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 financier when debt financing is used. By contrast, equity financing provided by a financier who contributes to the project 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.

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

JEL Classification: G32, D23, G24 .

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 debt financing 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 incomplete contracting 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.

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 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 once financing is obtained. Doing so lowers the credibility of the lender's liquidation threat since it reduces the lender's bargaining power in any renegotiation. Asset specialization is one way of achieving this 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 because their redeployability will be low (Williamson, 1988; Benmelech, 2008).[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.[2]

[1] Furthermore, the liquidation value of specialized assets could also be lower if the potential buyers are more likely to be in financial distress at the same time as the borrowing firm (Shleifer and Vishny, 1992). Acharya, Bharath, and Srinivasan (2007) provide evidence that industry-wide distress affects lenders' recovery rates.

[2] Specificity of assets may also affect firms' incentives to use debt as a committment device to produce high quality products (Maksimovic and Titman, 1991).

One way of resolving such inefficiencies is to involve an equity investor who can contribute to the project by exerting effort and who stands to cash out if and when the firm goes public or is acquired, an act that provides a verifiable valuation of the firm. We formalize this 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.[3] 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. However, while active financing has a clear beneficial side, it is not always feasible. When there is little scope for specializing the assets, the active financier's effort adds little value to the firm. This reduces the entrepreneur's incentive to take the firm public and equity financing becomes infeasible.

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 makes at least some of its future cash flows verifiable. However, this only happens if the entrepreneur finds it in his own 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. The entrepreneur will choose the former only when the input of the active financier is sufficiently large and when the project is relatively successful in its early stages.

From the perspective of the financiers, this tension is reflected in the choice of financial contract that can be feasibly offered. A "passive" financier, recognizing that it cannot help improve long term firm value, will always opt for a short term debt contract. An

[3] Several papers provide evidence on the beneficial role of VCs (Gorman and Sahlman, 1989; Megginson and Weiss, 1991; Hellmann and Puri, 2000, 2002; Baum and Silverman, 2004; Hsu, 2004).

active financier, 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 provide the entrepreneur with sufficient incentives to follow through with the IPO. Therefore, 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.

Our main contribution is to analyze the role of asset specificity in financial contracting when firms have the ability to choose, at least to some extent, how much to specialize their investments. We predict that projects with a large scope for specializing assets will be financed by active investors such as VCs, while projects with little need or scope for specialized assets will be financed through debt, which should be supplied by lenders such as banks. We also show that whenever equity financing is feasible it dominates a loan contract since loans can result in a deadweight loss from inefficient liquidation. However, when equity is not feasible a convertible security sold to an active financier can be used to make financing feasible by providing the financier with the right to liquidate and recover at least part of his investment in low cash flow states.

Our paper also contributes to the general financial contracting literature by explaining the feasibility of equity financing even in the absence of control rights considerations. In an incomplete contracting framework, equity is generally not optimal or even feasible unless future cash flows are at least partially verifiable (Aghion and Bolton, 1992; Dewatripont and Tirole, 1994). Equity financing can also be feasible if it is assigned substantial control rights. For example, from the transaction cost perspective, Williamson (1988) argues that assets with limited redeployability are more likely to be financed with equity if equityholders have control of the board. Similarly, Fluck (1998) shows that outside equity can be optimal when it has unconditional control rights and can credibly threaten to dismiss managers. We show that when the financier can contribute to the success of the project, outside equity can be feasible in a framework where contracts are incomplete at the time financing is provided even when there is no scope for granting control rights to outside equity. This is not to say that control rights are unimportant, and recent papers have argued that the allocation of control rights as well as cash flow rights are indeed important but separate components of financing arrangements (Hellmann, 1998; Kaplan and Stromberg, 2002; Schmidt, 2003). Rather, we establish that control right considerations need not be present for equity-like cash flow claims to be optimal.

Our model provides a number of unique testable predictions. We show that convertible contracts increase the entrepreneur's incentives to take the firm public because he realizes that the financier can liquidate the firm's assets otherwise. We therefore predict that firms that are largely financed by convertible securities should go public with lower cash flows on average than firms that are largely financed by equity, and that they should go public sooner. We also argue that projects with a higher degree of asset specificity should be more commonly financed by more experienced or central VCs. This occurs because the entrepreneur has greater incentives to specialize when the relative contribution of the financier is larger. In addition, we show that long term debt may be feasible when issued in conjunction with equity financing provided by an active financier since the lender can free-ride on the active financier's role in taking the firm public.

Our model also explains several empirical observations. From the perspective of the firm's investment choices, we predict that, as the relative contribution of the active financier increases, the probability of exit through an IPO or acquisition increases. Empirically, it has been shown that firms financed by VCs with greater experience or network centrality - a proxy for the VC's contribution - have higher IPO or acquisition rates (Stuart, Hoang, and Hybels, 1999; Hochberg, Ljungqvist, and Lu, 2005; Sorensen, 2007). In addition, the commonly observed changes in the allocation of equity prior to the IPO arise in our model as part of the renegotiation between the entrepreneur and the financier to provide optimal incentives for both parties to invest. Additionally, we show that passive financiers have incentives to introduce covenants that restrict entrepreneurs' scope for specializing assets.

There is recent empirical support for the important strategic role that asset specificity plays in financing. For example, Benmelech and Bergman (2008) find that airlines successfully renegotiate their lease obligations downward when the redeployability of their airplanes is low and when their financial positions are sufficiently poor. A natural but relatively ignored implication of this finding is that firms and financiers should take the possibility of future renegotiation into account when making their initial investment and financial contracting decisions. One exception is Benmelech, Garmaise, and Moskowitz (2005), who show empirically that higher redeployability is indeed associated with better loan conditions.

