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Short-term termination without deterring long-term investment: A theory of debt and buyouts[☆]

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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 efficient long-term projects that risk low short-term earnings. This paper demonstrates how risky debt can overcome this tension. Leverage concentrates equityholders' stakes, inducing 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 invest without fear of termination. Unlike models of managerial discipline based on total payout, dividends are not a substitute for debt—they allow for termination upon non-payment, but at the expense of investment since they do not concentrate ownership and induce monitoring. Debt is dynamically consistent as the manager benefits from monitoring. In traditional theories, monitoring constrains the manager; here, it frees him to invest.

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1. Introduction

This paper studies the tension between two first-order problems faced by the modern firm. The first is how to terminate unskilled managers early. The financial crisis demonstrates the substantial losses that can occur if misguided decisions are left unchecked. A quite separate challenge is how to incentivize skilled managers to invest for the long-term. Nowadays, competitive success increasingly hinges upon intangible assets such as human capital (Zingales, 2000). Since intangibles only pay off in the long-run, managers may underinvest in them (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

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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 payment. The failure to do so reveals that earnings are weak, the manager is likely unskilled, and thus termination is desirable. Indeed, Jensen (1989) argues that this disciplinary effect explains why buyouts are levered: debt is “a mechanism to force managers to disgorge cash rather than spend it on empire-building projects”. However, such a justification 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 only effect of debt is discipline, equity-holders are irrelevant and dispersed ownership would be equally effective. Third, it is the manager who controls leverage going forward, and he can raise equity to repay the debt and free himself from its discipline. Fourth, the disciplinary effect may deter investment.

This is where the second effect of debt comes in: the *concentration effect*, which addresses investment. The 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 theories of 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, since missing a dividend also reveals low earnings, and are thus a perfect substitute—these models are theories of total payout (debt plus dividends) rather than debt in particular. Here, the financing structure must not only allow termination, 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, it can have the opposite effect by inducing monitoring. Moving to the optimal level of debt, it is borderline nonrepayable in disciplinary models. 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 excessive divestment; here, it is efficient as it increases concentration. Finally, the model

predicts that leverage should coincide with concentrated equity investors who actively monitor, as shown 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 leverage (e.g., Rajan and Zingales, 1995), this paper emphasizes that leverage is the product of two factors: the level of total payout and its division 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. 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. Their 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 (LBOs), which are often undertaken to discipline managers to scrap inefficient projects, but monitoring helps ensure that efficient investment is not also cut. Indeed, Kaplan and Strömberg (2009) show that, from the 1990s, buyouts have predominantly been in middle-aged firms in growing industries such as IT/media/telecoms, financial services, and healthcare. Lerner, Sorensen, and Strömberg (2011) 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 having growth opportunities 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.

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, in models where only credibility of the signal matters, borderline nonrepayable debt is optimal—debt is just high enough that a bad type defaults; additional debt would augment signaling costs. In addition, dividends are equally credible as they also have a disciplinary effect: Bhattacharya (1979)

shows that Ross's (1977) idea of signaling 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 the long-term project to be taken. Since good managers have a greater probability of having growth opportunities, 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 also to single-firm models in which investors initially impose debt on the manager to solve free cash flow problems (e.g., Jensen, 1986; Stulz, 1990). 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 is consistent with the findings of Lemmon, Roberts, and Zender (2008).

The manager's desire for monitoring in turn results from the 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 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 Indeed, Cornelli and Karakas (2010) find that LBOs lead to increases in operating performance, but also a reduction in CEO turnover, suggesting that buyouts allow the manager to have a longer-term horizon.

Turning to welfare effects, signaling reduces fundamental value in traditional models. In Ross (1977), it leads to bankruptcy risk; in Stein (1989) and Miller and Rock (1985), it reduces investment. There are no offsetting real benefits 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 have growth opportunities.

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 trade-off between termination and investment,² 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.³ In their model, monitoring has no real effects. While one could combine their result with the literature on the disciplinary effect of blockholders (e.g., Burkart, Gromb, and Panunzi, 1997) and conclude that the concentration effect can alleviate agency issues, such logic implies that the manager will unlever; here, he wishes to retain leverage. The concentration effect echoes Jensen and Meckling (1976) and Innes (1990), where debt magnifies a manager's equity holding, *directly* inducing effort. Here, there is no fundamental effort conflict, yet debt is still effective. Leverage incentivizes effort by investors rather than the manager, *indirectly* improving the manager's actions. The model contains two layers of agency problems: investor monitoring and managerial investment; solving the former addresses the latter. In a

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

² Acharya, Mehran, and Thakor (2010) also show how capital structure is driven by a trade-off between its effects on investment and managerial rent extraction (the analogy of inefficient continuation). However, in that paper, the goal is to deter rather than encourage risky investments.

