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Abstract

The option to terminate a manager early minimizes investor losses if he is unskilled. However, it also deters a skilled manager from undertaking long-term projects that risk low earnings. This paper demonstrates how risky debt can overcome this tension. Leverage concentrates equityholders' stakes, creating incentives for them to learn the cause of low earnings. If they result from investment (poor management), the firm is continued (liquidated). Therefore, unskilled managers are terminated and skilled managers can invest without fear of termination. Unlike models of managerial discipline based on total payout, here dividends are not a substitute for debt – they achieve termination upon nonpayment, but not concentration, ex post monitoring and thus ex ante investment. Debt is dynamically consistent as the manager benefits from monitoring by a concentrated investor. In traditional theories, monitoring constrains the manager; here it frees him to take long-term projects, contrasting the standard intuition that debt reduces investment. The model derives implications for how capital structure and dividend policy depend on the relative severity of different agency problems.

KEYWORDS: Termination, liquidation, managerial myopia, ownership concentration, monitoring, leverage, private equity
JEL CLASSIFICATION: D82, G32, G33

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1 Introduction

This paper studies the tension between two first-order problems faced by the modern firm: how to terminate unskilled managers early, and how to induce skilled managers to pursue growth. The recent financial crisis demonstrates the substantial losses that can occur if misguided decisions are left unchecked. One key challenge for shareholders is to detect and halt such mistakes early. A quite separate challenge is how to incentivize managers to invest for the long-term. Nowadays, competitive success increasingly hinges upon intangible assets such as human capital (Zingales (2000)). Since intangibles are invisible to outsiders in the short-term, managers concerned with interim performance may underinvest (Stein (1988).)

These two challenges fundamentally conflict. Investors can mitigate the value destroyed by an unskilled manager by forcing him to reveal short-term earnings, thus giving themselves the option to terminate him if profits are low. However, the same termination threat may deter a skilled manager from undertaking efficient long-term projects that risk low short-term earnings.

This paper demonstrates how risky debt can alleviate this tension, by playing two distinct roles which address the two separate challenges. The *disciplinary effect* of debt addresses termination by forcing the manager to make an interim cash payment. The failure to do so reveals to investors that earnings are weak, the manager is likely unskilled, and thus termination might be desirable. Indeed, Jensen (1989) argues that this disciplinary effect is a primary reason for why buyouts are typically levered: debt is "a mechanism to force managers to disgorge cash rather than spend it on empire-building projects." However, such a justification for debt leaves many questions unanswered. First, dividends can also impose discipline: as Jensen also notes, "debt is a substitute for dividends." Second, buyouts typically feature a concentrated shareholder – but, if the key feature is the discipline imposed by debt, equityholders are irrelevant and dispersed ownership would be equally effective. Third, it is the manager who controls leverage going forward, and he has incentives to raise equity to repay the debt and free himself from its discipline. Fourth, the disciplinary effect may deter long-term investment.

This is where the second effect of debt comes in: the *concentration effect*, which addresses investment. Our core model contains a single firm, single large investor and a continuum of atomistic investors. If atomistic investors provide debt, the large investor's limited funds comprise a greater proportion of the total equity. Thus, a non-paying manager is not automatically fired; instead, the large investor's concentrated stake gives her an incentive to gather costly information on the underlying cause of weak earnings. If the cause is low managerial skill, the firm is liquidated; if the cause is investment, it is continued. Knowing that investors will make an informed liquidation decision ex post, the manager pursues long-run growth ex ante. A skilled manager invests without fear of termination; an unskilled manager is efficiently terminated.

The concentration effect distinguishes this paper from prior theories on the disciplinary role of debt: it has different implications for the substitutability of dividends for debt, the effect of debt on investment, the optimal level of debt, and the concurrence of risky debt with concentrated equity. In Jensen (1986), Stulz (1990) and Zwiebel (1996), debt also forces the manager

to pay out cash. Dividends would have the same disciplinary effect and are thus a perfect substitute: these models are theories of total payout (debt plus dividends) rather than debt in particular. Here, debt is critically different from dividends because the financing structure must not only allow termination (impose discipline), but also induce investment. The latter requires the concentration effect, which only debt has. Turning to the effect of debt, in Jensen (1986) and Stulz (1990), debt reduces investment by lowering free cash. Here, debt can increase investment, since it encourages investors to monitor and thus become aware of the investment, inducing the manager to undertake it in the first place. Moving to the optimal level of debt, in a number of disciplinary models, the efficient amount of debt is borderline nonrepayable. Since the only role of debt is to impose discipline, it should be just high enough that a bad type cannot pay it. In Lambrecht and Myers (2008), strictly nonrepayable debt induces the manager to disinvest suboptimally quickly; here, it is efficient as it increases concentration. Finally, the model predicts that leverage should coincide with concentrated equity investors who actively monitor, as documented empirically by Cotter and Peck (2001).

The above predictions are primarily generated by the concentration effect. Moreover, by analyzing two distinct and conflicting agency problems (liquidation and investment), the model studies the interaction between the concentration and disciplinary effects together, which generates additional implications. These relate to the joint determinants of capital structure and dividend policy as a function of the relative severity of a firm's agency issues. While standard empirical studies analyze the determinants of overall leverage (e.g. Rajan and Zingales (1995)), this paper emphasizes that leverage is the product of two factors: the level of total payout (debt plus dividends) and the division of a given level of total payout between debt and dividends. The importance of short-term termination determines the need for the disciplinary effect and thus the level of total payout. If termination is unlikely to be optimal (e.g. the firm is a start-up with low liquidation value), total payout should be low; indeed, such firms are typically unlevered and pay no dividends. The importance of long-term investment determines the need for the concentration effect and thus the composition of total payout. If growth opportunities are attractive, any payout should be in the form of debt. Along the cross section, while Rajan and Zingales find that leverage is negatively correlated with growth opportunities, the model predicts a positive correlation once total payout is controlled for. Rajan and Zingales's negative correlation suggests that a growing firm prefers to be unlevered – but if termination is important, being unlevered is not an option. The appropriate comparison is debt versus other forms of payout that would achieve termination; debt is less detrimental to growth than dividends.

One application of the model is to leveraged buyouts, where debt is substantial and leads to a concentrated shareholder who actively monitors. LBOs are often undertaken to impose discipline on managers and force them to scrap inefficient projects, but monitoring helps ensure that the requirement to make interim payments does not lead efficient investment being cut. Indeed, Denis (1995) finds that Kroger's recapitalization, where ownership remained dispersed, led to significant reductions in capital expenditure. In contrast, in Safeway's LBO where KKR took a concentrated stake, debt was serviced mainly by asset sales. Similarly, Cotter and

Peck (2001) find that LBOs perform more strongly if ownership is concentrated. Kaplan and Strömberg (2009) show that, from the 1990s, buyouts have predominantly been in middle-aged firms in industries such as IT/media/telecoms, financial services and healthcare, which likely have valuable growth opportunities. Lerner, Sorensen and Strömberg (2010) find that LBOs lead to no decrease in innovation activity and an increase in the quality of innovation.

The above single-firm model is analyzed in Section 2. Section 3 extends the model to multiple large investors and heterogeneous managers, where good managers have a higher probability of becoming inspired than bad types. A separating equilibrium is sustainable where bad managers run unlevered firms financed exclusively by small shareholders, and good managers run levered firms and are financed by both large and atomistic investors who earn abnormal returns. One interpretation of the latter is private equity; indeed, Ljungqvist and Richardson (2003) find that private equity investors enjoy superior returns.

The two roles of debt, which lead to firm viability in a single-manager setting, also achieve separation in a multi-manager setting. The disciplinary effect of debt renders it a *credible* signal of managerial quality: bad managers avoid leverage as they are likely to default. However, if only credibility of the signal mattered, borderline nonrepayable debt would be optimal – debt should be just high enough that a bad type defaults; additional debt would augment signaling costs. In addition, dividends would be equally credible as they also have a disciplinary effect: indeed, Bhattacharya (1979) shows that the Ross (1977) idea of signaling value with debt can also be achieved with dividends.

However, credibility is not the only issue. The signal must be a *desirable* one that good managers wish to emit. In standard models, a good manager automatically wishes to reveal his quality, as his pay is exogenously assumed to depend on short-run value (Ross (1977), Bhattacharya (1979)) or signaling quality is necessary to raise financing (Myers and Majluf (1984), Fulghieri and Lukin (2001).) Here, pay is not tied to short-run value and even bad managers can raise financing, so the traditional motives to signal do not exist. This is where the concentration effect comes in: it provides a motive to signal. This motive is not to obtain a greater *level* of funds, but to attract a different *type* of funds. Signaling quality attracts large investors. A large investor provides no more funds than several small investors, but is critically different as she has the incentive to monitor, thus allowing an inspired manager to take the long-term project. Since good managers have a greater probability of becoming inspired, this advantage is more important to them and separation is achieved.

The different motives for signaling lead to different results on the dynamic consistency of debt and the effect of signaling on total surplus. In this and other models, debt hurts the manager owing to the disciplinary effect, but he willingly bears these costs to signal quality. If the goal of signaling is to raise funds, it is already achieved in the first period. Hence, once funds have been raised, the manager has incentives to delever and free himself from discipline. This concern applies not only to signaling theories, but single-firm models in which investors initially impose debt on the manager to solve free cash flow problems (e.g. Jensen (1986) and Stulz (1990).) However, as noted by Zwiebel (1996), it is the manager who controls leverage

going forward, and he may subsequently reduce it to increase free cash.

Here, debt is dynamically consistent since its advantages are not confined to the first period, and so the manager has an incentive to retain it. Debt benefits the manager by inducing monitoring: this requires not only attracting a large investor through initially signaling quality, but also persuading her to monitor in the future by maintaining leverage. In short, the disciplinary effect renders debt a credible signal in the first period. The concentration effect renders it a desirable signal that the firm wishes to maintain in future periods. This persistence of leverage in a given firm is consistent with the findings of Lemmon, Roberts and Zender (2008).

The manager's desire for monitoring in turn results from our analysis of a different agency problem to prior debt theories. In Jensen (1986), Stulz (1990) and Zwiebel (1996), there is a fundamental effort conflict where firm value maximization requires the manager to exert effort or forgo private benefits. Investors' role is thus to be an "adversary" of the manager, preventing shirking or private benefits. Monitoring hurts the manager, and so he wishes to delever to reduce investors' incentives to do so. Here, there is no effort conflict with respect to project selection: the long-term project maximizes both firm value and private benefits. A monitor's role is to be an "ally" of the manager, allowing him to choose the project that he wishes to anyway in the absence of termination concerns. Since the monitor helps the manager, the latter has an incentive to retain the former through maintaining leverage.[1]

Turning to welfare effects, signaling reduces fundamental value in traditional models. In Ross (1977), signaling leads to bankruptcy risk; in Stein (1988) and Miller and Rock (1985) it reduces investment. There are no offsetting positive real effects as separation merely changes outsiders' *perceptions* of short-run value. In Myers and Majluf (1984) and Fulghieri and Lukin (2001), signaling does have real benefits, because it allows a firm to raise financing and thus invest. Here, the real benefits arise through a quite different mechanism. Signaling has no effect on the *level* of funds raised: firms receive the same as in a pooling equilibrium. Instead, the benefit comes in the different *type* of funds. Signaling allocates scarce large investors to good managers, who benefit most from monitoring as they are most likely to become inspired. In turn, monitoring improves investment.

Some features of this paper have been individually examined in prior models. By bringing together effects studied in previously disparate literatures, this paper analyzes unexplored interactions (e.g. the conflict between termination and investment, and the concentration effect alleviating a side-effect of the disciplinary effect) and thus generates new insights unattainable from piecing together the individual results of prior research. In Boot and Thakor (1993), as in this paper, leverage concentrates shareholders' fixed dollar wealth and induces monitoring.[2]

[1] Zwiebel (1996) also achieves dynamic consistency, through the different mechanism of an ever-present raider (an adversary).

[2] In Boot and Thakor and the present paper, debt is valuable as it makes equity informationally sensitive and induces shareholders to monitor. By contrast, in Gorton and Pennacchi (1990), the desirability of debt arises because it is informationally insensitive and its owners have low incentives to monitor. Thus, uninformed investors wish to trade debt. Mahrt-Smith (2004) studies how institutional factors jointly affect capital structure and ownership structure, rather than the how the former affects the latter.

In their model, monitoring has no real effects. While one could piece together their result with the literature on the effect of blockholders on real decisions (e.g. Burkart, Gromb and Panunzi (1997)) and conclude that the concentration effect can alleviate agency issues, this paper explicitly models two specific and conflicting agency problems to deliver new results. For example, applying the standard result that the blockholder exerts discipline (e.g. Burkart et al.) suggests the manager will unlever; here he wishes to retain the blockholder. In a model of investment alone, growth could simply be induced by giving the manager a long-term contract and so there is no need for concentration; this paper adds a termination problem to create endogenous short-term concerns for the manager and overturn the standard intuition that debt harms investment, when compared with other mechanisms that allow termination. Considering both problems allows us to break down debt into total payout (which depends on the termination issue) and its composition between debt and dividends (which depends on the investment issue), generating joint implications for capital structure and dividend policy.

The concentration effect also echoes Jensen and Meckling (1976) and Innes (1990), where debt magnifies a manager's equity holding, *directly* inducing effort.[3] Here, there is no fundamental effort conflict, yet debt is still effective. Leverage incentivizes effort by investors rather than the manager, *indirectly* inducing him to choose the efficient project. The model contains two layers of agency problems: investor monitoring and managerial investment; solving the former addresses the latter.[4] With a single problem of managerial investment, debt would not be a solution. Other papers contain a link between leverage and monitoring that does not arise through concentration. In Townsend (1979), debt is optimal and verification only occurs in bankruptcy, as in this model; his is a pure exchange economy with no real effects. In Harris and Raviv (1990), debt leads to monitoring because they exogenously assume that an audit occurs if and only if the firm is bankrupt. In reality, investigations can occur at all times; we endogenize the monitoring decision.[5] Von Thadden (1995) shows how debt can exert discipline; dividends would have the same effect. He also considers myopia and demonstrates that it can be alleviated by monitoring, which he assumes to be contractible. This paper demonstrates how debt can induce non-verifiable monitoring. In Gümbel and White (2007), debt induces monitoring by shifting control to a "tough" investor, rather than by the concentration effect.[6] As in von Thadden, the manager makes an effort decision and the monitor is an adversary; here she is an ally, giving the manager a reason to retain her. Edmans (2009) also links concentrated ownership to ex post monitoring and thus ex ante investment. He assumes exogenous short-

[3] In Stulz (1988) and Harris and Raviv (1988), debt gives the manager a greater share of votes, enabling him to resist takeover attempts. They do not consider investment decisions.

[4] Application of Jensen and Meckling (1976) suggests that the shareholder should be levered, since the effort conflict is at the shareholder level. Here, the conflict is addressed by introducing leverage at the firm level. The large shareholder's wealth is the maximum that she can invest after taking on all feasible personal leverage.

[5] Debt has a second informational role in Harris and Raviv: non-payment reveals that cash flows are low. This role is also featured here and is not unique to debt – non-payment of dividends has the same effect.

