ABSTRACT

This thesis consists of three essays in financial economics.

Chapter 1 is entitled “Inside Debt.” Existing theories advocate the use of cash and equity in executive compensation. However, recent empirical studies have documented the prevalence of debt-like instruments such as pensions. This chapter rationalizes the use of such inside debt as an efficient solution to the agency costs of debt. Owing to its greater sensitivity to liquidation payoffs, inside debt is more effective at optimizing project selection than the bonuses, private benefits and reputational concerns advocated by prior literature. Contrary to intuition, it is typically inefficient to align the manager with firm value by granting him equal proportions of debt and equity.

Chapter 2 is entitled “Sports Sentiment and Stock Returns” and co-authored with Diego García and Øyvind Norli. We investigate the stock market reaction to sudden changes in investor mood. Motivated by psychological evidence of a strong link between soccer outcomes and mood, we use international soccer results as our primary mood variable. We find a significant market decline after soccer losses. For example, a loss in the World Cup elimination stage leads to a next-day abnormal stock return of $-49$ basis points. This loss effect is stronger in small stocks and in more important games, and is robust to methodological changes. We also document a loss effect after international cricket, rugby, and basketball games.

Chapter 3 is entitled “Leverage, Ownership Concentration, and the Tension Between Liquidation and Investment.” Allowing early liquidation minimizes investor losses if the manager is unskilled. However, the possibility of liquidation deters a skilled manager from undertaking long-term projects that risk interim turbulence. This chapter introduces a novel role of debt that overcomes this tension. Leverage concentrates equityholders’ stakes, creating incentives for them to find out whether short-term losses result from low ability or a temporary downturn in a profitable project. If the firm is fundamentally sound, it is not liquidated upon poor performance. Debt therefore allows termination without inducing myopia. Unlike models of managerial discipline based on total payout, here dividends are not a substitute for debt as they achieve liquidation without incentivizing monitoring.
Thesis Supervisor: Stewart C. Myers
Title: Robert C. Merton Professor of Financial Economics
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In writing this thesis, I am very fortunate to have enjoyed insights, guidance and support from a large number of outstanding people. Highlighting individuals runs the great risk of erroneously omitting others equally deserving of my gratitude. However, my education in finance has taught me that risks should sometimes be taken.

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This thesis is dedicated to the memory of my father, James Edmans.
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1 Inside Debt

1.1 Introduction

Shareholders ultimately bear the agency costs suffered by other stakeholders (Jensen and Meckling (1976)). Therefore, it appears intuitive that shareholders should compensate the manager according to firm value, rather than equity value alone. However, until recently, empirical research documented that CEOs are remunerated exclusively with cash and equity-like instruments, such as shares and options. Accordingly, theorists have focused on justifying such a compensation scheme. For example, Dewatripont and Tirole (1994) seek to answer the question "why are managers’ monetary incentives ... traditionally correlated with the value of equity rather than the value of debt?" Important for the justification of pure equity compensation are papers that propose cash salaries, solvency-contingent bonuses and private benefits as adequate solutions to the agency costs of debt. Therefore, existing literature has no role for inside debt compensation.

However, recent empirical studies such as Bebchuk and Jackson (2005) and Sundaram and Yermack (2006) have found that U.S. CEOs hold substantial inside debt in the form of defined benefit pensions. Such compensation contrasts with the predictions of existing models, and implies the need for theories that explain why managers’ monetary incentives are sometimes correlated with the values of both debt and equity. Is inside debt compensation efficient and, if so, under what conditions? If it is efficient, should the manager hold inside debt in the same proportion as inside equity, so that he is aligned with firm value?

