Financing and Corporate Growth under Repeated Moral Hazard[1]

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Abstract

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We develop an incomplete contracts model to study the extent to which control rights of different financings affect corporate growth. The model admits a standard hold-up problem under equity financing; insiders may be disincentivized to do R&D because outside investors can use their control rights to expropriate large parts of the returns by hiring more efficient managers in the future. Debt financing may give rise to a double moral hazard problem; both managers and shareholders may divert corporate resources to themselves before debt is serviced. However, in many cases, these phenomena do not occur in equilibrium and control rights are irrelevant. Cross-sectional predictions are derived from those cases where control rights matter. Consistent with the empirical evidence, leverage is inversely related to growth and to profitability.

1 Introduction

> Equity aversion can strike even experienced entrepreneurs. Take Stuart Harper, the 50 year old founder of Electrum Multimedia Software in Edinburgh... "We set up Electrum consciously without venture capital money because we wanted to have control of what we do with the business," says Mr. Harper. He acknowledges that it has meant some sacrifices, in terms of more rapid growth of the business... But, he adds, it's allowed them to build a company at their own pace. *Wall Street Journal Europe, May 25, 2001*[1]

There is evidence that financial contracting affects growth. For example, studies by Goldsmith (1969) and Rajan and Zingales (1998) provide evidence that financial development stimulates economy-wide growth.[2] At the corporate level, Lang, Ofek, and Stulz (1996) find that firms with high growth rates have less leverage than slower growing firms. Possible explanations include the ideas that debt reduces overinvestment by reducing the agency costs of free cash flows [Jensen (1986)] and that debt inhibits investments due to the debt overhang problem [Myers (1977)]. In this paper, we study an alternative link between financing and corporate growth. We develop a model that addresses the idea, encapsulated in the quotation above, that financial contracts may affect corporate growth through how they allocate control rights between entrepreneurs and managers on the one hand and investors on the other. Empirical evidence that the distribution of control rights is an important consideration behind the choice of financing in some cases is provided by Kaplan and Strömberg (2001).

The model traces a firm from an R&D phase through a capital investment phase and on to a production stage where cash flows are generated. A key feature is that the incumbent manager whose efforts are behind the R&D will at some point need to be replaced in order for the firm's assets to be operated efficiently. One can either view the incumbent manager literally as an entrepreneur whose expertise lies in developing ideas rather than running mature enterprises or as a manager whose skills may be outdated if he takes the firm to a higher technological level. The model thus incorporates two key stages of growth: the

[1]Charles Fleming, "Take it or leave it: Why entrepreneurs shun outside funds", *Wall Street Journal Europe*, Networking supplement, p.23, Friday-Saturday, May 25-26, 2001.

[2]See Levine (2005) for an overview.

initial R&D stage and the entrepreneurial replacement stage.

To focus on control rights, the model is cast in an incomplete contracts framework along the lines of Bolton and Scharfstein (1990, 1996) and Hart and Moore (1998) where cash flows are noncontractible.[3] Thus, the model incorporates agency costs along the lines of Jensen and Meckling (1976) and Jensen (1986); whoever runs the firm has the ability to divert cash flows to themselves. An important implication is that if the entrepreneur is replaced, he suffers a loss of private benefits and therefore a potential reduction in the return to his R&D efforts.

In a noncontractible cash flows framework, Fluck (1998) shows that outside equity financing is only feasible in an infinite (or uncertain) horizon model which creates a tradeoff for managers between short term gains from retaining current cash flows for themselves, on the one hand, and long term benefits from continued employment, on the other [see also Myers (2000)]. We therefore adopt the basic Fluck/Myers infinite horizon setup, but modify it by introducing the R&D and entrepreneurial replacement stages. The novel feature of our analysis is thus the analysis of second stage growth and its link with first stage growth.

Our main focus is on whether debt and equity financing impact differently on growth, at either the R&D or the entrepreneurial replacement stages, because of differences in control rights. While equity grants investors unconditional control rights, debt grants them control only in the case of default. This matters because the party with control decides whether or not to replace the entrepreneur.

Under equity financing, the model allows for the possibility of a hold-up problem; shareholders may be able to use their unconditional control rights to extract rents from the initial R&D efforts of the entrepreneur by replacing him with a more efficient outside manager at a later stage.[4] This is the source of equity aversion, as described in the quotation above, in the model. An entrepreneur may prefer debt financing as this allows him to retain control over the replacement decision.[5] This may feed back into his incentive

[3]Zender (1991) develops a model with a mixture of contractible and noncontractible cash flows.

[4]The hold-up problem has been studied in other contexts by, for example, Goldberg (1976), Klein et al (1978), Grossman and Hart (1986), Hart and Moore (1990), Berkovitch, Israel, and Zender (1998), among others. See Hart (1995) for an overview.

[5]That debt may facilitate entrenchment of the incumbent has been stressed, for example, by Stulz (1988), Harris and Raviv (1988), and Zwiebel (1996).

to do R&D. Thus, debt and equity financing *may* impact differently on growth because of differences in control rights. We show that the extent to which there is a hold-up problem under equity financing, and thus equity aversion, depends on the level of moral hazard associated with new managers – or on what we can interpret as the effectiveness of the firm's internal governance.

We also identify a potential drawback to debt financing, namely that it may give rise to a double moral hazard problem, where both an outside manager and the entrepreneur may have access to the firm's cash flows before debt is serviced. This turns out to be an issue for projects that are relatively marginal, where yields under entrepreneurial management would not cover the cost of capital. We show that double moral hazard and the hold-up problem never come into play simultaneously.

The hold-up problem under equity financing has been emphasized previously by Burkart, Gromb, and Panunzi (1997). These authors develop a model where increased monitoring by a large shareholder reduces management's scope for consuming private benefits, with the result that managers also put in less effort towards identifying good projects. These authors' main focus is on the relation between ownership concentration and the level of monitoring and managerial effort. With respect to the hold-up problem, our model differs on two key counts: First, in our model ownership concentration plays no role; shareholders are assumed always to be sufficiently coordinated to make use of their control rights. Second, in our model the hold-up problem is endogenous; it is not necessarily an equilibrium phenomenon. When it is not, the choice of financing is irrelevant (unless double moral hazard comes into effect); when it is, debt is preferred.

The endogeneity of the hold-up problem under equity financing in our model is linked to the endogeneity of the entrepreneur's shareholdings. The possibility that the entrepreneur will be replaced in the future by a more efficient manager affects the size of his shareholding. In particular, an increase in cash flows reported under outside management would increase the entrepreneur's equilibrium shareholding, since investors only need to break even. Through this shareholding mechanism, therefore, more efficient managers may help align the entrepreneur's and investors' interests and thus reduce, or even eliminate, the hold-up problem.

Rajan (1992) shows that a hold-up problem also can arise under short term debt if the entrepreneur is locked into a relationship with a particular creditor. In his model, it may be beneficial to borrow long term from dispersed creditors [see also von Thadden (1995)]. We abstract from these issues; creditors are not assumed to have any particular power over the entrepreneur. A hold-up problem does not arise under debt financing in our model.

Our first result is that in a large range of cases, there is no hold-up or double moral hazard problem and control rights are irrelevant. An intuitive way to think about this near-equivalence of debt and equity relates to the repeated nature of the interaction between players in our model. Analogously to the traditional Miller-Modigliani capital structure irrelevance argument, investors and managers can undo the allocation of control rights specified by the financial contract through the strategies they play when they are engaged in repeated interaction. We abstract from some issues that have been emphasized in the incomplete contracts literature on financing and control rights, notably incentivizing managerial effort once assets are in place [Aghion and Bolton (1992), Dewatripont and Tirole (1994), Berkovitch and Israel (1996), Wang and Dybvig (2004)]. Our general point here is that repeated interaction weakens the importance of explicit control rights.

Assuming that debt and equity are equally likely when the choice of financing is irrelevant, the model delivers several cross-sectional predictions. First, there is an inverse relation between leverage and second stage growth. This is because when debt is used to get around the hold-up problem, second stage growth fails to materialize. In particular, in a cross-section we would expect to see a preponderance of relatively highly levered firms that have stagnated after an initial growth spurt. This is consistent with the empirical observation that debt finance dominates among smaller firms.[6]

Second, there is an inverse relation between profitability and leverage. This is consistent with the empirical evidence (Kester (1986), Rajan and Zingales (1995), Fama and French (2002)). This relation occurs in our model not because debt stifles profitability, but because debt is chosen when there is equity aversion, which is something that arises when profitability is relatively low.

Third, there is a systematic relation between economic value added (EVA) and leverage, but the direction of the relation depends upon the ability of outside investors to restrain rent extraction by insiders. In an economy with a high (low) level of corporate governance, the relation is positive (inverse). We are not familiar with empirical evidence that relates

[6] *Finance for Small Firms – An Eighth Report*, Bank of England, March 2001.

to this prediction.

Fourth, the model suggests that the use of leverage in an economy is related to the effectiveness of corporate governance. In particular, when governance is either very good or very bad, either debt or equity will give rise equivalent outcomes. However, between those extremes debt financing is likely to prevail. For example, the 1980's LBO boom in the US may have been the by product of a transition from relatively low to a relatively high level of corporate governance. This supports the thesis of Holmstrom and Kaplan (2001) that the waning of the LBO boom in the 1990's was related to improvements in corporate governance.

Finally, we explore two extensions to our basic analysis. First, we show that the constrained-optimal outcome in our model can be achieved by a dynamic financing strategy where debt is issued in stages. The first stage is the financing of the capital investment necessary to get the firm up and running. The second stage is an LBO, where outside managers borrow capital to buy out the entrepreneur.[7] Second, we consider a variety of models of debt and bankruptcy codes. We show that this does not alter the thrust of our conclusions.

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 contains the analysis under equity financing. Section 4 considers debt financing. Section 5 compares debt versus equity and draws out some empirical implications. Section 6 explores extensions. Section 7 concludes. An appendix contains proofs not presented in the text.

2 The Model

There are three sets of players; an entrepreneur, outside managers, and investors. There are an infinite number of periods, indexed by t. All parameter values are common knowledge and cash flows are noncontractible.