[6] Specifically, debt shifts control to the creditor, who is biased towards shut-down owing to his concave claim. Since the equityholder has a convex claim, she has incentives to gather information to allow the firm to continue. Here, debt has no control shift effect compared to dividends: equityholders in a firm that has missed its dividend are already tough and wish to liquidate the firm – the essence of the myopia issue.

term concerns and that the blockholder's investment can always be increased if required and capital structure is irrelevant. Here, her funds are limited and monitoring is instead induced by debt. This method of increasing concentration has an important advantage: while the dollar investment is chosen by the blockholder, leverage is under the manager's control.

Diamond (1991, 1993) also considers the costs and benefits of short-term debt. As in this paper, short-term debt can lead to inefficient liquidation, although not investment distortions as there is no project selection decision. The benefit of short-term debt is that a high-quality borrower expects that positive information will freely appear, reducing the cost of refinancing. In this paper, information is costly and debt has the different objective of inducing its production. Diamond (1984) does consider monitoring incentives; as in Edmans (2009), monitoring is induced by increasing the dollar investment by the monitor rather than by capital structure. In addition, the monitor in Diamond is a creditor and motivated to monitor by the possibility of downside protection. Here, a key benefit of monitoring is upside potential through growth opportunities, which is only enjoyed by the monitor if she is a shareholder. In Aghion and Bolton (1992) and Dewatripont and Tirole (1994), an interim termination/continuation decision also depends on the realization of a public signal. In those models, the signal automatically appears; here it must be generated at a cost and so the financial structure must elicit monitoring. Cohn and Rajan (2010) also feature a concentrated outside investor whose governance role is to generate a public signal, rather than engage in direct intervention like an "adversary". None of the papers mentioned consider dividends as a potential alternative to debt.

Our modeling setup draws from Stein (2005), who also analyzes the tension between liquidation and long-term decisions, within the context of arbitrageurs contemplating long-run convergence trades. This paper builds on Stein by adding leverage and a monitoring technology, to allow both issues to be solved simultaneously.

2 The Model

A penniless manager (M) seeks financing of I dollars for a project. There exists a single large investor (L) who has funds of x, and a pool of atomistic investors with one dollar each, where $1 < x < I$. In reality, L corresponds to an institutional investor such as a private equity fund or mutual fund, and the atomistic investors represent households.[7] There are four periods, summarized in Figure 1. At $t = 0$, M raises x of funds from L and $I - x$ of funds from the atomistic investors. (It will become clear that any structure in which L invests less than x is weakly dominated, as her monitoring incentives are weaker.) M is restricted to issue the standard securities of debt and equity (in any combination); as we will show, this restriction is without loss of generality. As in an IPO, all equityholders pay the same price for their shares

[7] x is the maximum that L is able to invest after taking on as much personal leverage as she is able (or chooses) to. The assumption of limited funds, even in the presence of personal leverage, is standard in the literature (see, for example, Boot and Thakor (1993) and Fulghieri and Lukin (2001)) and necessary in models of ownership structure. If x was unlimited, a single investor would be able to own the entire firm, which would cure most agency problems.

and all creditors pay the same price for their debt. F is the face value of debt raised; it matures at $t = 2$ and its market value D is determined to ensure all creditors break even. M can also promise a dividend at $t = 2$. Let P denote the total payment required at $t = 2$, which is the sum of the debt repayment F and the promised dividend. For brevity, we sometimes use the term "financing structure" to refer to M's joint decisions of capital structure and dividend policy.

At $t = 1$, with probability π the manager is "inspired", i.e. obtains an investment idea. Whether he is inspired is private information. An inspired manager can invest in either a Risky (R) or Safe (S) investment project; the project choice is noncontractible. (We will sometimes refer to choosing R rather than S as "investing".) An uninspired manager has no good ideas and loses money over time. At $t = 2$ the firm generates unobservable cash E (also referred to as "earnings.") If the firm is liquidated at $t = 2$ it is worth $V_2 \geq E$; if it is continued until $t = 3$ it is worth V_3 (also referred to as "fundamental value.") Note that V_3 is the firm's *total* value accrued over its life – it is not incremental to E. V_2 is verifiable at $t = 2$ if the firm is liquidated, and V_3 is verifiable at $t = 3$ if the firm is still in existence. The manager is assumed to be essential for the firm's continuation, so termination of the manager is equivalent to liquidation of the firm; thus, these terms are used interchangeably.

As in Stein (2005), equityholders capture the full surplus, so creditors break even and M's objective function consists of private benefits, such as reputational concerns or utility from incumbency, which are increasing in both firm value and his tenure. He earns b_2 if the firm is terminated and b_3 in total if the firm is continued, and his outside option is zero. Appendix B shows that the model's results also hold if M instead receives a fraction of the firm's assets that increases in his tenure. The payoffs are given below:

Table 1: Payoffs to Investment Strategies

	Uninspired	Inspired, S	Inspired, R
E	V^U	K^S	V^U with probability γ, K^S w.p. $1-\gamma$
V_2	K^U	K^S	K^U if $E = V^U$, K^S if $E = K^S$
V_3	V^U	V^S	V^R
b_2	b^L	b^L	b^L
b_3	b^M	b^M	b^H

The parameters in Table 1 satisfy the following conditions:

$$V^U < K^U < I \tag{1}$$

$$K^U - V^U > b^M - b^L \tag{2}$$

$$V^R > V^S > K^S > I \tag{3}$$

$$b^M > b^L > 0 \tag{4}$$

$$b^H > b^M. \tag{5}$$

(1) means that terminating an uninspired manager at $t = 2$ increases investor returns; (2) means it also increases total surplus. (3) demonstrates that R leads to a higher V_3 than S. The disadvantage of R is that it has a probability γ of leading to the same low earnings as an uninspired manager at $t = 2$. We will sometimes refer to a manager who chooses R but delivers $E = V^U$ as "unlucky" or suffering "interim losses." (4) denotes that M prefers not to be terminated. (5) means that M's incentives are aligned with investors if the firm is allowed to continue until $t = 3$: the same project that maximizes firm value (R) also maximizes M's private benefits. This distinguishes the paper from models of the effort conflict, where actions that benefit investors are intrinsically costly to managers. While E is unobservable directly, the above conditions mean that promising $P > V^U$ reveals E to investors: only firms for which $E = K^S$ will be able to make the full repayment, so failure to pay reveals that $E = V^U$. A required payment of $P > V^U$ thus has a *disciplinary effect*.[8]

At $t = 2$, events proceed as follows. First, the level of E determines which claimholders (creditors, if there are any, or shareholders) are in control and have the right to choose whether to continue or liquidate the firm. Creditors have control if $E < F$, else shareholders. Second, to guide the liquidation decision, any investor may choose to engage in monitoring at $t = 2$; the decision to monitor is unobservable. Monitoring costs the investor c and has a probability $\phi < 1$ of success; as in Diamond (1984), we assume no gains from duplicate monitoring.[9] If monitoring succeeds, it generates a publicly observable, unverifiable signal that is fully informative of V_3.[10] Formally, the public signal is $N \in \left\{V^R, V^S, V^U, \varnothing\right\}$, where N stands for "news." V^i indicates that $V_3 = V^i$ and $\varnothing$ is the null signal that appears if no monitoring occurs, or monitoring occurs and is unsuccessful (w.p. $1 - \phi$). Third, the party in control takes the continuation/liquidation decision based on the signal N and the level of earnings E, if the latter has been revealed via

[8] Since the maximum possible E is K^S, we restrict the analysis to $P \leq K^S$ and so for brevity do not include the condition $P \leq K^S$ in the rest of the paper.

[9] We assume that the cost is non-pecuniary (e.g. effort expenditure or an opportunity cost). The model can easily be extended to allow c to be a financial cost, as in Boot and Thakor (1993) and Fulghieri and Lukin (2001). In addition, investors cannot coordinate to share the monitoring costs. This assumption is standard in any model with multiple shareholders (see also, e.g., Burkart, Gromb and Panunzi (1997), Maug (1998), Kahn and Winton (1998), Bolton and von Thadden (1998)) – if perfect coordination is possible, shareholder structure is irrelevant. The results continue to hold if shareholders can coordinate but at a cost. The model can be easily extended to allow gains from duplicate monitoring; it would involve additional conditions to ensure that households will not monitor which would lengthen the analysis.

[10] The nonverifiability of the signal rules out contracts that directly reward L for producing a signal. The assumption that signals are observable but noncontractible is standard in the incomplete contracts literature (e.g. Aghion and Bolton (1992) and Dewatripont and Tirole (1994).) It is likely difficult to write into a contract what constitutes a good or bad signal, even though this will be evident ex post, since the number of possible such signals is likely to be very large. Once the signal is discovered, its nature (good or bad) is unambiguous – for example, monitoring could involve undertaking an independent analysis of a drug in progress or the quality of an existing product. Even if we allow the signal to be falsified, the monitor has no incentives to do so since, given the signal, all parties agree on the termination decision. The model can be extended to signals that are only privately observable to the monitor. To ensure the monitor does not shirk and simply claim to have found a positive signal, she could write credit protection to credibly communicate a positive signal, communicate it via trading shares (see, e.g., Edmans (2009)), or there could be a cost of communicating the signal so that she will only do so if the signal is truly positive. The analysis assumes observable signals since our focus is information acquisition incentives; the credible communication of acquired information has been studied elsewhere.

$P > V^U$. Formally, she chooses action $A : N \times E \to \{T, C\}$[11] where T involves terminating the manager and liquidating the firm, and C involves continuing the firm. If a signal is generated, all investors agree on the optimal decision – firm value is maximized by liquidation upon $N = V^U$ and continuation upon $N \in \left\{V^R, V^S\right\}$; since both debt and equity are non-decreasing in firm value, this termination policy is followed regardless of who has control. When $N = \varnothing$ and so firm value is uncertain, we will show that, under the optimal financing structure, the party in control will always take the first-best decision. Thus, the identity of the party in control does not matter. This deliberately distinguishes the model from Dewatripont and Tirole (1994), Grinstein (2006) and Gümbel and White (2007) where the signal is not fully informative and so creditors may take the conservative action T even when it is inefficient, because they have a concave claim in the firm. Here, the driver of capital structure is monitoring incentives rather than control rights. In sum, if a signal is generated, it is sufficient to determine A and earnings do not matter; earnings only affect A if there is no signal. Thus, the action function is either $A(N)$ or $A(\varnothing, E)$. The timing of events is similar to Aghion and Bolton (1992) and Dewatripont and Tirole (1994) except that in those papers, the public signal automatically appears; here, it must be generated at a cost.[12]

The first-best solution involves an uninspired manager always being terminated at $t = 2$, and an inspired manager always choosing R at $t = 1$ and being continued at $t = 2$. To make the financing problem interesting, we need to impose two sets of parametric restrictions. The first ensures that the investment problem exists in the first place, i.e. a manager forced to make a high interim payment will myopically choose S, but can be cured by monitoring. It is clearer to introduce these assumptions later during the actual analysis, as the reader can more easily see their effect. These will be conditions (10), (11) and (15). The second ensures that the termination and investment problems are sufficiently severe that, if unsolved, the firm is negative-NPV – i.e. the firm is only viable if we achieve sufficiently close to first-best. These assumptions are as follows:

$$\pi V^S + (1-\pi)K^U < I \tag{6}$$

$$\pi V^R + (1-\pi)V^U < I. \tag{7}$$

Condition (6) states that, if an inspired manager always chooses S, the firm is unprofitable – even if investors obtain the maximum possible liquidation value of K^U if M is uninspired. Condition (7) states that, if an uninspired manager is never terminated, the firm will not be profitable – even if investors obtain the maximum possible terminal value of V^R if M is inspired. Thus, for the firm to be financed, both the investment and termination issues must be (at least partially) solved. While we impose conditions (10), (11) and (15) throughout the paper, we will

[11] This is a slight abuse of notation since N and E are elements of sets rather than sets, but we use it since there is no possibility of confusion.

[12] Also as in these papers, we assume no bankruptcy costs in a reorganization (i.e. when creditors have control and continue the firm); if bankruptcy costs exist, they reduce the desirability of debt. Since the negative effect of bankruptcy costs on leverage has been well explored in the literature, we exclude them here.

relax (6) and (7) in Section 2.4.

The full optimization problem involves M choosing the amount of debt and equity to issue to both L and atomistic investors, the amount of dividends to promise and the level of monitoring for each investor to undertake, to maximize his private benefits subject to the participation constraint that all investors at least break even, and the incentive constraint that each investor's monitoring decision is incentive compatible. To highlight the importance of monitoring, and the role of debt in inducing non-contractible monitoring, we commence in Section 2.1 by analyzing a variant of the model in which monitoring is impossible and derive conditions under which the firm is unviable, and thus the optimal financing structure must involve monitoring with positive probability. We assume contractible monitoring in Section 2.2 and show that the firm is viable when monitoring occurs. In Section 2.1, the optimization problem does not involve M choosing each investor's level of monitoring nor monitoring incentive constraints; in Section 2.2, M chooses the monitoring level but there are no incentive constraints. Section 2.3 considers the core model with non-contractible monitoring and thus all constraints, and analyzes how to induce monitoring via the choice of financing structure. Section 2.4 compares total surplus under different financing structures. We use the Perfect Bayesian Equilibrium (PBE) solution concept throughout: all players take the optimal actions given their beliefs about other players' actions, these beliefs are correct in equilibrium, and updated according to Bayes' rule.

2.1 No Monitoring

If there is no monitoring technology, the action A cannot depend on the signal N, but can depend on earnings E if they are revealed through a disciplinary payment of $P > V^U$. Since there is no monitoring constraint in Sections 2.1 and 2.2, there is no role for debt and so we can assume that the payment P is entirely in the form of dividends without loss of generality. We first consider the case where $P \leq V^U$ so all firms can make the payment. Since investors never learn E, M need not worry about it and can simply choose R if inspired. If

$$\pi V^R + (1-\pi)V^U > \pi\left(\gamma K^U + (1-\gamma)K^S\right) + (1-\pi)K^U, \tag{8}$$

firm value is maximized under continuation at $t = 2$. Since equity value equals firm value, shareholders always take the efficient termination decision that maximizes firm value (in this case, continuation at $t = 2$), and so the termination decision is renegotiation-proof.[13] From (6) and $V^S > K^U > K^S$, the right-hand side of (8) is less than I. Thus, for the remainder of the paper, we assume that (8) holds – if it did not hold, then the left-hand-side of (8) would be less than I and the firm would not be viable, from (7). Since the firm is always continued, it is worth V^R if M is inspired and V^U otherwise.

[13] A renegotiation-proof termination decision is one that maximizes firm value, rather than total surplus (the sum of firm value and private benefits). This is because private benefits are inalienable and so the manager cannot offer them in a renegotiation.

Lemma 1 *(No monitoring, no discipline). Assume that no monitoring occurs. In the subgame following the announcement of a non-disciplinary payment $P \leq V^U$, the unique PBE is the following:*

(i) If the firm is financed, the manager chooses R if inspired.