³ 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 (2005) studies how institutional factors jointly affect capital structure and ownership structure, rather than how the former affects the latter.

model of investment alone, growth could be induced by simply giving the manager a long-term contract and so there is no role for debt. This paper adds a termination problem to endogenize giving the manager short-term concerns (via the threat of firing) as optimal.

Other papers contain a link between leverage and monitoring that does not arise through concentration. In Townsend (1979), debt ensures that verification only occurs in bankruptcy; 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; this paper endogenizes the monitoring decision.⁴ In Gümbel and White (2007), debt induces monitoring by shifting control to a “tough” investor, rather than by the concentration effect.⁵ 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.

Von Thadden (1995) and Edmans (2009) also analyze how ex post monitoring can induce ex ante investment. Von Thadden assumes that monitoring is contractible; this paper shows how debt can induce non-verifiable monitoring. He also studies how debt can exert discipline; dividends would have the same effect. As in this paper, Edmans studies how ownership concentration can induce monitoring, but assumes that the monitor’s dollar investment can always be increased if required and so capital structure is irrelevant. Here, her funds are limited and concentration is instead achieved using debt. This method of achieving concentration has an important advantage as it is directly under the manager’s control. Another difference is that this paper endogenizes the manager’s short-term concerns via a termination problem. Monitoring in Diamond (1984) is similarly induced by increasing the monitor’s dollar investment rather than by capital structure. In addition, the monitor in Diamond is a creditor and motivated by downside protection. Here, the gains from monitoring are the upside potential from growth opportunities, which are only enjoyed if the monitor is a shareholder.

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 distortions in investment as there is no such decision. The benefit of short-term debt is that a high-quality borrower expects that positive information will freely appear, reducing refinancing costs. In this paper, information is costly and debt has the different objective of inducing its production. In Aghion and Bolton (1992) and Dewatripont and Tirole

⁴ 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.

⁵ 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 investment issue.

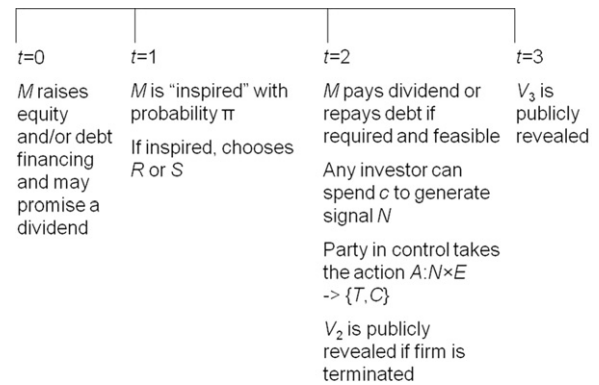


Fig. 1. Timeline of the model.

(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 above papers consider dividends as an alternative to debt.

The modeling setup draws from Stein (2005), who also analyzes the tension between liquidation and long-term decisions, within the context of financial 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 manager (M) seeks financing of I , dollars for a project. A single large investor (L) has funds of x , and a pool of atomistic investors has 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.⁶ There are four periods, summarized in Fig. 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 I will show, this restriction is without loss of generality. As in an IPO, all equityholders pay the same price for their shares and all creditors pay the same price for their debt. The face value of debt raised is denoted F ; debt matures at $t=2$ and its market value D is determined to ensure all creditors break even. M , can also promise a

⁶ x is the maximum that L can invest after taking on as much personal leverage as she is able to. The assumption of limited funds, even in the presence of personal leverage, is standard in the literature (see, e.g., Boot and Thakor, 1993; and Fulghieri and Lukin, 2001) and necessary in models of ownership structure. If x was unlimited, a single investor could own the entire firm, which would cure most agency problems.

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. I will 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) project; the project choice is non-contractible. (I will sometimes refer to choosing R rather than S as “investing”.) An uninspired manager has no project 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”). 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.

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 in Table 1.

The parameters in Table 1 satisfy the following conditions:

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

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

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

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

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

Eq. (1) means that terminating an uninspired manager at $t=2$ increases investor returns; Eq. (2) means it also increases total surplus. Eq. (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 $t=2$. I will sometimes refer to a manager who chooses R but delivers $E = V^U$ as “unlucky”

or suffering “interim losses”. The “investment problem” refers to the challenge of inducing an inspired manager to efficiently choose R , since he may prefer S to avoid being viewed as uninspired. Eq. (4) denotes that M prefers not to be terminated. The “termination problem” refers to the challenge of efficiently firing an uninspired manager, since he will not depart voluntarily. Eq. (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. A required payment of $P > V^U$ thus has a disciplinary effect.⁷

At $t=2$, events proceed as follows. First, the level of E determines which claimholders 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), I assume no gains from duplicate monitoring.⁸ If monitoring succeeds, it generates a publicly observable, unverifiable signal that is fully informative of V_3 .⁹ Formally, the public signal is $N \in \{V^R, V^S, V^U, \emptyset\}$, where N stands for “news”. The signal V^i indicates that $V_3 = V^i$; \emptyset is the null signal that appears if no monitoring occurs,

⁷ 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.

