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The disciplinary role of debt and equity contracts: Theory and tests

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Abstract

We study how equity and debt contracts commit investors to discipline managers. Our model shows that the optimal allocation of debt, equity, and control rights depends on which disciplinary action is more efficient. When the efficient action is managerial replacement, then control rights should be allocated to equity holders, and capital structure should consist of equity and long-term debt. When the efficient action is liquidation, then control rights can be allocated to the manager, and capital structure should consist of equity and short-term debt. We find empirical support to the model's predictions in a sample of leveraged buyout transactions.
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1. Introduction

Investors who wish to align managerial incentives often face a commitment problem. At the outset, they would like the manager to realize that they will discipline the manager if they do not get a reasonable return on their investment. However, after realizing poor return, investors might find it too costly to discipline. A lack of credible commitment to discipline ex-post adversely affects managerial incentives ex-ante.

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Many theoretical studies have looked at the role of equity and debt in solving this commitment problem (e.g., Dewatripont and Tirole, 1994, 1996; Berglöf and von Thadden, 1994; Dewatripont and Maskin, 1995; Berkovitch and Israel, 1996; Bolton and Scharfstein, 1996; Fluck, 1998). These studies show how allocation of debt claims, equity claims, or various combinations of claims across different investors motivate the investors in control to disciplinary actions.

Although this role of equity and debt is potentially important, there is little empirical work that tests whether firms structure their claims to credibly commit investors to discipline managers. This study tries to fill this gap by analyzing both theoretically and empirically the commitment role of debt and equity.

The theoretical part has a two-period principal-agent model. In the model, managerial effort is costly and unobservable to investors, and so investors have to motivate the manager to exert effort. Investors can consider two different disciplinary actions. One is decreasing firms' activities by liquidating some assets and stopping projects. Such action reduces any perks associated with managing large operation.[1] Another disciplinary action is replacing the manager with a new one. Either action results in the manager losing the benefits of controlling a large firm. Disciplinary actions are ex-post costly to implement; and so, absent a credible commitment, investors will always prefer not to discipline. The manager who realizes that investors will not use any disciplinary action will not exert effort, consequently.

The model shows that, in order to maximize ex-ante efficiency, investors should commit to the least costly disciplinary action. To commit to such action, control rights should be allocated to investors who find it optimal to discipline, even if such action is costly ex-post.

We postulate, that the fundamental features of decreasing firms' activities and of replacing the manager are that the former action decreases the volatility of future cash flows because liquidation is safer than continuation; and the latter increases the volatility of such flows because of the uncertainty associated with a new manager. Thus, if investors wish to commit to liquidation and decreasing activities, then when cash flow is low, control should be allocated to investors who have incentives to decrease volatility of future cash flows. Debt holders are natural candidates. They prefer a decrease in volatility because they hold a concave claim—they do not participate in the gains associated with high cash-flow realizations because the most they can get is the face value of their debt. Therefore, when liquidation is the efficient disciplinary action, short-term debt, rather than long-term debt, is optimal because it is necessary to transfer control to the debt holders as soon as the cash flow is low. In contrast, investors who wish to commit to managerial replacement should allocate control to investors who find it optimal to increase volatility of future cash flows. In this case, when cash flow is low, equity holders should have control. They prefer an increase in volatility because they are the residual claimants, holding a convex claim. To ensure that the equity claim is indeed convex, there should also be another group of claimants who hold a debt claim. However, these debt holders should not have control when the cash flow is low. To ensure that control is not transferred to the debt holders when the cash flow is low, the firm should issue long-term debt rather than short-term debt.

Compensation and managerial own investment in the company are also considered in the model. The results of the model suggest that compensation contract is in general a complement, rather than a substitute, to disciplinary actions. However, when managerial investment in the company is high enough, commitment to disciplinary actions is not necessary because managerial

[1] The argument that managers prefer large operations to small ones has appeared in the finance literature in many different contexts. See, for example, Jensen (1986), Harris and Raviv (1988), and Stulz (1990).

incentives are naturally aligned. In fact, commitment to disciplinary actions is suboptimal. In such a case, having long-term debt and managerial control is optimal, because it immunes the manager from unnecessary ex-post liquidations and replacements.

Leveraged Buyout (LBO) transactions in the 1980's are a unique laboratory for testing the commitment role of equity and debt. Empirical and theoretical research suggest that one of the primary goals of LBO transactions in the 1980s was to align managerial incentives with value maximization, and that incentive considerations played a major role in the design of capital structure and the allocation of control rights in these transactions.

The main findings of the empirical section are that, all else constant, LBO firms with equity holders' control have on average longer debt maturity than LBO firms with managerial control. But when managerial investment in the LBO is large, debt maturity increases. We also find that, all else constant, the likelihood of liquidation decreases the shorter the maturity of the debt, and the likelihood of managerial replacement increases the longer the maturity of the debt.

Besides providing evidence on commitment with debt and equity, this article reconciles two different views in the literature. Existing theories propose very different interpretations of the role of equity and debt in committing investors. On the one hand, Dewatripont and Tirole (1994, 1996), Berglöf and von Thadden (1994), Bolton and Scharfstein (1996), and Dewatripont and Maskin (1995), all emphasize the active role of debt holders in disciplining the manager. In their models, equity holders are passive. Control is transferred to debt holders if the manager does not pay the debt, and they decide whether to stop financing, liquidate, etc. On the other hand, theories by Berkovitch and Israel (1996) and Fluck (1998) emphasize the active role of equity holders in overseeing managers and in replacing them if they do not perform well. In Berkovitch and Israel (1996), debt holders never exercise their right to liquidate. Fluck (1998) considers active debt holders; but in her model, there is no advantage of using debt over equity.

This article shows that the decision whether to have active debt holders or to have active shareholders depends on which disciplinary action is the most efficient one, and that, in general, having them both is suboptimal.

The article proceeds as follows: In the next section, we outline the theoretical model. Section 3 summarizes the model's empirical predictions. Section 4 describes the sample and the choice of variables, and Section 5 describes the empirical tests and the results. Section 6 concludes. All proofs are in Appendix A.

2. The model

A firm is established at date 0 and operates for two periods. The sequence of events and decisions, summarized in Fig. 1, is as follows: At date 0, the entrepreneur who established the firm hires a manager and sells the cash flow and control rights to risk-neutral investors. In period 1, the manager makes an unobservable choice of effort $e \in \{e_L; e_H\}$ with $e_L < e_H$. The high effort level is efficient, but costs the manager Ψ in utility. We can interpret the low and high effort levels as the choice of a bad or a good project.

At date 1, the firm realizes cash flow $y_1 \in \Re_+$. The cash flow at date 1 is distributed $F_H : \Re_+ \to [0, 1]$ if the effort exerted by the manager is e_H, and $F_L : \Re_+ \to [0, 1]$ if the effort is e_L. f_L and f_H are the density functions of these distributions. We assume that the monotone likelihood ratio property (MLRP) holds: $\mathrm{d}[f_L(y_1)/f_H(y_1)]/\mathrm{d}y_1 < 0$, $\forall y_1 \in \Re_+$. The monotone likelihood ratio property implies that F_H first-order stochastically dominates F_L. Denote $\bar{y}_{1H} \equiv \int_0^\infty y_1 \,\mathrm{d}F_H$ and $\bar{y}_{1L} \equiv \int_0^\infty y_1 \,\mathrm{d}F_L$, the (finite) expected cash flows at date 1 associated with effort levels e_H and e_L, respectively.

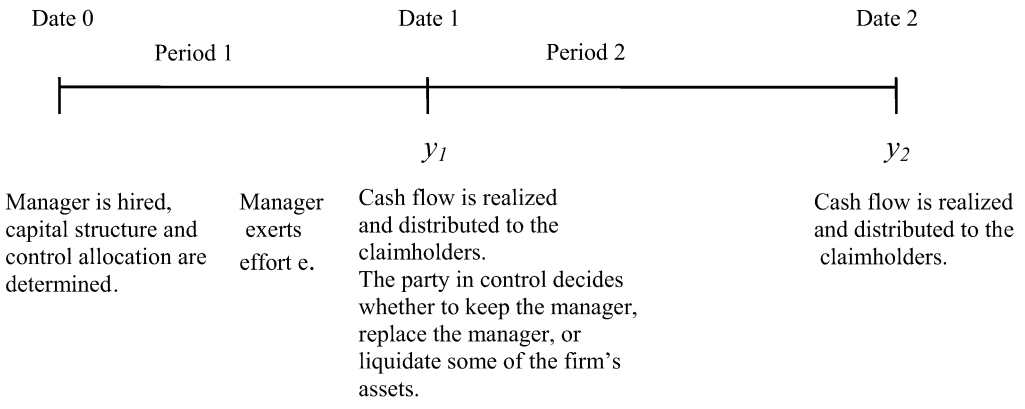

Fig. 1. Sequence of events.

After the manager chooses the level of effort and y_1 is realized, investors who have control decide how to proceed. As in Grossman and Hart (1986), we assume that this decision is non-contractible.