(ii) If the firm is financed, it is never liquidated at $t = 2$.

(iii) The firm is not financed.

Proof Since the probability of termination is unaffected by the manager's choice, part (i) follows automatically from (5). For part (ii), investors' beliefs are $\pi(1-\gamma)$ that the manager has chosen R and $E = V^U$, $\pi\gamma$ that the manager has chosen R and $E = K^S$, and $1-\pi$ that the manager is inspired. From (8), the firm is continued. For part (iii), the expected gross return to investors is

$$\pi V^R + (1-\pi)V^U. \tag{9}$$

From (7), investors make a loss, and therefore will not finance the firm to begin with. ■

The problem with the above structure is that an uninspired manager is never terminated, since he is not forced to reveal his low earnings at $t = 2$. Since investors' participation constraint is violated, they will not finance the firm. A possible solution is for M to promise a disciplinary payment of $P > V^U$. Since an uninspired manager cannot make such a payment, his low quality is revealed even without a monitoring technology, allowing efficient liquidation. However, the disadvantage is that the high payment requirement may deter an inspired manager from choosing R since it risks yielding $E = V^U$, in which case he cannot make the payment and may be viewed as uninspired. This leads to the following Lemma.

Lemma 2 *(No monitoring, discipline). Assume that no monitoring occurs and that the following two conditions hold:*

$$\frac{1-\pi}{1-\pi+\pi\gamma}V^U + \frac{\pi\gamma}{1-\pi+\pi\gamma}V^R < K^U, \tag{10}$$

$$(1-\gamma)b^H + \gamma b^L < b^M. \tag{11}$$

In the subgame following the announcement of a disciplinary payment $P > V^U$, the unique PBE is the following:

(i) If the firm is financed, the manager chooses S if inspired.

(ii) If the firm is financed, it is liquidated at $t = 2$ if the payment is not met, otherwise it is continued.

(iii) The firm is not financed and all payoffs are zero.

Proof Let an inspired manager pursue a mixed strategy of R w.p. α and S w.p. $(1-\alpha)$. The posterior probability that a non-paying manager is inspired is $\frac{\pi\alpha\gamma}{1-\pi+\pi\alpha\gamma}$. Investors will terminate the firm if $\frac{1-\pi}{1-\pi+\pi\alpha\gamma}V^U + \frac{\pi\alpha\gamma}{1-\pi+\pi\alpha\gamma}V^R < K^U$, which holds from (10). This proves part (ii). Given

this, part (i) follows from (11). For part (iii), the expected gross return to investors is

$$\pi V^S + (1-\pi)K^U. \tag{12}$$

From (6), investors make a loss, and therefore will not finance the firm to begin with. ■

The intuition is as follows. The maximum posterior probability that a non-paying manager is inspired is $\frac{\pi\gamma}{1-\pi+\pi\gamma}$. This probability is reached if an inspired manager always chooses R, otherwise the posterior is lower. Equation (10) means that investors prefer to terminate a non-paying manager: even if the posterior probability that M is inspired is the highest possible, it is still insufficient to outweigh the gains from early liquidation if M is uninspired. Equation (11) shows that an inspired manager myopically chooses S to avoid the risk of non-payment; by (6), the firm is not viable if an inspired manager never chooses R. For the remainder of the paper, we assume that (10) – (11) hold, else there is no myopia problem to begin with: an inspired manager nonchalantly chooses R.

Combining the results of Lemmas 1 and 2 yields the following corollary:

Corollary 1 *(Firm unviable without monitoring.) In the absence of a monitoring technology, the firm cannot be financed.*

Proof Directly from Lemmas 1 and 2. ■

The firm cannot be financed without monitoring. If a low payment is promised, an inspired manager chooses R but an uninspired manager is never terminated. If a high payment is promised, an uninspired manager is terminated but an inspired manager chooses S. This is the tension between termination and investment, which is the heart of the paper.

The model has a close parallel to the case in which E is publicly observable and so there is no need for a disciplinary payment. The high-payment case of Lemma 2 corresponds to giving M a short-term contract which allows him to be fired at $t = 2$. This enables investors to terminate an uninspired manager, but deters an inspired manager from choosing R. The low-payment case of Lemma 1 corresponds to giving M a long-term contract which guarantees his employment until $t = 3$. This induces investment, but prevents termination if $E = V^U$. Indeed, in standard myopia models (e.g. Stein (1988)), the manager is exogenously assumed to place weight on interim earnings but the investment issue would be solved by a long-term contract; here such a solution is unworkable as there is also a termination issue. In both interpretations, the essence of myopia is information asymmetry: investors can only base their termination decisions on observable variables, and without monitoring they can only observe earnings E (either directly if it is public or indirectly via observing the payment) rather than fundamental value V_3.

2.2 Contractible Monitoring

We now introduce a contractible monitoring technology. While we assume that monitoring is verifiable, we continue to assume that investors cannot observe whether M is inspired or

which project he selects. This highlights the fact that eliciting monitoring is sufficient both to induce optimal project selection by an inspired manager and to overcome an uninspired manager's desire to continue – i.e. solving investors' moral hazard problem is sufficient to solve M's. If M's project choice and inspiration were observable, monitoring would be unnecessary as investors could just terminate a manager it knows to be uninspired and instruct an inspired manager to choose R. That the key effort decision is at the investor level distinguishes the model from Jensen and Meckling (1976), where debt is used to directly solve agency problems at the manager level.

Since L has the greatest stake in the firm, she has the strongest incentive to monitor (which will become important in Section 2.3 when monitoring is non-contractible), so the analysis focuses on her being the monitor. If monitoring is successful, the efficient action is given by $A\left(V^U\right) = T$ and $A\left(V^R\right) = A\left(V^S\right) = C$. If monitoring is unsuccessful, there are four possible termination policies. The first is $A\left(\varnothing\right) = C$, i.e. the firm is always continued. Since the termination decision does not depend on E, an inspired manager need not be concerned with E and so chooses R. If he is uninspired, with probability ϕ monitoring succeeds and investors terminate the firm for K^U; else the firm is continued and investors recover V^U. The returns to all investors and the manager are given by:

$$\pi V^R + (1-\pi)\left(\phi K^U + (1-\phi)\, V^U\right) - c \tag{13}$$

$$\pi b^H + (1-\pi)\left(\phi b^L + (1-\phi)\, b^M\right). \tag{14}$$

A second option is $A\left(\varnothing, V^U\right) = T$, i.e. at $t = 0$ M has promised $P > V^U$. Note that L does not need to monitor if the payment has been made as this reveals $E = K^U$ and thus $A = C$ is optimal. If the payment is missed (which reveals $E = V^U$), monitoring occurs and the firm is terminated if $N \in \left\{V^U, \varnothing\right\}$. Since the termination decision now depends on E, an inspired manager who chooses R risks termination if he is unlucky (w.p. γ) and monitoring fails (w.p. $1-\phi$). Nevertheless, he still chooses R if

$$\left(1 - \gamma\left(1-\phi\right)\right) b^H + \gamma\left(1-\phi\right) b^L > b^M, \tag{15}$$

i.e. the gain in private benefits from pursuing R outweighs the risk of termination. The key difference with (11), M's incentive constraint without monitoring, is that he is only terminated with probability $\gamma\left(1-\phi\right)$ rather than γ – even if he is unlucky, he is continued if monitoring is successful. Put differently, monitoring means that (w.p. ϕ) investors make the liquidation decision according to fundamental value rather than earnings. Therefore the manager chooses the project which maximizes fundamental value rather than earnings, i.e. R. We assume that (15) holds throughout the paper, otherwise monitoring becomes irrelevant as it cannot cure myopia. In sum, assumptions (10), (11) and (15) jointly mean that M acts myopically if and

only if there is no monitoring. The returns to all investors and the manager are given by:

$$(\pi - \pi\gamma(1-\phi))V^R + (1 - \pi + \pi\gamma(1-\phi))K^U - (1 - \pi + \pi\gamma)c. \tag{16}$$

$$(\pi - \pi\gamma(1-\phi))b^H + (1 - \pi + \pi\gamma(1-\phi))b^L. \tag{17}$$

A third possibility is $A(\varnothing) = T$. As with $A(\varnothing) = C$, E is irrelevant for the termination decision so an inspired manager chooses R. However, from (8), it is never efficient to terminate a manager in the absence of a signal or earnings realization. A final possibility is $A\left(\varnothing, V^U\right) = C$ (i.e. monitor if and only if a disciplinary payment is not met, and continue the firm if monitoring is unsuccessful), but from (10) it is never efficient to continue a loss-making manager in the absence of a signal. Thus, neither of these termination policies are renegotiation-proof.

In sum, both $A(\varnothing) = C$ or $A\left(\varnothing, V^U\right) = T$ involve renegotiation-proof termination decisions. Comparing (13) and (16), the difference is that if monitoring fails, $A\left(\varnothing, V^U\right) = T$ leads to the "Type I error" of inefficient termination of an inspired but unlucky manager, and $A(\varnothing) = C$ leads to the "Type II error" of inefficient continuation of an uninspired manager. Note that (10) implies that (16) > (13). This is intuitive: (10) means it is optimal to shut down a loss-making manager in the absence of a signal, and so Type II errors are more important than Type I errors. Thus, $A\left(\varnothing, V^U\right) = T$ maximizes investor returns as it minimizes Type II errors. However, since (14) > (17), M's payoff is higher and so either $A(\varnothing) = C$ or $A\left(\varnothing, V^U\right) = T$ may be the first-best termination policy that maximizes total surplus (the sum of firm value and private benefits).[14] If firm value is relatively important, $A\left(\varnothing, V^U\right) = T$ is first-best; if private benefits are relatively important, $A(\varnothing) = C$ is first-best. (Note that, if investors' participation constraints can be satisfied under $A(\varnothing) = C$, the manager will choose it since his private benefits are higher.)

Since monitoring is contractible, there are no incentive constraints and only participation constraints. Let $w(\cdot)$ be the payoff received by L for a given firm value; we later show how to implement the payoff function $w(\cdot)$ by the choice of capital structure. The following Lemmas summarize the two potential first-best termination policies.

Lemma 3 *(Monitoring, no discipline). Assume that L always monitors. In the subgame following the announcement of a non-disciplinary payment $P \leq V^U$, the unique PBE is the following:*

(i) If the firm is financed, the manager chooses R if inspired.

(ii) If the firm is financed, it is liquidated at $t = 2$ if $N = V^U$, otherwise it is continued.

[14] The "efficient termination *decision*" and the "first-best termination *policy*" are two separate concepts. The former is a $t = 2$ concept: after any payment, if promised, has been made or not made, and any signal has been realized, is it optimal to terminate or continue the firm? The latter is a $t = 0$ concept that also studies whether it is optimal to demand a payment in the first place (and thus make the termination decision depend on it), i.e. compares returns *across* the cases where a payment is promised and a payment is not promised. An additional difference is the first-best termination policy maximizes total surplus, whereas the efficient termination decision maximizes investor returns alone since it is concerned with renegotiation proofness (see also footnote 11).

(iii) If the firm is financed, the expected gross returns to L and all households are, respectively:

$$\pi w\left(V^R\right) + (1-\pi)\left(\phi w\left(K^U\right) + (1-\phi)\, w\left(V^U\right)\right) - c, \tag{18}$$

$$\pi\left(V^R - w\left(V^R\right)\right) + (1-\pi)\left(\phi\left(K^U - w\left(K^U\right)\right) + (1-\phi)\left(V^U - w\left(V^U\right)\right)\right), \tag{19}$$

If (18) $\geq x$ *and* (19) $\geq I - x$*, the firm is financed and the manager's payoff is*

$$\pi b^H + (1-\pi)\left(\phi b^L + \left(1-\phi\right)b^M\right). \tag{20}$$

Proof Part (i) is as in Lemma 1. For part (ii), the optimal A is automatic for $N \neq \varnothing$. For $N = \varnothing$, $A = C$ from (8). Part (iii) follows from simple calculations. ■

Lemma 4 *(Monitoring, discipline). Consider the subgame following the announcement of a disciplinary payment $P > V^U$ and assume that L monitors if the payment is not met. The unique PBE is the following:*

(i) If the firm is financed, the manager chooses R if inspired.

(ii) If the firm is financed, it is liquidated at $t = 2$ if both the payment is not met and $N \in \left\{V^U, \varnothing\right\}$, otherwise it is continued.

(iii) If the firm is financed, the expected gross returns to L and all households are, respectively:

$$\left(\pi - \pi\gamma\left(1-\phi\right)\right) w\left(V^R\right) + \left(1 - \pi + \pi\gamma\left(1-\phi\right)\right) w\left(K^U\right) - \left(1 - \pi + \pi\gamma\right) c, \tag{21}$$

$$\left(\pi - \pi\gamma\left(1-\phi\right)\right)\left(V^R - w\left(V^R\right)\right) + \left(1 - \pi + \pi\gamma\left(1-\phi\right)\right)\left(K^U - w\left(K^U\right)\right). \tag{22}$$

If (21) $\geq x$ *and* (22) $\geq I - x$*, the firm is financed and the manager's payoff is*

$$(\pi - \pi\gamma(1-\phi))b^H + (1 - \pi + \pi\gamma(1-\phi))b^L. \tag{23}$$

Proof Part (i) is as in Lemma 2. For part (ii), the optimal A is automatic for $N \neq \varnothing$. For $N = \varnothing$, $A = T$ from (10). Part (iii) follows from simple calculations. ■

2.3 Non-Contractible Monitoring

We now move to the core case of non-contractible monitoring. The previous two sub-sections have shown that the firm is viable only if monitoring occurs, so we focus on how to induce voluntary monitoring by L. We consider the two potential first-best termination policies in turn. $A(\varnothing) = C$ corresponds to $P \leq V^U$, in which case L's incentive constraint is:

$$\phi\left(1-\pi\right)\left(w\left(K^U\right) - w\left(V^U\right)\right) \geq c. \tag{24}$$

Since the default decision is continuation, a signal is only valuable if it leads to termination, i.e. delivers $N = V^U$. This occurs if the manager is uninspired (w.p. $(1-\pi)$) and monitoring is successful (w.p. ϕ.) Efficient termination augments L's payoff by $w\left(K^U\right) - w\left(V^U\right)$.

$A\left(\varnothing, V^U\right) = T$ corresponds to $P > V^U$, in which case L monitors at $t = 2$ if and only if the payment is missed. The incentive constraint is now:

$$\phi \frac{\pi\gamma}{1-\pi+\pi\gamma}\left(w\left(V^R\right) - w\left(K^U\right)\right) \geq c. \tag{25}$$

The posterior probability that a non-paying manager is inspired is $\frac{\pi\gamma}{1-\pi+\pi\gamma}$, in which case successful monitoring leads to efficient continuation and so L's payoff rises by $w\left(V^R\right) - w\left(K^U\right)$.