⁸ We assume that the cost is non-pecuniary (e.g., effort expenditure). 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, else shareholder structure would be irrelevant. The results continue to hold if shareholders can coordinate but at a cost. The model can be extended to allow for the possibility of duplicate monitoring; it would merely involve additional conditions to show that households will choose not to monitor.

⁹ The nonverifiability of the signal rules out contracts that directly reward L for producing a signal. The assumption that signals are observable but non-contractible is standard in the incomplete contracts literature (e.g., Aghion and Bolton, 1992; 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.

Table 1
Payoffs to investment strategies.

This table details earnings E , firm value V , and private benefits b under an uninspired manager, an inspired manager who chooses the safe project S , and an inspired manager who chooses the risky project R .

Variable	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

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 $P > V^U$. Formally, she chooses action $A : N \times E \rightarrow \{T, C\}$ where T (C) refers to termination (continuation). 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 $N \in \{V^R, V^S\}$; since both debt and equity are non-decreasing in firm value, the optimal termination decision is taken regardless of who has control. When $N = \emptyset$ and so firm value is uncertain, I 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 $A(\emptyset, E)$. 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.¹⁰

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, I need to impose two sets of parametric restrictions. The first ensures that an investment problem exists (i.e., a manager forced to make a high interim payment will 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 it achieves sufficiently close to first-best. These assumptions are

$$\pi V^S + (1-\pi)K^U < I, \quad (6)$$

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

Condition (6) states that, if an inspired manager always chooses S , the firm is unprofitable, even if investors obtain the maximum liquidation value of K^U if M is uninspired. Condition (7) states that, if an uninspired manager is never terminated, the firm is unprofitable, even if investors obtain the maximum terminal value of

V^R if M is inspired. While conditions (10), (11), and (15) are imposed throughout the paper, (6) and (7) are relaxed 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 by each investor, 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, I 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. I 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 compatibility 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. I 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 I can assume that the payment P is entirely in the form of dividends without loss of generality. I 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. I assume that

$$\pi V^R + (1-\pi)V^U > \pi(\gamma K^U + (1-\gamma)K^S) + (1-\pi)K^U, \quad (8)$$

and so 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 action is renegotiation-proof.¹¹ Since the firm is always continued, it is worth V^R if M is inspired and V^U otherwise.

Lemma 1 (No monitoring, no discipline). Assume that no monitoring occurs. In the subgame following the announcement

¹⁰ 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.

¹¹ 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.

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 and all payoffs are zero.

Proof. 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 uninspired. 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. \square

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 $t=2$. 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 $\pi\alpha\gamma/(1-\pi+\pi\alpha\gamma)$. Investors will terminate the firm if $[(1-\pi)/(1-\pi+\pi\alpha\gamma)]V^U + [\pi\alpha\gamma/(1-\pi+\pi\alpha\gamma)]V^R < K^U$, 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. \square

The intuition is as follows. The maximum posterior probability that a non-paying manager is inspired is $\pi\gamma/(1-\pi+\pi\gamma)$. This probability is reached if an inspired manager always chooses R , otherwise the posterior is

lower. Eq. (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. Eq. (11) shows that an inspired manager myopically chooses S to avoid the risk of non-payment, and so the firm is not viable from (6). For the remainder of the paper, I assume that (10) and (11) hold, else there is no investment problem: 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. \square

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 focus 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.

2.2. Contractible monitoring

I now introduce a contractible monitoring technology. While I assume that monitoring is verifiable, I 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 moral hazard problem. If M 's project choice and inspiration were observable, monitoring would be unnecessary as investors could just terminate a manager they know to be uninspired and instruct an inspired manager to choose R . That the key unobservable action 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 becomes 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 $A(V^U) = T$ and $A(V^R) = A(V^S) = C$. If monitoring is unsuccessful, there are four possible termination policies. The first is $A(\emptyset) = C$, i.e., there is no disciplinary payment and the firm is continued in the absence of a signal. 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

$$\pi V^R + (1-\pi)(\phi K^U + (1-\phi)V^U) - c, \quad (13)$$

$$\pi b^H + (1-\pi)(\phi b^L + (1-\phi)b^M). \quad (14)$$

A second option is $A(\emptyset, V^U) = T$, i.e., at $t=0$, M has promised a disciplinary payment of $P > V^U$ and so, if there is no signal to guide the liquidation decision, liquidation occurs if and only if the payment is not met. Note that L does not need to monitor if the payment has been made as this reveals $E = K^S$ and thus $A = C$ is optimal. If the payment is missed (which reveals $E = V^U$), monitoring occurs and the firm is terminated if $N \in \{V^U, \emptyset\}$. 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

$$(1-\gamma(1-\phi))b^H + \gamma(1-\phi)b^L > b^M, \quad (15)$$

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 $\gamma(1-\phi)$ 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 . I 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

$$(\pi - \pi\gamma(1-\phi))V^R + (1-\pi + \pi\gamma(1-\phi))K^U - (1-\pi + \pi\gamma)c, \quad (16)$$