Investors have three different options. The first, D, is to decrease firms' activities by liquidating some assets and stopping projects. The second, R, is to replace the manager. The third, K, is to keep the manager and continue operations. If the firm pursues action $A \in \{D, R, K\}$, the distribution of second-period cash flow is $G_A : \Re_+ \to [0, 1]$, and its density function is g_A. We define $\bar{y}_{2A} \equiv \int y_2 \, \mathrm{d}G_A$ the (finite) expected cash at date 2 associated with action A.

We make several additional assumptions. First, we assume that the distribution of the cash flow in the second period is independent of y_1, and the effort decision.[2] Second, we make the following assumptions about the distribution of cash flow associated with each of the actions:

Assumption 1 (*Simple decrease in risk*). There exists $y_{2D} \in (0, \infty)$ such that $G_D(y_2) < G_K(y_2)$ for $0 < y_2 < y_{2D}$ and $G_D(y_2) > G_K(y_2)$ for $y_{2D} < y_2$.

Assumption 2 (*Simple increase in risk*). There exists $y_{2R} \in (0, \infty)$ such that $G_R(y_2) < G_K(y_2)$ for $0 < y_2 < y_{2R}$ and $G_R(y_2) > G_K(y_2)$ for $y_{2R} < y_2$.

The first assumption is that actions associated with decreasing firms' activities are inherently safer than those of continuation. This assumption implies that there is less uncertainty about the value received from liquidation of assets than from operating these assets. The second assumption is that managerial replacement is inherently more risky than keeping existing manager. This assumption implies that there is additional uncertainty about managerial type and firms' prospects when a new manager takes place. Clayton et al. (2005) give supporting evidence for this assumption.

[2] This assumption is not crucial for the results, but it significantly simplifies the analysis. The results will still hold even when there is a positive correlation between the cash flow that the manager generates at dates 1 and 2. In such a case, for some low cash flow realizations, investors would find it ex-post efficient to discipline. However, the ex-post efficient policy in general would not coincide with the ex-ante optimal policy. Commitment to aggressive disciplinary policy would still be optimal, as long as the shift in the distribution for high effort relative to low effort is large enough.

In the rest of the analysis, we also make the following assumption:

Assumption 3. $\bar{y}_{2k} > \max(\bar{y}_{2R}, \bar{y}_{2D})$.

This assumption means that it is ex-post efficient to keep the manager than to discipline the manager. It is supported by the fact that disciplinary actions like liquidation and replacement are often costly, thus reducing their attractiveness ex-post.

In the model, the manager does not have personal funds (this assumption will be relaxed later), and managerial reservation utility is zero. A manager who is not disciplined in the second period extracts nontransferable benefits of control, $B > 0$, from running the firm in the second period. For tractability, we assume that the manager does not respond to compensation (this assumption will also be relaxed later), and so the only way for investors to motivate the manager to exert effort is to change the probability of keeping the manager ex-post.

2.1. Continuation, replacement, and liquidation

To understand the policy that maximizes the value of the firm, we first consider a case of no moral hazard. When there is no moral hazard, the first-best solution is ex-post efficient. In that case, the manager continues to work without disturbance in the second period because the value under the manager is higher than the value of replacing the manager with a new one or of decreasing activities and liquidating assets.

However, when moral hazard exists, the first-best solution will not provide the right incentives for the manager to exert effort. Let $V \in \{D, R\}$ denote the disciplinary action with the highest value and let $\bar{y}_{2v} = \max\{\bar{y}_{2D}, \bar{y}_{2R}\}$ denote its value. Since $\bar{y}_{2v} < \bar{y}_{2K}$ (i.e., disciplinary actions are costly), no matter how hard the manager works in the first period, it is optimal to keep the manager in the second period. But since exerting e_H yields utility of $B - \Psi$ and exerting e_L yields B, the manager will prefer to exert e_L in the first period. A manager who knows that disciplinary actions are too costly to implement will not have incentives to exert effort in the first period.

Given the moral hazard problem, investors should find a way to provide managerial incentives. To maximize the value of the firm under moral hazard, investors should commit to an optimal disciplinary policy that minimizes ex-post inefficiency while providing the manager with enough incentives to exert effort.[3]

Let $p_D(y_1)$ be the probability of decreasing firms' activities in period 2, and $p_R(y_1)$ be the probability of replacing the manager in period 2, given the realization of y_1. The maximization problem of the investors is as follows:

$$\max_{p_D(y_1)p_R(y_1)} \bar{y}_{1H} + \int_0^\infty \left\{\bar{y}_{2k}\big(1 - p_D(y_1) - p_R(y_1)\big) + \bar{y}_{2R}p_R(y_1) + \bar{y}_{2D}p_D(y_1)\right\} f_H(y_1)\,\mathrm{d}y_1 \tag{1}$$

[3] We, of course, assume that the disciplinary cost is not too large. Otherwise, it is optimal not to provide any incentives and let the manager choose e_L.

subject to

$$B\int_0^{\infty}\big(1-p_D(y_1)-p_R(y_1)\big)f_H(y_1)\,\mathrm{d}y_1-\Psi$$
$$\geqslant B\int_0^{\infty}\big(1-p_D(y_1)-p_R(y_1)\big)f_L(y_1)\,\mathrm{d}y, \tag{2}$$
$$0\leqslant p_D(y_1)\leqslant 1,\ 0\leqslant p_R(y_1)\leqslant 1.$$

The maximization problem (1) consists of the expected cash flow at date 1 when the effort level is e_H, plus the expected cash flow at date 2. The expected cash flow at date 2 consists of three terms: the expected second-period cash flow for all y_1 realizations where management is kept, plus the expected second-period cash flow for all y_1 realizations where the manager is replaced, plus the expected second period cash flow for all y_1 realizations in which assets are liquidated.

Inequality (2) is the incentive compatibility constraint. The left-hand side is the utility of the manager from exerting effort level e_H, and the right-hand side of the inequality is the utility of the manager from exerting effort level e_L.

We note that in the optimal solution to maximization problem (1), for any realization of y_1 in which the manager is disciplined, the firm should always choose the disciplinary action that has the highest value. The reason is that both actions have the same effect on the manager, and so it is always best to minimize ex-post inefficiency by choosing the action with the highest value. Proposition 1 provides formal proof to this argument.

Proposition 1. *If $\bar{y}_{2D}>\bar{y}_{2R}$ then $p_R(y_1)=0$ for all y_1. If $\bar{y}_{2D}<\bar{y}_{2R}$ then $p_D(y_1)=0$ for all y_1.*

Using the result in Proposition 1, the maximization problem (1) can be restated as follows:

$$\max \bar{y}_1+\int_0^{\infty}\big\{\bar{y}_{2k}\big(1-p_v(y_1)\big)+\bar{y}_{2v}p_v(y_1)\big\}f_H(y_1)\,\mathrm{d}y_1 \tag{3}$$

subject to

$$B\int_0^{\infty}\big(1-p_v(y_1)\big)f_H(y_1)\,\mathrm{d}y_1-\Psi\geqslant B\int_0^{\infty}\big(1-p_v(y_1)\big)f_L(y_1)\,\mathrm{d}y_1, \tag{4}$$
$$0\leqslant p_v(y_1)\leqslant 1$$

where $p_v(y_1)$ is the probability of choosing action V (the action with the highest value), given the realization of y_1. The first-order condition of the maximization problem becomes

$$(\bar{y}_{2k}-\bar{y}_{2v})f_H(y_1)-\lambda B\big(f_H(y_1)-f_L(y_1)\big) \tag{5}$$

where $\lambda\leqslant 0$ is the Lagrange multiplier associated with constraint (4). Proposition 2 provides the optimal solution to maximization problem (3):

Proposition 2. *The optimal solution to maximization problem (3) involves disciplining the manager when the cash flow realization y_1 is below a threshold level y_1^*. The threshold level y_1^* is the smallest solution to the equation $F_L(y_1)-F_H(y_1)=\Psi/B$.*

Proposition 2 states that the optimal solution to problem (3) is to commit to keeping the manager only if the first-period cash flow is above the threshold y_1^*. This strategy means that to align managerial incentives, investors should commit to a disciplinary action if y_1 is in the range $(0, y_1^*)$; although for those realizations, it is ex-post efficient to keep the manager. Thus, investors face a trade-off between incentive alignment and ex-post inefficient continuation policy.

As noted earlier, it is difficult to implement an optimal rule without a credible commitment. When cash flow is realized at date 1, the manager has already exerted the effort; and at that point, the action that maximizes the value of the firm is to keep the manager. A decision rule that maximizes firm value at date 1 does not consider the adverse effect on the incentives of the manager to exert effort.

2.2. Implementing the optimal decision rule

To implement the optimal disciplinary policy, investors in control should have incentives to discipline if the cash flow at date 1 is low. The way investors commit to these disciplinary decisions is by allocating control ex-post to investors who find it optimal to discipline.

We consider three types of claims that can be distributed among different investors at the outset: short-term debt, long-term debt, and equity. At date 0, the entrepreneur sells these claims to different investors. Short-term debt holders hold debt that expires at date 1. Long-term debt holders hold debt that expires at date 2. Equity holders hold the residual claim over the cash flow. Denote F_{short}, F_{long} the face value of the short-term and long-term debt respectively.