These questions are the focus of this paper. Initially taking the manager’s equity stake as exogenous, I illustrate that inside debt can be more effective at optimizing project selection than the mechanisms considered in prior research. Both inside debt and existing measures pay off fully in solvency, thus encouraging the manager to avoid bankruptcy. However, creditors are concerned not only with the probability of insolvency but also with the liquidation value given insolvency. In a bankruptcy, pension beneficiaries generally have equal priority with other unsecured creditors, but salaries, bonuses and private benefits give zero payoffs if the manager is fired. They are thus more akin to binary options rather than debt. This advantage of inside debt is particularly important if the manager’s project choice affects liquidation values, rather than just the probability of solvency. Bonuses may worsen project selection by encouraging the manager to “gamble for resurrection” to try to earn his bonus, rather than optimally liquidating the firm. Existing measures were shown to be adequate only under specific frameworks, such as where solvency can be guaranteed (John and John (1993)), or

1 Alternative explanations are that pensions reflect stealth compensation, or are primarily driven by tax considerations – in which case the tax system encourages firms to adopt otherwise suboptimal pay schemes. The aim of this paper is to show that pension compensation may be efficient.
liquidation value is always zero (Hirshleifer and Thakor (1992)).

In addition, since the optimal amount of a bonus depends on project parameter values, a bonus solution is only implementable if such parameters are known in advance. In reality, many investment opportunities only appear after compensation is set. Inside debt compensation ensures that the manager optimally accepts (rejects) any positive (negative)-NPV projects that arise, regardless of their specific parameter values.

Inside debt remains desirable in a more complex framework which also features an effort decision and thus an endogenous justification for equity compensation. This result extends previous models which focus exclusively on the agency costs of debt (project selection) and do not incorporate the agency costs of equity (effort). If the manager’s total pay is held constant, granting inside debt reduces his inside equity and so the optimal compensation scheme must trade off effort and project selection. However, it typically does not align the manager purely with equity (as advocated by existing research) nor purely with firm value (as intuition might suggest). In the most common case, a debt-equity exchange reduces effort and so optimal compensation involves an equity bias, where the manager’s equity stake exceeds his debt holding. However, the exchange may increase effort if effort has a high expected payoff in bankruptcy, either because bankruptcy is likely, or because effort pays off primarily in liquidation states. In contrast to the “agency costs of equity” nomenclature, suboptimal effort may not purely result from insufficient inside equity. In such cases, the optimal compensation involves a debt bias, as found by Sundaram and Yermack (2006) in 13% of cases.

In sum, inside debt is especially beneficial for highly levered firms where the agency costs of debt are first-order. One example is LBOs, where the private equity sponsor is effectively the manager and often holds both debt and equity. In addition, somewhat surprisingly, inside debt is also desirable for solvent firms with low leverage at the other end of the spectrum. Since debt is close to risk-free, the CEO may be willing to exchange salary for inside debt, leaving his equity unchanged. Even though asset substitution is initially a second order concern, the incentive value of the debt stake can become significant if the firm suffers a downturn that results in a sharp decline in equity value. The manager’s debt becomes the dominant portion of his investment in the company, aligning him with creditors precisely when this is desirable.

Once debt has been raised, shareholders may have incentives to grant the manager additional equity, reigniting his incentives to expropriate creditors. In addition to the standard defenses in the literature, in this paper there are additional impediments to renegotiation. It is the ratio of the manager’s equity to debt share that induces creditor expropriation. Therefore, once he has been given a sizable debt stake, shareholders may need to make such a large extra grant of shares to restore asset substitution incentives that the cost is excessive.

Finally, I discuss whether executive pensions fulfill the role of debt advocated by the
model. In many cases, pensions are substantial and their payoffs are sufficiently similar to debt to deter creditor expropriation. One interpretation is that pensions are deliberately used to reduce the agency costs of debt. This view is consistent with the positive correlation between firm leverage and pension compensation (Sundaram and Yermack (2006)). A second is that pensions are primarily tax-motivated, but have the side benefit of aligning the manager with creditors. Their presence removes the need for managers to hold actual debt, and also suggests that the tax system does not induce firms to adopt otherwise inefficient compensation schemes. Both interpretations are consistent with the relative paucity of real-life examples of risk-shifting. Theories of asset substitution assume that the CEO is purely equity-aligned, but in practice managers hold substantial debt compensation which greatly reduces their incentives to expropriate creditors. However, in some situations, pensions may not be sufficient in magnitude or may pay off differently from debt. If pensions are junior to creditors in bankruptcy, they are similar to a binary option. If pensions can be ring-fenced from general creditors, they are close to risk-free and do not affect incentives. In such cases, there may be a case for supplementing pensions with actual debt securities.