In either case, L's payoff $w(\cdot)$ must be sufficiently sensitive to firm value for monitoring to be incentive compatible. Since $w(\cdot)$ can only take on two values in either case, regardless of which termination policy we wish to implement, it is sufficient to consider linear schemes that satisfy limited liability. Such a scheme has the general form $w(z) = \max(gz + h, 0)$. Since a positive h increases $w\left(K^U\right)$, $w\left(V^U\right)$ and $w\left(V^R\right)$ equally, it has no effect on monitoring incentives and so we can consider only non-positive h. The payoff function $w(z) = \max(gz + h, 0)$ for $h \leq 0$ can be implemented by issuing debt with face value $-h/g$ and giving L equity. Without loss of generality, we can thus the analysis to M issuing only the standard securities of debt and equity, and L holding equity. L thus has an equity stake of $\frac{x}{I-D}$. In the presence of multiple claims (debt and equity) it is not automatic that the party in control will take the efficient termination decision when $N = \varnothing$, so we must verify that the termination decision is efficient (so that there is no scope for renegotiation) in addition to L's monitoring incentives.

Termination policy $A(\varnothing) = C$ involves $P \leq V^U$ and thus can be implemented with debt of $F \leq V^U$; since the payment is non-disciplinary, there is no role for dividends. Termination policy $A\left(\varnothing, V^U\right) = T$ can be implemented by two methods. The first is issuing risky debt of $F > K^U$. There is no role for dividends, since risky debt already achieves a disciplinary effect. The second is a combination of debt and dividends that creates a total required payment $P > V^U$. This latter includes the case of $V^U < F \leq K^U$: while debt of $F > V^U$ is risky to the manager since he cannot repay it if he delivers $E = V^U$, it is not risky to creditors if $F \leq K^U$, since they can recover K^U in a liquidation. We thus use the terms "riskless" and "risky" debt to denote the cases of $F \leq K^U$ and $F > K^U$, and "repayable" and "nonrepayable" debt to denote the cases of $F \leq V^U$ and $F > V^U$. We consider these three cases in turn.

2.3.1 Risky Debt

We first consider $F > K^U$. Creditors have control if $E = V^U$. If $N = \varnothing$, they liquidate the firm if

$$\frac{1-\pi}{1-\pi+\pi\gamma}V^U + \frac{\pi\gamma}{1-\pi+\pi\gamma}F < K^U. \tag{26}$$

This holds as a direct consequence of (10); (10) also means that liquidation is efficient.[15]

We now consider whether L will gather information. With risky debt and L owning equity, $w\left(V^R\right) = \frac{x}{I-D}\left(V^R - F\right)$ and $w\left(K^U\right) = 0$. Indeed, from the general incentive constraint (25), L's monitoring incentives are maximized when $w\left(K^U\right)$ is at its lowest possible value of 0; this is achieved by having risky debt of at least K^U. Then, the incentive constraint (25) becomes

$$\phi \frac{\pi\gamma}{1-\pi+\pi\gamma} \frac{x}{I-D}(V^R - F) \geq c. \tag{27}$$

The left-hand side of (27) contains the term $\frac{x}{I-D}$. We denote the positive effect of F on $\frac{x}{I-D}$ and thus monitoring incentives as the *concentration effect*. (We will shortly derive conditions on F to ensure that (27) is satisfied).

With incentive-compatible monitoring and efficient termination under a disciplinary payment, the equilibrium is similar to Lemma 4 and given as follows:

Lemma 5 *(Risky debt, no dividends.) Assume that* (27) *holds. In the subgame in which there is risky debt of $F > K^U$ and no dividends, the following is a PBE:*

(i) If the firm is financed, the manager chooses R if inspired.

(ii) If the firm is financed and the payment is met, L does not monitor at $t = 2$. If the payment is not met, L monitors. If $N \in \left\{V^R, V^S\right\}$, the firm is continued, otherwise it is liquidated. If the payment is not met and L does not monitor, the firm is liquidated.

(iii) The expected gross returns to L and all other shareholders are, respectively:

$$\frac{x}{I-D}\left[(\pi - \pi\gamma(1-\phi))\left(V^R - F\right)\right] - (1-\pi+\pi\gamma)c, \tag{28}$$

$$\frac{I-D-x}{I-D}\left[(\pi - \pi\gamma(1-\phi))\left(V^R - F\right)\right], \tag{29}$$

If (28) $\geq x$*, the firm is financed and the manager's payoff is*

$$(\pi - \pi\gamma(1-\phi))b^H + (1-\pi+\pi\gamma(1-\phi))b^L, \tag{30}$$

else the firm is not financed and all payoffs are zero.

(iv) If the firm is financed, the market value of debt is given by

$$D = (\pi - \pi\gamma(1-\phi))\,F + (1-\pi+\pi\gamma(1-\phi))\,K^U. \tag{31}$$

[15] (10) also means that, even if we introduce new players into the model (potential new investors at $t = 2$), the manager cannot continue by raising external funds – since the firm is now negative-NPV, no investor will finance it. A outside investor also has no incentive to pay c to decide whether to inject equity. The core model assumes public signals and so a non-investor can never profit from monitoring. Here we consider private signals. If the signal is bad, she will not invest and thus loses c overall. If the signal is good, she will try to inject equity but the firm will infer the good signal and price equity so that she gets zero return on the injection, and again loses c overall. If we assume that new investors have bargaining power and can profit from an equity injection, the results of the model still go through – debt is beneficial as it means that new investors are able to obtain concentrated stakes, increasing their profit from investing on a good signal and thus their monitoring incentives.

Proof Parts (i) and (ii) are as in Lemma 4. Parts (iii) and (iv) follow from simple calculations. Since (28) $\geq x$ implies (29) $> I - D - x$, (28) $\geq x$ is sufficient for all shareholders' participation constraints to be satisfied and so the firm to be financed. ■

The lower bound to F is the minimum debt level that allows (27) to be satisfied. Substituting (31) into (27) defines the lower bound as:

$$\underline{F} = \frac{c\left(1-\pi+\pi\gamma\right)\left(I-(1-\pi+\pi\gamma(1-\phi))K^U\right)-\phi\pi\gamma x V^R}{c\left(1-\pi+\pi\gamma\right)\left(\pi-\pi\gamma(1-\phi)\right)-\phi\pi\gamma x}. \tag{32}$$

The upper bound to F is given by substituting (31) into $D = I - x$, i.e.

$$\overline{F} = \frac{I-x-\left(1-\pi+\pi\gamma(1-\phi)\right)K^U}{\pi-\pi\gamma(1-\phi)}. \tag{33}$$

Therefore, if

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}\left(V^R-\overline{F}\right) \geq c, \tag{34}$$

then monitoring can be induced under risky debt. If (34) is violated, the monitoring technology is sufficiently ineffective that, even if L holds the firm's entire equity, she still does not monitor.

The power of risky debt comes from two effects. The first is the disciplinary effect. Debt forces the firm to pay out cash. Since uninspired managers cannot meet the payout requirement, they are efficiently terminated. However, the disciplinary effect has the potential disadvantage of deterring inspired managers from choosing R. This is where the second role of risky debt comes in: the concentration effect. Leverage increases L's equity stake and thus her monitoring incentives: mathematically, a rise in F augments D (from (31)) and thus $\frac{x}{I-D}$ in (27). Note that there is a countervailing effect: an increase in F reduces shareholders' benefits from efficient continuation of an unlucky manager, which are $V^R - F$. This is because creditors receive $F - K^U$ from efficient continuation, and therefore capture more of the gains. This is an example of the Myers (1977) "debt overhang" effect. Combining the two effects, a rise in F reduces the total gains to all shareholders from efficient continuation, but gives L a greater proportion of these equity gains. The overall effect of increasing F on L's incentives is given by differentiating the left-hand side of (27) to yield:

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}x\frac{\left(V^R-F\right)\left(\pi-\pi\gamma(1-\phi)\right)-(I-D)}{(I-D)^2}. \tag{35}$$

If the firm is viable (i.e. (28) $\geq x$ holds), we have (29) $> I - D - x$ which implies (35) > 0, i.e. the concentration effect of debt outweighs the debt overhang effect. Put differently, the firm is viable under risky debt only if the net benefits of debt are positive, as is intuitive.

2.3.2 Repayable Debt and No Dividends

We now turn to the case of repayable debt of $D = F \leq V^U$. Since shareholders always have control, and repayable debt simply reduces their payoff in all cases by F, it has no effect on

their termination decision and the efficient termination decision is always implemented. We first assume no dividends, so $P = F \leq V^U$ and all firms can make the payment. This corresponds to policy $A(\varnothing) = C$, where an inspired manager chooses R and the firm is continued if $N = \varnothing$. We have $w\left(K^U\right) = \frac{x}{I-F}\left(K^U - F\right)$ and $w\left(V^U\right) = \frac{x}{I-F}\left(V^U - F\right)$ so the monitoring constraint (24) becomes:

$$\phi(1-\pi)\frac{x}{I-F}\left(K^U - V^U\right) \geq c. \tag{36}$$

If (36) is satisfied, then L always monitors. Hence, repayable debt achieves both (occasional) liquidation and investment. The equilibrium is the following analog of Lemma 3:

Lemma 6 *(Repayable debt, no dividends.) Assume that* (36) *holds. In the subgame in which there is repayable debt of $F \leq V^U$ and no dividends, the unique PBE is the following:*

(i) If the firm is financed, the manager chooses R if inspired.

(ii) If the firm is financed, L monitors at $t = 2$. If $N = V^U$, the firm is liquidated, otherwise it is continued. If L does not monitor, the firm is continued.

(iii) If the firm is financed, the expected gross returns to L and all other shareholders are, respectively:

$$\frac{x}{I-F}\left[\pi V^R + (1-\pi)\left(\phi K^U + (1-\phi)V^U\right) - F\right] - c \tag{37}$$

$$\frac{I-F-x}{I-F}\left[\pi V^R + (1-\pi)\left(\phi K^U + (1-\phi)V^U\right) - F\right], \tag{38}$$

else the firm is not financed and all payoffs are zero.

If (37) $\geq x$*, the firm is financed and the manager's payoff is:*

$$\pi b^H + (1-\pi)\left(\phi b^L + \left(1-\phi\right)b^M\right). \tag{39}$$

Proof Parts (i) and (ii) are as in Lemma 3. Part (iii) follows from simple calculations. Since (37) $\geq x$ implies (38) $> I - D - x$, (28) $\geq x$ is sufficient for all shareholders' participation constraints to be satisfied and so the firm to be financed. ■

It may not be possible to satisfy (36) with repayable debt. L's monitoring incentives are maximized when F is at its highest possible repayable value of V^U. Indeed, from the general incentive constraint (24), L's monitoring incentives are maximized when $w\left(V^U\right)$ is at its lowest possible value of 0; since L holds equity, this is achieved by having debt of V^U. Thus, if

$$\phi(1-\pi)\frac{x}{I-V^U}\left(K^U - V^U\right) < c, \tag{40}$$

then L will not monitor under repayable debt. The equilibrium is as in the no-monitoring, low-payment case (Lemma 1); the firm is unviable since an uninspired manager is never terminated. (40) is likely to be satisfied when I is large compared to x (L's funds fall significantly short of the total needed to finance the firm) and V^U is small (repayable debt capacity is low).

Repayable debt has a concentration effect, but no disciplinary effect and thus suffers two drawbacks. First, in the absence of discipline, the default decision is to continue the firm, and so the gains from monitoring are the savings from efficient liquidation, $K^U - V^U$. In contrast, the disciplinary effect of risky debt changes the default decision to liquidation. Therefore, the incentive to monitor depends on the gains from continuation, $V^R - F$. This may be significantly larger than $K^U - V^U$, particularly in growth firms where V^R is high. Thus, the incentive constraint (36) may be violated. Second, even if the incentive constraint can be satisfied (i.e. (40) does not hold), L monitors excessively. Monitoring is only worthwhile if $E = V^U$, because if $E = K^S$, L automatically knows that M is inspired. Since all firms can repay the debt, L is unable to learn E and must pay the monitoring cost in all states. Thus, the participation constraint (37) $\geq x$ may be violated. The disciplinary effect of risky debt reveals E without cost: if the firm meets its debt repayment, L knows that $E = K^S$ and so does not need to monitor. This echoes Townsend (1979), where verification only occurs in bankruptcy.

2.3.3 Riskless Debt and Dividends

The two weaknesses of repayable debt can be addressed by increasing P above V^U in one of two ways: either increasing F to between V^U and K^U so that it becomes nonrepayable (but stays riskless), or combining it with a dividend promise exceeding $V^U - F$, so that $P > V^U$. The combination of riskless debt and a dividend leads to a disciplinary effect and addresses both of the above issues. If $F \leq V^U$ (i.e. the discipline comes from dividends), shareholders have control if $E = V^U$ and always take the efficient termination decision as in Section 2.3.2. If $F > V^U$, creditors have control if $E = K^S$ and liquidate if (26) holds, which is efficient as in Section 2.3.1. We have $w\left(V^R\right) = \frac{x}{I-F}\left(V^R - F\right)$ and $w\left(K^U\right) = \frac{x}{I-F}\left(K^U - F\right)$. L's incentive constraint becomes:

$$\phi \frac{\pi\gamma}{1-\pi+\pi\gamma} \frac{x}{I-F}\left(V^R - K^U\right) \geq c. \tag{41}$$

Lemma 7 *(Riskless debt, dividends.) Assume that* (41) *holds. In the subgame in which there is riskless debt of* $F \leq K^U$ *and dividends so that* $P > K^U$*, the strategy profile in Lemma 5 is a PBE.*

If (41) is satisfied, riskless debt and dividends have the same effect as risky debt. However, it may not be possible to satisfy (41) with riskless debt. L's monitoring incentives are maximized when F is at its highest possible riskless value of K^U. Thus, if

$$\phi \frac{\pi\gamma}{1-\pi+\pi\gamma} \frac{x}{I-K^U}\left(V^R - K^U\right) < c, \tag{42}$$

then insufficient concentration is achieved under riskless debt. The equilibrium is as in the no-monitoring, high-payment case (Lemma 2), and the firm is unviable since an inspired manager chooses S. Using the results of Lemmas 5, 6 and 7 leads to Proposition 1.

Proposition 1 *Assume that* (34), (40) *and* (42) *hold, and that* (28) $> x$. *The firm cannot be financed with pure equity or riskless debt, but can be financed by risky debt.*

Proof See Lemmas 5, 6 and 7. The Appendix proves that the set of parameters that satisfies these conditions is non-empty. ■

If the conditions in Proposition 1 are satisfied, both effects of risky debt are necessary for the firm to be viable. Like debt, dividends also impose discipline: indeed, in a number of theories of debt (e.g. Jensen (1986), Stulz (1990), Zwiebel (1996)), the only purpose of debt is to force payout of cash and so dividends are a substitute. Similarly, in the dividend model of Myers (2000), the manager must pay out cash in the form of dividends to prevent diversion and is terminated if he misses a payment; debt would have the same effect. Here, allowing liquidation is not the only objective. Dividends (or a combination of dividends and riskless debt) are not a satisfactory substitute for risky debt because they do not achieve sufficient concentration, and thus have the side-effect of deterring investment.