Besides allocations of claims, at date 0, the entrepreneur can allocate control rights either to equity holders or to the manager. At date 1, control is transferred to debt holders if $y_1 < F_{\text{short}}$. If control is transferred, then debt holders decide how to proceed. (If control is transferred to debt holders, and short- and long-term debt holders are in dispute over the optimal way to discipline, then we assume that short-term debt holders decide with probability $\frac{1}{2}$ and long-term debt holders decide with probability $\frac{1}{2}$.) If $y_1 > F_{\text{short}}$, then control is not transferred and it remains in the hands of either the manager or the equity holders (whoever was given control rights at the outset), and they decide how to proceed.

We also assume that if short-term debt is paid in full at date 1, then the equity holders use the rest of the cash flow to pay the long-term debt. This feature of long-term debt reflects the common covenants in debt contracts that prevent residual claim holders from receiving dividends before at least part of the debt is retired.

Our goal is therefore to construct an allocation of claims among equity holders, short- and long-term debt holders, and of control rights between the manager and equity holders, that implements the optimal choice of disciplinary action, and consequently maximizes firm value.

Assumptions 1 and 2 imply that the fundamental features of decreasing activities and replacing managers are that the former action decreases the volatility of future cash flows and the latter increases the volatility of such flows because of the uncertainty associated with a new manager. When $\bar{y}_{2D} > \bar{y}_{2R}$, then when cash flow is low, control should be allocated to investors who find it optimal to decrease volatility of future cash flows. Debt holders are natural candidates. They prefer a decrease in volatility because they hold a concave claim. They do not participate in the gains associated with high cash flow realizations, because the most they can get is F_{short}.

Similarly, if $\bar{y}_{2R} > \bar{y}_{2D}$, then when cash flow is low, control should be allocated to investors who find it optimal to increase volatility of future cash flows. In this case, equity holders are

natural candidates. They prefer an increase in volatility because they are the residual claimants, holding a convex claim. To ensure that the claim of the equity holders is indeed convex, debt should also be part of the optimal capital structure. But since, in this case, control should not be transferred to debt holders at date 1 regardless of the cash flow realization, the debt should be long-term debt.

We formally characterize these optimal allocations in the following propositions. We start in Propositions 3 and 4 with the general characterization of the optimal allocation, assuming that such allocation exists. We then formally show in Propositions 5 and 6 the necessary and sufficient conditions for an allocation to exist and the exact set of allocations of short-term debt, long-term debt, equity claims and control rights that implements the optimal decision rule.

Proposition 3. *Consider the case where* $\bar{y}_{2R} > \bar{y}_{2D}$. *If an optimal allocation exists, then*:

(a) *It should not include* $F_{\text{short}} > 0$.
(b) *It should not include managerial control.*
(c) *It should include* $F_{\text{long}} > 0$.

Proposition 3 suggests that when $\bar{y}_{2R} > \bar{y}_{2D}$, then it is necessary to allocate control to investors who prefer to increase the volatility of the cash flows when y_1 is low. Having short-term debt is suboptimal in this case, because with short-term debt, there will be some low realizations of y_1 in which control will be transferred to debt holders, and they have motivation to liquidate rather than to replace the manager, because of their concave claim. Managerial control is also suboptimal, because the manager will never wish to be replaced, and to forgo the benefits of control. Therefore, equity-holder control and long-term debt are the only possible candidates. Long-term debt is necessary to ensure that equity holders have a convex-enough claim to motivate them to replace the manager when cash flow is low, even when replacement is costly.

Another way to illustrate why long-term debt is necessary to provide incentives to the equity holders to replace the manager, is to view the equity claim as a call option. In the model, the cash flow claim of the equity holders is $\max(y_1 + y_2 - F_{\text{short}} - F_{\text{long}}, 0)$. This claim is like a call option with a strike price of $F_{\text{short}} + F_{\text{long}}$. Since the value of a call option increases with the volatility, equity holders gain from increased volatility of future earnings even when such an increase is costly. To ensure that their claim is convex, a debt claim is required. If there was no debt, shareholders would try to maximize the value of the firm, and would not benefit from increased volatility. The debt claim, however, cannot be short-term debt, because otherwise the debt holders will gain control when y_1 is low and will liquidate. Long term debt is the solution in this case. Long-term debt holders will not have control when short-term cash flow is low. At the same time, equity holders will have extra incentives to replace the managers because, when debt is in place, they have extra incentives to increase the volatility of future earnings.

We continue the characterization of the optimal allocation in Proposition 4.

Proposition 4. *Let* $\bar{y}_{2R} < \bar{y}_{2D}$. *If an optimal allocation exists, then it should include* $F_{\text{short}} > 0$.

Proposition 4 suggests that when decreasing activities is the disciplinary action with the highest value, then short-term debt is desirable. If there is no short-term debt, and equity holders retain control, they always prefer either not to discipline at all or to replace the manager. If the

manager retains control, the manager will never choose any disciplinary measure because the manager will forgo the benefits of control.

Under some mild restrictions (basically, that the inefficiency of either disciplinary action is not too large and the risk induced by replacing the manager is large enough), there exists a set of allocations that implements the decision rules. We describe it in Propositions 5 and 6.

Proposition 5. *Let $\bar{y}_{2R} > \bar{y}_{2D}$. Necessary and sufficient conditions for optimal allocation to exist are that the inefficiency from replacing the manager is not too large, and the risk induced by replacing the manager is large enough* (*the exact conditions are described in the proof*). *The allocation is unique and consists of allocating control rights to equity holders, and cash flow rights to equity holders and long-term debt holders. The exact face value of long-term debt is $F_{\text{long}} = y_1^* + x_1$, where y_1^* is defined in Proposition 2 and x_1 is the smallest solution to the equation $\int_0^x (G_R(y_2) - G_K(y_2))\,\mathrm{d}y_2 = \bar{y}_{2R} - \bar{y}_{2D}$.*

Proposition 6. *Let $\bar{y}_{2D} > \bar{y}_{2R}$. Necessary and sufficient conditions for a solution to exist are that the inefficiency from decreasing activities is not too large* (*the exact condition is described in the proof*). *The set of optimal allocations includes control allocation to either the manager or to equity holders, and $F_{\text{short}} = y_1^*$.*

The optimal allocation described in Proposition 5 has long-term debt and equity holders' control. The level of long term debt is optimized so that the equity holders will have enough incentives to replace the manager when the cash flow y_1 is below the threshold, but will not have incentives to replace the manager when the cash flow y_1 is above the threshold. It is necessary that the risk from replacing the manager is large enough relative to the costs of replacing the manager, so that equity holders will have enough incentives to discipline.

The optimal allocation described in Proposition 6 has short-term debt, to ensure that when cash flow is low, debt holders, who prefer liquidation, have control. It is possible to allocate control rights at the outset either to the manager or to the equity holders, but it is necessary to have short-term debt, so that the disciplinary action will involve liquidation. Long-term debt is sub-optimal in this case, because for some low realizations of y_1, short-term debt holders and long-term debt holders will have differing views of how to continue, which will reduce the credibility of liquidation. The optimal level of short-term debt is the amount of cash flow below which the manager should be disciplined.

The model has several simplifying assumptions to keep it tractable. However, the general results are robust: When investors wish to discipline by decreasing activities, they have to use short-term debt. Active debt holders have incentives to decrease activities when the firm defaults, because they hold a concave claim. Equity holders do not play a role in this case, and therefore, the manager can have control at the outset.

When investors wish to discipline by replacing the manager, they should not use short-term debt, because short-term debt holders prefer to decrease activities. Long-term debt makes the equity holders' claim convex, giving the equity holders incentives to replace the manager when cash flow is low.

2.3. The effect of managerial compensation on the optimal allocations

In the above analysis, we assume that a compensation contract to the manager is not allowed. In this section we show that when benefits of control are large enough, and the cost of the dis-

ciplinary actions is not too large, then even when a compensation contract is allowed, there is still a role for disciplinary actions. We also show that the strategic allocation of debt, equity, and control rights is similar to the one described in Section 2.2.

Suppose that the manager can receive a wage $w(y_1)$ as a function of the realization of y_1. Further assume that the compensation cannot be higher than some large number $\overline{w}$. The maximization problem of the entrepreneur becomes:

$$\max_{w(y_1),p_v(y_1),I} \bar{y}_{1H} + \int_0^\infty \left\{\bar{y}_{2k}\left(1 - p_v(y_1)\right) + \bar{y}_{2v}p_v(y_1) - w(y_1)\right\} f_H(y_1)\,\mathrm{d}y_1 \tag{6}$$

subject to

$$\begin{aligned} &\int_0^\infty \left(B\left(1 - p_v(y_1)\right) + w(y_1)\right) f_H(y_1)\,\mathrm{d}y_1 - \Psi \\ &\quad \geqslant \int_0^\infty \left(B\left(1 - p_v(y_1)\right) + w(y_1)\right) f_L(y_1)\,\mathrm{d}y_1, \\ &0 \leqslant p_v(y_1) \leqslant 1,\ 0 \leqslant w(y_1) \leqslant \overline{w}. \end{aligned} \tag{7}$$

Proposition 7 characterizes the optimal solution to the above maximization problem.