A number of papers (Sahlman, 1990; Gompers, 1995; Kaplan and Stromberg, 2002, 2004) provide information about the financial contracts that are used in VC financing. Since we focus on these financial contracts, our paper is related to the literature that analyzes optimal contracting in the venture capital industry (Dessi, 2005; Admati and Pfleiderer, 1994; Casamatta, 2003; Hellmann, 1998, 2006; Dessein, 2005). However, we argue that asset specificity should be an important consideration in contract choice and show that, even abstracting from control rights, common contracts such as equity, convertible contracts and option-like contracts can exist under active but not passive financing.

Our analysis is also closely related to the literature that studies alternative sources of finance. Ueda (2004) contrasts VC to bank financing and argues that VCs have a superior ability to evaluate projects than banks, but also have the potential to steal the entrepreneur's idea. Winton and Yerramilli (2007) propose that VCs can monitor more intensively the continuation strategies of entrepreneurs. However, VCs face a higher cost of capital. We complement this literature by showing that asset specificity is important for explaining the set of contracts offered by these financiers as well as entrepreneurs' financial and investment choices.

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 not verifiable 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 or an active financier. An active financier is one who can contribute to the success of the project and is described in more detail below. 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

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- Financier and EN agree on the initial contract.
- EN decides on asset specificity *k* of the investment and invests in the project.

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- First period cash flow C_1 is realized.
- The agents renegotiate the initial contract. EN makes a take it or leave it offer. Financier decides to accept or reject. If new contract is not accepted initial contract remains valid.
- The EN decides whether to do an IPO, and whether to honor its contractual obligations.
- The financier can exercise any rights that are enforceable, such as liquidation.
- The EN and (and possibly also the financier) decides on effort level if project is not liquidated.

2

- Second period cash flow C_2 is realized if the project was continued.
- If the firm is public, agents share the value of the firm based on the final contract.
- If the firm is not public, cash flows are not observable and contracts that depend on cash flows cannot be enforced.

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 return from the project increases, but the value of assets under alternative use decreases. Specifically, we assume that the investment's liquidation value at $t = 1$ is equal to $L = \frac{\gamma I}{k}$, where $\gamma \in (0, 1)$. 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.

At $t = 1$, the cash flow C_1 is realized, which is random and has probability density function $f(\cdot)$ with support in $[\underline{C}, \infty)$, $\underline{C} > 0$. 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 entrepreneur.[4] On the other hand, active investors are specialized

[4] An alternative is to assume that the cash flow C_1 simply represents a signal about the future cash flows of the firm in that higher C_1 is indicative of a higher C_2, and implies a higher marginal contribution of the

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. We formalize this by assuming that an active financier can exert effort e_{AF} at time 1 that increases the time 2 cash flows, $C_2 = \widetilde{C}_1 k(e_{EN} + \phi e_{AF})$, where $\phi > 0$ measures the relative contribution of the active investor. The cost of effort is equal to $\frac{1}{2}e^2$ for both the entrepreneur and the active investor.

In practice, of course, active investors - such as VCs - may also provide helpful input to the firm from inception, which would correspond in our model to an additional effort decision at time 0. Adding such an effort decision adds significant notational burden and complexity without affecting the qualitative nature of our results. What is important in our analysis is that some component of the value derived from the financier's input can only be obtained by the entrepreneur if he either sells the company or takes it public. For instance, we could as well assume that VCs play a certification role vis-a-vis third party investors, reducing underpricing and increasing the value to the entrepreneur conditional on a equity issue (Megginson and Weiss, 1991; Barry, Muscarella, Peavy, and Vetsuypens, 1990). Furthermore, venture capitalists are known to retain a significant portion of their holdings in the firm after the IPO (see, e.g., Megginson and Weiss (1991)), creating an incentive for additional input even after the IPO takes place (Brav and Gompers, 1997). All of these motivate the entrepreneur to take the firm public rather than diverting cash flows, and thus create an incentive for the financier to invest resources in the firm.

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. Y can also capture the effect of any additional cash infusion to the firm that comes from new investors through an IPO, for instance, and that would be available for investment purposes. We assume that $Y \geq \sqrt{\frac{2I}{\underline{C}} + 2}$, which implies that it is always socially optimal to continue the project even if the entrepreneur invests alone. While the firm's time 2 cash flows and value cannot initially be contracted

effort of the entrepreneur and the active financier, but does not need to be reinvested. The analysis of this alternative case is similar.

upon, they becomes verifiable only if the entrepreneur decides at time 1 to make the firm a public entity by time 2, 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 firm's cash flows.[5] 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. The results, however, can be extended to the case where both the financier and the entrepreneur have some bargaining power. 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 (we will use the terms "lender" and "financier" interchangeably in this section). 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 the firm did not go public, cash flows are not verifiable. If, on the other hand, the firm is public at time 2, the financier can force the EN to make the promised payment, if any, by going to court. However, if the only required payment to the financier 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

[5]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.

the entrepreneur decides not to go public, the financier 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 financier would never be repaid in equilibrium. Anticipating this, the financier would refuse to lend at time 0. We can now state the following, which parallels results in Hart and Moore (1998).

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, the financier 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 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 financier can either accept or reject the EN's offer. If the financier rejects the EN's offer the original contract remains in place and either the original payment P_1 must be made or the financier can liquidate the assets.