This paper is organized as follows. Section 1.2 is a brief literature review. Section 1.3 illustrates where inside debt is the optimal solution to risk-shifting for a manager who is exogenously equity-aligned. Section 1.4 endogenizes equity compensation as the result of a shirking problem, introduces a trade-off between inside debt and inside equity, and identifies the factors that determine the optimal holdings of each. Section 1.5 addresses renegotiation concerns, Section 1.6 discusses the recent empirical evidence on pensions, and Section 1.7 concludes. The Appendix (Section 1.8) contains proofs.

1.2 Related Literature

Theorists’ focus on justifying cash and equity compensation likely stems from the long-standing belief that debt compensation is not used in reality: see Murphy (1999) for a comprehensive survey. However, two recent papers by Bebchuk and Jackson (2005) and Sundaram and Yermack (2006) find that defined benefit pensions are a substantial component of CEO pay and have significant debt-like features. Sundaram and Yermack point out the lack of a theoretical framework to complement their empirical results: “the possibility of using debt instruments for management compensation has received little attention ... A top priority would appear to be the development of theory that illustrates conditions under which debt-based compensation ... represent[s] the solution to an optimal contracting problem.” This paper is a first step in this direction.

Jensen and Meckling (1976) were the first to theorize the agency costs of debt. They include a brief section wondering why inside debt (awarded in the same proportion to inside equity) is not used as a solution, but are “unable to incorporate this dimension formally into
our analysis in a satisfactory way.” They suggest that the manager’s salary is a sufficient mechanism and thus have no role for inside debt. This paper shows that salaries are typically inadequate given their insensitivity to liquidation value. It also illustrates that their hypothesis of firm value compensation is generally suboptimal.

John and John (1993) propose two solutions to the agency costs of debt: solvency-contingent bonuses and reduced inside equity. Bonuses work in their model as solvency can be guaranteed; this paper shows that, in a more general framework, solvency-contingent bonuses are imperfect given their binary payoff structure. Their model also abstracts from managerial effort and so there are no side-effects associated with lowering the manager’s equity; in fact, zero incentive pay and a flat salary would be optimal. This paper features both effort and project selection, to provide an endogenous justification for equity compensation, and illustrates the trade-offs that arise. Similarly, Brander and Poitevin (1992) do not include an effort choice and show that a bonus is only fully effective if solvency can be guaranteed. Hirshleifer and Thakor (1992) illustrate that a manager’s reputation (which they assume has a zero payoff in bankruptcy) deters risk-shifting since they assume the liquidation value is always zero. When the manager can affect liquidation value, a binary instrument is ineffective.

Biais and Casamatta (1999) do consider both project selection and effort, but from the perspective of an entrepreneur raising outside financing rather than a firm compensating a manager. The entrepreneur continues to hold pure equity; their contribution is to show that he will raise both outside debt and outside equity (Hellwig (1994) has a similar conclusion). Another difference is that they assume that the safe project should always be taken; in this paper, it is not known in advance whether the risky or safe project is optimal and so the firm must guard against excessive managerial conservatism.

Dybvig and Zender (1991) also illustrate that optimal compensation can eliminate an inefficiency. They focus on the “lemons” problem of Myers and Majluf (1984) and their optimal contract involves the manager committing to subscribe to future equity issues. This paper considers a quite different inefficiency, creditor expropriation, and the optimal contract involves the manager holding debt. Their primary goal is to resurrect the Modigliani-Miller capital structure and dividend irrelevance theorems; mine is to advocate inside debt in executive compensation.

1.3 Debt and Project Selection

1.3.1 Assumptions

The model consists of four periods. At $t = -1$, shareholders offer a compensation contract to the manager. At $t = 0$, risky debt is raised with face value of $F$ and market value $D_0 < F$. Current total firm value is $V_0 = E_0 + D_0$. All agents are risk-neutral, and the
risk-free rate is normalized to 0. The assumption that $F$ is exogenous is discussed in Section 1.3.4. Potential bondholders observe the manager’s contract when calculating $D_0$, and so at $t = -1$, shareholders select the contract that maximizes $V_0$.