Proposition 7. *The optimal solution to the maximization problem when compensation contract is allowed includes also a disciplinary action for low realizations of y_1, provided that the loss from disciplining the manager is not too large, and the benefits of control are large enough* (*the exact condition is in the proof*).

Proposition 7 says that even when a compensation contracts is allowed, it is still optimal to discipline the manager for some low realizations of cash flows. The intuition behind this result is that disciplinary mechanisms as well as compensation contracts involve a tradeoff. The tradeoff is between the amount of incentives that each mechanism provides and the cost of that mechanism. When investors offer a compensation contract, the cost is the actual incentive compensation that the manager gets from running the firm, and the benefit is the incentives to the manager. The MLRP condition implies that it is efficient to provide the highest compensation possible for the highest possible outcomes. When investors commit to disciplinary actions, the cost is the ex-post inefficient action. The benefit is the incentives of the manager to exert high effort. The MLRP condition implies that it is most efficient to discipline for the lowest possible outcomes. When the benefits (B) are large enough, and the cost of the disciplinary action is low enough, then disciplinary actions for low enough realizations have lower shadow cost than compensation schemes alone, and therefore, they should be part of the optimal incentive scheme.

Since the optimal commitment scheme is similar to the one in Section 2.1 (disciplining the manager when y_1 is lower than a certain threshold), the optimal allocation of control rights, equity, and debt should have the same characteristics as the allocation in Section 2.2.

2.4. The effect of managerial holdings on the optimal allocation

So far, we assume that the manager has no personal wealth to invest in the firm. We abstract from the possibility that the manager might already have some initial financial stake invested.

It is important to understand how the inclusion of such financial stake affects the results, since managers often invest some of their own money in the firm they manage.

In this section, we show that if the manager holds a large-enough financial stake in the firm, managerial incentives are naturally aligned, and therefore, disciplinary actions are not necessary. In that case, equity holders and debt holders should not commit to any disciplinary action. In fact, committing to disciplinary actions would impose unnecessary cost on investors and on the manager. The optimal allocation of control rights and cash flow rights in this case would involve immunizing the manager from disciplinary action, by, for example, allocating control to the manager and having long-term debt, or having no debt at all. However, when managerial stake in the firm is low, then disciplinary actions will be necessary to align managerial incentives, and the results in Sections 2.2 and 2.3 will still hold.

Suppose that the manager has a financial stake in the firm. Let $0 \leqslant \alpha < 1$ denote the managerial financial stake in the firm. The maximization problem of the entrepreneur becomes:

$$\max_{w(y_1),p_v(y_1),I} \int_0^\infty (1-\alpha)\big\{y_1 + \bar{y}_{2k}(1 - p_v(y_1) + \bar{y}_{2v}p_v(y_1)\big\} f_H(y_1)\,\mathrm{d}y_1 \tag{8}$$

subject to

$$\begin{aligned}
&\alpha \int_0^\infty \big[y_1 + \bar{y}_{2k}\big(1 - p_v(y_1)\big) + \bar{y}_{2v}p_v(y_1)\big] f_H(y_1)\,\mathrm{d}y_1 + \int_0^\infty B\big(1 - p_v(y_1)\big) f_H(y_1)\,\mathrm{d}y_1 - \Psi \\
&\quad \geqslant \alpha \int_0^\infty \big[y_1 + \bar{y}_{2k}\big(1 - p_v(y_1)\big) + \bar{y}_{2v}p_v(y_1)\big] f_L(y_1)\,\mathrm{d}y_1 \\
&\qquad + \int_0^\infty B\big(1 - p_v(y_1)\big) f_L(y_1)\,\mathrm{d}y_1, \qquad (9) \\
&0 \leqslant p_v(y_1) \leqslant 1.
\end{aligned}$$

The first-best is achieved when the manager exerts effort in the first period and the firm does not need to resort to any disciplinary action in the second period ($p_v(y_1) = 0$). Substituting the first-best contract in the incentive compatibility constraint (9), we obtain that: $\alpha(\bar{y}_{1H} - \bar{y}_{1L}) - \Psi \geqslant 0$.

Since exerting effort in the first period is efficient, $(\bar{y}_{1H} - \bar{y}_{1L}) - \Psi > 0$, and therefore, there exists an $\alpha^* < 1$ such that for all managerial stakes $\alpha > \alpha^*$, managerial incentives are naturally aligned. When $\alpha < \alpha^*$, then incentives are not naturally aligned, and the incentive compatibility constraint does not hold. The way to make the incentive compatibility hold is to discipline the manager ex-post with some positive probability.

3. Predictions

The theoretical part has several predictions about the correlation between capital structure, debt maturity, control allocation, and disciplinary actions. We can formalize these predictions into hypotheses as follows:

Hypothesis 1. Short-term debt should be higher when the manager has control and lower when outside shareholders have control.

Hypothesis 2. All else being equal, short-term debt should be lower when managerial investment in the firm is high.

Hypothesis 3. All else being equal, the likelihood of liquidation should increase with the level of short-term debt, and decrease when managerial investment in the firm is high.

Hypothesis 4. All else being equal, the likelihood of managerial replacement should decrease with the level of short-term debt and decrease when managerial investment in the firm is high.

Hypothesis 1 follows directly from Propositions 5 and 6. The relations between managerial investment and the likelihood of liquidation and of replacements in Hypotheses 2, 3 and 4 follow directly from the discussion in Section 2.4, and the relations between the likelihood of liquidation and replacements and the debt structure in Hypotheses 3 and 4 follow from Propositions 5 and 6. In the following section we test the above hypotheses.

4. Sample and variables

4.1. Sample

When choosing a dataset to test the models' predictions, it is important to ensure that the model is applicable to the dataset in question. LBOs are especially suited for testing the model. LBOs are going-private transactions, led by outside equity holders or incumbent management, and financed with large amounts of debt, outside equity, and management investment. Empirical and theoretical research suggests that one of the primary reasons of LBO transactions in the 1980s was to align managerial incentives with value maximization.[4] Thus, it is safe to assume that in these transactions, incentive considerations played a major role in the design of capital structure and allocation of control rights.

The assumptions of the model fit well with LBO transactions. First, the model assumes that the manager exerts considerable effort in the short run. This assumption is supported by evidence on large operational changes after the buyout (e.g., Bakerand Wruck, 1989; Smith, 1990; Kaplan, 1989).

Second, the predictions of short- and long-term debt rely on the fact that short-term cash indicates managerial effort. This assumption is more appropriate for LBOs, since LBOs often occur in mature industries where managerial effort is correlated with efficient operations and short-term cash flow. The assumption is less appropriate for firms with large growth opportunities where managerial effort is focused on long-term cash flow.

Third, the model considers the choice among incentive mechanisms within the organization. The model does not consider outside disciplinary mechanisms, such as takeover pressure. Many LBO transactions are a response to market pressure (Shleifer and Vishny, 1988). After the transaction, the firm's voting rights are not publicly traded, and the role for internal incentive mechanisms becomes more important.

[4] For a survey of supporting empirical work see, for example, Jensen (1993).

Therefore, to perform the empirical tests, we use a sample of LBO firms between 1986 and 1989. We choose the late years of the buyout wave because data are more accessible for that period of time and because all firms in those years go private after the 1986 tax reform. We identify firms that go private between 1986 and 1989 by examining the Mergers and Acquisitions Review from 1986 through 1989, and the W.T. Grimm's Mergerstat Review from 1986 to 1989. We reduce the sample to going-private transactions with the following characteristics:

(a) The transaction is completed between January 1, 1986 and December 31, 1989.
(b) The new private company is an independent entity, not a subsidiary of another private company.
(c) The going private transaction is financed by more than 50% debt.
(d) The total value of the deal (value of the stock and securities paid to shareholders plus refinancing of the old debt) is more than $100 million. The reason for the size criterion is to allow for larger, more fully disclosed transactions. It is also consistent with previous analysis of similar samples (Kaplan and Stein, 1993).
(e) The majority of debt financing is not obtained through an employee share ownership plan (ESOP).

Seventy-five firms meet these criteria. We exclude from the sample seven firms in which managers own the majority of the shares or effectively have control prior to the buyout. The reason for excluding these seven is that an article by Halpern et al. (1999) suggests that these buyouts are not necessarily driven by value-maximization considerations.

Finally, we obtain information about the firms by examining the Lexis–Nexis news database, the proxy statements, 10K and 8K statements before and after the buyout and bankruptcy filings. Out of the 68 remaining firms, 44 firms provide enough debt and governance information for the tests.

In our final sample, about 4% of the transactions occur in 1986, 11% occur in 1987, 50% occur in 1988, and 25% occur in 1989. This clustering indicates the trend in LBO transactions during the sample period. The Merger and Acquisition Review reports 1988 as a peak year in transactions. In their sample, Kaplan and Stein (1993) find similar clustering.