Therefore, at time 1 the EN must decide 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 decides not to divert the time 1 cash flow, he chooses his effort level by solving one of the following optimization problems:

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

$$\text{IPO} : \max_e YkC_1e_{EN} - \frac{1}{2}e^2 - T - P_2 \quad (2)$$

In case (1), the EN makes a payment P_1 to the lender 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 $e^I_{EN} = YkC_1$ and $e^{NI}_{EN} = Yk(C_1 - P)$ 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.

$$\text{Don't pay and face liquidation} \;:\; C_1 + max\,\{L - P_1, 0\} \tag{3}$$

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

$$\text{IPO and pay } P_2 \;:\; \frac{1}{2}Y^2k^2{C_1}^2 - T - P_2 \tag{5}$$

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 at time 1, P_1, or the liquidation value L: $P_2 \leq \min\{P_1, L\}$. At the same time, the financier need never accept an offer less than $\min\{P_1, L\}$. Hence, $P_2 = \min\{P_1, L\}$.[6] The payoff of the financier is therefore not affected by the decision of the entrepreneur at time 1 because the renegotiation process makes the financier indifferent between all possible outcomes.

Lemma 2. *The lender 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

[6]There is a further constraint that is necessary, which is that $P_1 \leq C_1$ when the entrepreneur decides to pay the loan back and proceeds with the project. However, since the threshold values of C_1 for which the entrepreneur chooses among the three possible strategies are endogenous, this constraint is never binding and is therefore ignored.

specificity k of the investment. The payoff to the entrepreneur from (passive) debt financing is equal to:

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

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 the 3 different options available to the entrepreneur: 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. C_a represents the level of cash flows for (3) and (4) are equal; C_b is the level of cash flows for (4) and (5) are equal. We note that renegotiating the loan to extend maturity (and committing to take the firm public) may or may not ever dominate simply repaying the loan. Here, we write the payoff to the entrepreneur from debt financing assuming that such a region exists. In the appendix, we provide the condition for the existence of this region.

The entrepreneur determines the optimal level of specialization from maximizing (6) with respect to k. One important consideration related to debt-based financing is that firms financed through loans should take into account the effect of specialization on their bargaining power with the lender in addition to any increase in productivity. For that we have the following result.

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. □

Lemma 3 highlights a strategic role for asset specialization stemming from the anticipation of future renegotiation of outstanding debt agreements. 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.

While we assume for simplicity that the entrepreneur has all bargaining power in renegotiation, the result in Lemma 3 holds more generally for firms that are more financially constrained, but for whom P_1 is still strictly below L, if we allow the financier to have any bargaining power in renegotiation. For example, with Nash bargaining the payoff to the financier resulting from renegotiation will always be increasing in the liquidation value of assets. This, in turn, creates an incentive at the margin for the entrepreneur to lower the liquidation value of assets, which can be achieved by further specializing them. Empirically, Benmelech and Bergman (2008) find that liquidation value plays an important strategic role by allowing airlines to successfully renegotiate their lease obligations downwards when the redeployability of the airplanes is low and when their financial position is sufficiently poor. However, whether in consequence this creates an incentive to invest in more specialized equipment is an untested prediction.

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

$$I - W \leq \min\{L, P_1\} = \min\left\{\frac{\gamma I}{k^*}, P_1\right\} \tag{7}$$

Assuming that credit markets are competitive, (7) will hold with equality.[7] If the wealth of the entrepreneur is less than the difference between the liquidation value and the amount of investment, a passive loan will not be feasible. We can now establish the following simple result.

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

It is worth emphasizing that the degree of specialization chosen by the entrepreneur, k^*, will be sufficiently low when his marginal cost of specializing the assets, $g'(k)$, is large. Therefore, companies with an opportunity to significantly specialize their assets once they have obtained financing may never receive loans in the first place, even if the projects are highly productive. 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 passive equity is never feasible. Equity does not provide the financier with the right to liquidate the assets. In addition, at time 1, the entrepreneur has no incentive to take the firm public since the financier contributes nothing to the success of the project. As a result, the financier cannot receive any payment from the entrepreneur for its equity investment.

Finally, it is useful to note that much of the literature on the special role of lending by institutions such as banks has attributed a monitoring function to banks that allow them to reduce information asymmetries vis-a-vis entrepreneurs. In our model, "monitoring" serves no direct function as there is no asymmetry of information: cash flows are observable by both the financier and the entrepreneur, but suffer from a verifiability problem by third parties, which limits their contractibility. In such cases, the role of the bank is then to

[7] 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 $P_1 \leq L$.

obtain repayment by applying pressure through the threat of liquidation.

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 venture capitalist. We analyze only equity contracts in this section, deferring discussion of other contracts to the next section.

We again use backwards induction. The entrepreneur agrees at time 0 to give an equity stake 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 active financier 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 so that the financier'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 financier can renegotiate the terms of the initial contract, with the EN making 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 the agents' 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^I_{EN} and when he decides to keep the firm private is denoted by e^{NI}_{EN}. If the entrepreneur takes the firm public, he shares the future cash flows with the financier, who may also exert effort and thus help increase the value of the firm. The effort level of the entrepreneur when he decides to do the IPO is obtained from the following problem:

$$\max_e (1-\beta)[kYC_1(e+\phi e_{AF})-T]-\frac{1}{2}e^2, \tag{8}$$

which yields $e_{EN}^I = (1-\beta)kYC_1$. Likewise, the effort level of the financier when the entrepreneur commits to do the IPO is obtained by maximizing:

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

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

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

$$\max_e kYC_1 e-\frac{1}{2}e^2. \tag{10}$$

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

Note that the level of effort of the EN is larger when he rejects the IPO, $e_{EN}^{NI} > e_{EN}^I$. In other words, there is a double sided moral hazard problem as in Holmstrom (1982), which prevents both the entrepreneur and the active financier from investing at the first best level. While the EN exerts a higher level of effort by not going public, this does not imply that going public is never optimal. The overall increase in project value depends also on the effort of the financier, 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 investor's equity share β is set to satisfy his ex ante participation constraint, which may not coincide with the optimal provision of incentives. The following preliminary result shows that agents should renegotiate the sharing rule at time 1, once C_1 is known, so as to increase the joint payoff.