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

A third possibility is $A(\emptyset) = T$. As with $A(\emptyset) = C$, 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 $A(\emptyset, V^U) = C$ (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 $A(\emptyset) = C$ or $A(\emptyset, V^U) = T$ involve renegotiation-proof termination decisions. I will call these the “non-disciplinary policy” and the “disciplinary policy,” respectively. Comparing investor payoffs under the two policies ((13) and (16)), the difference is that if monitoring fails, the disciplinary policy leads to the “Type I error” of inefficient termination of an inspired but unlucky manager, and the non-disciplinary policy leads to the “Type II error” of inefficient continuation of an uninspired manager. Note that (10) implies that (16) $>$ (13), i.e., investor returns are higher under the disciplinary policy. 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, the disciplinary policy maximizes investor returns as it minimizes Type II errors. However, since M 's payoff is higher under the non-disciplinary policy (i.e., (14) $>$ (17)), either may be the first-best policy that maximizes total surplus (the sum of firm value and private benefits).¹²

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

$$\pi w(V^R) + (1-\pi)(\phi w(K^U) + (1-\phi)w(V^U)) - c, \quad (18)$$

$$\pi(V^R - w(V^R)) + (1-\pi)(\phi(K^U - w(K^U)) + (1-\phi)(V^U - w(V^U))). \quad (19)$$

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

$$\pi b^H + (1-\pi)(\phi b^L + (1-\phi)b^M), \quad (20)$$

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

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

¹² 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).

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 $N \in \{V^U, \emptyset\}$, otherwise it is continued.
- (iii) If the firm is financed, the expected gross returns to L and all households are, respectively:

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

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

If (21) $\geq x$ and (22) $\geq 1 - x$, the firm is financed and the manager's payoff is

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

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

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

2.3. Non-contractible monitoring

I now move to the core case of non-contractible monitoring, which requires us to impose the monitoring constraints. The previous two subsections have shown that the firm is viable only if monitoring occurs, so I focus on how to induce voluntary monitoring by L . I consider the two potential first-best termination policies in turn. The non-disciplinary policy $A(\emptyset) = C$ corresponds to $P \leq V^U$, in which case L 's incentive constraint is

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

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 $w(K^U) - w(V^U)$.

The disciplinary policy $A(\emptyset, V^U) = T$ 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

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

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

In either case, L 's payoff $w(\cdot)$ must be sufficiently sensitive for monitoring to be incentive compatible. Regardless of which termination policy we wish to implement, $w(\cdot)$ can only take on two values and so 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 $w(K^U)$, $w(V^U)$,

and $w(V^R)$ equally, it has no effect on monitoring incentives and so I 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, I can thus restrict the analysis to M issuing only the standard securities of debt and equity, and L holding equity. L thus has an equity stake of $x/(1 - D)$. 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 $N = \emptyset$, so I must verify that the action is efficient (so that there is no scope for renegotiation) in addition to L 's monitoring constraint being satisfied.

The non-disciplinary policy $A(\emptyset) = C$ 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. The disciplinary policy $A(\emptyset, V^U) = T$ can be implemented either with risky debt of $F > K^U$ or a combination of debt and dividends that yields 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. I 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 $F > V^U$.

I first consider risky debt of $F > K^U$ to implement the disciplinary policy. I then study repayable debt of $F \leq V^U$ to implement the non-disciplinary policy. Finally, I analyze riskless debt and dividends where $P > V^U$ and $F \leq K^U$ to implement the disciplinary policy.

2.3.1. Risky debt

With $F > K^U$, creditors have control if $E = V^U$. If $N = \emptyset$, 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.¹³

I now consider whether L will gather information. With risky debt and L owning equity, $w(V^R) = [x/(1 - D)](V^R - F)$ and $w(K^U) = 0$. Indeed, from the incentive constraint (25), L 's monitoring incentives are maximized when $w(K^U)$ is at its lowest possible value of zero; this is achieved by having risky debt of at least K^U . Then, the incentive constraint (25) becomes

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

¹³ Eq. (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. An outside investor also has no incentive to pay c to decide whether to invest, because the signal is public and so a non-investor can never profit from monitoring. With private signals, the results of the model still go through as debt allows new investors to acquire concentrated stakes if they receive a good signal, increasing their profits and thus monitoring incentives.