Gümbel and White (2007) were the first to note that debt increases shareholders' incentives to monitor because it shifts control to creditors and thus changes the default decision to liquidation. In their setting, there is no concentration effect because a shareholder has unlimited funds, and only the disciplinary effect matters. Therefore, the optimal level of debt is borderline nonrepayable: F is just above V^U, i.e. just sufficient to shift control to creditors. Similarly, in many other settings in which debt exerts discipline, borderline nonrepayable debt is also strictly optimal: for example, in Lambrecht and Myers (2008), strictly nonrepayable debt would induce the manager to disinvest suboptimally quickly. Here, the concentration effect is also important, and so the optimal debt level is strictly nonrepayable.

2.4 Comparison of Financing Structures

Thus far, we have assumed that both the termination and investment problems need to be simultaneously solved for the firm to be viable (assumptions (6) and (7)), and so monitoring is crucial. Combined with (34), (40) and (42), only risky debt achieves sufficient concentration to induce monitoring. However, in other settings, one of the agency problems may be relatively unimportant, and so it may be possible to finance the firm even if it is not solved. In such a case, other financing structures become feasible and may dominate the levered firm. This subsection relaxes assumptions (6) and (7), so that the non-monitoring equilibria of Lemmas 1 and 2 may now become viable, and condition (40) so that monitoring may be feasible under repayable debt, allowing the equilibrium of Lemma 3 to hold. (We do not separately consider the case of riskless debt plus a dividend because, if monitoring is incentive compatible, it leads to the same outcome as risky debt.) The four equilibria in Lemmas 1-4 can be implemented by the following capital structures given in Table 2:

Table 2: Implementation of Equilibria

Equilibrium	Implementation
No monitoring, no discipline (Lemma 1)	No dividends, no debt
No monitoring, discipline (Lemma 2)	Dividend exceeding V^U, no debt
Monitoring, no discipline (Lemma 3)	Repayable debt $F \leq V^U$, no dividends
Monitoring, discipline (Lemma 4)	Risky debt $F > K^U$, no dividends

While the previous section compared the mechanics of the four structures, here we compare their payoffs, to generate empirical predictions for how capital structure and dividend policy depend on the relative severity of the firm's agency problems. From Lemmas 1-4, total surplus (investor returns plus manager's private benefits, gross of the initial investment I) under each structure are given by[16]:

$$\begin{aligned}
\textit{Unlevered, No Dividend } (NODIV) \quad &: \quad \pi\left(V^R + b^H\right) + (1-\pi)\left(V^U + b^M\right) && (43)\\
\textit{Unlevered, Dividend } (DIV) \quad &: \quad \pi\left(V^S + b^M\right) + (1-\pi)\left(K^U + b^L\right) && (44)\\
\textit{Repayable Debt } (REPAYABLE) \quad &: \quad \pi\left(V^R + b^H\right) && (45)\\
&\quad + (1-\pi)\left(\phi\left(K^U + b^L\right) + (1-\phi)\left(V^U + b^M\right)\right) - c\\
\textit{Risky Debt } (RISKY) \quad &: \quad (\pi - \pi\gamma(1-\phi))\left(V^R + b^H\right) && (46)\\
&\quad + (1 - \pi + \pi\gamma(1-\phi))\left(K^U + b^L\right) - (1 - \pi + \pi\gamma)\, c.
\end{aligned}$$

The relative surplus depends on a number of terms. $(K^U - V^U)$ reflects the magnitude of the termination issue: if it is high, there are significant savings from terminating an uninspired manager. It will be high if the firm has tangible assets that can be eroded by an uninspired manager – for example, free cash that could be wasted on inefficient investment, or non-core assets which would decline in value if not sold. If the firm has predominantly intangible assets, liquidation value is low even with early termination, and so there are few gains from efficient liquidation. $(V^R - V^S)$ reflects the magnitude of the investment issue: if it is high (e.g. the firm has significant growth opportunities), there is significant value creation from inducing an inspired manager to take the risky project. π reflects the manager's quality. If it is low, the manager is likely uninspired and so termination becomes important. The ratio of ϕ to c reflects the effectiveness of monitoring. $\left(b^M - b^L\right)$ reflects the private benefits lost from early termination, and $\left(b^H - b^M\right)$ measures the manager's intrinsic incentives to choose R over S.

As previously established, if both termination and investment are important ($\left(K^U - V^U\right)$ and $\left(V^R - V^S\right)$ are high), $RISKY$ maximizes investor returns and may indeed be the only viable financing structure. This is likely the case in middle-aged firms. Such firms have growth opportunities, but also abundant tangible assets that could be wasted under inefficient continuation. The model thus provides a justification of risky debt for public firms with both growth opportunities and tangible assets. Another potential application is to LBOs, where substantial

[16] We compare total surplus since either investor returns or private benefits may be relevant for determining which structure is observed empirically. If only one structure generates sufficient investor returns to allow investors to break even, that structure will be chosen; if more than one structure achieves break-even, the manager will choose the structure that maximizes his private benefits.

leverage leads to concentrated outside equity. Jensen (1989) highlights that one advantage of leverage is that it forces "managers to disgorge cash rather than spend it on empire-building projects." However, if only the disciplinary effect is important, then dividends would be equally effective, borderline nonrepayable debt would be optimal, and there would be no role for shareholder monitoring so ownership concentration is unimportant. Here, the concentration effect is also important and thus debt is not a substitute for dividends, strictly nonrepayable debt is efficient, and large shareholders actively monitor. If high leverage coincides with dispersed ownership, there is no monitoring and so the requirement to make debt repayments will induce myopia.[17] Indeed, Cotter and Peck (2001) find that concentrated private equity investors engage in active monitoring, and LBOs perform more strongly if ownership is concentrated. Denis (1995) compares the recapitalization of Kroger with the LBO of Safeway. In both cases, the debt-to-value ratio jumped to over 90%, but outside ownership remained dispersed at the former whereas the LBO sponsor (KKR) obtained a concentrated stake in the latter. Both firms generated cash to service its debt load, consistent with the disciplinary effect of debt, but Kroger achieved this primarily by cutting capital expenditures whereas Safeway sold non-core assets. Denis does not study the quality of investment (which is typically hard to measure); if at least some of the projects scrapped at Kroger were positive-NPV, this result is consistent with the model's predictions that debt combined with active equity monitoring imposes discipline but without leading to short-term behavior.

While LBOs in the 1980s were in mature firms in old economy industries and predominantly driven by the desire to curb inefficient investment, Kaplan and Strömberg (2009) show that, from the 1990s, buyouts have predominantly been in middle-aged firms in industries such as IT/media/telecoms, financial services and healthcare. Such firms likely have growth opportunities, and so LBOs have the twin objectives of curbing wasteful expenditure without deterring efficient projects. Indeed, it might seem that a better way to cut inefficient investment would be to ask the manager to pay high dividends, which would save on the transaction costs of an LBO. However, the former might deter efficient investment. Kaplan (1989) finds that investment in general declines after an LBO but value increases, which suggests that it is inefficient projects that are being cut. Lerner, Sorensen and Strömberg (2010) find that innovation as measured by patenting activity does not decline and patent quality as measured by citations increases, which implies that efficient investment is not harmed.

Investment, but not termination, is an important issue in two main types of firm. First, a start-up has high growth opportunities and thus a large payoff $\left(V^R - V^S\right)$ from taking the efficient project. On the other hand, the savings from efficient termination $(K^U - V^U)$ are low for two reasons: it has few tangible assets and so little is recovered in a liquidation, even if it comes early (both K^U and V^U are low), and it has low free cash so an uninspired manager that is allowed to continue will not reduce firm value significantly. Second, if the manager is talented (π is high), it is unlikely that termination is optimal. From (43) – (46), $NODIV$

[17] The prediction that high leverage coincides with concentrated ownership is also generated by Gümbel and White (2007), although for reasons unrelated to myopia.

and $REPAYABLE$ lead to the greatest investor returns. When investment is important, it is critical to achieve V^R with the highest probability. These structures achieve this because they never terminate an inspired manager that pursues R, even if he becomes unlucky (i.e. they minimize Type I errors). The disadvantage is that they do not terminate an uninspired manager with certainty, but Type II errors are unimportant if the termination issue is small. Indeed, start-ups are typically unlevered and pay few dividends.

We now compare $NODIV$ and $REPAYABLE$. The latter dominates if (45) > (43), i.e.

$$c < (1-\pi)\,\phi\left(K^U - V^U + b^L - b^M\right). \tag{47}$$

For $REPAYABLE$ to be feasible, we must have (36) so that L has an incentive to monitor. Since $F < I - x$, (36) implies $c < (1-\pi)\,\phi\left(K^U - V^U\right)$. Therefore, if the monitoring technology is sufficiently effective for repayable debt to be feasible, it always increases investor returns. However, it reduces M's payoff as he is sometimes terminated, so either may maximize total surplus. In contrast, if (36) is violated, there is no monitoring under repayable debt, so it leads to the same outcome as the unlevered firm with no dividends. Indeed, $NODIV$ is a special case of $REPAYABLE$ where $F = 0$.

The final case is where termination is important, but investment is less so. This is likely the case in a mature firm with few growth opportunities and significant free cash flow that could be wasted by an uninspired manager, or if managerial quality is low. In such a firm, DIV and $RISKY$ achieve the highest investor payoffs, because they terminate an uninspired manager with certainty. Comparing these two structures, dividends dominate debt if (44) > (46), i.e.

$$(1-\pi+\pi\gamma)\,c > \pi\left(V^R - V^S + b^H - b^M\right) - \pi\gamma\,(1-\phi)\left(V^R - K^U + b^H - b^L\right). \tag{48}$$

For the risky structure to be feasible, we must have (27) so that L has an incentive to monitor. This condition is consistent with $(1-\pi+\pi\gamma)\,c > \pi\left(V^R - V^S\right) - \pi\gamma\,(1-\phi)\left(V^R - K^U\right)$, i.e. investor returns being higher under DIV. Thus, even though M's payoff is lower (from (15)), total surplus may be higher. Previously we showed that, if $REPAYABLE$ is feasible (i.e. (36) is satisfied), investor returns are always higher than under $NODIV$. Here, even if $RISKY$ is feasible (i.e. (27) is satisfied), investor returns can still be inferior to DIV. The intuition is as follows. If γ is sufficiently high, investors would like to dissuade M from pursuing R if inspired, because it runs the risk of inefficient termination if monitoring is unsuccessful. Since V^R is low (investment is unimportant), this disadvantage is not outweighed by the upside of R. L can dissuade M from pursuing R by committing not to monitor if earnings are low. However, the decision to monitor only takes place once low earnings have been realized, and so does not depend on γ (see (27)): γ only affects the possibility that low earnings are realized in the first place. Thus, even if γ is high (so that L wishes an inspired manager to choose S at $t = 1$), she may still monitor once losses have occurred at $t = 2$. Since M expects to be monitored, he selects R, even if it is inefficient. If the disciplinary payout at $t = 2$ is via dividends rather

than debt, the concentration effect is avoided and L can commit not to monitor.

2.5 Discussion and Empirical Implications

The $NODIV$ and $REPAYABLE$ structures considered above involve little payout, DIV involves a high payout in the form of dividends, and $RISKY$ involves a high payout in the form of debt. Thus, while most existing research focuses on the factors affecting total debt, the above analysis suggests that total debt should be decomposed into two components: the level of total payout P (debt plus dividends) and the composition of a given level of total payout between debt and dividends, $\frac{F}{P}$. We have:

$$\underbrace{Debt}_{F} = \underbrace{Total\ Payout}_{P} \times \underbrace{\frac{Debt}{Total\ Payout}}_{F/P}$$

$$\text{where } Total\ Payout\ =\ Debt\ +\ Dividends.$$

In turn, the two components of debt depend on the importance of the disciplinary and concentration effects, and thus the two agency problems. The severity of the termination issue determines the importance of the disciplinary effect, and thus the optimal level of total payout. For firms in which early termination is unlikely to be optimal (e.g. start-ups), there is no need to discipline the manager – requiring a payment would merely induce myopia. Therefore, both debt and dividends should be low, as is the case empirically.

The severity of the investment issue determines the importance of the concentration effect, and thus the optimal composition of a given level of total payout. If the termination issue is important and an interim payout is required, it should be in the form of debt rather than dividends if long-run growth is critical. This has both cross-sectional and time-series implications. With regards to the cross-section, firms with more growth opportunities should feature debt rather than dividends. The positive association between growth opportunities and debt appears to contradict existing theory (Myers (1977)) and evidence (Rajan and Zingales (1995)). Those papers argue that debt is detrimental to growth, and so a growing firm would prefer to be unlevered rather than levered. However, if the termination issue is important, then being unlevered is not an option. The appropriate comparison is debt versus other forms of payout that would achieve termination; debt is less detrimental to growth than these other solutions. Rajan and Zingales study debt in isolation (F) rather than in conjunction with dividends: while they show that growth firms use less debt, the model predicts that this relationship is overturned once total payout P is controlled for, or equivalently when studying $\frac{F}{P}$ instead of F. The time-series implication is that changes in the relative severity of the two agency problems within a firm should drive changes in capital structure and dividend policy. For a start-up, inefficient continuation is a minor issue and so total payout should be zero. As it matures, payout is necessary to address the termination issue; the model predicts that firms should start issuing debt before they commence paying dividends.

In addition to the determinants of debt, the model also makes predictions on its effects. Compared to the counterfactual of paying out the equivalent amount of dividends, debt increases the level of investment, by changing it from short-term to long-term projects. This contrasts the standard intuition that debt reduces investment – as explained above, if the termination issue is important, debt should be compared to dividends rather than the case of no debt.

We finally discuss whether other securities can play the role of debt in the model. Preferred equity also has a disciplinary effect since preferred shareholders are promised a dividend, and a concentration effect since it does not dilute ordinary shareholders. Thus, the model can also be applied as a theory of preferred equity. Heinkel and Zechner (1990) is the only other theory of preferred equity of which we are aware[18], which is based on the flexibility afforded by the ability to defer preferred dividends, rather than the concentration and disciplinary effects. In contrast, repurchases are not a substitute for debt. The manager could promise to repurchase at least V^U dollars of shares at $t = 2$, leading to a disciplinary effect. However, repurchases do not generate the concentration effect when it is needed. The manager is able to repurchase shares if $E = K^S$, which concentrates L's stake, but this is of little use since monitoring is unnecessary in this state. In contrast, if $E = V^U$, the manager cannot execute the full repurchase. Thus, full concentration is not achieved, precisely when monitoring is necessary.

3 Heterogeneous Managers

3.1 Analysis

This section extends the model to a setting of heterogeneous managers and multiple large investors. There now exist two manager types. There are n good managers (type G) who have a probability π_G of becoming inspired, and a continuum of bad managers (type B) who have a probability π_B of becoming inspired, where $\pi_B < \pi < \pi_G$. The manager's type is private information. In addition, there are n large investors.[19]

We now allow bankruptcy to be personally costly to the manager. In the core model, a manager who is unable to pay debt is just as likely to be fired as a manager who misses a dividend. In reality, firing is likelier in a bankruptcy because the "default" decision (in the absence of further information) is liquidation; in solvency, the "default" decision is continuation and it requires an active decision by shareholders to close the firm. For example, Zwiebel (1996) assumes that managers are replaced in bankruptcy with certainty if termination is efficient, but shareholders face a cost of firing a manager in solvency due to entrenchment. Myers (2000) assumes that shareholders face costs of collective action in liquidating a solvent firm. We model

[18] Other debt theories based on tax advantages or contingent control cannot be applied to preferred equity, since it does not have these features.