Lemma 4. *The optimal sharing rule β^* is determined by the relative contribution of the active financier with respect to the entrepreneur, ϕ. This sharing rule is given by:*

$$\beta^* = \frac{\phi^2}{1+\phi^2}. \tag{11}$$

If necessary, agents agree on fixed transfers P_{AF} and P_{EN} from the time 2 cash flows for the active financier 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 take the firm public under the sharing rule β^*, i.e., $P_{AF} + P_{EN} \leq YC_2 - T$.

Proof: See the appendix. □

The lemma establishes in our framework a result that is well-known in the literature, which is that whenever the initial contract does not lead to ex post maximization of surplus, the entrepreneur can always propose a different contract that maximizes joint profit. 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 verifiable 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 financier. 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. From now on we will use this preliminary result to characterize the equilibrium by assuming 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 outcome of renegotiation between the financier and the EN depends on whether the EN is willing to undertake the IPO under the initial sharing rule (i.e., equity stake) 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 active financier'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 financier is equal to his payoff from going public under the initial contract β. If the IC constraint of the entrepreneur is not satisfied under the initial sharing rule, the outside option of the financier 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 investor 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*

$$C_{high} = \sqrt{\frac{T(1-\beta)}{[\frac{1}{2}(1-\beta)^2 + (1-\beta)\beta\phi^2 - \frac{1}{2}]k^2Y^2}}. \tag{12}$$

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

$$C_{low} = \sqrt{\frac{2T}{k^2Y^2}\frac{\left(1+\phi^2\right)}{\phi^4}}. \tag{13}$$

Proof: See the appendix. □

Lemma 5 describes exactly how 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 financier's payoff is 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 financier 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 financier 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 financier's outside option under renegotiation.[8]

One immediate implication of Lemma 5 is that only firms whose projects are relatively successful early on - those for which $C_1 > C_{low}$ - will go public. Moreover, this cash flow is lower the lower is k. Firms whose initial cash flows are low, which is indicative of low future cash flows, will not find it optimal to incur the cost of going public and will instead prefer to remain private. For these firms, the long term payoff to the financier is zero, which can be interpreted as an unsuccessful portfolio project in the context of VC-backed financing.

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

$$\begin{aligned}
\Pi_{EN}^{AF} &= -W + \int_{\underline{C}}^{C_{low}} \frac{1}{2} Y^2 k^2 C^2 f(C) dC \\
&+ \int_{C_{low}}^{C_{high}} [V(\beta^*) - c_{EN}(\beta^*) - c_{AF}(\beta^*)] f(C) dC \\
&+ \int_{C_{high}}^{\infty} [V(\beta^*) - \beta V(\beta) + c_{AF}(\beta) - c_{EN}(\beta^*) - c_{AF}(\beta^*)] f(C) dC - g(k),
\end{aligned} \tag{14}$$

where

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

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

$V(\beta)$ denotes the value generated by the active financier and the EN when the firm goes public and the financier has an equity share of β. The variables $c_{AF}(\beta)$ and $c_{EN}(\beta)$ denote the equilibrium costs of effort for the financier and the EN, respectively.

The entrepreneur's optimal level of specialization can be solved from maximizing Π_{EN}^{AF} with respect to k. This time the EN specializes assets only to increase productivity as there is no strategic purpose to reducing liquidation value.

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

Proof: See appendix. □

The lemma shows that an entrepreneur has an incentive to specialize more when the relative contribution of the active financier, ϕ, is higher in order to benefit more from the financier's effort. Coupled with Lemma 5, it establishes that firms financed by active financiers with more significant contributions should have a higher probability of going public or being acquired, as found empirically by Stuart, Hoang, and Hybels (1999), Hochberg, Ljungqvist, and Lu (2005), and Sorensen (2007) in the context of VCs with greater experience or network centrality. An additional untested prediction of our model is that projects with higher level of asset specificity should be matched with more experienced or central VCs. This is a result of the entrepreneur's greater incentive to specialize when the relative contribution of the financier is larger.

We can now calculate the payoff of the investor from financing the project. The financier captures surplus only when the entrepreneur's IC constraint is satisfied at time 1 under the initial sharing rule β. The financier'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 financial markets are competitive, the expected payoff of the financier must be equal to zero:

$$-(I-W)+\int_{C_{high}}^{\infty}\left(k^2Y^2C^2\left(\beta(1-\beta)+\frac{1}{2}\beta^2\phi^2\right)-\beta T\right)f(C)dC=0. \tag{15}$$

The initial share of the financier can now be determined from this equation. As long as a $0 < \beta < 1$ exists that satisfies (15), the entrepreneur can raise funds from the active financier. Note that asset specialization increases the payoff of the financier. Unlike the passive investor, the active financier prefers projects with highly specialized assets since the financier's effort is more valuable and the entrepreneur is more likely to take the firm public.