The left-hand side (LHS) of (27) contains the term $x/(I-D)$. I denote the positive effect of F on $x/(I-D)$ and thus monitoring incentives as the *concentration effect*. (I 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 L 's monitoring constraint (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 $N \in \{V^R, V^S\}$, 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:

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

$$\frac{I-D-x}{I-D}[(\pi - \pi\gamma(1-\phi))(V^R - F)]. \quad (29)$$

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

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

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

$$D = (\pi - \pi\gamma(1-\phi))F + (1 - \pi + \pi\gamma(1-\phi))K^U. \quad (31)$$

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

The lower bound to F is the minimum debt level that allows L 's monitoring constraint (27) to be satisfied. Substituting the market value of debt (31) into (27) defines the lower bound as

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

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

$$\bar{F} = \frac{I - x - (1 - \pi + \pi\gamma(1-\phi))K^U}{\pi - \pi\gamma(1-\phi)}. \quad (33)$$

Therefore, if

$$\phi \frac{\pi\gamma}{1 - \pi + \pi\gamma} (V^R - \bar{F}) \geq c, \quad (34)$$

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 disciplinary effect forces the firm to pay out cash. Since uninspired managers cannot make the payment, 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 $x/(I-D)$ and thus her monitoring incentives in (27). Note that there is a countervailing effect: creditors gain $F - K^U$ from the efficient continuation of an unlucky manager. Thus, if debt is riskier, they profit more and so shareholders' gains $V^R - F$ are reduced—an example of debt overhang (Myers, 1977). 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 her monitoring constraint (27) to yield

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

If the firm is viable, we have (29) $> I-D-x$ (households' participation constraint is satisfied) which implies (35) > 0 , i.e., the concentration effect of debt outweighs the debt overhang effect. 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

With repayable debt of $D = F \leq V^U$, shareholders always have control. Since repayable debt simply reduces their payoff in all cases by F , it has no effect on their termination decision and the efficient action is always taken. I first assume no dividends, so $P = F \leq V^U$ and all firms can make the payment. This implements the non-disciplinary policy $A(\emptyset) = C$. We have $w(K^U) = (x/(I-F))(K^U - F)$ and $w(V^U) = (x/(I-F))(V^U - F)$, so the monitoring constraint (24) becomes

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

If (36) is satisfied, then L monitors and the firm is liquidated if and only if $N = V^U$. 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 L 's monitoring constraint (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:

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

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

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 $\pi b^H + (1-\pi)(\phi b^L + (1-\phi)b^M)$. (39)

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

It may not be possible to satisfy L 's monitoring constraint (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 $w(V^U)$ is at its lowest possible value of zero; since L holds equity, this is achieved by having debt of V^U . Thus, if

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

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. Eq. (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, L 's 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, L 's 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 $P > V^U$. Either change leads to a disciplinary effect and

addresses the two above drawbacks. 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 $w(V^R) = (x/(I-F))(V^R - F)$ and $w(K^U) = (x/(I-F))(K^U - F)$. L 's incentive constraint (25) becomes

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

Lemma 7 (Riskless debt, dividends). Assume that L 's monitoring constraint (41) is satisfied. 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 L 's monitoring constraint (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

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

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 5–7 leads to Proposition 1.

Proposition 1. Assume that (34), (40), and (42) hold (monitoring is induced under risky debt, but not repayable debt nor riskless debt and dividends), and that (28) $> x$ (L 's participation constraint is satisfied under risky debt). The firm cannot be financed with pure equity or riskless debt, but can be financed by risky debt.

Proof. See Lemmas 5–7. Appendix A proves that the set of parameters that satisfies these conditions is non-empty. \square

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 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 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

Table 2

Implementation of equilibria.

This table illustrates how the four equilibria defined in Lemmas 1–4 can be implemented via the choice of capital structure and dividend policy.

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

just above V^U , i.e., just sufficient to shift control to creditors. Here, the concentration effect is also important, and so the optimal debt level is strictly nonrepayable.

2.4. Comparison of financing structures

Thus far, I 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 the conditions in Proposition 1, 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 become viable, and condition (40) so that monitoring may be feasible under repayable debt, allowing the equilibrium of Lemma 3 to hold.¹⁴ The four equilibria in Lemmas 1–4 can be implemented by the capital structures given in Table 2.