[19] This assumption simplifies the analysis as it means that each G can be financed by one L, but it is not critical. If the number of large investors is $n_L < n_G$, some good managers can only obtain financing from atomistic investors, which leads to a very similar separating equilibrium as what follows but with n_G effectively being n_L. If $n_G > n_L$, some managers will be held by multiple large investors, which has no effect as a single large investor will monitor them anyway (given $p_G > \pi$ and (27)). The analysis is thus the same as if $n_G = n_L$.

such costs by specifying that, if liquidation is optimal for creditors, it occurs with certainty, but if liquidation is optimal for shareholders, it occurs only with probability $\lambda < 1$. Section 2 assumed that $\lambda = 1$, i.e. the disciplinary effect of dividends and debt are the same; with $\lambda < 1$, the results of Section 2 would be stronger – risky debt would be even more preferred because it has a greater disciplinary effect. Failure to meet a debt obligation bankrupts the firm and changes the default decision to liquidation.[20] All of the results in this section continue to hold with $\lambda = 1$ if we instead assume that M suffers an additional reputational loss of y from his firm being bankrupt: being fired because a firm is bankrupt damages M's reputation more than being fired from a solvent firm. We only require that M wishes to avoid bankruptcy – either because firing is more common ($\lambda < 1$) or more painful ($y > 0$).

We continue to relax (6) and (7) and instead make the following assumptions:

$$\pi_B V^S + (1-\pi_B)\left(\lambda K^U + (1-\lambda)V^U\right) = I \quad (49)$$

$$\pi_B V^R + (1-\pi_B)V^U < I \quad (50)$$

$$\frac{1-\pi_G}{1-\pi_G+\pi_G\gamma}V^U + \frac{\pi_G\gamma}{1-\pi_G+\pi_G\gamma}V^R < K^U. \quad (51)$$

(49) states that a firm run by a bad manager breaks even if M pursues S if inspired and is fired with probability λ if uninspired. Thus an unlevered firm which requires dividends of V^U is borderline viable. If the left-hand side was less than I, managers known to be bad would never be funded and so a separating equilibrium cannot exist. In reality, the pricing of physical capital will adjust so that bad managers will generate zero NPV – for example, if bad managers were unable to raise financing, demand for physical capital would drop, causing its price I to fall. Assumption (50) means that, if a bad manager runs an unlevered firm and is never fired, the firm is unviable. By (51), even if a good manager can signal his quality and all good managers who become inspired choose R, investors prefer to terminate a loss-making manager if $N = \varnothing$.[21] If (51) does not hold, signaling high quality would automatically solve myopia: a good manager is not fired if $E = V^U$, and so he can choose R if he becomes inspired.

Proposition 2 gives conditions under which a separating equilibrium is feasible.

Proposition 2 *Assume that the following conditions hold:*

$$\begin{aligned} & (\pi_G - \pi_G\gamma(1-\phi))b^H + (1-\pi_G+\pi_G\gamma(1-\phi))b^L \\ > \; & \pi_G b^M + (1-\pi_G)(\lambda b^L + (1-\lambda)b^M), \quad (52) \\ & (\pi_B - \pi_B\gamma(1-\phi))b^H + (1-\pi_B+\pi_B\gamma(1-\phi))b^L \\ < \; & \pi_B b^M + (1-\pi_B)(\lambda b^L + (1-\lambda)b^M). \quad (53) \end{aligned}$$

[20] Dewatripont and Tirole (1994) identify a similar reason why debt imposes greater discipline than dividends. Under certain parameter values, equityholders will not fire the manager if he fails to pay dividends as they have a convex claim; therefore, it is necessary to shift control to the creditor. In this paper, as in Myers (2000), equityholders do wish to fire the manager upon poor performance, which is the essence of the myopia issue.

[21] If creditors have control, they will terminate if $\frac{1-\pi_G}{1-\pi_G+\pi_G\gamma}V^U + \frac{\pi_G\gamma}{1-\pi_G+\pi_G\gamma}F < K^U$, which holds from $F \leq V^R$ and (51).

A separating equilibrium is sustainable in which:

(i) Good managers are financed with D of risky debt, x of equity from L, and $I - D - x$ of equity from atomistic investors. If the manager becomes inspired, he chooses R. If the payment is not met, L monitors at $t = 2$. If $N \in \{V^R, V^S\}$, the firm is continued, otherwise it is liquidated. If L does not monitor, the firm is liquidated. The gross returns to investors and the manager are given by

$$(\pi_G - \pi_G\gamma(1-\phi))\, V^R + (1 - \pi_G + \pi_G\gamma(1-\phi))K^U - (1 - \pi_G + \pi_G\gamma)c, \tag{54}$$

$$(\pi_G - \pi_G\gamma(1-\phi))b^H + (1 - \pi_G + \pi_G\gamma(1-\phi))b^L. \tag{55}$$

(ii) Bad managers are financed with equity from atomistic investors and promise a dividend exceeding V^U. If the manager becomes inspired, he chooses S. No monitoring occurs at $t = 2$. If the dividend payment is met, the firm is continued, otherwise it is liquidated with probability λ. The net returns to each atomistic investor are zero and M's payoff is given by

$$\pi_B b^M + (1 - \pi_B)(\lambda b^L + (1 - \lambda)b^M). \tag{56}$$

(iii) Investors have the off-equilibrium path belief that a manager who establishes any other structure is bad.

Since $\pi_G > \pi_B$, conditions (52) and (53) can simultaneously be satisfied. The first (second) condition ensures that G (B) does not deviate. L will monitor at $t = 2$ if

$$\phi \frac{\pi_G\gamma}{1 - \pi_G + \pi_G\gamma} \frac{x}{I - D} \left(V^R - F\right) \geq c, \tag{57}$$

which determines the lower bound on F. From $\pi_G > \pi$ and (34), (57) can always be satisfied.

In the analysis of Section 2, the disciplinary and concentration effects allowed the firm to be viable under risky debt. Here, the same two effects allow a separating equilibrium to be viable: the disciplinary effect means that debt is a *credible* signal of managerial quality, and the concentration effect renders it a *desirable* signal which good managers are willing to emit.

First, $\lambda < 1$ means that an uninspired manager in an unlevered firm is only occasionally fired, whereas an uninspired manager in a levered firm is definitely shut down. Debt therefore imposes stronger discipline than dividends. As in Ross (1977), this renders it particularly costly to bad managers, as they are more likely to be uninspired, and so taking on leverage can credibly signal managerial quality.

Second, good managers desire to signal as they benefit from revealing their quality – but the gains from signaling are quite different from standard signaling theories. In traditional models, the manager immediately benefits from revealing his quality: in Ross (1977) and Bhattacharya (1979) the signal leads to a higher stock price, to which his compensation is tied; in Myers and Majluf (1984) and Fulghieri and Lukin (2001), signaling high quality is necessary to raise funds. Here, managers are not paid according to the firm's market value and do not benefit

from receiving a greater *level* of funds, since all managers are financed and receive I. Even if a manager is revealed bad, he can still raise funds as the pricing of funds adjusts to reflect his low quality; such pricing does not affect his payoff as he receives only private benefits. We deliberately assume a constant investment scale of I and that the manager only receives private benefits so that the traditional motives to signal do not apply. Despite this, good managers do have an incentive to signal due to the concentration effect. Here, the benefit of signaling manifests solely in the *type* of funds. By revealing his quality, a good manager attracts scarce large investors. One large investor provides no more funds than multiple small investors, but is critically different as she has the incentive to monitor. Monitoring is beneficial because it allows inspired managers to pursue risky projects; this benefit is particularly large for good managers, since they are most likely to become inspired. In sum, the benefits of leverage are highest for type G and the costs are highest for type B, so separation is achieved.

The difference in the incentives to signal leads to dynamic consistency of leverage. Zwiebel (1996) notes that some theories of debt are "setup models", where high debt is only possible when the firm is initially set up. The manager dislikes the disciplinary effect of debt; thus, in Jensen (1986) and Stulz (1990), the manager does not adopt debt voluntarily but investors must force it upon him in the initial period. However, such leverage is unsustainable since it is the manager who controls the debt level going forward, and he may issue equity to buy back debt, thus freeing him from discipline. Even in models in which the manager voluntarily chooses high leverage to signal in the initial period, he may have incentives to reverse leverage later. In such models, even though the manager dislikes discipline, he chooses high leverage to be able to raise funds, since debt either commits not to overinvest or signals quality. Once funds have been raised, the manager has incentives to delever.[22]

Dynamic consistency issues occur in such papers because debt's only role is to act as either a signal (which is only valuable in the first period) or disciplining device (imposed by shareholders who only control leverage in the first period). Zwiebel was the first to present a dynamically consistent model of debt; he solves this issue by introducing a raider who is present in every period, and so it is individually rational for the manager to retain debt in every period.[23] Dividends would be equally effective; the theory is a dynamically consistent model of total payout. This paper presents a dynamically consistent model of debt in particular, which arises from its two roles. The disciplinary effect credibly signals high quality, but this signal is only relevant at $t = 0$, when funds are raised. If raising funds was the only goal, then immediately after funds were raised at $t = 0$, the manager would undo the signal and delever.

The concentration effect gives the manager an ongoing incentive to maintain leverage. Unlike in traditional models where the benefits of signaling are obtained only at $t = 0$, here the benefits are earned at $t = 2$ in the form of monitoring. Delevering would reduce L's incentives to acquire

[22] If outsiders expect such deleveraging, debt will be unable to signal quality in the first place.

[23] The key ingenuity in Zwiebel's model is that, even though the raider is always present, his presence is not sufficient to deter over-investment, because investment is sunk and cannot be overturned by the raider. Thus, debt is needed to deter over-investment.

information, thus preventing M from taking R if he becomes inspired. Dynamic consistency can be shown by giving the manager of a levered firm the option to issue equity to repurchase debt and promise a dividend just after $t = 0$, once funds have already been raised. A repurchase of debt at $t = 0$ must be accompanied by a dividend promise, because any structure that does not involve risky debt reveals the manager as bad from part (iii) of Proposition 2.[24] From (49) and (50), investors will immediately terminate a bad manager at $t = 0$ unless he promises a dividend. By promising a dividend, a manager who delevers avoids being fired since the firm remains viable (from (49)) and so the threat of firing which leads to dynamic consistency in Zwiebel does not apply here. Instead, a good manager retains debt even in the absence of an external threat – he does so because of the desire to pursue internal growth opportunities. Delevering loses the concentration effect of debt and so he will be unable to choose R if inspired. From (52), this disadvantage outweighs the fact that delevering reduces the firing probability if he turns out to be uninspired. Leverage is thus persistent, consistent with the empirical findings of Lemmon, Roberts and Zender (2008).

Here, dynamic consistency arises because L plays a different role than in most existing literature. In effort models where there is a conflict between firm value and the manager's utility function (e.g. Burkart, Gromb and Panunzi (1997)), the manager dislikes monitors since they are an "adversary" and force him to exert effort or forgo private benefits. Therefore, the manager would have incentives to deter L from monitoring by reducing leverage. Here, there is no fundamental conflict between firm value and private benefits, because the same project (R) maximizes both. Here, the monitor is an "ally", allowing the manager to continue operating if he is unlucky. Thus, the manager wishes to retain her through leverage.

As in Section 2, the importance of the concentration effect means that strictly nonrepayable debt is optimal. If credibility is the only requirement for signaling, only the disciplinary effect is important (since a bad manager wishes to avoid discipline) and so borderline nonrepayable debt is optimal to minimize signaling costs. However, for signaling to be desirable for good managers, debt must also lead to concentration. Also as in Section 2, the importance of the concentration effect means that dividends are not a substitute for debt. This contrasts with the Ross (1977) signaling model where debt can signal high quality since bad firms cannot meet the debt repayments: Bhattacharya (1979) shows that dividends can have the same effect.

A final difference with standard signaling models is that signaling can increase aggregate fundamental firm value. In a pooling equilibrium where all firms are unlevered and financed with dividends, a firm run by a good manager delivers investor returns of

$$\pi_G V^S + (1 - \pi_G) \left(\lambda K^U + (1 - \lambda) V^U \right)$$

compared to (54) in a separating equilibrium. If $\left(V^R - V^S \right)$ and $\left(K^U - V^U \right)$ are sufficiently high, i.e. the termination and investment issues are sufficiently important, the returns generated

[24] This off-equilibrium path belief is "reasonable" in the sense of Cho and Kreps (1987), since bad types would like to avoid leverage to reduce the probability of being terminated.

by a good manager are higher in a separating equilibrium. This is because the separating equilibrium allows good managers to be monitored, which encourages them to take R and also leads to them being terminated with certainty (rather than probability λ) if they become uninspired. The bad manager yields the same returns in both a pooling and separating equilibrium.

This result contrasts with a number of classical signaling models (e.g. Ross (1977), Bhattacharya (1979), Miller and Rock (1985), Stein (1989)) where signaling only increases outsiders' *perceptions* of firm value in the short-term; actual fundamental value falls because signaling is costly. (Moreover, since the increased perceived value of good firms is accompanied by a reduced perceived value of bad firms, even the short-run effect is a redistribution rather than an aggregate increase.) In Myers and Majluf (1984) and Fulghieri and Lukin (2001), signaling can increase real value by allowing a firm to raise funds and invest. Here, signaling has no effect on the *level* of funds raised, since all managers raise I in both equilibria. Instead, the real benefits of signaling arise because it affects the *type* of funds: scarce large investors are allocated to good managers, who benefit most from monitoring. Note that the allocation of blockholders is different from that implied by traditional theories where they play a disciplinary role (e.g. Burkart, Gromb and Panunzi (1997), Maug (1998), Kahn and Winton (1998), Bolton and von Thadden (1998)) – these theories would predict that monitors should acquire stakes in bad firms to correct agency problems. Here, the monitor is an "ally" of good managers rather than an "adversary" of bad managers, and so should be allocated to the former.

3.2 Applications and Empirical Implications

While Section 2.5 considered implications of the single-firm model, this section discusses further implications generated by the extended model and applications of the separating equilibrium.

The extended model generates the broad implication that managers should willingly seek and retain leverage. In standard disciplinary theories (e.g. Jensen (1986), Stulz (1990)), leverage is imposed by investors in the initial period, but it is the manager who controls it going forward, and he has incentives to delever. Here, the manager wishes to retain debt as it leads to monitoring by an ally. This has both cross-sectional and time-series implications. First, the model is consistent with the widespread prevalence of debt in reality: if leverage were not dynamically consistent, only firms that have just raised funds would be levered, and so the vast majority of firms at a given time would have no debt. Second, in a given firm, leverage should be persistent over time, as found by Lemmon, Roberts and Zender (2008).