At time $t = 0$, the entrepreneur decides whether to do R&D, at a cost of K, to develop a product idea. K is financed entirely by the entrepreneur himself; it can be thought of as "effort", a monetary amount, or an opportunity cost. Following R&D, the entrepreneur needs outside funds to make the necessary capital investments, which cost I, to realize the

[7] This is a different notion of stage financing than what one sees in the entrepreneurial literature, where venture capitalists issue financing in stages to the *same* entrepreneurial team [see Sahlman (1990)].

product idea. For simplicity, we assume that R&D does not consume time so that financing and capital investments, if any, also take place at time $t = 0$. We also assume this does not consume time. So if capital investments are made, a cash flow π_1 is produced at time $t = 0$. Every period thereafter a cash flow π_1 is produced as long as the entrepreneur manages the firm. The firm can be liquidated at any date, with the liquidation value being $L \leq I$.

At dates $t \geq 1$ it is possible to replace the incumbent manager with an alternative, outside manager. If an outside managers is put in charge of the firm, a cash flow of $\pi_2 > \pi_1$ is produced. There is an infinitely deep pool of identical outside managers. Outside managers are distinct from the initial investors.[8]

For simplicity, we assume that managers (including the entrepreneur) do not draw any salary. Their compensation is therefore completely determined by the portion of the cash flows they do not report to investors (i.e. their perk consumption). Managers are assumed to having no money initially so that shareholders cannot require newly engaged managers to pay for the right to extract perks in the future.

Whether or not the entrepreneur is replaced by an outside manager depends on the entrepreneur's actions and those of investors. The set of actions available to investors depend on how the entrepreneur has financed the capital investment. We consider equity and debt financing.

Equity financing

Investors require shares worth I. Denote the corresponding fraction of the shares by $1-\gamma$. So the entrepreneur's fraction is γ. All shares have the same dividend rights. Control is given to investors (the entrepreneur's shares can be viewed as non-voting).[9] After the cash flow π_1 is produced at date 0, the entrepreneur must decide on the initial dividend. Denote this by $y_{10}\pi_1$, where $y_{10} \in [0, 1]$ is the payout ratio. Cash not paid out is consumed

[8] While we are casting the model in terms of a startup where efforts towards R&D need to be taken by an entrepreneur, one could adapt the model to apply to a firm that is already up and running under a shareholding incumbent manager. The firm could be producing cash flows of π_0 under the incumbent manager, which would grow to π_1 if he put in an effort of K towards R&D and a further π_2 if the incumbent were replaced. We are essentially analyzing the special case that the current manager owns all shares (before raising capital) and $\pi_0 = 0$. The more general case would add some complexity, but the same basic economic forces would be at work.

[9] If the entrepreneur has control, equity cannot be raised because of the non-contractibility of cash flows.

by the entrepreneur.

From date 1 onwards, the following stage game takes place until the firm is liquidated (which may be never): Investors have the first move, which is to choose[10]

$$s_t \in \{retain, replace, liquidate\}. \quad (1)$$

That is, investors decide whether to *retain* the incumbent manager (who at first is the entrepreneur), *replace* the incumbent manager and continue with a new manager, or *liquidate* the firm. In case of liquidation, the game ends, shareholders receive the liquidation value L, and managers receive nothing.[11] If the firm is not liquidated, the cash flow π_i is produced, where $i = 1$ denotes the entrepreneur and $i = 2$ denotes an outside manager. Next, the manager who is in charge decides the payout ratio, $y_{it} \in [0, 1]$.[12] In other words, the reported cash flow is $y_{it}\pi_i$. Shareholders receive this as a dividend and the manager in charge consumes $(1 - y_{it})\pi_i$ (plus his share of the dividends if he is also a shareholder).

Debt financing

We focus on perpetual debt with a face value of I issued at par and with coupons of d_t, $t = 0, \ldots \infty$. The entrepreneur is the sole shareholder. In an extension in Section 6, we allow for the possibility that the entrepreneur may sell his shares. As long as debt is serviced in full, creditors have no rights to replace the manager or liquidate the firm.

The stage game each period is the same as for equity financing, with the following modifications: After the cash flow is produced, the manager in charge reports a cash flow of $y_{it}\pi_i$ to the entrepreneur (as shareholder) who, in turn, decides whether to service the debt or default. The manager consumes the nonreported portion of the cash flow. After debt has been serviced, the remaining cash flows goes to the entrepreneur. If an outside manager has not been appointed, this sequence of moves collapses to the entrepreneur deciding whether to service the debt. If the entrepreneur defaults, the firm is liquidated, creditors collect L, and shareholders (the entrepreneur) get nothing. Other models of debt are considered in Section 6.

[10]Shareholders are assumed to be coordinated. This can be motivated by there being few of them or by shareholders choosing a board of directors that acts in their interest.

[11]So the entrepreneur would receive γL, since he is also a shareholder.

[12]In equilibrium (see below), outside managers use the same payout ratios. For notational simplicity, we therefore do not distinguish between different outside managers.

Strategies and Payoffs

Pure strategies are deterministic functions mapping the history of the game into the decision sets described above. Players discount cash flow at the rate r and seek to maximize the discounted value of cash flows that would accrue to them. We focus on subgame perfect Nash equilibria in pure strategies.

First Best

To serve as benchmarks, we write down the first best outcomes at the different stages of the model. At the production stage, it is first best to keep the firm alive under an outside manager if the present value of the cash flows this will generate is larger than the liquidation value. That is,

$$\text{do not liquidate iff:} \quad \frac{1+r}{r}\pi_2 \geq L. \tag{2}$$

It is never first best to retain the entrepreneur, since $\pi_1 < \pi_2$.

At the financing and investment stage, the first best is that financing is provided and the investment made if the project has positive NPV. That is,

$$\text{finance the capital investment iff :} \qquad -I + \pi_1 + \frac{\pi_2}{r} \geq 0. \tag{3}$$

Similarly, at the R&D stage, the first best is for the entrepreneur to do R&D if this has positive NPV. That is,

$$\text{entrepreneur does R\&D iff:} \qquad -K - I + \pi_1 + \frac{\pi_2}{r} \geq 0. \tag{4}$$

These conditions can be recast in terms of discount rates. (2) implies that if an outside manager is appointed, it is first best to keep the firm alive if and only if

$$r \leq \frac{\pi_2}{L - \pi_2}. \tag{5}$$

The right hand side is the perpetual yield on the project, viewing L as the opportunity cost of keeping the firm alive.

(3) says that it is first best to invest in plant and machinery if and only if

$$r \leq \frac{\pi_2}{I - \pi_1} \tag{6}$$

If the firm cannot be kept alive under an outside manager, either because there is none moral hazard is too large, it may be run by the entrepreneur. In this case, it is optimal to make the capital investment if

$$r \leq \phi \equiv \frac{\pi_1}{I - \pi_1}. \tag{7}$$

The parameter ϕ is the yield on the project under the entrepreneur.

3 Equity Financing

The analysis of the model proceeds recursively. We start with the subgame where the firm is being run by an outside manager. We then study how the level of managerial moral hazard impacts on the entrepreneurial replacement decision and, in turn, on investors' willingness to provide financing and the entrepreneur's decision to do R&D.

3.1 Managerial Moral Hazard: Subgame where Outside Manager Runs Firm

Our analysis starts at the beginning of a period, where investors decide whether to liquidate the firm or keep it going. We study the extent to which deviations from first best occur and characterize some going concern equilibria. Define

$$r^* \equiv \frac{\pi_2}{L}. \tag{8}$$

Lemma 1 *Suppose an outside manager runs the firm. There is a subgame perfect equilibrium in which the firm is maintained as a going concern in perpetuity if and only if* $r \leq r^*$*. In this case, for any* y_2 *satisfying*

$$\frac{rL}{(1+r)\pi_2} \leq y_2 \leq \frac{1}{1+r} \tag{9}$$

the following is an equilibrium: For every t*, (a) when he is in charge, every manager uses the payout ratio* $y_{2t} = y_2$*; (b) shareholders play*

$$s_{t+1} = \begin{cases} \textit{retain} & \textit{if } y_{2t} \geq y_2 \\ \textit{replace} & \textit{if } y_{2t} < y_2. \end{cases} \tag{10}$$

Since the firm cannot be kept alive for $r \in (r^*, \pi_2/(L - \pi_2))$, first best is not achieved. The intuition for r^* as the threshold discount rate relates to the incentive compatibility condition that the manager's overall payoff must be at least equal to the most he can take out of the firm in the current period, i.e., π_2. Therefore, investors receive an overall payoff which is at most equivalent to a perpetuity of π_2, starting next period. Since the opportunity cost of keeping the firm alive is L, the maximum yield earned by outside investors is therefore π_2/L, or r^*.

The specific equilibria characterized in the lemma are stationary going concern equilibria. There is a continuum of these, indexed by the payout ratio y_2. The range of equilibrium payout ratios, (9), can be understood by looking at the two incentive compatibility constraints of the players.

First, if shareholders believe that they will receive a dividend of $y_2\pi_2$ in every period as long as the firm is maintained as a going concern, they will not liquidate if and only if

$$y_2\pi_2\frac{1+r}{r} \geq L. \tag{11}$$

This can be rearranged to form the left hand side of (9).

Second, if the manager believes that he will be retained for as long as he pays out the fraction y_2, his choice is between receiving a perpetuity of $(1-y_2)\pi_2$, starting this period, or taking out π_2 and then being fired. Thus the manager pays out $y_2\pi_2$ if and only if

$$(1-y_2)\pi_2\frac{1+r}{r} \geq \pi_2. \tag{12}$$

This can be rearranged to form the right hand side of (9).

Investors' incentive compatibility constraint, LHS(9), is increasing in r and imposes a lower bound on y_2. The manager's incentive compatibility constraint, RHS(9), is decreasing in r and imposes an upper bound on y_2. This contrast reflects the conflicting objectives of investors and the manager. Equating the left and right hand sides of (9) confirms that the two incentive compatibility constraints can be simultaneously satisfied if and only if $r \leq r^*$.

Our analysis does not pinpoint a specific equilibrium; there is a range of equilibrium y_2's which support the firm as a going concern. We may think of the particular y_2 that obtains as being influenced by the firm's internal governance [Gompers, Ishii, and Metrick (2003)] and also the quality of shareholders' rights prevailing in the legal environment where the firm operates. The idea is that the more effective is corporate governance, the smaller is the level of managerial moral hazard and the larger is the payout rate. Thus y_2 could be interpreted as an index of the effectiveness of corporate governance.[13] The case that y_2 satisfies the manager's incentive compatibility condition (9) with equality, is the case of maximum corporate governance, or minimum managerial moral hazard.[14][15]

There is also a liquidation equilibrium. If investors always liquidate then a best response for the manager is to pay out nothing, and *vice versa*. The implications on financing and R&D are worked out below.