Proposition 2. *There exists a minimum value $\underline{k}$ such that (active) equity financing is feasible only for $k^* \geq \underline{k}$, i.e., the participation constraint of the financier at time zero is satisfied by some $\beta \in (0, 1)$.*

Proof: See the appendix. □

This proposition establishes that equity, a long term claim on the firm, is feasible provided it is issued to a financier whose input is valuable for success. Such equity in our framework is a pure cash flow claim, with no associated control rights, whose value derives from the entrepreneur's willingness to sometimes take the firm public, thus allowing future cash flows to become (endogenously) contractible. We also note that, in contrast to financing by a passive investor, Proposition 2 requires that the entrepreneurs marginal cost of specializing assets, $g'(k)$, be sufficiently low, or equivalently that his opportunity to specialize is high. As a consequence of the relatively high degree of specialization these assets will have a relatively low liquidation value, so that debt financing may not even be feasible.[9]

Finally, while we abstract from control issues, in practice it is likely that a variety of control rights considerations can be important, particularly if there are additional agency problems to be resolved at time 1. Furthermore, the granting of control to an active financier

[9] A recent example of such a financing scheme can be found in the light jet industry where many startups in the last decade, such as Adam Aircraft or Eclipse Aviation, were financed by venture capital equity. Designing and producing a new jet plane requires substantial investment in machinery, equipment and human capital specific to the project. This capital investment then has very low liquidation value if the project proves unsuccessful: Adam Aircraft raised \$93 million, led by California based venture capital firm DMC and in the summer of 2007, invested some of it in production line equipment such as specialized laser placement machines that make exact measurements. The technology enabled the company to cut down substantially the time it took to make a plane. In February of 2008 the company shut down and filed for Chapter 7 bankruptcy. The assets of the company were subsequently sold for only \$10 million to AAI Acquisitions Inc., substantially below the amount invested in the company in the latest round of financing.

may be useful either if, contrary to our maintained assumption, the financier has some market power or if financing would not be feasible otherwise. Here, giving the financier the right to decide on the IPO at the end of the first period would not qualitatively change our results. Since the entrepreneur's input to the project is inalienable (see, e.g., Hart and Moore (1994)), forcing the firm to go public for significantly lower values of C_1 would simply result in the entrepreneur diverting all time 1 cash flows, leaving nothing for the financier to actually "take public." However, when equity financing is not feasible, providing liquidation rights to the active financier may be useful, an issue we discuss in the next section.

5 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 frequently used, particularly in the case of VC financing. 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 claim 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. 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 take the firm public, 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 make the payment or he may divert the cash flows, which will force the investor to liquidate. Therefore, the EN compares four different outcomes with the following payoffs.

$$\begin{aligned}
\text{Divert cash flows} &: \; C_1 + max\,\{L - P_1, 0\} \\
\text{Pay loan but no IPO} &: \; \frac{1}{2}Y^2k^2(C_1 - P_1)^2 \\
\text{IPO and investor converts} &: \; (1-\beta)[kYC_1(e^I_{EN}(\beta) + \phi e_{AF}(\beta)) - T] - \frac{1}{2}(e^I_{EN}(\beta))^2 \\
\text{Commit to IPO but investor liquidates} &: \; C_1 + max\,\{L - P_1, 0\}
\end{aligned} \tag{16}$$

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

$$\begin{aligned}
\text{Divert cash flows} &: \; min\,\{L, P_1\} \\
\text{Pay loan but no IPO} &: \; P_1 \\
\text{IPO and investor converts} &: \; \beta[kYC_1(e^I_{EN}(\beta) + \phi e_{AF}(\beta)) - T] - \frac{1}{2}(e_{AF}(\beta))^2 \\
\text{Commit to IPO but investor liquidates} &: \; min\,\{L, P_1\}
\end{aligned} \tag{17}$$

When the EN offers a new contract to the financier after the realization of C_1, he cannot propose a payment less than the financier's outside option. The convertible contract helps the financier receive payment in states of the world with low cash flow realizations by threatening to liquidate the project.

Proposition 3. *A convertible contract decreases the minimum value of k for which active financing becomes feasible.*

Proof: See the appendix. □

The proposition establishes that a convertible security enlarges the region of asset specificity where active financing is feasible. In fact, this region may extend all the way down to the region where debt financing is feasible. However, a convertible security introduces the possibility of liquidation and early (i.e., time 1) payment, which are both socially inefficient. Note that several combinations of (P_1, β) can be feasible when the agents agree on a convertible contract. As P_1 increases, the inefficiencies introduced by the convertible contract compared to a pure equity contract increase. The EN obviously prefers the contract that minimizes the inefficiencies.

Lemma 7. *The optimal convertible contract is the contract with the lowest P_1 that makes the convertible contract feasible.*

This lemma also implies that pure equity is the optimal contract whenever feasible since the entrepreneur prefers active financing with the lowest level of inefficiency, which is obtained when $P_1 = 0$. However, equity financing is only feasible for projects whose scope for specialization is sufficiently high. The convertible contract is thus optimal only when equity financing is not feasible.

We note that although pure equity financing is always preferred, it may not be uniquely optimal. There may be other linear and non-linear equity-like 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 active financier 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 C_1. Moreover, its existence depends on knowing the relative contribution of the financier with certainty at time zero, which is not an issue for the straight debt or equity contracts we consider. Our focus is on explaining the feasibility and optimality of common contracts, and we do not attempt to rule out all other possible contracts.

One interesting aspect of a convertible contract is that it provides different incentives to take the firm public compared to a pure equity contract. With a convertible contract the EN pays P_1 if he decides not to take the firm public 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 financier. Therefore, for a given level of asset specificity k, the convertible contract decreases the minimum level of time 1 cash flow, C_1, at which going public becomes optimal for the EN. This establishes that firms financed by convertible securities 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 C_1 at which committing to an IPO becomes optimal compared to pure equity financing.*

As a final point, we note that a convertible contract for a passive financier may also increase the region where such 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 financier after conversion is larger than P_1. In this case, a convertible contract increases the region where passive financing becomes feasible because it allows the financier to capture some additional surplus in states of the world with high time 1 cash flows. However, it can be shown that this convertible contract is never converted to equity, and will in fact always be renegotiated to a time 2 debt contract (with no further conversion rights) if the EN decides to do the IPO. Given that the passive financier cannot contribute to the project, allocating equity to him only dilutes the incentive of the EN to exert effort. As a result, all equity should be allocated to the EN to maximize total output.