The core model predicts that debt is positively correlated with investment when total payout is controlled for, since it induces monitoring. The extended model provides another reason for this association – debt wards off unskilled managers who are unable to innovate. Considering a single agent, Manso (2009) shows that tolerance of failure encourages innovation. This model shows an important counteracting effect in the presence of heterogeneous agents – intolerance of failure through disciplinary debt may screen out low-quality agents who are unable to innovate.

We now turn to real-life applications of the separating equilibrium. Good managers take on

risky debt and bad managers are unlevered; one interpretation is that the former corresponds to an LBO firm and the latter to a public corporation with low leverage.[25] Unlike in some signaling theories, here the motive for high-quality managers to signal is not to obtain more funds. This is consistent with the fact that private firms are typically smaller than public firms. In addition, while traditional signaling models suggest that borderline nonrepayable debt is optimal so that the debt is just high enough so that a low type cannot pay it, in private equity the debt is strictly nonrepayable. The model also predicts that levered firms should outperform standard corporations because they attract high-quality managers and allow them to invest optimally: L earns a strictly positive net return. Ljungqvist and Richardson (2003) find that private equity generates excess returns of 5-8% per year relative to public equity, and Kaplan and Schoar (2005) find that private equity firms outperform the S&P (gross of fees).[26]

Second, the model can be applied to analyze the capital structure of investment companies, the focus of Stein (2005). The two fund types analyzed by Stein have natural analogs in this model. The closed-end fund is similar to the unlevered firm with no dividends, which allows long-term investment but not liquidation. The open-end mutual fund is analogous to the unlevered firm with dividends: open-ending allows liquidation through permitting investor withdrawals, but at the expense of deterring long-term arbitrage trades. The levered structure is not considered by Stein. The analogy is hedge funds: leverage allows hedge funds to undertake risky arbitrage trades, but also deters bad managers from establishing such funds as they will likely be terminated. Indeed, Ackermann, McEnally and Ravenscraft (1999) find that the average hedge fund consistently outperforms mutual funds, even after risk and fees.

4 Conclusion

This paper addresses a fundamental dilemma in corporate governance: how can investors ensure that bad managers are terminated, without inducing good managers to take myopic actions to avoid termination? Equity financing without dividends allows investment but prevents optimal shut-down; promising dividends achieves termination but at the expense of myopia.

We show that debt can alleviate this tension by concentrating equityholders' stakes and thus inducing monitoring. Monitoring is desirable even absent an effort conflict as it allows investment. As a result, debt is superior to other disciplinary mechanisms that achieve termination, such as dividends, as it does not suffer the side-effect of inducing myopia. In addition, strictly nonrepayable debt is optimal because it increases concentration.

[25] The model complements existing justifications for the debt-financing of buyouts. One reason is that debt imposes discipline (Jensen (1989)); however, as argued previously, this effect may also be achieved by equity-financing acquisitions and demanding high dividends. Axelson, Stromberg and Weisbach's (2009) explanation is based on agency problems between fund managers and fund investors, rather than between fund managers and operating company managers.

[26] While buyouts usually do not retain their high leverage permanently, leverage typically remains significantly above the pre-buyout level (Kaplan (1991)). In addition, delevering is achieved through selling assets, rather than raising equity and diluting ownership. As assets are sold, the issue of inefficient continuation in non-core businesses is reduced; this reduces the optimal level of total payout and is consistent with the fall in debt.

The monitoring induced by leverage allows a separating equilibrium to be sustainable: good managers are willing to signal quality by assuming debt. Even though signaling does not lead to more initial funds, and the manager is not aligned to the firm's market value, a good manager has an incentive to signal to attract a different type of funds: active monitors, who allow him to undertake long-term projects. Once the signal has been given and financing has been raised, the manager has continued incentives to maintain leverage and thus a concentrated monitor.

While existing empirical studies investigate the determinants of total leverage, this paper suggests new avenues for future empirical work: breaking down leverage into total payout, and the proportion of payout in debt as opposed to dividends. Where the termination issue is unimportant (such as early stage firms), total payout should be low and the firm should feature neither debt nor dividends. Where both termination and investment are important, total payout should be high and in the form of debt rather than dividends. The conventional wisdom that debt is detrimental to growth may be overturned when levered companies are compared not to unlevered peers, but peers that pay out the same amount of cash in the form of dividends to overcome a termination problem. This prediction is consistent with the recent wave of LBOs, which are concentrated in middle-aged firms in industries with growth opportunities, and so the goal is to curb wasteful projects without deterring efficient investment.

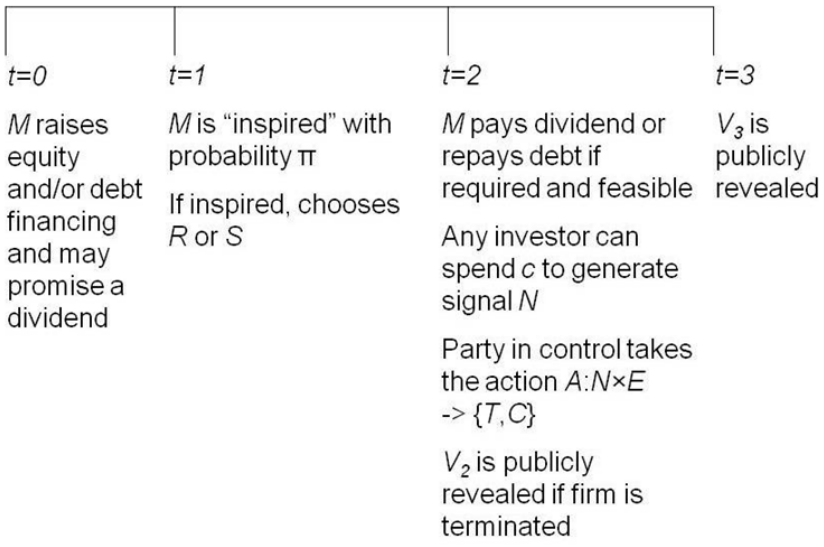

Figure 1. Timeline of the model

A Proofs

Proof of Proposition 1

It is sufficient to show that the conditions in Proposition 1 can be satisfied when $x = I - D$. Then, by continuity, there exists an open set of parameters satisfying all of the conditions. Setting $I - D = x$, the condition (28) $> x$ becomes

$$[(\pi - \pi\gamma(1-\phi))(V^R - F)] - (1 - \pi + \pi\gamma)c > x. \tag{58}$$

Note that

$$F \leq \bar{F} = \frac{I - (1 - \pi + \pi\gamma(1-\phi))K^U}{\pi - \pi\gamma(1-\phi)}.$$

Fix the values of all of the parameters except $\frac{c}{\phi}$, and then choose a value for $\frac{c}{\phi}$ such that (34) is satisfied at the upper bound of F given above. Then (40), (42) and (58) can be satisfied as long as c and x is small (so ϕ and $I - D$ are also small). Thus the set of parameters satisfying all of the conditions is non-empty.

B Incentive Pay

This section shows that the model's results are robust to replacing the manager's private benefits with incentive pay. So that the manager's pay is unaffected by the firm's leverage, we compensate him with a fraction of the firm's assets (rather than equity alone) and assume that his pay is senior to creditors. If pay depended on equity or was junior to creditors, pay would be reduced by increasing leverage and so the capital structure decision would be distorted by the desire to increase or decrease the manager's pay. Sundaram and Yermack (2007) and Wei and Yermack (2010) show that managers are compensated with debt as well as equity, and Calcagno and Renneboog (2007) cite bankruptcy regulations in certain countries (e.g. US, UK and Germany) that management can use to ensure that salaries are senior to creditors in a bankruptcy, and give a number of examples where this occurred.

For each period after $t = 1$ that the manager is employed by the firm, he receives a fraction β of the final firm value. Thus, he receives βV_2 if it is liquidated at $t = 2$, and $2\beta V_3$ if it is continued until $t = 3$. It is necessary for the fraction of assets received by the manager to increase with tenure (from β to 2β) to create a termination issue, i.e. give him an incentive to continue the firm even if he is uninspired. Otherwise, an uninspired manager would voluntarily liquidate the firm. In reality, managers are given additional equity compensation for each extra year they work; Gibbons and Murphy (1992) and Cremers and Palia (2010) find that a manager's equity alignment is increasing in his tenure, and Sundaram and Yermack (2007) find the same for a manager's debt stakes. Note that we do not consider giving the manager an optimal incentive contract. This is standard in models with a termination issue (e.g. Stulz (1990), Diamond (1991, 1993), Zwiebel (1996), where the manager receives private benefits that increase with his tenure) or an investment issue (e.g. Stein (1988), where the manager is

exogenously aligned with short-term earnings) – if it were possible to write an optimal contract that aligned the manager perfectly with firm value, all agency problems would disappear and there would be no need for external monitoring. Agency problems exist in reality since they may be too large to address with a contract – for example, myopic actions and entrenchment were severe in the recent financial crisis despite managers having substantial incentive pay (see, e.g., Fahlenbrach and Stulz (2010).). The problem of solving agency issues through contracting rather than monitoring is a separate question studied by a different literature. In particular, we show that it is not necessary to write an optimal contract to solve the manager's agency problem – inducing investor monitoring (i.e. solving the investor's agency problem) is sufficient.

With the manager receiving a fraction of the firm's assets that increases in his tenure, the payoffs in Table 1 now become (using b now to denote the manager's pay):

	Uninspired	Inspired, S	Inspired, R
E	V^U	K^S	V^U with probability γ, K^S w.p. $1-\gamma$
V_2	$(1-\beta)K^U$	$(1-\beta)K^S$	$(1-\beta)K^U$ if $E=V^U$, $(1-\beta)K^S$ if $E=K^S$
V_3	$(1-2\beta)V^U$	$(1-2\beta)V^S$	$(1-2\beta)V^R$
b_2	βK^U	βK^S	βK^U if $E=V^U$, βK^S if $E=K^S$
b_3	$2\beta V^U$	$2\beta V^S$	$2\beta V^R$

The analysis is very similar to the main paper. We first start by assuming no monitoring technology, as in Section 2.1. In the absence of a disciplinary payment, the condition for all shareholders to wish the firm to continue at $t=2$ (equation (8)) becomes:

$$(1-2\beta)\left(\pi V^R+(1-\pi)V^U\right)>(1-\beta)\left(\pi\left(\gamma K^U+(1-\gamma)K^S\right)+(1-\pi)K^U\right)$$

and the payoff to investors (equation (9)) is

$$(1-2\beta)\left(\pi V^R+(1-\pi)V^U\right).$$

As before, investors make a loss (from (7)) and so will not finance the firm to begin with.[27] Thus, Lemma 1 continues to hold.

With a disciplinary payment, the conditions for Lemma 2 (equations (10)-(11)) become:

$$(1-2\beta)\left(\frac{1-\pi}{1-\pi+\pi\gamma}V^U+\frac{\pi\gamma}{1-\pi+\pi\gamma}V^R\right) < (1-\beta)K^U \quad (59)$$

$$2(1-\gamma)V^R+\gamma K^U < 2V^S, \quad (60)$$

and the payoff to investors (equation (12)) is

$$\pi(1-2\beta)V^S+(1-\pi)(1-\beta)K^U.$$

[27] Indeed, in the presence of incentive compensation, (7) can be weakened to $(1-2\beta)\left(\pi V^R+(1-\pi)V^U\right)<I$, although this is not necessary.

As before, investors make a loss (from (6)) and so will not finance the firm to begin with.[28] Thus, Lemma 2 continues to hold.

With contractible monitoring and no disciplinary payment, Lemma 3 continues to hold and the expected gross returns to L, all households and the manager are given by:

$$\begin{array}{l}\pi w\left(V^R\right)+(1-\pi)\left(\phi w\left(K^U\right)+(1-\phi)\, w\left(V^U\right)\right)-c,\\ \pi\left((1-2\beta)\, V^R-w\left(V^R\right)\right)+(1-\pi)\left(\phi\left((1-\beta)\, K^U-w\left(K^U\right)\right)+(1-\phi)\left((1-2\beta)\, V^U-w\left(V^U\right)\right)\right),\\ 2\beta\pi V^R+\beta\,(1-\pi)\left(\phi K^U+2\,(1-\phi)\, V^U\right).\end{array}$$

If a disciplinary payment is required, an inspired manager will choose R if the following analog of (15) is satisfied:

$$2\,(1-\gamma\,(1-\phi))\, V^R+\gamma\,(1-\phi)\, K^U>2V^S.$$

As in the core model, this inequality is fully consistent with (60): in the presence of a disciplinary payment, monitoring is necessary and sufficient to encourage M to choose R. Lemma 4 continues to hold and the payoffs are given by:

$$\begin{array}{l}(\pi-\pi\gamma\,(1-\phi))\, w\left(V^R\right)+(1-\pi+\pi\gamma\,(1-\phi))\, w\left(K^U\right)-(1-\pi+\pi\gamma)\, c,\\ (\pi-\pi\gamma\,(1-\phi))\left((1-2\beta)\, V^R-w\left(V^R\right)\right)+(1-\pi+\pi\gamma\,(1-\phi))\left((1-\beta)\, K^U-w\left(K^U\right)\right)\\ 2\beta\,(\pi-\pi\gamma\,(1-\phi))\, V^R+\beta\,(1-\pi+\pi\gamma\,(1-\phi))\, K^U.\end{array}$$

With non-contractible monitoring and risky debt (Section 2.3.1), creditors liquidate (the equivalent of (26)) if

$$(1-2\beta)\left(\frac{1-\pi}{1-\pi+\pi\gamma}V^U+\frac{\pi\gamma}{1-\pi+\pi\gamma}F\right)<(1-\beta)\, K^U$$

which holds from (59). The condition for L to monitor, (27), becomes:

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}\frac{x}{I-D}\left((1-2\beta)\, V^R-F\right)\geq c.$$

Again, the $\frac{x}{I-D}$ term demonstrates the concentration effect. Lemma 5 continues to hold and the payoffs are given by:

$$\begin{array}{ll}\dfrac{x}{I-D}\,(\pi-\pi\gamma\,(1-\phi))\left((1-2\beta)\, V^R-F\right)-(1-\pi+\pi\gamma)\, c, & (61)\\ \dfrac{I-D-x}{I-D}\,(\pi-\pi\gamma\,(1-\phi))\left((1-2\beta)\, V^R-F\right),\\ 2\beta\,(\pi-\pi\gamma\,(1-\phi))\, V^R+\beta\,(1-\pi+\pi\gamma\,(1-\phi))\, K^U.\end{array}$$

As in the core model, (61) $> x$ is consistent with (6) and (7), so the firm may be viable.

[28] Indeed, in the presence of incentive compensation, (6) can be weakened to $\pi\,(1-2\beta)\, V^S+(1-\pi)\,(1-\beta)\, K^U<I$.