3.2 The Replacement Decision and the Hold-Up Problem

Next we consider the game at a point where the entrepreneur is in charge and shareholders must decide whether to liquidate, retain the entrepreneur, or replace him with an outside manager. We assume that the equilibrium payout rate of outside managers, y_2, is time invariant, as in the analysis above. Thus, either y_2 satisfies (9) and the firm is maintained as a going concern if an outside manager is appointed; or y_2 is zero and the firm would be liquidated under an outside manager. We focus on the former case in the text, but include the latter case in Theorem 1 below.

Conditional on y_2, constrained optimality says that:

$$\text{investors finance the capital investment iff : } \quad -I + \pi_1 + \frac{1}{r}\max\{y_2\pi_2, \pi_1\} \geq 0, \tag{13}$$

$$\text{entrepreneur does R\&D iff: } \quad -K - I + \pi_1 + \frac{1}{r}\max\{y_2\pi_2, \pi_1\} \geq 0. \tag{14}$$

[13]In a recent paper, Fulghieri and Suominen (2006) postulate a similar connection between governance and cash flow diversion.

[14]The stationary going concern equilibria that we study are natural to focus on since the model at this point is stationary and since outside managers are fundamentally identical. Going concern equilibria with time variant strategies are also possible. However, if there is a going concern equilibrium where outside managers use time variant payout ratios, there is an equilibrium in time invariant strategies which is payoff equivalent. A proof is available upon request.

[15]The result that there is a multiplicity of equilibria might be altered if competition among outside managers took a form different from the sequential structure we have adopted. For example, were it feasible for investors to generate Bertrand competition by setting up a bidding process among potential managers that would commit them to a pay-out rate, then it might be possible to achieve the minimal moral hazard bound in (9). But a less competitive process could well lead to a lower y_2. So y_2 could also be viewed as a measure of the competitiveness of the managerial labor market. The fact that managerial rent extraction is viewed as a prevalent problem in many institutional settings seems to lend empirical support for the formulation we have adopted as opposed to a model with Bertrand competition.

If shareholders believe that the entrepreneur will always match the dividends they expect from an outside manager, they will not replace the entrepreneur.[16] So to be retained, the entrepreneur must have a strategy of paying a periodic dividend of

$$y_1 \pi_1 = y_2 \pi_2. \tag{15}$$

Conditional constrained optimality requires that the entrepreneur matches dividends if $\pi_1 > y_2 \pi_2$.

If outside managers' payout ratio is so large that $y_2 \pi_2 > \pi_1$, it is impossible for the entrepreneur to match dividends. Shareholders understand this and therefore replace the entrepreneur. In equilibrium, the entrepreneur consumes the entire date 0 cash flow, π_1, and is replaced at date 1. This is exactly what is needed for conditional constrained optimality. There is no hold-up problem.

If the entrepreneur is able to match dividends, stationarity implies that if he prefers to do so once, he prefers to do so every period. If the entrepreneur anticipates being replaced, his best action is to consume all current cash flows. Hence, if $\pi_1 > y_2 \pi_2$, the entrepreneur matches dividends if and only if

$$(1 - y_1)\pi_1 \frac{1+r}{r} + \gamma y_1 \pi_1 \frac{1+r}{r} \geq \pi_1 + \gamma y_2 \frac{\pi_2}{r}, \tag{16}$$

where γ is the entrepreneur's shareholding. The left hand side of (16) is the present value of cash flows to the entrepreneur if he matches. The right hand side is the current cash flow, π_1, plus the present value of the future equilibrium dividends the entrepreneur collects under an outside manager. By substituting (15) into (16), we get

$$y_2 \leq \frac{\pi_1}{\pi_2[1 + (1 - \gamma)r]}. \tag{17}$$

The entrepreneur matches dividends and is retained if and only if this holds.

The matching condition (17) shows that the entrepreneur does not match dividends whenever he can. Thus constrained optimality does not obtain. This can give rise to the hold-up problem described in the Introduction, i.e., that an entrepreneur who anticipates losing rents when he will be replaced by outside management may decide to pass up a worthwhile R&D project. As an example, suppose that $y_2 \pi_2 = \pi_1 - \varepsilon$, where $\varepsilon > 0$ is

[16] While one can construct equilibria where the entrepreneur must pay more in dividends than an outsider manager in order to be retained, we do not believe these equilibria are very reasonable.

arbitrarily small. In this case, matching dividends would squeeze the entrepreneur's perk consumption towards zero. Hence, he prefers paying no dividends at date 0 and being replaced at date 1 over matching dividends forever. As a result, the firm may not get up and running in the first place. In the next section we explore in detail the conditions when this will prove to be the case.

3.3 Financing, Investment, and R&D

Finally, we study investors' decision to provide financing at date 0 and the entrepreneur's decision to do R&D. We start by focusing on the financing decision. There are two potential equilibrium scenarios, depending on whether or not the entrepreneur matches dividends.

First, if the entrepreneur does not match dividends, investors replace him at date 1 and receive dividends of $y_2\pi_2$ from that date onwards. We refer to this as a *managerial equilibrium*. Since, in equilibrium, investors' shares must be worth I initially, under a managerial equilibrium the entrepreneur's shareholding is

$$\gamma_m = 1 - \frac{rI}{y_2\pi_2}. \tag{18}$$

Second, if the entrepreneur matches dividends, he is not replaced and investors receive dividends of $y_2\pi_2$ every period, starting at date 0. We call this an *entrepreneurial equilibrium*. In this case, the entrepreneur's shareholding is

$$\gamma_e = 1 - \frac{rI}{y_2\pi_2(1+r)}. \tag{19}$$

Since negative shareholdings are not possible, (18) and (19) impose constraints on the equilibrium payout rate. In particular, in a managerial equilibrium, we must have

$$y_2 \geq \frac{rI}{\pi_2}, \tag{20}$$

and in an entrepreneurial equilibrium we must have

$$y_2 \geq \frac{rI}{(1+r)\pi_2}. \tag{21}$$

Both these constraints are more restrictive on y_2 than RHS(9). In other words, rasing financing is a tougher hurdle than keeping investors from liquidating once financing has been raised. In turn, these constraints give rise to upper bounds on the set of discount rates for which the project is financeable.

For managerial equilibria, combining (20) and the upper bound in (9) shows that the largest discount rate for which financing can be provided at date 0, r_m^*, satisfies

$$r_m^*(1 + r_m^*) \equiv \frac{\pi_2}{I}. \tag{22}$$

Comparing (22) with (8) we see that $r_m^* < r^*$. So it is possible that financing cannot be raised if the entrepreneur will be replaced even though the firm could be maintained as a going concern in this event. This relates to the fact that (21) is more restrictive than the smallest y_2 consistent with keeping the firm alive under an outside manager, RHS(9). Intuitively, what is going on is that there are now two sources of moral hazard. First, the entrepreneur consumes the entire date 0 cash flow; and second, the outside manager must receive compensation for not consuming the entire date 1 cash flow. From investors' perspective, this is the same as saying that the first two cash flows are lost. Equation (22) is an immediate implication since investors need to break even. Thus the underinvestment problem arising from managerial moral hazard is amplified by entrepreneurial moral hazard.

For an entrepreneurial equilibrium, combining (21) with the matching condition (17), we get that the threshold discount rate is

$$r_e^* \equiv \pi_1/I. \tag{23}$$

This may be smaller or larger than r_m^*, depending on the relation between π_1 and π_2. However, r_e^* is less than the yield on the project under the entrepreneur, ϕ [see (7)]. Thus conditional on the entrepreneur running the firm, underinvestment happens because of entrepreneurial moral hazard.

Theorem 1

1. *Suppose that if the entrepreneur is replaced outside managers and shareholders play a going concern equilibrium with a payout ratio of y_2 satisfying (9), as described in Lemma 1. In the subgame that starts with the financing decision at date 0, there are two types of equilibria where equity financing can be raised:*

   (a) *In a managerial equilibrium, the entrepreneur pays no dividend at date 0 and is replaced at date 1. The new manager pays a dividend of $y_2\pi_2$ and is retained* *in perpetuity. Such equilibria exist if and only if (i) $r \leq r_m^*$, and (ii) y_2 also satisfies*

$$y_2 \geq \frac{\pi_1}{\pi_2} - \frac{r^2 I}{\pi_2}. \tag{24}$$

(b) *In an entrepreneurial equilibrium, the entrepreneur pays a dividend of $y_1\pi_1 = y_2\pi_2$ every period and is retained in perpetuity. Such equilibria exist if and only if (i) $r \leq r_e^*$, and (ii) y_2 also satisfies*

$$y_2 \leq \frac{\pi_1}{\pi_2} - \frac{r^2 I}{(1+r)\pi_2}. \tag{25}$$

2. *Suppose that the above conditions are not met or that the firm would be liquidated if an outside manager were appointed. There is an equilibrium where financing can be raised if and only if $r \leq r_e^*$.*

The theorem shows that underinvestment is more severe than just what entrepreneurial and managerial moral hazard would suggest. Part 1 of the theorem shows that there are scenarios where financing cannot be raised even though the entrepreneur is able to match dividends and r is less than the threshold discount rates, r_e^* or r_m^*. In particular, (24) and (25) show that it is not possible to raise financing when the cash flow that would be reported by an outside manager, $y_2\pi_2$, is "slightly" less than the cash flow generated under the entrepreneur, π_1, and the discount rate is sufficiently high. This is because matching dividends in this case squeezes the present value of the entrepreneur's perk consumption to such an extent that he prefers diverting all cash flows to himself while he is in charge. This leads to a suboptimal replacement decision and ultimately to underinvestment.

The theorem also shows that as the cost of capital, r, increases, underinvestment prevails for an increasing range of y_2's. Intuitively, the hold-up problem becomes more severe because the entrepreneur's shareholdings are decreasing in r. Thus, the entrepreneur's preferences become less congruent with those of investors. In other words, as projects become more marginal (NPV closer to zero), the conflict of interest between the entrepreneur and investors grows. Thus equity aversion, as discussed in the introduction, is associated primarily with marginal projects. This and other features of the equilibrium are illustrated in Figure 1.

