the convertible contract the total payoff is equal to:

$$\begin{aligned} -I + \int_{C_0}^{C_u} (C+L)f(C)dC + \int_{C_u}^{C_y} (\frac{1}{2}(kY(C-P))^2)f(C)dC \\ + \int_{C_y}^{\infty} (\frac{1}{2}(((1-\beta^*)kYC)^2 + (\beta^*\phi kYC)^2) - T)f(C)dC - g(k) \end{aligned}$$

From the formula for C_y and C_{low} we know that $C_y < C_{low}$. Since investment is always profitable between C_0 and C_y and since not all the cash flows are invested in the convertible case, the total payoff of all equity financing is larger than the total payoff of the convertible contract in this region. If $C_y \leq C_1 \leq C_{low}$, the payoff from an all-equity contract is larger because C_{low} is the level of cash flow that equates payoffs from investing all time 1 cash flows and doing an IPO. If $C_1 \geq C_y$, then in this region the total payoff from both contracts are equal. Therefore the expected total payoff of the all equity contract is larger than the expected total payoff of the convertible security contract when the level of specialization is the same under both contracts.

The convertible contract may create incentives to further specialize the assets in order the decrease the bargaining power of the investor when the firm is financially constrained, i.e., $P_1 = L$. In this case the total social payoff is even smaller under convertible financing because the level of specialization chosen by the entrepreneur will be larger than the optimal level of specialization in pure equity financing. At the same level of k, equity financing dominates convertible financing. Therefore, equity financing at k^* will dominate convertible financing at any k which is different from k^* as well. □

Condition for extending the term of the bank loan: With bank financing, as the cash flow gets larger it is certain that paying P_1 will dominate diverting the cash flow. However, it is not clear whether paying P_1 can actually dominate diverting before it itself is dominated by the choice of doing an IPO. The existence of a region where paying P_1 dominates both the IPO and diverting the cash flow requires the payoff from paying P_1 to be larger than the payoff from the other two options. If we add up these two conditions we get:

$$k^2Y^2(C_1 - L)^2 \geq C_1 + \frac{1}{2}k^2Y^2C_1^2 - T + L - 2P_2 \tag{32}$$

References

Acharya, V. V., S. T. Bharath, and A. Srinivasan, 2007, "Does Industry-wide Distress Affect Defaulted Firms? Evidence from Creditor Recoveries," *Journal of Financial Economics*, 85, 787–821.

Admati, A. R., and P. C. Pfleiderer, 1994, "Robust Financial Contracting and the Role of Venture Capitalists," *The Journal of Finance*, June, 371–402.

Aghion, P., and P. Bolton, 1992, "An Incomplete Contract Approach to Financial Contracting," *Review of Economic Studies*, 59, 473–494.

Baum, J. A., and B. S. Silverman, 2004, "Picking Winners or Building Them? Alliance, Intellectual, and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Startups," *Journal of Business Venturing*, 19, 411–436.

Benmelech, E., M. J. Garmaise, and T. J. Moskowitz, 2005, "Do Liquidation Values Affect Financial Contracts? Evidence from Commercial Loan Contracts and Zoning Regulation," *The Quarterly Journal of Economics*, August, 1121–1154.

Casamatta, C., 2003, "Financing and Advising: Optimal Financial Contracts with Venture Capitalists," *The Journal of Finance*, LVII, NO. 5, 2059–2085.

Dessein, W., 2005, "Information and Control in Ventures and Alliances," *The Journal of Finance*, LX, NO. 5, 2513–2549.

Dessi, R., 2005, "Start-up Finance, Monitoring, and Collusion," *The RAND Journal of Economics*, 36, NO. 2, 255–274.

Dewatripont, M., and J. Tirole, 1994, "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence," *The Quarterly Journal of Economics*, 139, 1027–1054.

Fluck, Z., 1998, "Optimal Financial Contracting: Debt versus Outside Equity," *The Review of Financial Studies*, 11, NO. 2, 383–418.

Gompers, P. A., 1995, "Optimal Investment, Monitoring, and the Staging of Venture Capital," *The Journal of Finance*, 50, 1461–1489.

Gompers, P. A., and J. Lerner, 1999, "The Venture Capital Cycle," *The MIT Press*.

Gorman, M., and W. A. Sahlman, 1989, "What Do Venture Capitalists Do?," *Journal of Business Venturing*, 4, 231–248.

Hart, O. D., and J. H. Moore, 1994, "A Theory of Debt Based on the Inalienability of Human Capital," *The Quarterly Journal of Economics*, CIX, 841–879.

——— , 1998, "Default and Renegotiation: A Dynamic Model of Debt," *The Quarterly Journal of Economics*, 113, NO. 1, 1–41.

Hellmann, T., 1998, "The Allocation of Control Rights in Venture Capital Contracts," *The Rand Journal of Economics*, Vol 29, No.1, 57–76.

——— , 2006, "IPOs, Acquisitions, and the Use of Convertible Securities in Venture Capital," *Journal of Financial Economics*, Vol 81, 649–679.

Hellmann, T., L. A. Lindsey, and M. Puri, 2007, "Building Relationships Early: Banks in Venture Capital," *Forthcoming in Review of Financial Studies*.

Hellmann, T., and M. Puri, 2000, "The Interaction between Product Market and Financing Strategy: The Role of Venture Capital," *The Review of Financial Studies*, 13, NO. 4, 959–984.

——— , 2002, "Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence," *The Journal of Finance*, LVII, NO. 1, 169–197.

Hochberg, Y., A. Ljungqvist, and Y. Lu, 2005, "Whom You Know Matters: Venture Capital Networks and Investment Performance," *Forthcoming in The Journal of Finance.*

Holmstrom, B., 1982, "Moral Hazard in Teams," *Bell Journal of Economics.*

Hsu, D. H., 2004, "What Do Entrepreneurs Pay for Venture Capital Affiliation?," *The Journal of Finance*, LIX, NO. 4, 1805–1844.

Kaplan, S. N., and P. Stromberg, 2002, "Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts," *Review of Economic Studies*, pp. 1–35.

——— , 2004, "Characteristics, Contracts, and Actions: Evidence from Venture Capitalist Analyses," *The Journal of Finance*, LIX, NO. 5, 2177–2210.

Megginson, W. L., and K. A. Weiss, 1991, "Venture Capitalist Certification in Initial Public Offerings," *The Journal of Finance*, XLVI, NO. 3, 879–903.

Sahlman, W. A., 1990, "The Structure and Governance of Venture-capital Organizations," *Journal of Financial Economics*, 27, 473–521.

Schmidt, K. M., 2003, "Convertible Securities and Venture Capital Finance," *The Journal of Finance*, LVIII, NO. 3, 1139–1166.

Shleifer, A., and R. W. Vishny, 1992, "Liquidation Values and Debt Capacity: A Market Equilibrium Approach," *The Journal of Finance*, XLVII, 1343–1366.

Ueda, M., 2004, "Banks versus Venture Capital: Project Evaluation, Screening, and Expropriation," *The Journal of Finance*, LIX, NO. 2, 601–621.

Williamson, O. E., 1988, "Corporate Finance and Corporate Governance," *The Journal of Finance*, XLIII, 567–591.

Winton, A., and V. Yerramilli, 2007, "Entrepreneurial Finance: Banks versus Venture Capital," *forthcoming, Journal of Financial Economics.*