The market value of debt (31) and its upper and lower bounds for debt, ((32) and (33)) are

$$\begin{aligned} D &= (\pi - \pi\gamma(1-\phi))\, F + (1-\beta)\,(1-\pi+\pi\gamma(1-\phi))\, K^U. \\ \underline{F} &= \frac{c(1-\pi+\pi\gamma)[I-(1-\beta)(1-\pi+\pi\gamma(1-\phi))K^U] - \phi\pi\gamma x(1-2\beta)V^R}{c(1-\pi+\pi\gamma)(\pi-\pi\gamma(1-\phi)) - \phi\pi\gamma x} \\ \overline{F} &= \frac{I-x-(1-\beta)(1-\pi+\pi\gamma(1-\phi))K^U}{\pi-\pi\gamma(1-\phi)}, \end{aligned}$$

and so the condition for risky debt to induce monitoring, (34), is

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}\left((1-2\beta)\,V^R - \overline{F}\right) \geq c. \tag{62}$$

The marginal effect of increasing F on L's incentive to monitor, (35) is

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}x\frac{((1-2\beta)V^R - F)(\pi-\pi\gamma(1-\phi)) - (I-D)}{(I-D)^2},$$

which is positive if $(61) > x$, i.e. the firm is viable.

Turning to repayable debt (Section 2.3.2), the condition for L to monitor, (36), becomes

$$\phi\,(1-\pi)\,\frac{x}{I-F}\left((1-\beta)\,K^U - (1-2\beta)\,V^U\right) \geq c.$$

Lemma 6 continues to hold and the payoffs are given by:

$$\begin{aligned} &\frac{x}{I-F}\left(\pi\,(1-2\beta)\,V^R + (1-\pi)\left(\phi\left((1-\beta)\,K^U\right) + (1-\phi)\,(1-2\beta)\,V^U\right) - F\right) - c, \quad (63) \\ &\frac{I-F-x}{I-F}\left(\pi\,(1-2\beta)\,V^R + (1-\pi)\left(\phi\left((1-\beta)\,K^U\right) + (1-\phi)\,(1-2\beta)\,V^U\right) - F\right), \\ &2\beta\pi V^R + \beta\,(1-\pi)\left(\phi K^U + 2\,(1-\phi)\,V^U\right). \end{aligned}$$

However, L will not monitor under repayable debt if the following analog of (40) holds:

$$\phi\,(1-\pi)\,\frac{x}{I-V^U}\left((1-\beta)\,K^U - (1-2\beta)\,V^U\right) < c. \tag{64}$$

With riskless debt plus a dividend, the condition for L to monitor, (41), becomes

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}\frac{x}{I-F}\left((1-2\beta)\,V^R - (1-\beta)\,K^U\right),$$

and monitoring is impossible if the following analog of (42) holds:

$$\phi\frac{\pi\gamma}{1-\pi+\pi\gamma}\frac{x}{I-K^U}\left((1-2\beta)\,V^R - (1-\beta)\,K^U\right) < c. \tag{65}$$

Thus, if (62), (64) and (65) hold, and $(61) > x$, then risky debt is the only viable financing structure (the analog of Proposition 1.) To prove that the set of parameters satisfying these

conditions is non-empty, as in the proof of Proposition 1 we only need to consider the case $x = I - D$. Then (61) $> x$ becomes

$$(\pi - \pi\gamma(1-\phi))((1-2\beta)V^R - F) - (1 - \pi + \pi\gamma)c > x. \tag{66}$$

We first take $x = 0$. The LHS of (64) and (65) are zero, so for any positive c, (64) and (65) trivially hold. Now we just need to set $\frac{c}{\phi} \in (0, \frac{\pi\gamma}{1-\pi+\pi\gamma}\left((1-2\beta)V^R - \overline{F}\right))$ to make (62) hold. When c is sufficiently small (so that ϕ is also small but $\frac{c}{\phi}$ is fixed), (66) holds. Since all inequalities are strict and all functions are continuous, there exists $\hat{x} \in (0,1)$ such that for all $x \in (0, \hat{x})$, all conditions hold.

Finally, for the extension to heterogeneous managers, Section 3, conditions (49)-(51) become:

$$\begin{aligned}
\pi_B(1-2\beta)V_S + (1-\pi_B)\left(\lambda(1-\beta)K^U + (1-\lambda)(1-2\beta)V^U\right) &= I \\
(1-2\beta)\left(\pi_B V^R + (1-\pi_B)V^U\right) &< I \\
(1-2\beta)\left(\frac{1-\pi_G}{1-\pi_G+\pi_G\gamma}V^U + \frac{\pi_G\gamma}{1-\pi_G+\pi_G\gamma}V^R\right) &< (1-\beta)K^U.
\end{aligned}$$

The sufficient conditions for a separating equilibrium, (52) and (53), are now:

$$\begin{aligned}
& 2(\pi_G - \pi_G\gamma(1-\phi))V^R + (1-\pi_G+\pi_G\gamma(1-\phi))V^U \\
> \; & 2\pi_G V^S + (1-\pi_G)\left(\lambda V^U + 2(1-\lambda)V^S\right), \\
& 2(\pi_B - \pi_B\gamma(1-\phi))V^R + (1-\pi_B+\pi_B\gamma(1-\phi))V^U \\
> \; & 2\pi_B V^S + (1-\pi_B)\left(\lambda V^U + 2(1-\lambda)V^S\right).
\end{aligned}$$

The returns to investors in a levered firm, a good manager, and a bad manager ((54)-(56)) are respectively given by:

$$\begin{aligned}
& (\pi_G - \pi_G\gamma(1-\phi))(1-2\beta)V^R + (1-\pi_G+\pi_G\gamma(1-\phi))(1-\beta)K^U - (1-\pi_G+\pi_G\gamma)c \\
& 2(\pi_G - \pi_G\gamma(1-\phi))\beta V^R + (1-\pi_G+\pi_G\gamma(1-\phi))\beta K^U \\
& 2\pi_B\beta V^S + (1-\pi_B)\left(\lambda\beta V^U + 2(1-\lambda)\beta V^S\right).
\end{aligned}$$

L will monitor at $t = 2$ if

$$\phi\frac{\pi_G\gamma}{1-\pi_G+\pi_G\gamma}\frac{x}{I-D}\left((1-2\beta)V^R - F\right) \geq c$$

which can always be satisfied from $\pi_G > \pi$ and (62).

References

[1] Ackermann, Carl, Richard McEnally and David Ravenscraft (1999): "The Performance of Hedge Funds: Risk, Return and Incentives." *Journal of Finance* 54, 833-874

[2] Aghion, Philippe and Patrick Bolton (1992): "An Incomplete Contracts Approach to Financial Contracting." *Review of Economic Studies* 59, 473-494

[3] Axelson, Ulf, Per Strömberg and Michael S. Weisbach (2009): "Why Are Buyouts Levered? The Financial Structure of Private Equity Funds." *Journal of Finance* 64, 1549-1582

[4] Bhattacharya, Sudipto (1979): "Imperfect Information, Dividend Policy, and 'The Bird in the Hand' Fallacy." *Bell Journal of Economics* 10, 259-70

[5] Bolton, Patrick and Ernst-Ludwig von Thadden (1998): "Blocks, Liquidity, and Corporate Control." *Journal of Finance* 53, 1-25

[6] Boot, Arnoud and Anjan Thakor (1993): "Security Design." *Journal of Finance* 48, 1349-1389

[7] Burkart, Mike, Denis Gromb and Fausto Panunzi (1997): "Large Shareholders, Monitoring, and the Value of the Firm." *Quarterly Journal of Economics* 112, 693-728

[8] Cho, In-Koo and David Kreps (1987): "Signaling Games and Stable Equilibria." *Quarterly Journal of Economics* 42, 179-221

[9] Cohn, Jonathan B. and Uday Rajan (2010): "Optimal Corporate Governance in the Presence of an Activist Investor." Working paper, University of Texas at Austin

[10] Cotter, James F. and Sarah W. Peck (2001): "The Structure of Debt and Active Equity Investors: The Case of the Buyout Specialist." *Journal of Financial Economics* 59, 101-147

[11] Cremers, Martijn and Darius Palia (2010): "Tenure and CEO Pay." Working Paper, Yale University

[12] Denis, David J. (1994): "Organizational Form and the Consequences of Highly Leveraged Transactions: Kroger's Recapitalization and Safeway's LBO." *Journal of Financial Economics* 36, 193-224

[13] Dewatripont, Mathias and Jean Tirole (1994): "A Theory of Debt and Equity: Diversity of Securities and Manager-Shareholder Congruence." *Quarterly Journal of Economics* 109, 1027-1054

[14] Diamond, Douglas W. (1984): "Financial Intermediation and Delegated Monitoring." *Review of Economic Studies* 51, 393-414

[15] Diamond, Douglas W. (1991): "Debt Maturity Structure and Liquidity Risk." *Quarterly Journal of Economics* 106, 709-737

[16] Diamond, Douglas W. (1993): "Seniority and Maturity of Debt Contracts." *Journal of Financial Economics* 33, 341-368

[17] Edmans, Alex (2009): "Blockholder Trading, Market Efficiency and Managerial Myopia." *Journal of Finance* 64, 2481-2513

[18] Fahlenbrach, Rüdiger and René M. Stulz (2010): "Bank CEO Incentives and the Credit Crisis." *Journal of Financial Economics*, forthcoming

[19] Fulghieri, Paolo and Dmitry Lukin (2001): "Information Production, Dilution Costs, and Optimal Security Design." *Journal of Financial Economics* 61, 3-42

[20] Gibbons, Robert and Kevin J. Murphy (1992): "Optimal Incentive Contracts in the Presence of Career Concerns: Theory and Evidence." *Journal of Political Economy* 100, 468-505.

[21] Gorton, Gary B. and George Pennacchi (1990): "Financial Intermediaries and Liquidity Creation." *Journal of Finance* 45, 49-71

[22] Grinstein, Yaniv (2006): "The Disciplinary Role of Debt and Equity Contracts: Theory and Tests." *Journal of Financial Intermediation* 15, 416-443

[23] Gümbel, Alexander and Lucy White (2007): "Good Cop, Bad Cop: Complementarities Between Debt and Equity in Disciplining Management." Working Paper, University of Oxford

[24] Harris, Milton and Artur Raviv (1988): "Corporate Control Contests and Capital Structure." *Journal of Financial Economics* 20, 55-86

[25] Harris, Milton and Artur Raviv (1990): "Capital Structure and the Informational Role of Debt." *Journal of Finance* 45, 321-349

[26] Heinkel, Robert and Jozef Zechner (1990): "The Role of Debt and Preferred Stock as a Solution to Adverse Investment Incentives." *Journal of Financial and Quantitative Analysis* 25, 1-24

[27] Innes, Robert (1990): "Limited Liability and Incentive Contracting With Ex-Ante Action Choices." *Journal of Economic Theory* 52, 45-67

[28] Jensen, Michael C. and William Meckling (1976): "Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure." *Journal of Financial Economics* 3, 305-360

[29] Jensen, Michael C. (1986): "The Agency Costs of Free Cash Flow: Corporate Finance and Takeovers." *American Economic Review* 76, 323-329

[30] Jensen, Michael (1989): "Eclipse of the Public Corporation". *Harvard Business Review* 67, September-October, 61-74

[31] Kahn, Charles C. and Andrew Winton (1998): "Ownership Structure, Speculation, and Shareholder Intervention." *Journal of Finance* 53, 99-129

[32] Kaplan, Steven N. (1989): "The Effects of Management Buyouts on Operating Performance and Value." *Journal of Financial Economics* 24, 217-254

[33] Kaplan, Steven N. (1991): "The Staying Power of Leveraged Buyouts." *Journal of Financial Economics* 29, 287-313

[34] Kaplan, Steven N. and Antoinette Schoar (2005): "Private Equity Returns: Persistence and Capital Flows." *Journal of Finance* 60, 1791-1823

[35] Kaplan, Steven N. and Per Strömberg (2009): "Leveraged Buyouts and Private Equity." *Journal of Economic Perspectives* 23, 121-146

[36] Lambrecht, Bart and Stewart C. Myers (2008): "Debt and Managerial Rents in a Real-Options Model of the Firm." *Journal of Financial Economics* 89, 209–231

[37] Lemmon, Michael L., Michael R. Roberts and Jaime F. Zender (2008): "Back to the Beginning: Persistence and the Cross-Section of Corporate Capital Structure." *Journal of Finance* 63, 1-37

[38] Lerner, Josh, Morten Sorensen and Per Strömberg (2010): "Private Equity and Long-Run Investment: The Case of Innovation." *Journal of Finance*, forthcoming

[39] Ljungqvist, Alexander and Matthew Richardson (2003): "The Cash Flow, Return and Risk Characteristics of Private Equity." Working Paper, New York University

[40] Mahrt-Smith, Jan (2005): "The Interaction of Capital Structure and Ownership Structure." *Journal of Business* 78, 787-816

[41] Manso, Gustavo (2009): "Motivating Innovation." Working paper, Massachusetts Institute of Technology

[42] Maug, Ernst (1998): "Large Shareholders and Monitors: Is There a Trade-Off Between Liquidity and Control?" *Journal of Finance* 53, 65-98

[43] Miller, Merton and Kevin Rock (1985): "Dividend Policy Under Asymmetric Information." *Journal of Finance* 40, 1031-1051

[44] Myers, Stewart C. (1977): "Determinants of Corporate Borrowing." *Journal of Financial Economics* 13, 147-175

[45] Myers, Stewart C. (2000): "Outside Equity." *Journal of Finance* 55, 1005-1037

[46] Myers, Stewart C. and Nicolas Majluf (1984): "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have." *Journal of Financial Economics* 13, 187-221

[47] Rajan, Raghuram G. and Luigi Zingales (1995): "What Do We Know about Capital Structure? Some Evidence From International Data." *Journal of Finance* 50, 1421-1460

[48] Ross, Stephen A. (1977): "The Determinants of Financial Structure: The Incentive Signaling Approach." *Bell Journal of Economics* 8, 1-32

[49] Stein, Jeremy C. (1988): "Takeover Threats and Managerial Myopia." *Journal of Political Economy* 46, 61-80

[50] Stein, Jeremy C. (2005): "Why Are Most Funds Open-End? Competition and the Limits to Arbitrage." *Quarterly Journal of Economics* 120, 247-272

[51] Stulz, René M. (1988): "Managerial Control of Voting Rights: Financing Policies and the Market for Corporate Control." *Journal of Financial Economics* 20, 25-54

[52] Stulz, René M. (1990): "Managerial Discretion and Optimal Financing Policies." *Journal of Financial Economics* 26, 3-26

[53] Sundaram, Rangarajan and David Yermack (2007): "Pay me later: inside debt and its role in managerial compensation." *Journal of Finance* 62, 1551-1588.

[54] Townsend, Robert (1979): "Optimal Contracts and Competitive Markets with Costly State Verification." *Journal of Economic Theory* 21, 265-293

[55] Von Thadden, Ernst-Ludwig (1995): "Long-Term Contracts, Short-Term Investment and Monitoring." *Review of Economic Studies* 62, 557-575

[56] Wei, Chenyang and David Yermack (2010): "Deferred Compensation, Risk, and Company Value: Investor Reactions to CEO Incentives." Working paper, Federal Reserve Bank of New York

[57] Zingales, Luigi (2000): "In Search of New Foundations." *Journal of Finance* 55, 1623-1653

[58] Zwiebel, Jeffrey (1996): "Dynamic Capital Structure Under Managerial Entrenchment." *American Economic Review* 86, 1197-1215

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