6 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. However, it may also be possible for both types of financing to be feasible at the same time. Here we analyze the entrepreneur's choice assuming that both types of financing 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 (passive) loan, with (14), his payoff when financed with (active) equity. The EN always prefers the financial contract that maximizes his payoff, which, since we assume that financial markets are competitive, is maximized when total output is maximized.

Assume that the level of specialization with equity financing is equal to the level of specialization with debt financing. If both forms of financing are feasible, equity financing always dominates debt financing because debt financing sometimes results in inefficient outcomes - liquidation and under investment - due to the existence of the promised short term debt payments. Therefore for the same level of specialization, equity financing is always preferred by the entrepreneur. When we allow the EN to choose the level of specialization k under equity financing, the EN chooses a different level of specialization, which increases the total payoff further. Therefore if both a passive loan and active equity are feasible, equity always dominates debt.

Proposition 4. *If both a loan and equity are feasible, the entrepreneur always chooses (active) equity over a (passive) loan.*

Proof: See the appendix. □

We can use the same method as above to compare a passive to an active loan. Given that there is no difference in terms of value creation between the active and passive investor with debt financing, the entrepreneur is indifferent between these two. However, our model nevertheless predicts that we are less likely to observe loans from active financiers because such loans are dominated by convertible contracts. An active convertible contract replicates the payoff from a pure debt contract in bad states of the world. However, in good states of the world when the entrepreneur would like to go public the contract can be converted to equity, which increases the total payoff. Therefore, with an active financier the entrepreneur always prefers to issue a convertible instead of a pure debt contract.

One reason why debt financing from a passive investor may be preferred by the entrepreneur is if there is a difference in the costs associated with passive and active financing. In particular, this cost may be higher for active financing, such as that provided by VCs, to reflect the greater level of involvement with the firm. This would also be true if active financing were in shorter supply so that, contrary to our assumption, the market for active financing were not competitive. In the context of our model, this would be reflected in a higher opportunity cost of funds, or by giving the financier some bargaining power in renegotiation. Specifically, suppose that the opportunity cost of providing financing for both the passive and the active investors are increasing and convex in the amount of financing provided, but that it is higher for the active investor (as in Winton and Yerramilli (2007)). The optimal capital structure for the firm should then consider the increasing costs of each kind of financing and would favor straight debt when the input of the active financier is not as valuable.

We have argued that a natural interpretation of a "passive" financier who provides funding through a debt contract is that of a bank. In many instances, these are institutions that specialize in recovery in states of default, suggesting that their ability to obtain high liquidation values may sometimes be greater than that of active financiers, such as VCs. To the extent that at least in some instances banks obtain higher liquidation values (i.e., if $\gamma_{passive} > \gamma_{active}$), this provides yet another justification for why debt financing should be tied to banks rather than an active financier.

7 Long Term Debt

We have shown that a passive investor 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 passive investor jointly finances the project with an active investor. A long term loan does not provide the passive lender with liquidation rights at time 1, but it does entitle the lender 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 go public if he also raises funds from an active investor. Thus, a long term loan can be viable by "piggy-backing" on the active financier'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 an active investor and obtains the rest, $(1-\omega)(I-W)$, as a long term loan from a passive lender. In return the active investor receives a share β of residual cash flows from the firm, while the lender 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 lender P_2 and the rest of the cash flows are shared between the active financier and the EN. If the firm is not public, the payoffs of both the lender and the active financier are zero. The lender relies on the active financier'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 lender and the active financier. If the EN is willing to follow through with the IPO even under the initial financing terms, then the lender and the active financier 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 lender at time 1, the lender's outside option in this case is equal to zero. In equilibrium, of course, the lender 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 passive lender at time zero as

$$-(1-\omega)(I-W)+\int_{C_r}^{\infty} P_2 f(C)dC, \tag{18}$$

where

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

and $V(\beta)$ is as defined earlier and represents the value generated by the active financier 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 passive lender 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 passive lender and the active financier 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 (active) 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. As in the previous section, if active financing is more costly than passive financing, an entrepreneur may well wish to minimize his use of active financing and rely on long term debt financing for the remainder.

8 Imposing Restrictions on Asset Specificity

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 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 restrict asset specificity. The value of α is determined by the financier at a cost that is increasing and convex in α.

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

On the other hand, a passive lender 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, which is the only thing the financier cares about. The financier will restrict the firm's ability to specialize the assets until the cost of imposing restrictions outweighs the benefits. As a result, the feasible region for passive debt financing increases. Since the credit market is competitive and restrictions decrease the total payoff, the equilibrium contract should impose the fewest restrictions possible to guarantee feasibility.

Lemma 9. *Imposing restrictions on the specificity of assets is socially sub-optimal. An active investor never imposes restrictions on asset specificity. A passive lender may impose restrictions on the specialization of assets up to the level at which a loan just becomes feasible.*

A final point is that while we have focused on the incentives for different financiers to impose restrictions on the firm, it is also possible that the ability of these financiers differs along this dimension. As a concrete example, much of the literature that studies the special nature of banks has emphasized their ability to "monitor" firms and control agency problems that may otherwise make loan repayment uncertain (see, e.g., Besanko and Kanatas (1993)). In the context of our model, a greater ability to monitor by a bank (i.e., by the passive financier) can be interpreted as the bank facing a lower cost of imposing restrictions on the entrepreneur's choice of asset specialization. This function of monitoring can also then be used as an alternative justification for the preference of debt financing from a bank rather than from an active financier such as a VC, since the bank's superior ability to restrict specialization helps reduce the firm's cost of borrowing.

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 the entrepreneur cannot commit not to specialize the firm's assets.