Sample firms cluster in two major industries, manufacturing (59%) and retail stores (30%). A total of 24 firms (55%) experience direct outside takeover pressure prior to the buyout. The large number of takeover attempts supports the hypothesis that the buyouts are a response to market pressure (Shleifer and Vishny, 1988). By comparison, 42% of the firms in Lehn and Poulsen's (1989) sample between the years 1980 and 1987 experience direct takeover pressure.

4.2. Choice of variables

To test the empirical predictions, the variables in the model should match the variables in the data as closely as possible. These variables are the financial decision variables at the time of the buyout; the disciplinary actions after the buyout; and the observable variables that affect cash flow patterns across firms.

4.2.1. Managerial ownership and control

To measure the extent of managerial control in the sample, we use the Shapley value (Shapley, 1953). The Shapley value expresses the probability that management is pivotal in a random coalition formation. For example, managers who have more than 50% of the votes are pivotal in

any coalition and, therefore, have a Shapley value of 1. If voting rights are split equally among the manager and two other institutional investors, then the manager has a Shapley value of one-third.

We take the managerial voting rights and the voting rights of the different buyout investors from the financial statements at the time of the buyout. We also add any voting rights that the manager can obtain in the first two years after the buyout, unless those voting rights are contingent on performance.

The model predicts that for large managerial ownership, managerial incentives are naturally aligned, and therefore, short-term debt is not necessary to discipline the manager. To control for large managerial ownership, we use a dummy variable which equals 1 if managerial investment in the LBO exceeds 80% of the total amount of equity in the firm, and 0 otherwise. A total of 4 firms have managerial investment larger than 80%.

4.2.2. Debt maturity

To measure debt maturity, we use the ratio of debt amortized in the first two years after the buyout to the total amount of debt. Our choice of two years is somewhat ad hoc, but we believe it is in line with the model assumption that investors should be able to assess within the first two years how well the firm is doing under the CEO. For robustness, we also consider the percentage of debt that matures within the first year and within the first three years after the buyout. We pay particular attention to the specifics of the bank deals. For example, although almost all firms have short-term lines of credit, some of them have harsh restricting covenants, such as requiring the firms to clear the balance on their line of credit at the end of each year. Other firms have very lenient terms, allowing them to draw lots of cash and repay it over a long period of time.

4.2.3. Managerial replacement

We define managerial replacement as the change of a CEO within the first two years after the buyout, unless the CEO is age 60 or over when replaced. We obtain information about replacements from the 10K statements after the buyout, media reports after the buyout, and the proxy statements of buyout firms that go public again.

4.2.4. Liquidations and decreasing activities

We define decreasing activities as the sale of assets, a division or several divisions within the first two years after the buyout. We exclude sales of divisions that were planned at the time of the buyout, and the liquidation of some divisions to finance the expansion of other divisions. We obtain information about asset sales and subsequent financing from the statement of cash flow after the buyout.

4.2.5. Other variables

The likelihood of disciplinary actions depends not only on the fraction of the debt that is due, but also on the patterns of cash flows that the firm expects to generate. To illustrate this point, consider, for example, two firms that commit to discipline their managers with short-term debt. The first firm expects high levels of relatively safe cash flow in the short run, and the second firm expects low levels of cash flow in the short run. To discipline their manager with short-term debt, the first firm will need to undertake higher levels of short-term debt than the second firm. It is, therefore, important to control for these cash flow patterns in the empirical analysis.

We use three variables to control for differences in cash flow patterns across firms. The first is a dummy variable, which equals 1 if the firm announces at the buyout that it plans to sell some assets within the first two years after the buyout. The second is the market-to-book ratio, defined

Table 1
Descriptive statistics

Variable	Mean	25th Pctl	Median	75th Pctl
Sales ($millions)	1600	348	677	1745
Total debt ($millions)	1081	257	448	1299
Debt-to-Assets	81%	60%	72%	89%
Percentage Bank Debt	47%	36%	52%	61%
Amortization—by first year	4%	0%	2%	4%
Amortization—by second year	11%	1%	6%	12%
Amortization—by third year	16%	5%	12%	21%
Planned asset sales (% of firms)	30%			
Managerial ownership after the buyout	35%	13%	26%	45%
Shapley value	0.32	0	0	0.67
Manager large investor (% of firms)	9%			
Market to Book ratio	1.42	1.09	1.26	1.49
Fire-sale within the first two years (% of firms)	23%			
Replaced their manager within the first two years (% of firms)	20%			

Notes. The sample consists of 44 leveraged buyout firms that went private between 1986 and 1989. Financial information is from the first 10K statement after the buyout. Planned asset sales is a dummy variable that equals 1 if the firm announces at the time of the buyout that it plans to sell assets, and 0 otherwise. Manager large investor is a dummy variable that equals 1 if the manager owns after the buyout more than 80% of the equity and 0 otherwise. Fire-sale is a dummy variable which equals 1 if the firm had a net sale of assets in its cash flow statements within the first two years after the buyout. Replaced their manager is a dummy variable which equals 1 if the firm replaced the manager in the first two years after the buyout, and the manager age at the time of the buyout was 60 or lower. Total debt is the long-term debt plus the current maturities of the debt.

as the market value of equity (based on the price two months before the buyout) plus the book value of the debt obligation after the buyout, all divided by the book value of the assets after the buyout. This variable controls for differences in expected performance across different firms. The third variable is an industry dummy, which captures differences in growth opportunities across different industries.

Hypotheses 3 and 4 predict a relation between disciplinary actions after the buyout and debt structure at the time of the buyout. Disciplinary actions should be correlated with worse performance, and therefore, when testing these hypotheses we should control for performance after the buyout. We use the ratio of earnings before taxes, interest, depreciation, and amortization to assets (ROA) two years after the buyout to control for performance.

Table 1 shows descriptive statistics of firms in the sample. Firms at the time of the buyout have average sales of $1600 million, with a median of $677 million. The difference between the mean and the median suggests that the sample is skewed by several large firms. The average debt to asset ratio is 81%, suggesting that these firms are highly levered. Banks lend about 47% of the debt, and the rest is public debt and private placements.

The amortization figures suggest that around 50% of the firms need to pay 2% or less of the debt within the first year; but by the third year, they need to pay 12% of the debt. However, there is large variation in the amortization of the debt. For example, the upper quartile of the three-year amortization levels is 21%—almost double the median amortization. About 30% of the firms announce at the buyout that they plan to sell some of their equipment and plants to repay the debt.

Managers own on average 35% of the shares of the firm after the buyout, with 50% of the managers holding 26% or less. However, the statistics of the Shapley value suggest that in more than half of the buyouts, the manager does not have any control. These buyouts typically have one large investor (e.g., a large buyout firm) who has the majority of the shares. In 25% of the firms, the Shapley value is 0.67 or higher, suggesting that managers in these firms have substantial control.

Firms in the sample have relatively little growth opportunities, as measured by the market-to-book ratio of assets. The average market-to-book ratio is 1.49 with a median of 1.29. Around 23% of the firms had unplanned liquidations of some of their assets during the first two years of the buyout. In 20% of the firms, the manager was replaced within the first two years of the buyout.

5. Tests

5.1. Debt maturity and managerial control

Hypothesis 1 suggests that equity holders' control should be a substitute for short-term debt. This prediction means that managerial Shapely value should be positively correlated with short-term debt. Hypothesis 2 suggests that when the manager has large investment in the buyout, short-term debt is not necessary. We therefore form the following regression:

$$\begin{aligned} Short\_Term\_Debt = {} & a_0 + a_1 Shapley + a_2 Manager\_Large\_Investor \\ & + a_3 Planned\_Asset\_Sale + a_4 Market\_to\_Book + Industry. \end{aligned} \tag{10}$$

The model predicts that the coefficient of the *Shapley* variable (a_1) should be positive (i.e., when the manager has more control, the firm should have more short-term debt), and the coefficient of the *Manager_Large_Investor* variable (a_2) should be negative, since managerial incentives are naturally aligned when the manager has large investment in the company, and therefore, short-term debt is not needed.[5]

Other variables that affect short-term debt are those that affect expected cash flow patterns in the future. These variables include *Planned_Asset_Sales* dummy, the *Market_To_Book* ratio, and the industry dummy. We expect firms that plan a sale of assets and firms that are more profitable to have more cash flows in the short run, and therefore, they will be able to have more short-term debt.

Table 2 shows the results. We first show the univariate analysis in panel A, and then show the regression results in panel B. In panel A, the sample is divided into firms that have no managerial control ($Shapley = 0$) and firms that have some managerial control ($Shapley > 0$). (This cut-off provides two groups of approximately similar size.)

The table shows that the group of $Shapley = 0$ has significantly lower short-term debt than the group of $Shapley > 0$. The average amortization of debt in the first two years when the manager has no control ($Shapley = 0$) is 4% compared with 20% when the manager has some control ($Shapley > 0$). The difference is significant at the 1% level. The difference is also significant

[5] We test a relation between two endogenous variables—short-term debt and the Shapely value. Thus, our decision about which variable to put on the right hand of the regression is somewhat ad hoc. We also tried an opposite specification, where the dependent variable is the Shapley value—and we get the same inferences.