From Lemmas 1–4, total surplus under each structure is given by¹⁵

$$\text{Unlevered, No dividend (NODIV): } \pi(V^R + b^H) + (1 - \pi)(V^U + b^M), \quad (43)$$

$$\text{Unlevered, Dividend (DIV): } \pi(V^S + b^M) + (1 - \pi)(K^U + b^L), \quad (44)$$

$$\begin{aligned} \text{Repayable debt (REPAYABLE): } & \pi(V^R + b^H) \\ & + (1 - \pi)(\phi(K^U + b^L) + (1 - \phi)(V^U + b^M)) - c, \end{aligned} \quad (45)$$

$$\begin{aligned} \text{Risky debt (RISKY): } & (\pi - \pi\gamma)(1 - \phi)(V^R + b^H) \\ & + (1 - \pi + \pi\gamma)(1 - \phi)(K^U + b^L) - (1 - \pi + \pi\gamma)c. \end{aligned} \quad (46)$$

¹⁴ I 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.

¹⁵ I 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.

The relative surplus depends on a number of terms. The term $(K^U - V^U)$ 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 inefficient continuation, for example, free cash that could be wasted, 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. The term $(V^R - V^S)$ 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. The variable 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. The term $(b^M - b^L)$ reflects the private benefits lost from early termination, and $(b^H - b^M)$ measures the manager's intrinsic incentives to choose R over S .

As previously established, if both termination and investment are important ($(K^U - V^U)$ and $(V^R - V^S)$ 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 both growth opportunities and tangible assets. The model can thus justify risky debt in public middle-aged firms, and also in LBOs. Concerning the latter, *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 would be 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 repay debt will induce myopia.¹⁶ Indeed, *Cotter and Peck (2001)* find that concentrated private equity investors engage in active monitoring, and LBOs perform more strongly if

¹⁶ The prediction that high leverage coincides with concentrated ownership is also generated by *Gümbel and White (2007)*, although for reasons unrelated to myopia.

ownership is concentrated. Denis (1994) compares the recapitalization of Kroger with the LBO of Safeway. In both cases, the debt-to-value ratio jumped to over 90%, but ownership remained dispersed at the former whereas Kohlberg Kravis Roberts obtained a concentrated stake in the latter. Both firms generated cash due to 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 some of the projects scrapped at Kroger were positive-NPV, this result is consistent with the model's predictions that debt plus shareholder monitoring imposes discipline without inducing myopia.

While LBOs in the 1980s were in mature firms in old-economy industries and predominantly undertaken to curb inefficient investment, Kaplan and Strömberg (2009) show that, from the 1990s, buyouts have predominantly been in middle-aged firms in growing industries such as IT/media/telecoms, financial services, and healthcare. Such LBOs aim to preserve growth opportunities in addition to scrapping bad projects. Indeed, if reducing waste is the only goal, it may be more effectively achieved by asking 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 (2011) find that innovation as measured by patenting activity does not fall and patent quality as measured by citations rises, which implies that efficient investment is not harmed. Cornelli and Karakas (2010) find that LBOs both improve performance and reduce CEO turnover, suggesting that they allow the manager to take a longer-term perspective.

Investment, but not termination, is an important issue in two main types of firms. First, a start-up has high growth opportunities ($V^R - V^S$), but the savings from efficient termination ($K^U - V^U$) are low because it has little cash for an uninspired manager to waste, and few tangible assets that can be recovered even if liquidation comes early. Second, if the manager is talented (π is high), it is unlikely that termination is optimal. From (43)–(46), *NODIV* 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 minor. Indeed, start-ups are typically unlevered and pay few dividends.

I now compare *NODIV* and *REPAYABLE*. Comparing investor returns under both structures ((43) and (45)), investor returns are higher under *REPAYABLE* if

$$c < (1 - \pi)\phi(K^U - V^U + b^L - b^M). \quad (47)$$

For *REPAYABLE* to be feasible, L 's monitoring constraint (36) must be satisfied. Since $F < I - x$, (36) implies

$c < (1 - \pi)\phi(K^U - V^U)$. Therefore, if the monitoring technology is sufficiently effective for repayable debt to be feasible, it always increases investor returns. However, M 's payoff is lower under *REPAYABLE* as he is sometimes terminated, so either financing structure 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, 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 investor returns under both structures ((44) and (46)), they are higher under dividends than debt if

$$(1 - \pi + \pi\gamma)c > \pi(V^R - V^S + b^H - b^M) - \pi\gamma(1 - \phi)(V^R - K^U + b^H - b^L). \quad (48)$$

For the risky structure to be feasible, L 's monitoring constraint (27) must be satisfied. This condition is consistent with $(1 - \pi + \pi\gamma)c > \pi(V^R - V^S) - \pi\gamma(1 - \phi)(V^R - K^U)$, i.e., investor returns being higher under *DIV*. Thus, even though M 's payoff is lower (from (15)), total surplus may be higher. Previously I 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., L 's monitoring constraint (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 liquidation if monitoring is unsuccessful. If 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 the monitoring constraint (27)): γ only affects the possibility that low earnings are realized in the first place. Thus, even if γ is high (so that, ex ante at $t = 1$, L wishes an inspired manager to choose S), she may still monitor ex post at $t = 2$ once losses have occurred. Since M expects to be monitored, he selects R . 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, F/P . We have

$$\underbrace{\text{Debt}}_F = \underbrace{\text{Total payout}}_P \times \underbrace{\frac{\text{Debt}}{\text{Total payout}}}_{F/P},$$

where

$$\text{Total payout} = \text{Debt} + \text{Dividends}.$$

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 investment 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. While Rajan and Zingales 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 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.