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 active financing feasible in instances when such financing would not be possible with equity only. Moreover, the use of a convertible contract decreases the level of profitability (realization of cash flows) at which the entrepreneur is willing to do an IPO relative to an all-equity contract. Our model also implies that long term debt can be feasible when used in conjunction with active (equity) financing by piggy-backing on the active financier'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 financiers 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 passive debt financing is given by (6). The derivative of (6) with respect to k can be calculated as:

$$\begin{aligned}
\frac{\partial \Pi_{EN}}{\partial k} = & \int_{\underline{C}}^{C_a} \frac{\partial \max\{L-P_1,0\}}{\partial k} f(C)dC + (C_a + \max\{L-P_1,0\} f(C_a)\frac{\partial C_a}{\partial k} \\
& + \int_{C_a}^{C_b} Y^2 \left[k(C-\min\{L,P_1\})^2 - \frac{1}{2}k^2 \frac{\partial \min\{L,P_1\}}{\partial k} \right] f(C)dC \\
& + \frac{1}{2}k^2Y^2(C_b - \min\{L,P_1\})^2 f(C_b)\frac{\partial C_b}{\partial k} - \frac{1}{2}k^2Y^2(C_a-\min\{L,P_1\})^2 f(C_a)\frac{\partial C_a}{\partial k} \\
& + \int_{C_b}^{\infty} \left(kY^2C^2 - \frac{\partial \min\{L,P_2\}}{\partial k} \right) f(C)dC - \left(\frac{1}{2}k^2C_b^2 - F - \min\{L,P_2\} \right) f(C_b)\frac{\partial C_b}{\partial k} \\
& - \frac{\partial g(k)}{\partial k},
\end{aligned} \tag{19}$$

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:

$$\begin{aligned}
\frac{\partial \Pi_{EN}}{\partial k} = & \int_{\underline{C}}^{C_a} \frac{\partial \max\{L-P_1,0\}}{\partial k} f(C)dC \\
& + \int_{C_a}^{C_b} Y^2 \left[k(C-\min\{L,P_1\})^2 - \frac{1}{2}k^2 \frac{\partial \min\{L,P_1\}}{\partial k} \right] f(C)dC \\
& + \int_{C_b}^{\infty} \left(kY^2C^2 - \frac{\partial \min\{L,P_1\}}{\partial k} \right) f(C)dC - \frac{\partial g(k)}{\partial k}.
\end{aligned} \tag{20}$$

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 Lemma 4: We want to maximize the joint payoff, which is obtained from substituting the equilibrium levels of effort, $e^I_{EN}(\beta)$ and $e_{AF}(\beta)$, into the total payoff function, $kYC_1\left(e^I_{EN}(\beta) + \phi e_{AF}(\beta)\right) - \frac{1}{2}\left(e^I_{EN}(\beta)\right)^2 - \frac{1}{2}\left(e_{AF}(\beta)\right)^2$. This yields

$$(kYC_1)^2\left((1-\beta) + \phi^2\beta - \frac{1}{2}(1-\beta)^2 - \frac{1}{2}\phi^2\beta^2\right). \tag{21}$$

Maximizing (21) with respect to β yields

$$\beta^* = \frac{\phi^2}{1+\phi^2}. \tag{22}$$

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. I solve the case when the EN is willing to do IPO with the initial sharing rule, the proof is the same when the EN is not willing to do IPO except that the IC constraint of the active financier has zero on the right hand side. Let's assume that the initial sharing rule is $\beta \neq \beta^*$. We need to show that positive and feasible side payments P_{AF} and P_{EN} exist such that both agents prefer to renegotiate to the optimal sharing rule β^*. The IC constraint of the financier is

$$\begin{aligned}&\beta^*[kYC_1(e^I_{EN}(\beta^*) + \phi e_{AF}(\beta^*)) - T - P_{AF} - P_{EN}] + P_{AF} - \frac{1}{2}e^2_{AF}(\beta^*) \geq \\ &\beta[kYC_1(e^I_{EN}(\beta) + \phi e_{AF}(\beta)) - T] - \frac{1}{2}e^2_{AF}(\beta).\end{aligned} \tag{23}$$

For the EN, his IC constraint is

$$\begin{aligned}&(1-\beta^*)[kYC_1(e^I_{EN}(\beta^*) + \phi e_{AF}(\beta^*)) - T - P_{AF} - P_{EN}] + P_{EN} - \frac{1}{2}\left(e^I_{EN}(\beta^*)\right)^2 \geq \\ &(1-\beta)[kYC_1(e^I_{EN}(\beta) + \phi e_{AF}(\beta)) - T] - \frac{1}{2}\left(e^I_{EN}(\beta)\right)^2.\end{aligned} \tag{24}$$

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:

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

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 financier indifferent among the sharing rules.

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

$$\beta[kYC_1(e^I_{EN}(\beta) + \phi^2 \beta kYC_1) - T] - \frac{1}{2} e^2_{AF}(\beta) - P_{AF} + \frac{1}{2} e^2_{AF}(\beta^*) \geq 0. \qquad (25)$$

We can solve the value of P_{VC} from the IC constraint of the financier and replace it in

(25). After simplifying, (25) becomes:

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

Given that total cash flow is larger with the optimal sharing rule, the optimal share of the active financier, β^*, has to be lower than his initial share, β, to make the financier worse off (without side payments). The active financier exerts lower effort at a lower cost when her share of cash flows is lower. Therefore, $\frac{1}{2}e^2_{AF}(\beta^*) \leq \frac{1}{2}e^2_{AF}(\beta)$. On the other hand, we know that $kYC_1(e^I_{EN}(\beta^*) + \phi e_{AF}(\beta^*)) - T > \beta[kYC_1(e^I_{EN}(\beta) + \phi e_{AF}(\beta)) - T]$ given that doing the IPO is socially optimal. Therefore, condition (25) holds, which shows that the P_{AF} 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:

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

C_{low} corresponds to the case where the entrepreneur is willing to go public, but only under the optimal sharing rule, $\beta^* = \frac{\phi^2}{1+\phi^2}$. In this case, the outside option of the active financier is zero, so that the entrepreneur compares the surplus from remaining private to the total surplus from going public given β^*. This is given by

$$\frac{1}{2}Y^2k^2{C_{low}}^2 = kYC_{low}(e^I_{EN}(\beta^*) + \phi e_{AF}(\beta^*)) - \frac{1}{2}(e^I_{EN}(\beta^*))^2 - \frac{1}{2}(e_{AF}(\beta^*))^2 - T$$

Substituting for $\beta^* = \frac{\phi^2}{1+\phi^2}$, $e^I_{EN}(\beta^*)$, $e_{AF}(\beta^*)$ yields the condition

$$\frac{1}{2}Y^2k^2{C_{low}}^2 = k^2Y^2C^2_{low}\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) - T.$$

We can now solve for C_{low} to obtain

$$C_{low} = \sqrt{\frac{2T}{k^2Y^2}\frac{\left(1+\phi^2\right)}{\phi^4}},$$

as desired. $\square$

Proof of Lemma 6: Take the derivative of the entrepreneur's profit with respect to k, which, after some simplification, yields:

$$\begin{aligned}\frac{\partial \Pi_{EN}^{AF}}{\partial k} &= \int_{\underline{C}}^{C_{low}} kY^2C^2 f(C)dC \\ &+ \int_{C_{low}}^{C_{high}} kY^2C^2\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) f(C)dC \\ &+ \int_{C_{high}}^{\infty} kY^2C^2\left[\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) - 2\left(\beta(1-\beta)+\frac{1}{2}\beta^2\phi^2\right)\right] f(C)dC - \frac{\partial g}{\partial k} = 0.\end{aligned} \tag{27}$$

Using the participation condition for the active financier, given by (15), we can rewrite the first order condition for maximization of Π_{EN}^{AF} with respect to k, given in (27), as

$$\begin{aligned}\frac{\partial \Pi_{EN}^{AF}}{\partial k} &= \int_{\underline{C}}^{C_{low}} kY^2C^2 f(C)dC \\ &+ \int_{C_{low}}^{\infty} kY^2C^2\left(\frac{\phi^4+\phi^2+1}{1+\phi^2}\right) f(C)dC \\ &-\frac{2}{k}\int_{C_{high}}^{\infty} \beta T f(C)dC - \frac{2(I-W)}{k} - \frac{\partial g}{\partial k} = 0.\end{aligned} \tag{28}$$

We can now differentiate this first order condition with respect to the active financier'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 $\frac{\partial \Pi_{EN}^{AF}}{\partial k}$ 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 (15) and $\frac{\partial C_{high}}{\partial\phi}<0$, both terms must be positive. Therefore, the derivative of $\frac{\partial\Pi_{EN}^{AF}}{\partial k}$ with respect to ϕ is positive, implying a higher first order condition and therefore a large equilibrium value of specialization, k^*. □

Proof of Proposition 2: In (15), increasing k decreases C_{high}, which increases the region where the entrepreneur does an IPO and also increases the payoff in the case of IPO. As we continue increasing k, the payoff of the active financier will be equal to $I-W$ for a given β such that $0<\beta<1$. □

Proof of Proposition 3 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.

$$\begin{aligned}
C_u \text{ solves } &: C_1+max(L-P_1,0)=\frac{1}{2}Y^2k^2(C_1-P_1)^2 \qquad (29)\\
C_v \text{ solves } &: \frac{1}{2}Y^2k^2(C_1-P_1)^2=(1-\beta)[kYC_1(e_{EN}^I(\beta)+\phi e_{AF}(\beta))-T]-\frac{1}{2}(e_{EN}^I(\beta))^2\\
C_x \text{ solves } &: C_1+max(L-P_1,0)=(1-\beta)[kYC_1(e_{EN}^I(\beta)+\phi e_{AF}(\beta))-T]-\frac{1}{2}(e_{EN}^I(\beta))^2\\
C_y \text{ solves } &: \frac{1}{2}Y^2k^2(C_1-P_1)^2=(1-\beta^*)[kYC_1(e_{EN}^I(\beta^*)+\phi e_{AF}(\beta^*))-T]-\frac{1}{2}(e_{EN}^I(\beta^*))^2\\
C_z \text{ solves } &: C_1+max(L-P_1,0)=(1-\beta^*)[kYC_1(e_{EN}^I(\beta^*)+\phi e_{AF}(\beta^*))-T]-\frac{1}{2}(e_{EN}^I(\beta^*))^2
\end{aligned}$$

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:

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

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

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

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:

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

With the convertible contract the total payoff is equal to:

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

From the formula for C_y and C_{low} we know that $C_y < C_{low}$. Since investment is always profitable between $\underline{C}$ 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. □

Proof of Proposition 4: Let's first assume that the level of specialization is equal to the level that is optimal under passive debt financing. Given that $Y \geq \sqrt{\frac{2I}{\underline{C}} + 2}$, it is always socially optimal to continue the project at time 1. However, in the case of debt financing if the cash flows are between $\underline{C}$ 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 passive debt 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 an active investor: 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 passive debt financing because there is no social waste and all cash flows are invested. While following this strategy would not be feasible since the active investor 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 active financier to exert effort when necessary. Therefore, when both forms of financing are feasible, active equity financing always dominates passive debt financing, even if they involve different levels of specialization. □

Condition for extending the term of the passive (e.g., bank) loan: With passive debt 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:

$$k^2Y^2(C_1 - P_1)^2 \geq C_1 + \frac{1}{2}k^2Y^2C_1^2 - T + L - 2P_2 \tag{30}$$

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