At $t = 1$, the manager can invest in one of two projects: $R$ (risky) or $S$ (safe). $R$ has probability $p_R$ of “success,” in which case the firm is worth $V_{GR}$ at $t = 1$. In “failure” (which occurs with probability $(1 - p_R)$), firm value is $V_{BR}$. $S$ pays $V_{GS}$ with probability $p_S$, and $V_{BS}$ otherwise. I assume $V_{GR} \geq V_{GS} > F$, $V_{BR} < V_{BS} < F$ and $p_R \leq p_S$. At $t = 1$ firm value is assumed to be observable and verifiable, otherwise outside equity is problematic.\footnote{Since project choice can be inferred from $V$, it does not matter whether the project is directly observable.} At $t = 2$, all payoffs are realized and the debt matures.

If all of the parameters were known at $t = -1$, shareholders would know the optimal project and can implement it with certainty. The compensation scheme would have a discontinuous effect: if the manager’s incentive compatibility constraint is (is not) satisfied, the optimal project is always (never) selected. Similarly, if $S$ ($R$) is optimal, there are no disadvantages with an excessively conservative (aggressive) scheme. In reality, unforeseen projects often appear after compensation is set, and the compensation scheme should induce the manager to accept (reject) any positive (negative)-NPV projects that arise. I therefore assume that $V_{GR} \sim U[\min(V_{GS}, V_{GRH}), \max(V_{GR}, V_{GRH})]$. $V_{GR}$ is observed privately by the manager at $t = 0$, and never observed by investors (unless $R$ is selected and is successful). The optimal project is thus not known in advance. All other parameters are publicly known at $t = -1$; I later discuss relaxing this assumption.

While the core model focuses on project selection, it can easily be extended to involve other agency costs of debt. Hence the terms “asset substitution” and “risk-shifting” should be interpreted as any value-destructive managerial action exacerbated by financial distress. Examples include debt overhang, concealing information, failing to disinvest, paying excessive dividends, or tunneling resources away from the firm.

The manager holds a proportion $\alpha$ of the firm’s equity. Previous research (e.g. John and John (1993)) takes $\alpha$ as exogenous; this section follows this approach and asks the question “given equity is held in reality, what is the optimal accompanying compensation scheme?” I show that, in a general framework, inside debt is typically more effective than the binary mechanisms shown by prior theories to be adequate under specific parametric conditions. Section 1.4 endogenizes equity compensation as a means of inducing effort.

1.3.2 Optimal Compensation With Standard Instruments

The endogenous components of the compensation scheme are initially stated in general terms: the manager is paid $f(V)$ if firm value is $V$. The only restriction is that feasible contracts must be weakly monotonic in firm value, else the manager could simply destroy firm value to
increase his pay (e.g., Bolton and Dewatripont (2005, p. 148)). Formally,

\[ f(V_{GR}) \geq f(V_{GS}) \geq f(V_{BS}) \geq f(V_{BR}) \geq 0. \] (1)

Optimal project selection occurs if the manager chooses S, i.e., inequality (3) is satisfied, if and only if the risky project has a lower NPV, i.e., inequality (2) is satisfied:

\[ p_RV_{GR} + (1-p_R)V_{BR} \leq pSV_{GS} + (1-p_S)V_{BS}, \] (2)

iff \( p_R[\alpha(V_{GR}-F)+f(V_{GR})] + (1-p_R)f(V_{BR}) \leq p_S[\alpha(V_{GS}-F)+f(V_{GS})] + (1-p_S)f(V_{BS}). \) (3)

**Proposition 1** First-best project selection can be implemented by

\[ pSf(V_{GS})-pRf(V_{GR})+(1-pS)f(V_{BS})-(1-pR)f(V_{BR}) = \alpha[F(p_S-p_R)+(1-p_S)V_{BS}-(1-p_R)V_{BR}]. \] (4)

I denote any contract that satisfies (4) an “incentive compatible contract.” The “optimal contract” is the cheapest feasible contract that is also incentive compatible. In this subsection, I restrict feasible contracts to the standard instruments of equity, debt, and the solvency-contingent bonus advocated by prior theories. If salary is junior to creditors and thus not received in bankruptcy, as assumed by most theory papers (e.g., Innes (1990), Dewatripont and Tirole (1994), Robe (1999)), the portion of salary in excess of the reservation wage may function as a bonus. Calcagno and Renneboog (2006) cite a number of bankruptcy regulations and real-life examples which suggest that salaries are sometimes senior to creditors, in which case they do not affect any incentive constraints.