Table 2
Debt maturity and control
Panel A. Univariate analysis

Variable	*Shapley* = 0	*Shapley* > 0	Difference	*p*-value	
Managerial ownership after the buyout	15%	59%	−44%	0.00	***
Shapley value	0	0.7	−70%	0.00	***
Amortization—by first year	2%	7%	−6%	0.00	***
Amortization—by second year	4%	20%	−16%	0.00	***
Amortization—by third year	9%	26%	−17%	0.00	***
Number of firms	24	20			

Panel B. Regression analysis

	Dependent variable: Short-term debt			
	Predicted sign	(% amortized in 1 year)	(% amortized in 2 years)	(% amortized in 3 years)
Intercept		−0.014	−0.003	0.030
		(0.33)	(0.48)	(0.29)
Shapley	+	0.048**	0.205***	0.223***
		(0.03)	(0.00)	(0.00)
Manager large investor dummy	−	−0.030	−0.143**	−0.162***
		(0.21)	(0.01)	(0.01)
Planned asset sale dummy		0.088***	0.131***	0.147***
		(0.00)	(0.00)	(0.00)
Market to Book ratio		0.013	0.027	0.031
		(0.22)	(0.17)	(0.16)
Industry		+	+	+
Adjusted R^2		25%	42%	44%

Notes. The table shows tests of the relation between debt maturity and control. The sample consists of 44 leveraged buyout firms that went private between 1986 and 1989.

** Significance at the 5% level. In panel B, the numbers in parentheses are the *p*-values (one side test).

*** Idem., 1%.

when the amortization is measured over the first year and over the first three years after the buyout.

Table 2 panel B shows the results of three different regressions, where the dependent variable is debt amortization over one, two, and three years. The numbers in parentheses are the *p*-values from the one-side test. Consistent with the prediction of the model, the coefficient of the *Shapley* variable is positive, and the coefficient of the *Manager_Large_Investor* dummy is negative in all three regressions. The coefficient of the *Shapley* variable is statistically significant in all three regressions, and the coefficient of the *Manager_Large_Investor* variable is statistically significant in two out of the three regressions.[6]

The effects of managerial control and managerial investment on debt structure are also economically meaningful. For example, when the dependent variable is amortization of debt two years after the buyout, the coefficient of the *Shapley* variable is around 0.2. This result means that a move from the 50 percentile to the 75 percentile in the *Shapley* variable (a difference of 0.67) is associated with an increase of about 13% in the amortization over the first two years.

[6] The relation between debt maturity and control is also consistent with Cotter and Peck (2001).

The coefficient of the *Manager_Large_Investor* variable is 0.131, which means that when the manager is a large investor, the amortization over the first two years decreases by about 13%.

Overall, the positive relation between short-term debt and managerial control and the negative relation between short-term debt and large managerial investment are consistent with Hypotheses 1 and 2.

5.2. Debt maturity, liquidations, and managerial replacements

Hypotheses 3 and 4 predict that debt maturity and control allocation decisions are associated with the ex-post disciplinary actions. All else constant, there should be a higher probability of liquidation when the debt is short term, and all else constant, there should be a higher probability of managerial replacement when the debt is long term.

To test these hypotheses, we form the following two probit regressions:

$$\begin{aligned} FireSale = {} & a_0 + a_1 Short\_Term\_Debt + a_2 Manager\_Large\_Investor \\ & + a_3 Planned\_Asset\_Sale + a_4 Market\_to\_Book + a_5 ROA + Industry\_Dummy, \end{aligned} \tag{11}$$

$$\begin{aligned} Manager\,Replaced = {} & b_0 + b_1 Short\_Term\_Debt + b_2 Manager\_Large\_Investor \\ & + b_3 Planned\_Asset\_Sale + b_4 Market\_to\_Book + b_5 ROA \\ & + Industry\_Dummy. \end{aligned} \tag{12}$$

Regression (11) estimates the probability that a firm will liquidate some of its assets in the first two years after the buyout. The independent variables from the model are short-term debt and the *Manager_Large_Investor* dummy. We expect a positive relation between short-term debt and the probability of fire sale ($a_1 > 0$), because short-term debt holders prefer this disciplinary action to managerial replacement. We also expect a negative relation between the *Manager_Large_Investor* dummy and fire sale ($a_2 < 0$) because when the manager has a large stake, committing to aggressive disciplinary action is not required, and therefore, there should be less disciplinary actions. The control variables include the *Planned_Asset_Sale*, firm's return on assets two years after the buyout (*ROA*), and the *Market_to_Book* variable to control for the amount of cash that the firm is expected to generate in the short term, which might affect its level of short-term debt.

Regression (12) estimates the probability that a firm will replace the manager in the first two years after the buyout. The independent variables from the model are similar to those in regression (12). However, in this case, the model predicts that $b_1 < 0$—i.e., a higher probability of managerial replacements when the firm has less short-term debt. The model also predicts that when the manager is a large investor, there will be no need for ex-post inefficient replacements, and therefore $b_2 < 0$.

Table 3 shows the results of regression (11). The table shows three different regressions, for the three specifications of short-term debt. All three regressions show a positive relation between the likelihood of liquidation and the amount of short-term debt. The result is significant at the 10% level in two of the three models. The table also shows that the *Managerial_Large_Investor* coefficient is negative in two out of the three regressions, but it is not statistically significant.

Table 4 shows the results of regression (12). Again, the table shows three different regressions, for the three specifications of short-term debt. All three regressions show a negative relation between the likelihood of managerial replacement and the amount of short-term debt. The coefficient is statistically significant at the 10% level when the independent variable is the 2-year

Table 3
Debt maturity and asset liquidations

	Predicted sign			
Intercept		5.80**	4.62**	4.60**
		(0.02)	(0.02)	(0.02)
Amortization (1 year)	+	7.03*		
		(0.10)		
Amortization (2 years)	+		3.45	
			(0.14)	
Amortization (3 years)	+			3.42*
				(0.09)
Manager Large Investor	−	0.06	−0.19	−0.13
		(0.49)	(0.45)	(0.47)
Market to Book		−4.53**	−3.36**	−3.48**
		(0.03)	(0.04)	(0.03)
Planned sales dummy		−0.23	−0.16	−0.16
		(0.39)	(0.42)	(0.42)
Return on Assets two years after the buyout		−20.20***	−21.50***	−21.82***
		(0.01)	(0.00)	(0.01)
Industry		+	+	+

Notes. The table shows the results of a probit regressions, where the dependent variable is a dummy variable for whether the firm had an unplanned liquidation of assets in the first two years after the buyout. The sample consists of 44 firms that went private through a leveraged buyout transaction between 1986 and 1989. Return on assets is the earnings before interest, taxes, depreciation, and amortization, divided by the book value of assets, all measured two years after the buyout. Amortization (year) is the fraction of the debt that is due within the specified number of years. Market to Book is the market value of equity plus book value of liabilities divided by the book value of assets, all measured at the time of the buyout. Planned sales dummy is a dummy variable that equals 1 if the firm mentions at the time of the buyout that it plans to sell some of its assets. Manager Large Investor is a dummy variable that equals 1 if the manager bought 80% or more of the equity after the buyout. Industry is a dummy variable for whether the firm belongs to the retail industry. The numbers in parentheses are the p-values (one side test).

* Significance at the 10% level.
** Idem., 5%.
*** Idem., 1%.

amortization. The *Managerial_Large_Investor* coefficient is negative in all three regressions, as predicted by the model (albeit not statistically significant).

The short-term debt coefficients suggest an economically meaningful effect on the probabilities of liquidation and of managerial replacement. A move from the median to the 75 percentile in the two-year debt amortization (about 6%), is associated with roughly a 20% increase in the probability of liquidation, and roughly 20% decrease in the probability of managerial replacement.

Overall, we find a relation between debt maturity and disciplinary actions. Liquidations are more likely to occur when debt maturity is short, and replacements are more likely to occur when debt maturity is long. The relation is consistent with Hypotheses 3 and 4.

We note that the results are only marginally significant. Part of the reason might have to do with the relatively small sample size. However, the fact that the results follow through in this relatively restricted set of very highly-levered transactions, suggests that leveraged buyout transactions should not be viewed as homogeneous. The debt and control allocation decisions in these deals are related to one another and to ex-post disciplinary actions.

Table 4
Debt maturity and managerial replacements

	Predicted sign			
Intercept		−0.20	0.10	0.06
		(0.41)	(0.46)	(0.47)
Amortization (1 year)	−	−4.24		
		(0.21)		
Amortization (2 years)	−		−3.68*	
			(0.10)	
Amortization (3 years)	−			−2.01
				(0.15)
Manager Large Investor dummy	−	−7.27	−7.63	−7.41
		(0.50)	(0.50)	(0.50)
Market to Book		0.54	0.56	0.51
		(0.14)	(0.14)	(0.14)
Planned sales dummy		−0.69	−0.72	−0.81
		(0.18)	(0.17)	(0.13)
Return on Assets two years after the buyout		−9.43*	−10.33*	−9.58*
		(0.07)	(0.06)	(0.06)
Industry		+	+	+

Notes. The table shows the results of a probit regression, where the dependent variable is a dummy variable for whether the manager was replaced within two years after the buyout. The sample consists of 44 firms that went private through a leveraged buyout transaction between 1986 and 1989. Return on assets is the earnings before interest, taxes, depreciation, and amortization, divided by the book value of assets, all measured two years after the buyout. Amortization (year) is the fraction of the debt that is due within the specified number of years. Market to Book is the market value of equity plus book value of liabilities divided by the book value of assets, all measured at the time of the buyout. Planned sales dummy is a dummy variable that equals 1 if the firm mentions at the time of the buyout that it plans to sell some of its assets. Manager large investor, is a dummy variable that equals 1 if the manager bought 80% or more of the equity after the buyout. Industry is a dummy variable for whether the firm belongs to the retail industry. The numbers in parentheses are the p-values (one side test).