I 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 I am aware,¹⁷ 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.¹⁸

I now allow bankruptcy to be costly to the manager. In the core model, a manager who is unable to pay debt is just as likely to be fired as one who misses a dividend. In reality, firing is likelier in a bankruptcy because the “default” decision is liquidation; if a dividend is missed, the firm remains solvent and it requires an active decision by shareholders to close the firm. For example, Zwiebel (1996) assumes that managers are efficiently replaced in bankruptcy with certainty, 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. I model such costs by specifying that, if creditors have control and liquidation is optimal for them, it occurs with certainty, but if shareholders have control and liquidation is optimal for them, 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

¹⁷ Other debt theories based on tax advantages or contingent control cannot be applied to preferred equity, since it does not have these features.

¹⁸ 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 $n_G = n_L$.

would be stronger—risky debt would be even more preferred as it has a greater disciplinary effect.^{19,20}

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

$$\pi_B V^S + (1 - \pi_B)(\lambda K^U + (1 - \lambda)V^U) = I, \tag{49}$$

$$\pi_B V^R + (1 - \pi_B)V^U < I, \tag{50}$$

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

Assumption (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 $N = \emptyset$.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:

$$(\pi_G - \pi_G \gamma (1 - \phi))b^H + (1 - \pi_G + \pi_G \gamma (1 - \phi))b^L > \pi_G b^M + (1 - \pi_G)(\lambda b^L + (1 - \lambda)b^M), \tag{52}$$

$$(\pi_B - \pi_B \gamma (1 - \phi))b^H + (1 - \pi_B + \pi_B \gamma (1 - \phi))b^L < \pi_B b^M + (1 - \pi_B)(\lambda b^L + (1 - \lambda)b^M). \tag{53}$$

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

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

which determines the lower bound on F . From $\pi_G > \pi$ and (34) (which guarantees that *L* monitors under risky debt in the single-firm model), (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 is only occasionally fired from an unlevered firm but is always fired from a levered firm. 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 Larkin (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. I deliberately assume a constant investment scale of I and

¹⁹ *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. Here, as in *Myers (2000)*, equityholders do wish to fire the manager upon non-payment, which is the essence of the myopia issue.

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. We only require that *M* wishes to avoid bankruptcy, either because firing is more common ($\lambda < 1$) or more painful ($y > 0$).

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

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 quality in the initial period in order to raise funds, he may wish to reverse leverage later once funds have been raised.²²

Dynamic consistency issues occur in such models 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 (1996) 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 $t=0$ when funds are raised, here the benefits are earned at $t=2$ in the form of monitoring. Delevering would reduce *L*'s incentives to acquire 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 (1996) does not apply here. Instead, a good manager retains debt even absent an external threat—he does so because of the desire to pursue internal growth opportunities. Delevering loses the concentration effect of debt, preventing him from choosing *R* if inspired. From (52), this disadvantage outweighs the fact that delevering reduces the firing probability if he turns out to be uninspired.

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.

A final difference with standard signaling models is that signaling can increase economy-wide fundamental value. In a pooling equilibrium where all firms are unlevered and financed with dividends, a firm run by a good manager is worth

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

compared to (54) in a separating equilibrium. If $(V^R - V^S)$ and $(K^U - V^U)$ are sufficiently high, i.e., the termination and investment issues are sufficiently important, the returns generated 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.²⁵ 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,

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 overinvestment, because investment is sunk and cannot be overturned by the raider. Thus, debt is needed to deter overinvestment.

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.

²⁵ 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.

signaling has no effect on the level of funds raised, since all managers raise I in both equilibria. Instead, signaling 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 disciplinary theories (e.g., Burkart, Gromb, and Panunzi, 1997; Maug, 1998; Kahn and Winton, 1998; Bolton and von Thadden, 1998) which 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. 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 (forthcoming) 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.

I 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.²⁶ Unlike in some signaling theories, here the motive for signaling 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, in LBOs the debt is risky. The model also predicts that LBOs should outperform regular corporations because they attract high-quality managers and allow them to invest optimally: investor returns are strictly positive. Such outperformance is shown

by Ljungqvist and Richardson (2003) and Kaplan and Schoar (2005).²⁷

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 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.