Figure 1 puts the two parts of the theorem together by showing the various constraints that determine the combinations of r and y_2 for which equity financing can be raised in an entrepreneurial or managerial equilibrium. Referring to the figure, the colored/shaded (colorless/nonshaded) areas show combinations for which financing can (cannot) be raised. Entrepreneurial (managerial) equilibria obtain for low (high) managerial payout ratios. In particular, the firm can be financed by equity and operate under the control of the entrepreneur for payout rates below line e and for discount rates less than r_e^*. The firm can be financed by equity and operate under outside management after second stage growth for combinations of discount rates and payout rates lying below line a and above $\max[\text{line } f, \text{line } c]$.[17]

Figure 1 can be used to illustrate how inefficient replacement at date 2 feeds back to a failure to finance the firm at date 1 and a failure to do R&D at date 0. Inefficiency at date 1 is illustrated in Figure 1 by the non-shaded triangular region which is bounded below by line e, above by c and to the right by r_e^*. In this region, equity financing could be raised if investors could commit not to replace the entrepreneur. But equity investors' unconditional control rights renders such a hands off policy not credible. Thus at date 1, the hold-up problem leads to underinvestment at date 1 for marginal projects (high r) where $y_2\pi_2$ is "slightly" less than π_1.

Inefficiency at date 0 is illustrated by Figure 1 in a more indirect way. A failure to do R&D at date 0 can arise from inefficient replacement for two reasons. First, and most obviously, it may not be possible to raise financing at date 1, as just discussed.

[17] Figure 1 is drawn under the condition that π_2 is so much larger than π_1 that $r_m^* > r_e^*$. Note that $r_m^* > r_e^*$ if and only if $(1 + \pi_1/I)\pi_1/I < \pi_2/I$, that is, if and only if $\pi_2 > \pi_1(1 + \pi_1/I) = \pi_1(1 + r_e^*)$. Figures for $r_e^* \geq r_m^*$ would look similar. As noted in the legend for the figure, lines a and b represent the incentive compatibility constraints of an outside manager to pay out $y_2\pi_2$ per period and of investors not to liquidate, respectively. Hence the "triangle" formed by lines a and b represents the set of y_2's and r's for which the firm can be maintained as a going concern by an outside manager. Lines a and c form a smaller "triangle" representing the set of y_2's and r's for which financing can be raised if the firm will subsequently be run by an outside manager. Line c lies above line b because in a managerial equilibrium, the entrepreneur consumes the entire date 0 cash flow, whereas the outside manager will be paying out $y_2\pi_2$ from period 1 onwards. Additionally, if y_2 is above line b, financing can be raised in an entrepreneurial equilibrium. If y_2 is below line e, the entrepreneur prefers not to relinquish control if investors think that he will not. If y_2 is above line f, the entrepreneur prefers to relinquish control if investors think that he will do so.

Second, even if financing could be raised, inefficient replacement leads to a reduction in the cash flows that are available to the entrepreneur, thus reducing his incentive to do R&D. Specifically, as illustrated in Figure 1, there are combinations of r and y_2 for which $\pi_1 > y_2\pi_2$ but yet a managerial equilibrium obtains (the region bounded by lines d, e, and c). Thus, for some of these (r, y_2) pairs it is the case that

$$\text{NPV(R\&D, managerial)} \equiv \frac{y_2\pi_2}{r} + \pi_1 - I - K < 0. \tag{26}$$

but

$$\text{NPV(R\&D, entrepreneurial)} \equiv \frac{\pi_1}{r} + \pi_1 - I - K > 0. \tag{27}$$

Here, R&D would be been done if an entrepreneurial equilibrium could be guaranteed. But under the managerial equilibrium that will be played, the entrepreneur is not willing to do R&D.

This discussion also illustrates that inefficiencies arising from the hold-up problem may the exception rather than the rule. As seen in Figure 1, replacement is predominantly efficient; managerial equilibria occur when $y_2\pi_2 > \pi_1$, and entrepreneurial equilibria when the reverse holds. Thus the main source of inefficiency is a plain managerial moral hazard problem. For the most part, the players overcome the potential hold-up problem that is built into the model through the strategies that they play.

Finally, if appointing an outside manager leads to the liquidation of the firm, Theorem 1 (Part 2) shows that it is still possible to raise equity financing. The firm now needs to be run by the entrepreneur. However, just as there is a liquidation equilibrium under an outside manager, there is also one under entrepreneurial management. In this case, investors would not be willing to fund the project. This illustrates the fragility of equity financing. Essentially, it relies on two-way trust between investors and the entrepreneur. Investors must trust the entrepreneur (or outside managers) to report cash flows that are sufficient to cover the cost of capital; and the entrepreneur (or outside managers) must trust that investors will not replace him or liquidate the firm as long as he reports such cash flows.

4 Debt Financing

Under debt financing, investors do not have the right to replace the entrepreneur. Thus, investors' incentive compatibility constraint disappears from the analysis. This eliminates the hold-up problem, but not managerial or entrepreneurial moral hazard. In this section, we work out the specific implications of this. As in the previous section, we derive conditions for when financing can be raised in managerial or entrepreneurial equilibria.

The entrepreneur retains all shares. Thus, in a managerial equilibrium, the capital structure consists of debt and outside equity. In an entrepreneurial equilibrium, the capital structure consists of debt and inside equity.

We focus on equilibria where the firm is kept alive in perpetuity and therefore on perpetual debt contracts. Since the entrepreneur generates lower cash flows than outside managers ($\pi_1 < \pi_2$) and since outside managers do not arrive at the scene before date 1, an efficient debt contract may involve an initial grace period, where contractual debt service is reduced. Thus we consider debt contracts where the promised payments (coupons) are d_0 in the initial period and $d_1 \geq d_0$ in all subsequent periods. Because of the stationarity of the model, time varying coupons after date 1 cannot improve efficiency unless accompanied by a financial restructuring. This is studied in Section 6 (LBO's).

The coupons are determined by the fact that the debt must initially be worth I and by whether or not there is a grace period. If there is no grace period, $d_0 = d_1 = d$, and the coupon every period would be

$$d = \frac{Ir}{1+r}. \tag{28}$$

A grace period is needed if π_1 is less than this, which occurs when the cost of capital, r, is greater than the project's yield under the entrepreneur, ϕ. When $r > \phi$ we consider debt contracts with $d_0 = \pi_1$ since this minimizes the scope for entrepreneurial perk consumption and thus underinvestment.[18] In this case,

$$d_1 = (I - \pi_1)r, \tag{29}$$

which is greater than π_1 since, here, $r > \phi$. If $r \leq \phi$, we consider debt contracts with time invariant coupons given by (28).

[18] If $d_0 = 0$, our analysis would be much the same, but the range of discount rates under which debt financing could be raised would be reduced.

4.1 Entrepreneurial Replacement, Financing, and R&D

As before, we focus on going concern equilibria where an outside manager, if appointed, uses a time invariant payout ratio y_2. Since contractual debt service is fixed initially and therefore independent of reported cash flows, it is optimal for the entrepreneur to replace himself with an outside manager if the outside manager would report a larger cash flow than what the entrepreneur would generate, i.e.,

$$\text{entrepreneur is replaced iff:} \quad y_2\pi_2 > \pi_1. \tag{30}$$

This contrasts with equity financing, where a managerial equilibrium sometimes obtains when $y_2\pi_2 < \pi_1$ (see Theorem 1).

For financing to be raised under an entrepreneurial equilibrium, several conditions must be met. First, (30) must be reversed. Second, the coupon must be given by (28). Third, the entrepreneur must service debt, which he does provided

$$[\pi_1 - d]\,\frac{1+r}{r} = \left[\pi_1 - \frac{Ir}{1+r}\right]\frac{1+r}{r} \geq \pi_1, \tag{31}$$

since his best alternative at any given time is to consume π_1 and default. (31) can be rewritten as $r \leq r_e^*$ [see (23)].

Consider next managerial equilibria. In this case, $y_2\pi_2 > \pi_1$. Several incentive incompatibility constraints also need to be satisfied. First, the manager must prefer reporting $y_2\pi_2$ to reporting nothing and defaulting. Hence

$$y_2 \leq \frac{1}{1+r}, \tag{32}$$

just as under equity financing. Second, given that the outside manager reports $y_2\pi_2 > d_1$, the shareholder/entrepreneur must do better by servicing the debt than defaulting, i.e.,

$$(y_2\pi_2 - d_1)\frac{1+r}{r} \geq y_2\pi_2. \tag{33}$$

Combining (32) and (33), we get

$$\frac{d_1(1+r)}{\pi_2} \leq y_2 \leq \frac{1}{1+r}. \tag{34}$$

To raise debt financing in the first place, it must also be the case that before replacing himself (at date 1), the entrepreneur must prefer servicing debt at date 0^+. Hence,

$$\pi_1 - d_0 + \frac{y_2\pi_2 - d_1}{r} \geq \pi_1. \tag{35}$$

Since $d_0 \leq d_1$, we see that (35) is satisfied whenever (33) and (30) are satisfied, implying that the entrepreneur will wish to service debt initially if he will also do so once an outside manager has been appointed. Therefore, if no grace period is needed, (33) tells us that there is y_2 such that it is incentive compatible to service debt if and only if $r \leq r_m^*$ [see (22)], which parallels the result under equity financing. The case that a grace period is needed ($r > \phi$) is dealt with in the following theorem.

Theorem 2 *Suppose that outside managers use a time invariant payout ratio y_2. There are two types of equilibria where debt financing can be raised.*

1. *In an entrepreneurial equilibrium, the entrepreneur services debt in full every period and is never replaced. Such equilibria exist if and only if (a) $\pi_1 \geq y_2\pi_2$ and (b) $r \leq r_e^*$.*

2. *In a managerial equilibrium, the entrepreneur replaces himself at date 1. Debt is serviced every period, including date 0. Such equilibria exist if and only if one of the following two cases is satisfied:*
   Case 1 (No grace period, $r \leq \phi$): (a) $y_2\pi_2 > \pi_1$, (b) $r \leq r_m^*$, (c) $Ir/\pi_2 \leq y_2 \leq 1/(1+r)$.
   Case 2 (Grace period, $r > \phi$): (a) $y_2\pi_2 > \pi_1$, (b) $r \leq \phi^* \in (\phi, r_m^*)$, (c) $\frac{(I-\pi_1)(1+r)r}{\pi_2} \leq y_2 \leq \frac{1}{1+r}$, where ϕ^* is determined by $\phi^*(1+\phi^*)^2 = \frac{\pi_2}{I-\pi_1}$.