It is simple to show that additional equity compensation will exacerbate risk-shifting. Hence the contract consists of a fraction \( \beta \) of the firm’s debt and a bonus of \( J \) paid if and only if the firm is solvent. Thus \( f(V_{GS}) = f(V_{GR}) = \beta F + J, f(V_{BS}) = \beta V_{BS}, f(V_{BR}) = \beta V_{BR} \) and so

\[ \beta = \alpha - \frac{J(p_S-p_R)}{F(p_S-p_R)+(1-p_S)V_{BS}-(1-p_R)V_{BR}} < \alpha. \] (5)

A continuum of \((\beta, J)\) pairs satisfy the incentive compatibility condition. The optimal contract is the cheapest incentive compatible contract.

---

3The same condition rules out shareholders from punishing the manager upon a low \( V_{GR} \) realization, which might indicate that \( R \) is chosen when it was suboptimal. Shareholders cannot punish the manager for choosing \( S \), since they never observe \( V_{GR} \) if \( R \) is not selected and thus do not know whether \( S \) was suboptimal.
Proposition 2 The optimal standard contract \((\beta^*, J^*)\) is given by

\[
\begin{align*}
(\alpha, 0) & \quad \text{if } p_R(1 - p_S)V_{BS} > p_S(1 - p_R)V_{BR}, \\
\left(\alpha - \frac{J(p_S - p_R)}{F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR}}, J\right) & \quad \text{if } p_R(1 - p_S)V_{BS} = p_S(1 - p_R)V_{BR}, \\
0, \alpha \left[ F + \frac{(1 - p_S)V_{BS} - (1 - p_R)V_{BR}}{p_S - p_R} \right] & \quad \text{if } p_R(1 - p_S)V_{BS} < p_S(1 - p_R)V_{BR}.
\end{align*}
\]

where \(J \in \left[ 0, \alpha \left[ F + \frac{(1 - p_S)V_{BS} - (1 - p_R)V_{BR}}{p_S - p_R} \right] \right] \).

If \(p_S >> p_R\) and \(V_{BS}\) is close to \(V_{BR}\), the main advantage of \(S\) is its greater probability of solvency. Hence the bonus should be used exclusively: its zero bankruptcy payoff makes it particularly sensitive to solvency. This result is consistent with John and John (1993), who show that bonuses are a feasible solution under their assumption of \(p_S = 1\). However, if \(p_S\) is close to \(p_R\) and \(V_{BS} >> V_{BR}\), the main advantage of \(S\) is its greater liquidation value. Inside debt is optimal as, unlike the bonus, its payoff is sensitive to liquidation value. If \(p_S = p_R\), the bonus is completely ineffective. Bonuses and salaries are not sufficiently debt-like, as they only give incentives to achieve solvency rather than to maximize liquidation value.

While equation (5) suggests that bonuses reduce (but not eliminate) the need for inside debt, in some cases they exacerbate asset substitution. Now assume \(S\) represents “safe liquidation” and pays \(V_L\) for certain, where \(V_{BR} < V_L < F\).

Proposition 3 First-best liquidation can be implemented by

\[
\beta = \alpha + \frac{J}{V_L - p_R F - (1 - p_R)V_{BR}}.
\]

The optimal standard contract is given by \(\beta^* = \alpha, J^* = 0\).

Owing to their binary nature, bonuses exacerbate the problem (\(\beta\) is increasing in \(J\)) by giving the manager a natural inclination to gamble for resurrection by choosing \(R\). Hence the optimal compensation scheme only involves inside debt. This may explain why the solvency-contingent bonuses advocated by prior literature are rarely used. In practice, bonuses are typically positively related to shareholder value and so further increase \(\alpha\) and thus the desired \(\beta\).