I 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.

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 (which depends on the magnitude of the termination issue), and the division of total payout

²⁶ Axelson, Stromberg, and Weisbach (2009) justify leverage in buyouts based on agency problems between fund managers and fund investors, rather than between fund managers and operating company managers.

²⁷ 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.

between debt and dividends (which depends on the magnitude of the investment issue). 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.

Appendix 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

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

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 c/ϕ , and then choose a value for c/ϕ 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 are small (so ϕ and $I - D$ are also small). Thus, the set of parameters satisfying all of the conditions is non-empty.

Appendix 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, I 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 (in press) 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 I 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, 2011). The problem of solving agency issues through contracting rather than monitoring is a separate question studied by a different literature. In particular, I 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):

Variable	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. I 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 $t=2$ (Eq. (8)) becomes

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

and the payoff to investors (Eq. (9)) is

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

As before, investors make a loss (from (7)) and so will not finance the firm to begin with.²⁸ Thus, Lemma 1 continues to hold.

With a disciplinary payment, the conditions for Lemma 2 (Eqs. (10) and (11)) become

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

²⁸ Indeed, in the presence of incentive compensation, (7) can be weakened to $(1 - 2\beta)(\pi V^R + (1 - \pi)V^U) < I$, although this is not necessary.

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

and the payoff to investors (Eq. (12)) is

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

As before, investors make a loss (from (6)) and so will not finance the firm to begin with.²⁹ 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

$$\pi w(V^R) + (1-\pi)(\phi w(K^U) + (1-\phi)w(V^U)) - c,$$

$$\pi((1-2\beta)V^R - w(V^R)) + (1-\pi)(\phi((1-\beta)K^U - w(K^U)) + (1-\phi)((1-2\beta)V^U - w(V^U))),$$

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

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

$$\begin{aligned} &(\pi - \pi\gamma(1-\phi))w(V^R) + (1-\pi + \pi\gamma(1-\phi))w(K^U) - (1-\pi + \pi\gamma)c, \\ &(\pi - \pi\gamma(1-\phi))((1-2\beta)V^R - w(V^R)) \\ &+ (1-\pi + \pi\gamma(1-\phi))((1-\beta)K^U - w(K^U)), \end{aligned}$$

$$2\beta(\pi - \pi\gamma(1-\phi))V^R + \beta(1-\pi + \pi\gamma(1-\phi))K^U.$$

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

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

Again, the $x/(I-D)$ term demonstrates the concentration effect. Lemma 5 continues to hold and the payoffs are given by

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

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

$$2\beta(\pi - \pi\gamma(1-\phi))V^R + \beta(1-\pi + \pi\gamma(1-\phi))K^U. \quad (61)$$

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

²⁹ 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

$$D = (\pi - \pi\gamma(1-\phi))F + (1-\beta)(1-\pi + \pi\gamma(1-\phi))K^U,$$

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

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

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

$$\phi \frac{\pi\gamma}{1-\pi+\pi\gamma} ((1-2\beta)V^R - \bar{F}) \geq c. \quad (62)$$

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

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

Lemma 6 continues to hold and the payoffs are given by

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

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

$$2\beta\pi V^R + \beta(1-\phi)(\phi K^U + 2(1-\phi)V^U). \quad (63)$$

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

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

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

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

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

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

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, I only need to consider the case $x = I - D$. Then (61) $> x$ becomes

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

I first take $x=0$. The LHS of (64) and (65) are zero, so for any positive c , (64) and (65) trivially hold. Now I only need to set $c/\phi \in (0, (\pi\gamma/(1-\pi+\pi\gamma))((1-2\beta)V^R - \bar{F}))$ to make (62) hold. When c is sufficiently small (so that ϕ is also small but c/ϕ 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

$$\pi_B(1-2\beta)V_S + (1-\pi_B)(\lambda(1-\beta)K^U + (1-\lambda)(1-2\beta)V^U) = I,$$

$$(1-2\beta)(\pi_B V^R + (1-\pi_B)V^U) < I,$$

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

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

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

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

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

$$(\pi_G - \pi_G\gamma(1-\phi))(1-2\beta)V^R + (1-\pi_G + \pi_G\gamma(1-\phi))(1-\beta)K^U - (1-\pi_G + \pi_G\gamma)C,$$

$$2(\pi_G - \pi_G\gamma(1-\phi))\beta V^R + (1-\pi_G + \pi_G\gamma(1-\phi))\beta K^U,$$

$$2\pi_B\beta V^S + (1-\pi_B)(\lambda\beta V^U + 2(1-\lambda)\beta V^S).$$

L will monitor at $t=2$ if

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

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

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