The theorem is illustrated in Figure 2.[19] Managerial equilibria tend to occur for large payout rates and entrepreneurial equilibria tend to occur for small payout rates, just as under equity financing (Figure 1). The figure illustrates the absence of a hold-up problem by the fact that managerial equilibria do not occur when $y_2\pi_2 < \pi_1$.

Another advantage to debt is that it solves the fragility problem with equity financing; there is no liquidation equilibrium. Since investors only have conditional control rights, as long as debt is serviced the manager does not need to worry about investors liquidating the firm. Debt obviates the need for two-way trust between investors and the entrepreneur to keep the firm alive.

A disadvantage to debt is that the maximum discount rate for which debt financing can be raised may be less than the threshold discount rate under equity financing, r_m^* (Part

[19]Figure 2 is drawn for the case that $r_m^* > \phi$.

2, case 2). The reason is that debt may give rise to a double moral hazard problem; both an outside manager and the entrepreneur (as shareholder) may be involved in servicing debt. This arises in the case that the yield on the project under the entrepreneur is not sufficient to cover the cost of capital, i.e., $\phi < r$, which is an issue if $r_m^* > r_e^*$. In this case, a grace period is needed. The initial coupon is below what is needed for investors to cover the cost of capital. To compensate for this, later coupons are necessarily above the cost of capital. This results in a reduced threshold discount rate for debt financing.

Finally, along the same lines as under equity financing, when we trace the model back to the R&D stage, the set of parameter values for which R&D will be done is reduced relative to the set of parameter values for which financing can be raised.

5 Debt versus Equity: Implications and Predictions

We compare debt and equity financing under the equilibria described in Theorems 1 (part 1) and 2. Outside managers use a time invariant payout rate, y_2, under which the firm can be kept alive.

Theorem 3 *Suppose R&D has been done. Let r and y_2 be such that at least one type of financing can be raised, as described in Theorems 1 (part 1) and 2. Debt and equity financing lead to the same outcomes with respect to investments, production (replacement), and players' payoffs except in the following two cases:*

1. *Debt preferred because it avoids the hold-up problem:*

$$r \leq r_e^* \qquad \text{and} \qquad \frac{\pi_1}{\pi_2} - \frac{Ir^2}{(1+r)\pi_2} < y_2 < \frac{Ir}{\pi_2}. \tag{36}$$

2. *Equity preferred because it avoids double moral hazard:*

$$r > \phi \qquad \text{and} \qquad \frac{Ir}{\pi_2} < y_2 < \min\left\{\frac{1}{1+r}, \frac{(I-\pi_1)r(1+r)}{\pi_2}\right\}. \tag{37}$$

The theorem is illustrated in Figure 3. The main point is that in a large set of cases, the choice of financing with the associated distribution of control rights is irrelevant. Intuitively, this is because when players are engaged in repeated interaction, explicit control rights can be "undone" through the strategies followed by the players. Under equity financing, as long as investors earn an adequate return on their capital, either as measured by what they could earn from replacing the incumbent or liquidating the firm, investors do not make use of their unconditional control rights. So the incumbent can make equity work like debt, where investors can interfere only if debt is not serviced, by providing investors with an adequate return.

Differences between debt and equity arise for two reasons: the hold-up problem under equity financing and the double moral hazard problem under debt financing. The importance of the hold-up problem in making the choice of financing matter can be understood intuitively by noting that it is fundamentally a time inconsistency problem. Thus, it becomes impossible to undo the formal contractual arrangements through subgame perfect strategies. The hold-up problem manifests itself through inefficient entrepreneurial replacement. This happens when $\pi_1 > y_2\pi_2$ and the cost of capital is sufficiently high to make the project "marginal." LHS(36) is decreasing in r and RHS(36) is increasing in r, showing that the range of y_2's for which there is inefficient replacement is increasing in r. When the hold-up problem bites, debt is preferred. This is indicated by the green (medium shaded) region in Figure 3. Double moral hazard bites when $r > \phi$, i.e, when the cost of capital is larger than the project's yield under entrepreneurial management. This is indicated by the blue (darkly shaded) region in Figure 3.

These results are robust if we trace the analysis back to the R&D stage. But, as discussed above, there is now an increase in the set of parameter values for which the hold-up problem may arise. This is indicated by the light green (lightly shaded) region in Figure 3.

Since there are cases where either debt or equity are preferred, in a cross-section where r and y_2 vary, Theorem 3 gives rise to a number of empirical implications. We assume that debt and equity are equally likely when they lead to the same equilibrium outcomes.

Proposition 1 *There is an inverse relation between leverage and second stage growth.*

Cross-sectional differences in leverage are driven by combinations of y_2 and r for which there is a hold-up problem under equity or a double moral hazard problem under debt, as illustrated in Figure 3. In the "hold-up region", only debt financing can be raised, but second stage growth does not materialize. In the cross-section, this pushes debt towards an association with a failure to achieve second stage growth. In the "double moral hazard region", second stage growth is achieved under equity financing, while debt financing cannot be raised. This strengthens the inverse relation between leverage and second stage growth. Thus our model is broadly consistent with the empirical evidence that corporate growth rates are negatively correlated with leverage (Lang, Ofek, Stulz, 1996).

Our model can also be used to relate profitability, measured as return on assets as in the empirical literature, and leverage. Let us identify book assets with investment costs, I,[20] and per period reported return with $y_2\pi_2$.[21] Let us assume that the distribution of (r, y_2) is uniform on the rectangle with lower left corner $(0, 0)$ and upper right corner $(r_m^*, 1)$.

Proposition 2 *There is an inverse relation between leverage and profitability.*

Recently, it has been suggested that this relation can be explained by dynamic tradeoff models [Hovakimiam et al (2001), Hennessy and Whited (2005), Strebulaev (2006)]. We show that it is also consistent with incompleteness in financial contracting. Specifically, the inverse relation between leverage and profitability in Proposition 2 is driven by the cases in the cross-section where managers and investors are unable to overcome contractual incompleteness through dynamic strategies. These are the cases where the hold-up problem and double moral hazard come into play.

Let us define a *positive level of governance* as one where $y_2 \geq \pi_1/\pi_2$. A *negative level of governance* has $y_2 < \pi_1/\pi_1$. The motivation behind these definitions is that a positive level of governance stimulates replacement of the entrepreneur, which is the first best outcome. Different economies may have different governance levels, for example due to differences in investor protection and legal structures (La Porta et al, 1998). Within an economy, different firms may have different governance levels, for example, due to differences in corporate statutes and board attributes (Gompers et al, 2003). Define an

[20] Alternatively, we could identify $I + K$ with book assets. The results would be the same.

[21] In managerial debt and equity equilibria, the reported return is clearly $y_2\pi_2$. In an entrepreneurial equity equilibrium, the reported return is $y_1\pi_1 = y_2\pi_2$ [since we are working under Theorem 1 (Part 1)]. In an entrepreneurial debt equilibrium, all we can definitely say is that it is at least equal to the coupon which, by (21) and (28), is bounded above by the cash flow in an entrepreneurial equity equilibrium. So as not to create a bias when comparing debt and equity, we assume that reported cash flows in an entrepreneurial debt equilibrium equals this upper bound. Thus, regardless of the financing and the type of equilibrium, the reported return is $y_2\pi_2$. Of course, we get different $y_2\pi_2$'s under managerial and entrepreneurial equilibria.

economy with a positive (negative) level of governance as one where for each firm in the economy $y_2 \geq (<) \pi_1/\pi_2$, but the y_2's may vary across firms. Using these definitions, we derive two sets of predictions.

We start by looking at profitability relative to the cost of capital, as measured by economic value added (EVA). The reported EVA of a project in our model is $y_2\pi_2 - rI$.

Proposition 3 *In an economy where there is a negative (positive) level of governance, there is an inverse (positive) relation between leverage and EVA.*[22]

In the negative corporate governance economy, the relation between leverage and EVA is driven by firms with relatively good governance; where there would be a hold-up problem under equity financing. Since this is more severe for large discount rates, in the cross-section, debt financed firms are associated with more marginal projects and therefore lower EVA's. In the positive governance economy, the relation between leverage and EVA is driven by cases where debt financing cannot be raised because of a double moral hazard problem.

Proposition 4 *In an economy where there is a negative level of governance, there is a positive relation between leverage and the level of governance. In an economy where there is a positive level of governance, there is a nonmonotonic relation between leverage and the level of governance.*[23]

The reason there is a relation between leverage and governance in the negative governance economy is the hold-up problem. For an economy with a positive level of governance, double moral hazard may also give rise a relation between leverage and governance. However, the relation depends on the marginal distribution of discount rates. If these are uniformly

[22] In the positive governance case, the statement assumes that π_2 is so much larger than π_1 that $r_e^* < r_m^*$ (see footnote 17). If $r_e^* \geq r_m^*$, there would be no relation between leverage and EVA in the positive governance economy, since this would mean there would be no need for a grace period under debt financing and therefore no double moral hazard problem.

[23] If $r_e^* \geq r_m^*$ (see footnote 17), there would be no relation between leverage and governance in the positive governance economy. Looking at the full range of governance levels, there would thus be a nonmonotonic relation between governance and leverage: as y_2 increases from zero, there would be no effect initially, then a gradual increase in leverage, and then as $y_2 \geq \pi_1\pi_2$ there would be no effect again.

distributed, the relation would be nonmonotonic (as can be seen from Figure 3). Looking at the full range of governance levels, the broad pattern is thus that as governance increases from its lowest level ($y_2 = 0$), there is no effect initially, then a gradual increase in leverage (as y_2 approaches π_1/π_2). As the level of governance continues to increase in the positive region ($y_2 > \pi_1/\pi_2$), there is initially no effect, then a bias towards equity financing, and finally no effect again.