1.3.3 Optimal Compensation With Non-Standard Instruments

This subsection derives the optimal compensation scheme where the only restriction is the monotonicity condition, equation (1).
Proposition 4 The optimal unrestricted is contract is given by

\[
\begin{aligned}
f(V_{GR}) &= f(V_{GS}) = f(V_{BS}) = \frac{\alpha [F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR}]}{1 - p_R}, \\
f(V_{BR}) &= 0.
\end{aligned}
\]  

This contract can be interpreted as a bonus payable if and only if \( V \geq V_{BS} \). Thus far, \( V_{GR} \) has been assumed the only stochastic parameter. However, in more general settings, many parameters will be stochastic. The scheme in equation (8) becomes difficult to implement for two reasons. First, the optimal amount of the bonus depends on unknown parameters. This problem is also suffered by the solvency-contingent bonus of Section 1.3.2, but not by inside debt since \( \beta^* = \alpha \). A greater problem is that the optimal threshold that triggers a bonus payment is \( V_{BS} \), which may be unknown. (This contrasts with a solvency-contingent bonus where the threshold is \( F \), which is known). For both types of bonus, small departures in \( V_{BS} \) from the expected level only lead to the amount of the bonus being slightly suboptimal. However, for the non-standard bonus, small deviations from the required threshold can induce step-change losses in effectiveness. For example, if \( V_{BS} \) turns out even slightly lower than the threshold in the contract, the bonus becomes insensitive to the liquidation value. In addition, if a firm has multiple projects, \( V_{BS} \) likely differs between projects. Non-standard instruments are thus non-robust, whereas inside debt leads to optimal decisions for all projects regardless of their specific parameter values.

One parameter which may be known in advance is \( V_{BR} \). This is bounded below if the firm owns tangible assets (such as buildings) which the manager is prevented from selling owing to covenants, and is a minimum payoff for all projects. Feasible contracts can then involve the manager holding options on the firm’s debt with a strike price of \( V_{BR} \). Let the debt options represent a proportion \( \gamma \) of the overall outstanding debt.

Proposition 5 The optimal contract allowing for standard instruments and debt options is given by

\[
\begin{aligned}
\beta^* &= 0, \\
\gamma^* &= \alpha, \\
J^* &= 0.
\end{aligned}
\]

The debt option is cheaper than straight debt because all payments are reduced by \( V_{BR} \). If the manager is also being paid a salary that exceeds \( \gamma^* V_{BR} \), the debt option contract is equivalent to issuing straight debt and reducing the manager’s salary by \( \gamma^* V_{BR} \). Since a debt option is always exercised, it has the same incentive effects as debt, explaining the equivalence of \( \beta^* \) in equation (6) and \( \gamma^* \) in equation (9).
1.3.4 Alternative Mechanisms

I briefly discuss whether other mechanisms can attenuate asset substitution and thus render inside debt unnecessary. Private benefits, such as firm-specific human capital, prestige, perquisites, and reputation are principally determined by the firm’s solvency: if the manager is fired upon bankruptcy, he can no longer derive benefits from incumbency. They thus have a very similar effect to bonuses. Moreover, private benefits and reputation plausibly increase with shareholder value and thus may be incorporated into α, increasing the need for inside debt.

A second mechanism is a complex bonus that pays off exactly like debt. This would be consistent with the model, which merely requires any instrument with debt-like payoffs. Actual debt is a cleaner solution, as it avoids writing a complex contract – just as companies award equity directly in practice. Section 1.5 points out that a bonus may be less renegotiation-proof than a debt security.

In the core model, the face value of debt is set at the first-best level $F^{FB}$, which is optimal in the absence of agency costs of debt. These costs are foreseen by rational creditors and thus shareholders suffer a discount when raising debt. Alternatively, the trade-off theory would advocate lowering debt to a second-best level $F^{SB} < V^{BR}$, so that the firm is never bankrupt. This loses some of the benefits of debt, such as tax shields and reducing free cash flow. Either way, shareholders bear the agency costs of debt; the first manifestation is used for tractability.