* Significance at the 10% level.

6. Conclusion

In this study we show that debt holders and equity holders play different disciplinary roles. Equity holders prefer to discipline with actions that increase volatility, and debt holders prefer to discipline with actions that decrease volatility. It is inefficient to have both to discipline at the same time. Thus, debt and equity monitoring should be substitutes rather than complements. We show that a relation exists between the way firms choose their capital structure and control allocation and their choice of disciplinary actions. When managerial replacement is the most efficient disciplinary action, ex-ante the firm should issue long-term debt and equity and allocate control to outside equity holders. The long-term debt ensures that equity holders have a call-like claim, and therefore they will have extra incentives to replace the manager. Long-term debt is optimal in this case, because debt holders should not get control when cash flow is low.

When liquidation or decreasing activities is the optimal disciplinary action, ex-ante the firm should issue short-term debt and equity, and allocate control to the manager. Debt holders have a concave claim over the cash flows of the firm, and therefore they prefer liquidation over replacement. Short-term debt is necessary to ensure that control is transferred to debt holders when cash flow is low.

Commitment with financial claims seems important not only in the context of leveraged buyout transactions. Future research can look at other cases as well as at the commitment role of other financial instruments. Designing optimal instruments to facilitate investors' incentives is another avenue for future research.

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Appendix A

Proof of Proposition 1. Let $p_I^*(y_1)$ $I \in \{D, R\}$ denote the optimal decision rule. Without loss of generality, assume that $\bar{y}_{2R} < \bar{y}_{2D}$. We will show that any allocation where $p_R^*(y_1) > 0$ for some positive measure is not optimal. Suppose that the statement is wrong, implying that there is a set of positive measure, denoted M, where $p_R^*(y_1) > 0$ $\forall y_1 \in M$. Consider a candidate solution $p_I^{**}(y_1)$, where $p_I^{**}(y_1) = p_I^*(y_1)$ $\forall y_1 \in \Re_+/M$, $p_D^{**}(y_1) = p_D^*(y_1) + p_R^*(y_1)$ and $p_R^{**} = 0$ $\forall y_1 \in M$. This candidate solution satisfies the incentive compatibility constraint since, by design, $(1 - p_D^*(y_1) - p_R^*(y_1)) = (1 - p_D^{**}(y_1) - p_R^{**}(y_1))$ $\forall y_1$. The difference between firm value under the candidate solution and the value under the optimal solution is $(\bar{y}_{2D} - \bar{y}_{2R}) \int_M p_R^* \, \mathrm{d}y_1$. This expression is strictly positive. Therefore, the candidate solution $p_I^{**}(y_1)$ is strictly better than $p_I^*(y_1)$, contradicting the assumption that $p_I^*(y_1)$ is optimal. Therefore, $p_R^*(y_1) = 0$ $\forall y_1 \in \Re_+$. □

Proof of Proposition 2. The incentive compatibility constraint has to bind, because otherwise it is possible to decrease $p_v(y_1)$ and reduce the disciplinary costs. Therefore, $\lambda < 0$. Dividing by $f_L(y_1)$, the first-order condition (5) can be rewritten as follows: $(\bar{y}_{2k} - \bar{y}_{2v}) - \lambda B(1 - f_L(y_1)/f_H(y_1))$. By the MLRP assumption, $f_L(y_1)/f_H(y_1)$ decreases in y_1, suggesting that the solution is of the form $p_v(y_1) = 1$ for all $y_1 \leqslant y_1^*$ and $p_v(y_1) = 0$ for all $y_1 > y_1^*$. Upon substitution of the solution in the incentive constraint, we get that y_1^* is the smallest solution to the equation $F_L(y_1) - F_H(y_1) = \Psi/B$. □

Proof of Proposition 3. (a) Suppose that the optimal allocation has $F_{\text{short}} > 0$. Let $y_{2m} = \min(\bar{y}_{2D}, \bar{y}_{2R})$. Consider the following set of y_1 realizations: $\max(F_{\text{short}} - y_{2m}, 0) < y_1 < F_{\text{short}}$. For a realization y_1 from that set, debt holders receive y_1, the firm defaults and debt holders gain control. At that point, short-term debt holders hold a claim with a face value of $F_{\text{short}} - y_1$, which is smaller than y_{2m}. Debt holders will choose action $A \in \{R, K, D\}$ that maximizes their expected cash flow claim. Their claim from choosing action A is $\int \min(y_2, F_{\text{short}} - y_1) \, \mathrm{d}G_A(y_2)$, which can be rewritten as $F_{\text{short}} - y_1 - \int_0^{F_{\text{short}} - y_1} G_A(y_2) \, \mathrm{d}y_2$. Therefore, short-term debt holders prefer action A, which minimizes $\int_0^{F_{\text{short}} - y_1} G_A(y_2) \, \mathrm{d}y_2$. From Assumptions 1 and 2, and the fact

that of $F_{\text{short}} - y_1 < y_{2m}$, the action that minimizes this expression is D. But this action is always suboptimal. Therefore, the optimal allocation cannot include short-term debt.

(b) Since short-term debt is not optimal, control cannot be transferred at date 1 to debt holders. Thus, at date 1, control should be either allocated to the manager or to the equity holders. A manager who has control would never replace herself at date 1 because of the benefits she would forgo. Therefore, managerial control is not optimal.

(c) Given (a) and (b), the candidate solution must have equity holders control and no short-term debt. Finally, we show that if a solution exists, then it has to have $F_{\text{long}} > 0$. If $F_{\text{long}} = 0$, then at date 1, equity holders are the sole claimants; and therefore, they will choose an action at date 1 that maximizes the value of the firm. Since $\bar{y}_{2K} > \bar{y}_{2D}$, they will keep the manager regardless of the performance in the first period. This strategy is not ex-ante optimal, and therefore, $F_{\text{long}} = 0$ cannot be a part of an optimal allocation. □

Proof of Proposition 4. Suppose that $F_{\text{short}} = 0$. In that case, at date 1, either the manager or the equity holders have control. If the manager has control, the manager will never choose action D because of the benefits of control that the manager foregoes. Therefore, the only other possibility is that equity holders have control. Suppose that equity holders have control. If $F_{\text{long}} = 0$, then equity holders are the sole claimants, and they prefer the ex-post efficient action—keeping the manager. But a manager who will not be replaced is not going to exert effort. Therefore, the only possibility is shareholder control and $F_{\text{long}} > 0$. Consider the following set of y_1 realizations: $0 < y_1 < \min(F_{\text{long}}, y_1^*)$. By Proposition 2, for these realizations, investors in control should choose action D. We will show that equity holders will not choose action D. The claim of equity holders for that set of realizations is $\int \max(0, y_2 - (F_{\text{long}} - y_1))\,\mathrm{d}G_A(y_2)$, which, upon simplification, becomes $\bar{y}_{2A} - (F_{\text{long}} - y_1) - \int_0^{F_{\text{long}}-y_1} G_A(y_2)\,\mathrm{d}y_2$. This result implies that equity holders will prefer the action that maximizes $\bar{y}_{2A} + \int_0^{F_{\text{long}}-y_1} G_A(y_2)\,\mathrm{d}y_2$. But $\bar{y}_{2K} > \bar{y}_{2D}$ and $\int_0^{F_{\text{long}}-y_1} G_K(y_2)\,\mathrm{d}y_2 \geqslant \int_0^{F_{\text{long}}-y_1} G_D(y_2)\,\mathrm{d}y_2$ (by Assumption 2). Therefore, for any realization $0 < y_1 < \min(F_{\text{long}}, y_1^*)$, equity holders will find action K better than action D. Thus, there is no feasible allocation with $F_{\text{short}} = 0$ that motivates investors for the optimal disciplinary action. □

Proof of Proposition 5. Proposition 2 implies that the only possible allocation is equity holders' control and financing by equity and long-term debt. For an arbitrary long-term debt claim F_{long}, if at date 1 $y_1 > F_{\text{long}}$, then the long-term debt is fully repaid. At that point, equity holders prefer action K to action R since they become the sole owners of period 2 cash flow. The optimal replacement policy requires that the manager should be replaced for all $y_1 < y_1^*$. Thus, for realizations $y_1 < y_1^*$ the debt should not be repaid in full. Therefore, if there is an optimal allocation, it has to satisfy $F_{\text{long}} \geqslant y_1^*$.