6 Extensions

6.1 Constrained Optimal Financing: Leveraged Buyout

Regular debt financing, as studied above, solves the hold-up problem but does not ensure minimum managerial moral hazard, i.e. $y_2 = 1/(1+r)$. Here, we show that constrained optimality can be implemented through a leveraged buyout (LBO) at date 1.

The LBO works as follows: The firm initially issues debt at date 0 which raises I. Denote the contractual debt service of this debt by d_0^s for $t = 0$ and d_1^s for $t \geq 1$. Then $d_1^s = (I - d_0^s)r$. At date 1, the entrepreneur hires an outside manager and simultaneously exchanges his equity for junior debt and gives all the equity to the new manager. Let d_1^j denote contractual debt service on the debt claim held by the entrepreneur. Minimum moral hazard can be enforced by setting: $d_1^j = \frac{\pi_2}{1+r} - d_1^s$. Thus, the total debt outstanding as of date 1 will be π_2/r. This maximizes cash flows to the entrepreneur, subject to incentive compatibility, and therefore maximizes his incentives to do R&D.

The advantage of the LBO over regular debt financing is twofold. First, by overleveraging the firm relative to capital investment needs, the LBO encourages the manager to use the maximum incentive compatible pay out rate, much along the lines suggested by Jensen (1986). Second, the LBO creates a single layer of agency, thus eliminating double moral hazard. So the anticipation of an LBO as described above at date 1 means that financing can definitely be raised as long as $r \leq r_m^*$. Our model is thus consistent with the view that LBO's are a vehicle for improving efficiency through reducing managerial moral hazard [Jensen (1989), Holmstrom and Kaplan (2001)].[24]

[24] It is sometimes suggested that golden handshakes or parachutes, whereby managers receive compensation upon dismissal, may help improve managerial effort [e.g., Almazan and Suarez (2004), Berkovitch,

The advantages of the LBO in our model can be achieved without it actually being implemented. What is required is that investors and managers view a leveraged buyout by another manager as a credible threat. For in this case, a manager would need to use a payout ratio of $y_2 = 1/(1+r)$ to avoid being replaced.

Because credibility is something which is usually earned over time, our model can be used to tell a story that explains the growth of LBO's and their eventual decline. As more LBO's were done, the LBO as a disciplinary vehicle gained in credibility. We know, for example, that large LBO's were dependent on the junk bond market to bridge the gap between regular bank debt and equity financing. As this happened, our model suggests that the need for actually doing LBO's became less critical; the threat alone had disciplinary impact, perhaps through the medium of improved corporate governance, as suggested by Holmstrom and Kaplan (2001). Since LBO's have costs, for example, capital gains taxes and increased likelihood of financial distress, the actual use of LBO's declined.

6.2 Alternative Models of Debt

In models of debt, it is widely recognized that important results may turn on the complexity of the debt structure, for example because of the impact on the ease with which debt can be renegotiated [e.g., Berglöf and von Thadden (1994), Bolton and Scharfstein (1996), and Franks and Nyborg (1996), Diamond (2004)].[25] The bankruptcy code also impacts significantly on debt renegotiations [see, e.g., Bulow and Shoven (1978), Jackson (1982), Brown (1989), Franks and Torous (1989), Weiss (1990), Bergman and Callen (1991), Franks and Nyborg (1996), Franks, Nyborg, and Torous (1996), Berkovitch, and Israel, and Zender (1998).]

Our analysis has implicitly assumed a debt structure that is so complex as to be non-renegotiable and a formal bankruptcy where the firm is automatically liquidated. In this section, we relax these two assumptions. Our objective is to examine the robustness of

Israel, and Spiegel (2000)]. Yermack (2005) finds some support for this "bonding hypothesis". There is no role for a golden handshake in our model, however. A payment that compensates the entrepreneur upon replacement, increases the entrepreneur's incentive to consume all cash flows while he is in charge, thus exacerbating the problem of inefficient replacement and ultimately underinvestment.

[25] In practice, complexity can result from having multiple creditors, multiple layers of seniority, and multiple and fragmented collateral.

our results rather than to provide a comprehensive model of debt structure, default, and bankruptcy codes.

We consider two extreme debt structures; complex and simple. Complex debt cannot be renegotiated; default precipitates formal bankruptcy. Simple debt may be renegotiated; default triggers a workout stage, where the players' threat points are determined by what would happen in formal bankruptcy (see below).

Different models of debt affect equilibrium outcomes only if they affect the players' incentive compatibility constraints. Under debt financing, only the entrepreneur's and managers' constraints enter the analysis, since creditors can take no action while debt is serviced. If debt structure is complex, these constraints may differ if the firm can be kept alive after entering formal bankruptcy or if there are deviations from absolute priority (as in Chapter 11). There would now be an extra term, for example representing priority deviations, on the right hand side of (33) and (35). While this would alter the details of the analysis, it would not affect the thrust of the conclusions.

If debt structure is simple, the entrepreneur's incentive compatibility constraints would depend on his bargaining power. As an example, suppose that formal bankruptcy is liquidation. Upon default, creditors and the entrepreneur (or manager) would enter workout negotiations and share the surplus from keeping the firm alive according to their bargaining powers. If all bargaining power lies with the entrepreneur, the entrepreneur would default for sure at date 1 and creditors would be paid off with shares worth L. Thus debt could not be raised. The simple debt/maximum bargaining power to the debtor model is used by Fluck (1998), which explains her surprising result that equity dominates debt even though the reverse is true in the finite horizon model that Fluck builds on [Hart and Moore (1998)] and the related noncontractible cash flows models by Bolton and Scharfstein (1996) and the costly state verification models of Townsend (1978) and Gale and Hellwig (1985). However, if all bargaining power lies with creditors, it is straightforward that we get the same results as in Section 4, since the players' incentive compatibility constraints would be the same. However, a general point here, which has been made by many of the authors mentioned above, is that ex ante it may be optimal to set up a complex debt structure.

7 Conclusion

In this paper, we have studied whether there may be a relation between financing and corporate growth due to differences in control rights between different capital structures. As in much of the incomplete contracts literature, our analysis centers around a hold-up problem. In our model, insiders may have a disincentive to exert effort towards new developments because outsiders may expropriate some of the returns by installing new management. In contrast to much of the literature, however, the hold-up problem is endogenous in our model; it arises only if outside managers are "slightly worse" than the insider (taking managerial moral hazard into account).

Our first result is that in a large set of cases, the control rights of different financings are irrelevant; R&D, investments, output, and players' payoffs are not affected by the choice of financing. While we abstract from a number of issues that may be important in practice, the general point we make here is that repeated interaction between insiders and outside investors weakens the importance of explicit control rights.

The scenarios where control rights do matter give rise to a number of cross-sectional empirical predictions. For example, there are inverse relations between leverage versus growth and profitability. The model also predicts that there is a systematic relation between leverage and EVA which depends on the effectiveness of corporate governance in the economy. A high general level of governance implies a positive relation between leverage and EVA; while a low level of governance implies an inverse relation.

The prediction on leverage and profitability may deserve a comment. This relation is frequently cited in the capital structure debate. For example, Myers (1993) views it as strong evidence against the static tradeoff theory, but consistent with the pecking order theory. Recently, it has been shown that this relation can arise in dynamic models where firms trade off tax shields and bankruptcy costs [Hennessy and Whited (2005) and Strebulaev (2006)]. Our analysis shows that it can also arise cross-sectionally in a dynamic incomplete contracts model, even if the choice of financing is for the most part irrelevant.

Because we have wanted to focus on pure control rights effects, we have kept the model deliberately stripped down. However, the model naturally lends itself to extensions that would allow studying a number of important issues. For example, the repeated interaction feature of the model allows one to take the model in a direction where one can study true, dynamic capital structure in an incomplete contracts setting by including multiple opportunities for new developments and multiple rounds of financing. Additionally, introducing uncertain cash flows would establish a link to contingent claims valuation of corporate securities [Black and Scholes (1973), Merton (1974)]. Thus, the model could be adapted to study the dynamic interaction of financing and growth while pricing corporate securities in a setting where dividends and debt service are strategic, as in Anderson and Sundaresan (1996) and Mella-Barral and Perraudin (1997).

Appendix

Proof of Lemma 1

Consider an hypothetical equilibrium where the firm is kept alive in perpetuity. Denote the manager who is running the firm at date τ by $M(\tau)$. Let $V_{I\tau}$ and $V_{m\tau}$ be the present value of current and future cash flows under the hypothesized equilibrium for investors and $M(\tau)$, respectively. $V_{I\tau}$ must be at least L, otherwise investors would do better by liquidating the firm. $V_{m\tau}$ must be at least π_2, since the manager has the opportunity to consume the entire date τ cash flow (which is π_2). When the firm is kept alive in perpetuity under outside managers, the present value of the cash flows produced at date τ and in the future is $\pi_2(1+r)/r$. It follows that we must have

$$\frac{\pi_2(1+r)}{r} \geq L + \pi_2,$$

or

$$r \leq \frac{\pi_2}{L} = r^*.$$

This establishes that there is no equilibrium where the firm is kept alive in perpetuity if $r > r^*$.

Next we show that the strategies described in the Lemma [(a) and (b)] constitute a subgame perfect equilibrium, where the firm is kept alive in perpetuity, when y_2 satisfies (9) and $r \leq r^*$. We first show that the strategies constitute Nash equilibrium. Under the proposed equilibrium, the firm is kept alive forever under the same manager whose payoff as of an arbitrary date τ is

$$V_{m\tau} = \frac{(1-y_2)\pi_2(1+r)}{r} \geq \pi_2$$

since $y_2 \leq 1/(1+r)$ by (9). Thus the manager is better off adhering to (a) than not. Since all outside managers use the same strategy, investors are not better off replacing the current manager. Furthermore, investors are better off keeping the manager than liquidating, since $y_2 \geq rL/[(1+r)\pi_2]$ by (9). Given the strategies played by investors and other managers, an outside manager who may potentially be hired could not do better than using the same strategy as the current manager if he (the new manager) were to be hired. This establishes Nash equilibrium.