Finally, covenants are an imperfect solution due to the incompleteness of contracts: see Myers (1977). Covenants may increase asset substitution, as the manager risk-shifts even when the firm is some distance from bankruptcy to avoid breaching the covenant. Also, covenants may not be breached until after the key decision has been made (e.g., $R$ was irreversibly chosen and failed, leading to the covenant violation). Covenants can suboptimally restrict managerial flexibility, and thus are costly as is the case for the other solutions.

---

4This assumes that bankruptcy leads to termination. If the manager only has a probability $q$ of being retained in bankruptcy, only a proportion $(1 - q)$ of his private benefits are lost and so private benefits are even less effective at deterring risk-shifting. Hirshleifer and Thakor (1992) assume that the managerial labor market can distinguish between success and failure, but not the severity of failure, and so reputation has a binary payoff. In reality, a manager’s reputation may be particularly tarnished by especially severe bankruptcy, but the sensitivity of reputation to liquidation value is far less clear than for inside debt.

5This paper’s focus is on the optimal compensation scheme given that firms are partially debt-financed. A very rich literature illustrates the many benefits of debt financing, and therefore leverage is taken as exogenous in this paper.

6Several studies demonstrate that executive compensation has a significant effect on risk, despite covenants. Examples include DeFusco, Johnson and Zorn (1990), Saunders, Strock and Travlos (1990), Guay (1999), and Coles, Daniel and Naveen (2006).
1.4 Does Inside Debt Reduce Effort?

Section 1.3 followed prior literature by taking $\alpha$ as exogenous, and showed that inside debt is often the optimal accompaniment to achieve efficient project selection. However, a complete analysis must provide an endogenous justification for equity compensation, else the optimal contract would be $\alpha = \beta = 0$. This section endogenizes $\alpha > 0$ as the solution to an effort problem; the role of $\beta > 0$ is to mitigate the ensuing investment distortions. It introduces a key trade-off: if the manager is granted inside debt, shareholders may reduce his equity holding to avoid giving him rents. Consequently, effort may fall. I show that inside debt generally retains a role in optimal compensation, but the manager is no longer aligned with firm value.

1.4.1 Assumptions

As in Section 1.3, $V_{GR} \sim U[V_{GS}, V_{GRH}]$ is the only stochastic parameter. The manager chooses effort level $e \in [0, e_H]$, where $e_H < 1$, at a personal cost of $\frac{1}{2}e^2$. Effort has a probability $e$ of increasing the solvency value by $g$ and the bankruptcy value by $b$, where $V_{GS} + b < F$. Intangible investment, such as staff training and building customer relationships, will have a high $g$ and low $b$; the converse is true for exerting effort to scrap investment projects or liquidate assets.

I assume probabilities are unaffected by effort and that $p_R = p_S = p$. Hence “success” and “failure” can be thought of two states of nature, $\theta_G$ (good) and $\theta_B$ (bad). This assumption substantially clarifies the analysis along two dimensions. First, common probabilities $p_R = p_S$ render bonuses irrelevant, allowing a clean focus on the debt-equity tradeoff since optimal compensation involves only these instruments. While Section 1.3 considered the choice between debt and bonuses, this section tackles the question “when debt is the preferred method of optimizing project selection, how much debt should be held when an effort decision is introduced?”

Second, exogenous probabilities rule out complex feedback effects between the effort and project selection decisions, and allow them to be analyzed separately. In reality, effort usually increases the probability of success. This has a very similar effect to increasing $g$ in the analysis that follows, and thus the effects of effort-contingent probabilities can still be examined within this framework.

Shareholders solve the following problem:

---

7The bonus provides no incentives to exert effort to increase the bankruptcy value by $b$. Therefore, if inside debt is preferred for solving asset substitution, it remains superior when an effort decision is introduced.