If the cash y_1 is not enough to repay the long-term debt at date 1, then the claim to long-term debt holders is $F_{\text{long}} - y_1$, and the expected value of equity holders' claim from choosing action A is $\int_{F_{\text{long}}-y_1}^{\infty} (y_2 - (F_{\text{long}} - y_1))\,\mathrm{d}G_A(y_2)$, which further simplifies to $\bar{y}_{2A} - (F_{\text{long}} - y_1) - \int_0^{F_{\text{long}}-y_1} G_A(y_2)\,\mathrm{d}y_2$. A necessary and sufficient condition to ensure equity holders preferences for the optimal policy is that $\bar{y}_{2K} - (F_{\text{long}} - y_1) - \int_0^{F_{\text{long}}-y_1} G_K(y_2)\,\mathrm{d}y_2$ is smaller (larger) than $\bar{y}_{2R} - (F_{\text{long}} - y_1) - \int_0^{F_{\text{long}}-y_1} G_R(y_2)\,\mathrm{d}y_2$ for all $y_1 < y_1^*(F_{\text{long}} > y_1 > y_1^*)$. This condition further simplifies to $\bar{y}_{2K} - \bar{y}_{2R}$ being smaller (larger) than $\int_0^{F_{\text{long}}-y_1} G_R(y_2) - G_K(y_2)\,\mathrm{d}y_2$ for all $y_1 < y_1^*(F_{\text{long}} > y_1 > y_1^*)$. We note that if $F_{\text{long}} = y_1^*$, then for $y_1 < y_1^*$ close enough to

$y_1^*, \bar{y}_{2K} - \bar{y}_{2R} > \int_0^{F_{\text{long}}-y_1} G_R(y_2) - G_K(y_2)\,\mathrm{d}y_2$. Therefore, if there is an optimal allocation, it has to satisfy $F_{\text{long}} > y_1^*$.

Consider the expression $\int_0^x G_R(y_2) - G_K(y_2)\,\mathrm{d}y_2$. This expression starts at zero for $x = 0$, increases with x until the point $x = y_{2R}$ (defined in Assumption 2) and then decreases with x, until it reaches $\bar{y}_{2R} - \bar{y}_{2K} < 0$ for $x = \infty$. If the difference $\bar{y}_{2K} - \bar{y}_{2R}$ is not too large (the exact necessary condition is $\int_0^{y_{2R}} G_R(y_2) - G_K(y_2)\,\mathrm{d}y_2 > \bar{y}_{2K} - \bar{y}_{2R}$), then there are two solutions to the equation $\int_0^x G_R(y_2) - G_K(y_2)\,\mathrm{d}y_2 = \bar{y}_{2K} - \bar{y}_{2R}$. Denote these solutions x_1 and x_2. For all y_1 such that $F_{\text{long}} - y_1 < x_1$, equity holders prefer action K. For all y_1 such that $x_2 > F_{\text{long}} - y_1 > x_1$, equity holders prefer action R. For all y_1 such that $F_{\text{long}} - y_1 > x_2$, equity holders prefer action K again. Since action R should be optimal if and only if $0 < y_1 < y_1^*$, the optimal long-term claim should be $F_{\text{long}} = y_1^* + x_1$, with the requirement that $x_2 > F_{\text{long}}$. □

Proof of Proposition 6. Proposition 3 implies that short-term debt is necessary. Note that a solution must satisfy $F_{\text{short}} \geqslant y_1^*$ Otherwise, the firm will not default when $F_{\text{short}} < y_1 < y_1^*$, and at least for a subset of this regime neither equity holders nor the manager will favor action D. If the cash y_1 is not enough to repay the debt at date 1, then the claim to short-term debt holders from choosing action A is $\int_0^{F_{\text{short}}-y_1} y_2\,\mathrm{d}G_A(y_2) + (F_{\text{short}} - y_1)(1 - G_A(F_{\text{short}} - y_1))$. This expression further simplifies to $(F_{\text{short}} - y_1) - \int_0^{F_{\text{short}}-y_1} G_A(y_2)\,\mathrm{d}y_2$. Assumption 1 implies that there exists $y_{2D} < x < \infty$ such that $\int_0^{F_{\text{short}}-y_1} G_D(y_2)\,\mathrm{d}y_2 > \int_0^{F_{\text{short}}-y_1} G_K(y_2)\,\mathrm{d}y_2$ for all $F_{\text{short}} - y_1 < x$ and $\int_0^{F_{\text{short}}-y_1} G_D(y_2)\,\mathrm{d}y_2 < \int_0^{F_{\text{short}}-y_1} G_K(y_2)\,\mathrm{d}y_2$ for all $F_{\text{short}} - y_1 > x$.

Suppose that $F_{\text{short}} > y_1^*$. Consider the set $(y_1^* < y_1 < F_{\text{short}}\}$. For any realization of y_1 within that set, investors should choose action K. However, since $\int_0^{F_{\text{short}}-y_1} G_D(y_2)\,\mathrm{d}y_2 > \int_0^{F_{\text{short}}-y_1} G_K(y_2)\,\mathrm{d}y_2$ for all $F_{\text{short}} - y_1 < x$, short-term debt holders will prefer action D at least for some of the realizations $y_1^* < y_1 < F_{\text{short}}$; and even if long-term debt holders exist, action D will occur with positive probability. Therefore, if an optimal allocation exists, it has to have $F_{\text{short}} = y_1^*$. To ensure that the optimal allocation exists, short-term debt holders should prefer action D to action K when the firm defaults. A necessary and sufficient condition is that $F_{\text{short}} - y_1 < x$ for all $y_1 < y_1^*$ which is equivalent to requiring that $y_1^* < x$.

Managerial control is optimal, since the manager will never replace herself if short-term debt is paid in full. We note that the set of optimal allocation can include also long-term debt, as long as there is no dispute between short-term and long-term debt holders over which action they should choose when in default. This condition puts a cap on the amount of long-term debt that the firm can have. Similarly, equity holder control is possible, as long as long-term debt is not too high. If long-term debt is too high, then the equity holders' claim becomes too convex, and they will replace the manager too often. □

Proof of Proposition 7. The first-order conditions with respect to the optimal probability $p_v(y_1)$, and the optimal financial stake $w(y_1)$ are respectively:

$$(\bar{y}_{2v} - \bar{y}_{2k}) f_H(y_1) + \lambda B\big(f_H(y_1) - f_L(y_1)\big) \tag{A.1}$$

$$-f_H(y_1) - \lambda\big(f_H(y_1) - f_L(y_1)\big) \tag{A.2}$$

where $\lambda \leqslant 0$ is the Lagrange multiplier associated with the incentive compatibility constraint and the individual rationality constraint respectively. By the same argument as in Proposition 1, the incentive compatibility constraint has to bind, and therefore, $\lambda < 0$. Suppose that the disciplinary action is not optimal. Then the format of the first-order condition (A.2) implies that

there exists $y_1^{**} > 0$ such that the manager should receive full compensation for all $y_1 > y_1^{**}$ and should receive compensation 0 for all $y_1 < y_1^{**}$. The optimal y_1^{**} is determined by the incentive compatibility constraint, which, upon substitution of the optimal solution, becomes $\overline{w}(F_H(y_1^{**}) - F_L(y_1^{**}))\Psi = 0$.

Now, the first-order condition with respect to $w(y_1)$ implies that $-f_H(y_1^{**}) - \lambda(f_H(y_1^{**}) - f_L(y_1^{**})) = 0$. We can, therefore, write $-f_H(y_1^{**})/(f_H(y_1^{**}) - f_L(y_1^{**})) = \lambda^{**}$. Since $p_v(y_1) = 0$ for all y_1, the first-order condition $(\bar{y}_{2v} - \bar{y}_{2k})f_H(y_1) + \lambda B(f_H(y_1) - F_L(y_1))$ has to be negative for all possible realizations of y_1. The MLRP condition implies that the first-order condition (A.1) has its maximum value at $y_1 = 0$ and is monotonically decreasing in y_1. Therefore, if $(\bar{y}_{2v} - \bar{y}_{2k})f_H(0) + \lambda B(f_H(0) - f_L(0)) > 0$, then the assumption that the optimal solution includes no disciplinary action is not valid, and the optimal solution should include also a range in which $p_v(y_1) = 1$. The condition $(\bar{y}_{2v} - \bar{y}_{2k})f_H(0) + \lambda^{**}B(f_H(0) - f_L(0)) > 0$, can be simplified to $(\bar{y}_{2v} - \bar{y}_{2k}) + \lambda^{**}B(1 - f_L(0)/f_H(0)) > 0$. But this condition will hold as long as the managerial benefits from continuation are high enough and as long as the cost of the disciplinary action is low enough. Therefore, for high-enough benefits and low-enough costs, compensation contracts alone are not optimal. The first-order condition (A.1) implies that the optimal contract should also include a disciplinary action for low realizations of y_1 and no disciplinary action for high realizations of y_1. Therefore, the allocation of cash flow rights and control rights should be similar to the one in Section 2.2 even when incentive compensation is allowed. □

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