To establish subgame perfection, note first that since investors suffer no loss in payoff from replacing the current manager, they have a credible threat to replace him. The current manager therefore cannot benefit from paying a lower dividend than $y_2\pi_2$. Second, since there is an infinitely deep pool of alternative managers, the principle of induction establishes that the alternative manager also cannot do better than playing the same strategy as the incumbent once the outside manager is hired; the alternative manager is only placed in charge if the incumbent deviates, moreover, once this happens, the alternative simply becomes the new incumbent and is indistinguishable from the previous manager. Third, since all outside managers use the same strategy, investors cannot gain by replacing the current manager when he pays a dividend of $y_2\pi_2$. This establishes subgame perfection. □

Proof of Theorem 1

Part 1¿ Most of the work is already done in the text. To complete the proof, suppose that y_2 satisfies (9) such that the firm is viable as a going concern under an outside manager. Substituting in the expression for γ_m [equation (18)] into (17), we see that there is a managerial equilibrium if $r \le r_m^*$ and

$$y_2 \ge \frac{\pi_1}{\pi_2} - \frac{r^2 I}{\pi_2}.$$

Substituting in the expression for γ_e [equation (19)] into (17), we see that there is an entrepreneurial equilibrium if $r \le r_e^*$ and

$$y_2 \le \frac{\pi_1}{\pi_2} - \frac{r^2 I}{(1+r)\pi_2}.$$

Part 2.

Necessary condition (only if): Consider first the subgame that starts after the capital investment has been made. Since $I \ge L$, we must have $\pi_1(1+r)/r > L$, otherwise the cash flows would not be sufficient to cover the cost of investment. Consider an hypothetical equilibrium where the firm is kept alive forever under the entrepreneur, since this maximizes the total pie to be shared between investors and the entrepreneur. At the largest discount rate for which financing can be raised, we must have $\gamma = 0$. Thus, along the same lines as in the proof of Lemma 1, we must have $r \le \frac{\pi_1}{L}$. Since $I \ge L$, we can repeat this line of argument to establish that financing can only be raised if $r \le \frac{\pi_2}{I} = r_e^*$.

Sufficient condition (if):

Consider first the subgame that starts after the capital investment has been made. If $r \leq \frac{pi_1}{L}$, along the same lines as in the proof of Lemma 1, we have that for any y_1 satisfying

$$\frac{rL}{(1+r)\pi_1} \leq y_1 \leq \frac{1}{1+r} \tag{38}$$

the following is an equilibrium: (a) the entrepreneur uses the payout ratio $y_{1t} = y_1$; (b) shareholders play

$$s_{t+1} = \begin{cases} \text{retain} & \text{if } y_{1t} \geq y_1 \\ \text{liquidate} & \text{if } y_{1t} < y_1. \end{cases} \tag{39}$$

At date 0, since $I \geq L$ it is straightforward that it is equilibrium for investors to provide financing and the entrepreneur to pay out y_1, if $r < r_e^*$. This establishes Part 2 of the theorem. □

Proof of Theorem 2

Part 1: This is established in the text.

Part 2: The case that $r \leq \phi$ is established in the text. So suppose $r > \phi$. As discussed in the text, in this case a grace period is necessary and we set $d_0 = \pi_1$ and $d_1 = (I - \pi_1)r$. (34) then implies that there is y_2 for which it is incentive compatible to service this debt when an outside manager is in place if and only if $r \leq \phi^*$, where ϕ^* is implicitly defined by

$$\phi^*(1+\phi^*)^2 = \frac{\pi_2}{I - \pi_1}.$$

By the observation immediately after equation (35), the entrepreneur's incentive compatibility constraint for servicing debt prior to the appointment of the outside manager will also be satisfied since $d_0 < d_1$.

To conclude the proof of *Part 2* we need to verify that $\phi < \phi^* < r_m^*$. By definition, r_m^* is such that $q(r_m^*) = g(r_m^*)$, where $q(r) \equiv 1/(1+r)$ and $g(r) \equiv Ir/\pi_2$. By definition, ϕ^* is such that $q(\phi^*) = h(\phi^*)$, where $h(r) \equiv (I - \pi_1)r(1+r)/\pi_2$.

First, $g(r)$ is strictly increasing and linear and $h(r)$ is strictly increasing and strictly convex. Furthermore, $g(0) = h(0) = 0$ and $g(\phi) = h(\phi)$. This implies that for all $r > \phi$, we have $h(r) > g(r)$.

Second, $q(r)$ is strictly decreasing and $q(\phi) > g(\phi) = h(\phi)$ (since $\phi < r_m^*$). It follows that the point of intersection between $h(r)$ and $q(r)$, at $r = \phi^*$, is larger than ϕ. It also follows that ϕ^* is smaller than the r at which $g(r)$ intersects $q(r)$. In other words, $\phi^* < r_m^*$. □

Proof of Theorem 3

Part 1 (hold-up): From Theorems 1 and 2, we know that only debt financing can be raised if $r \leq r_e^*$ and y_2 is within the stated bounds. In particular, if $y_2 < Ir/\pi_2$ it is impossible to raise equity financing in a managerial equilibrium, and if $y_2 > \pi_1/\pi_2 - Ir/[(1+r)\pi_2$ entrepreneurial equilibria are not possible since the entrepreneur would prefer not to match dividends if his shareholding is γ_e (as given by (19)). Thus if these two conditions are met, equity financing cannot be raised.

Part 2 (Double Moral Hazard): From Theorems 1 and 2, we know that only equity financing can be raised if $r > \phi$ and y_2 is within the stated bounds. In particular, if $r > \phi$, the cost of capital is larger than the yield on the project under the entrepreneur, implying that financing cannot be raised in an entrepreneurial equilibrium and that a grace period is needed under debt financing. When $y_2 > Ir/\pi_2$, equity financing can be raised in a managerial equilibrium provided that the managerial incentive compatibility constraint, $y_2 < 1/(1+r)$, is satisfied. This constraint also needs to be satisfied if debt financing is to be raised in a managerial equilibrium. Finally, if $y_2 < (I - \pi_1)r(1+r)\pi_2$, we showed above that debt financing cannot be raised in a managerial equilibrium. This completes the proof. □

The following will be used in the proofs of the propositions below.

By Theorem 3, for any tuple (r, y_2), debt and equity are outcome equivalent except for a tuple in the two regions specified in the statement of the theorem. Since we assume that debt and equity are equally likely when they are outcome equivalent, any differences between debt and equity with respect to second stage growth are therefore determined on these two regions. Let Regions 1 and 2 be as described in Parts 1 and 2, respectively, in Theorem 3.

Proof of Proposition 1

On Region 1, only debt financing can be raised. Here, $\pi_1 > y_2\pi_2$ and so second stage growth is not achieved. On Region 2, only equity financing can be raised and second stage growth is achieved (here, $r > \phi$ implying that financing cannot be raised in an entrepreneurial equilibrium).[26] Thus, the probability of second stage growth is higher conditional on equity financing than conditional on debt financing. □

Proof of Proposition 2

Since I is independent of future profits, the Proposition follows immediately from Proposition 1 and the uniform distribution assumption. □

Proof of Proposition 3

Economy with positive level of governance ($y_2 \geq \pi_1/\pi_2$): In this case, any difference between debt and equity are determined on Region 2. The proposition follows directly from the fact that Region 2, where only equity can be raised, is to the right of the set of (y_2, r)'s on which debt and equity financing can both be raised and are outcome equivalent. In other words, if we fix y_2' and pick r' such that equity and debt both can be raised, then if $(y_2', \hat{r})$ is in Region 2, $\hat{r} > r'$. Hence $y_2'\pi_2 - \hat{r}I < y_2'\pi_2 - r'I$. The proposition follows by integrating over y_2.

Economy with negative level of governance ($y_2 < \pi_1/\pi_2$): In this case, any difference between debt and equity are determined on Region 1. The proposition follows directly from the fact that Region 1, where only debt can be raised, is to the right of the set of (y_2, r)'s on which debt and equity financing can both be raised and are outcome equivalent. □

Proof of Proposition 4

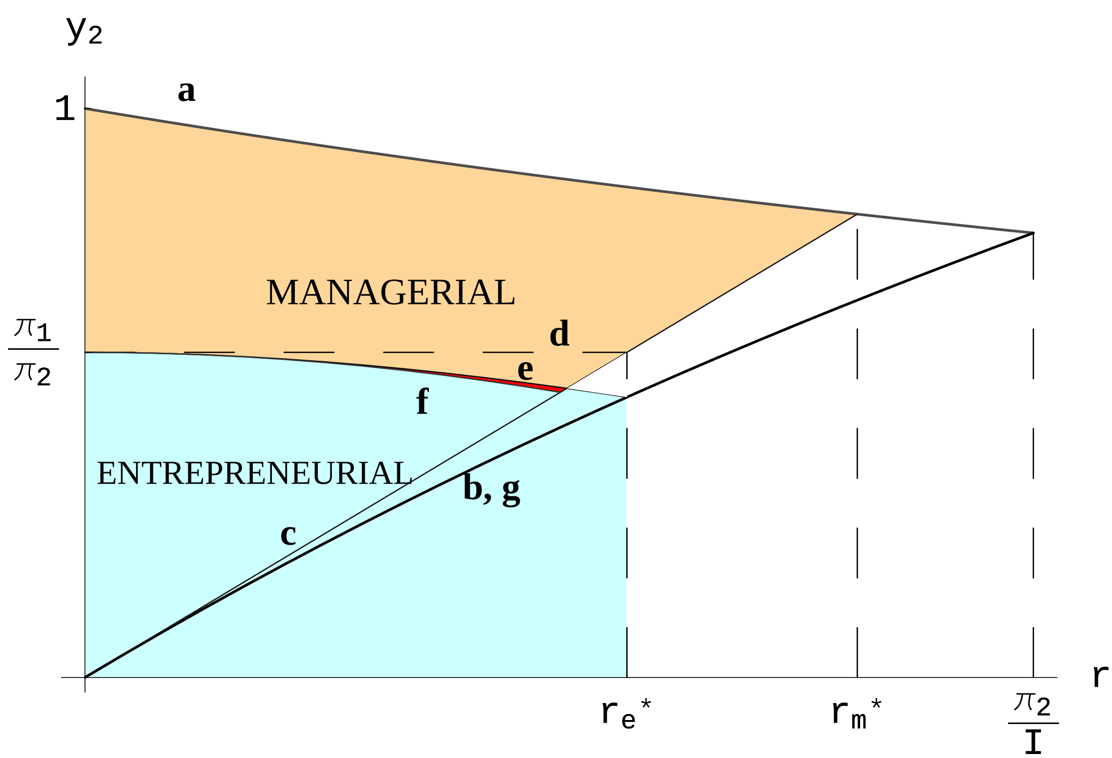
As y_2 increases from 0 and up to π_1/π_2 the set of discount rates for which only debt financing can be raised increases. Thus debt becomes more likely. □

[26] If $r_m^* \leq r_e^*$, Region 2 is empty.

Appendix 1: Figures

Figure 1: Equilibria under equity financing

This figure summarizes our analysis of the equity contract. The lines represent incentive compatibility and other constraints as described in the legend (see next page). Parameter values are: $I = L = 100$, $\pi_1 = 16$, $\pi_2 = 28$, yielding $r_e^* = .16$, $r_m^* = .2280$, and $\pi_2/I = .28$. The firm can be financed by equity and operate under the entrepreneur for discount rates less than r_e^* and payout rates below line **e**. This area is colored light blue (shaded light). The firm can be financed by equity and operate under outside management for combinations of discount rates and payout rates lying below **a** and above max[line **f**, line **c**]. This area is colored orange (shaded medium dark). For combinations of r and y_2 in the area between lines **e** and **f**, indicated by red (shaded dark), both managerial and entrepreneurial equilibria are possible. Colorless (nonshaded) areas represent combinations of y_2 and r for which equity financing is not feasible.



Legend for Figure 1

a Outside manager's incentive compatibility constraint

$$y_2 \leq \frac{1}{1+r}$$

b Investors' incentive compatibility constraint (do not liquidate outside manager)

$$y_2 \geq \frac{Ir}{(1+r)\pi_2}$$

c Financing provided in a managerial equilibrium

$$y_2 \geq \frac{Ir}{\pi_2}$$

d Feasibility of entrepreneur matching dividends of outside manager

$$y_2 \leq \frac{\pi_1}{\pi_2}$$

e Entrepreneur prefers to match dividends if $\gamma = \gamma_e$

$$y_2 \leq \frac{\pi_1}{\pi_2} - \frac{Ir^2}{(1+r)\pi_2}$$

f Entrepreneur prefers not to match dividends if $\gamma = \gamma_m$

$$y_2 \geq \frac{\pi_1}{\pi_2} - \frac{Ir^2}{\pi_2}$$

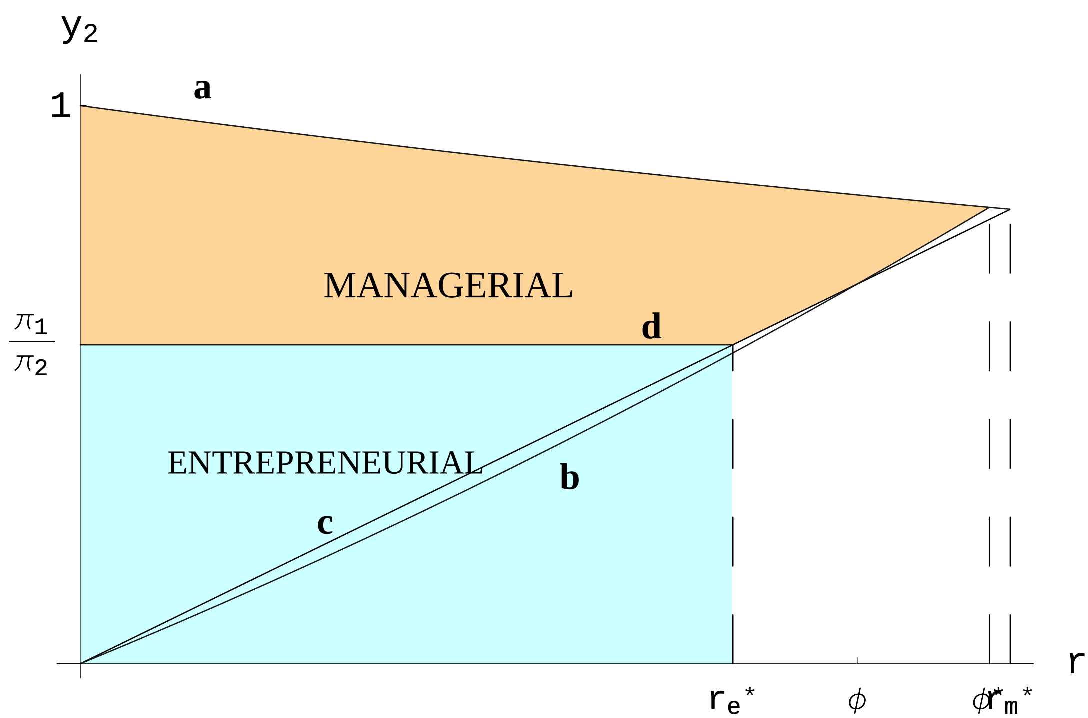
g Financing provided in entrepreneurial equilibrium (assuming firm can be kept alive by outside manager)

$$y_2 \leq \frac{Ir}{(1+r)\pi_2}$$

This uses $y_1\pi_1 = y_2\pi_2$ and is functionally equivalent to constraint **b**.

Figure 2: Equilibria under debt financing

This figure summarizes our analysis of the debt contract. The lines represent incentive compatibility and other constraints as described in the legend (see next page). Parameter values are: $I = L = 100$, $\pi_1 = 16$, $\pi_2 = 28$, yielding $r_e^* = .16$, $r_m^* = .2280$, $\phi = .1905$, and $\phi^* = .2229$. The firm can be financed by debt and operate under the entrepreneur for discount rates less than r_e^* and payout rates below line **d**. This area is colored light blue (shaded light). The firm can be financed by equity and operate under outside management for combinations of discount rates and payout rates lying below **a** and above max[line **d**, line **c**,line **b**]. This area is colored orange (shaded medium dark). Colorless (nonshaded) areas represent combinations of y_2 and r for which equity financing is not feasible.



Legend for Figure 2

a Outside manager's incentive compatibility constraint

$$y_2 \leq \frac{1}{1+r}$$

b Financing provided in a managerial equilibrium with a grace period (and $d_0 = \pi_1$)

$$y_2 \geq \frac{(I - \pi_1)r(1+r)}{\pi_2}$$

c Financing in a managerial equilibrium without a grace period

$$y_2 \geq \frac{Ir}{\pi_2}$$

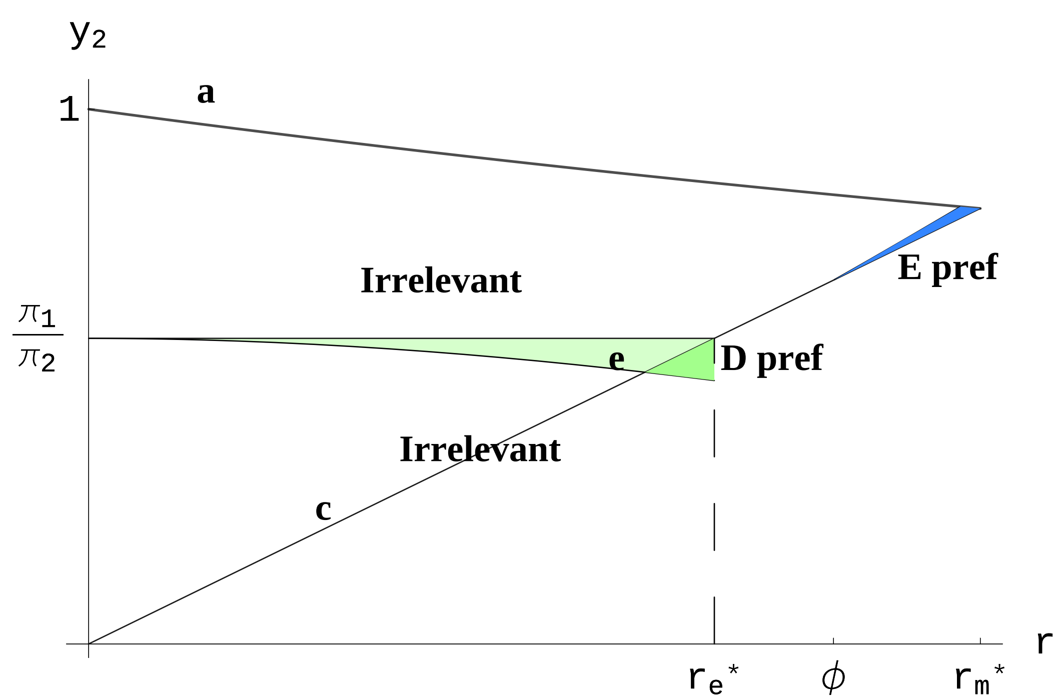
d Feasibility of entrepreneur matching dividends of outside manager

$$y_2 \leq \frac{\pi_1}{\pi_2}$$

Figure 3: Comparison of debt versus equity financing[27]

This figure combines Figures 1 and 2 and compares debt versus equity financing. The lines represent incentive compatibility and other constraints as described in the legends of the previous two figures (see particular the legend for Figure 1 for lines **a**, **c**, and **e**). Parameter values are: $I = L = 100$, $\pi_1 = 16$, $\pi_2 = 28$, yielding $r_e^* = .16$, $r_m^* = .2280$, $\phi = .1905$.

In regions marked "irrelevant", debt and equity lead to identical equilibrium payoffs. Debt is preferred in the region colored green (medium shading), bordered above by line **c**, below by **e**, and to the right by r_e^*. In this region, equity gives rise to a hold-up problem making equity financing infeasible, as described in the text. Debt is weakly preferred in the region colored light green (light shading), bordered above by $y_2 = \pi 1/\pi 2$, below by max[line **e**, line **c**]. In this region, equity financing can be raised but gives rise to inefficient replacement, due to the hold-up problem. Thus, in this region, the incentive to do R&D is reduced under equity financing relative to debt financing. Equity is preferred in the region colored blue (shaded dark), bordered by line **a**, line **c**, and the unlabeled line segment to the left of line **c** (which is a segment of line **b** in Figure 2).



[27]Figure 3 is drawn under the assumption that if (r, y_2) is such that both a managerial and an entrepreneurial equilibria exist, the entrepreneurial one obtains. This has the effect of making the choice between debt and equity irrelevant in the region that is colored red (shaded dark) in Figure 1, a detail which does not alter the message of Figure 3.

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