8If effort increases the probability of solvency, inside debt does not directly discourage effort by making $\theta_B$ less painful to the manager. The debt stake is worth $F$ in $\theta_G$ and only $V_{BR}$ or $V_{BS}$ in $\theta_B$, and so its value is maximized in solvency. These payoffs are in contrast to other compensation instruments such as severance pay, which only pay off in $\theta_B$ and so may indeed have a disincentive effect if probabilities are endogenous.
$$\begin{align*}
\max_{\alpha, \beta} & \quad E_0(1 - \alpha) + D_0(1 - \beta), \\
\text{s.t.} & \quad \alpha E_0 + \beta D_0 \geq U,
\end{align*}$$

where $U$ is the difference between the manager’s reservation wage and his salary. If the participation constraint is slack, shareholders will not choose to reduce $\alpha$ when $\beta$ is increased, but simply allow the manager to receive higher compensation. Since $\alpha$ is unaffected, the optimal level of inside debt can simply be derived by comparing its benefits (improved project selection and effort) with its costs (increased managerial rents). This is little different from standard models which determine the optimal equity level as the result of a trade-off between improved effort and increased rents (see, e.g., Bolton and Dewatripont (2005)). In particular, there is no trade-off between $\alpha$ and $\beta$, nor between project selection and effort as increasing $\beta$ improves both. It is easy to derive a strictly positive optimal $\beta$, just as the optimal $\alpha$ is usually strictly positive.

I therefore assume that salary is zero and the participation constraint is always binding. This occurs if $U$ is so high that, with $\beta = 0$, the firm is forced to pay the manager more equity than optimal under the effort-cost trade-off, to satisfy his participation constraint. Hence shareholders will choose to reduce his equity holding if the participation constraint is relaxed by a debt award. The problem becomes:

$$\begin{align*}
\max_{\alpha, \beta} & \quad V_0, \\
\text{s.t.} & \quad \alpha E_0 + \beta D_0 = U. \tag{10}
\end{align*}$$

From the participation constraint, $\alpha = \alpha(\beta)$. This assumption creates the sharpest possible trade-off: inside debt can only be granted if inside equity is reduced, presenting the toughest conditions under which to advocate a role for inside debt. The optimal level of inside debt is higher if the constraint does not bind, since the side-effects of debt grants are lower: the firm can choose not only to reduce $\alpha$, but also reduce cash salary or give the manager rents.\footnote{Since the manager is paid a fixed $U$, shareholders maximize $V_0 - U$. Since this is equivalent to maximizing $V_0$, $V_0$ appears in the objective function.}\footnote{The analysis under a non-binding constraint is available from the author upon request. As in the core model, both pure equity and pure firm value compensation are typically suboptimal.} Let $\bar{\alpha}$ be the equity stake that satisfies both (10) and the equation $\beta = \alpha$.

1.4.2 The Optimal Inside Debt Level

Consider first the manager’s effort decision.
Lemma 1 The manager chooses effort level

$$e^*(\beta) = p\alpha(\beta)g + (1 - p)b.$$  \hfill (11)

The marginal impact of increasing the level of inside debt $\beta$ on effort is given by

$$\frac{\partial e^*}{\partial \beta} = pg\frac{\partial \alpha}{\partial \beta} + (1 - p)b,$$  \hfill (12)

where

$$\frac{\partial \alpha}{\partial \beta} = \frac{E_0 \left[ -D_0 - \beta \frac{\partial D_0}{\partial \beta} \right] - [U - \beta D_0] \frac{\partial E_0}{\partial \beta}}{E_0^2} < 0,$$

$$\frac{\partial E_0}{\partial \beta} = -\frac{\beta}{\alpha^2} \frac{(1 - p)^2 (V_{BS} - V_{BR})^2}{p V_{GRH} - V_{GS}} + pg(1 - p)b,$$

$$\frac{\partial D_0}{\partial \beta} = \frac{(1 - p)^2 (V_{BS} - V_{BR})^2}{\alpha p V_{GRH} - V_{GS}} + (1 - p)^2 b^2.$$

The literature refers to suboptimal effort as the “agency costs of equity” and advocates maximizing $\alpha$ as a solution. However, substituting debt for equity raises effort if bankruptcy is likely ($p$ is low) and effort is more productive in bad states ($b > g$). Hence, inconsistent with the “agency costs of equity” nomenclature, shirking need not be a consequence of insufficient inside equity.

Now consider project selection. Firm value is maximized if $R$ is selected if and only if $V_{GR} > V_{GR}^{**}$, where $V_{GR}^{**}$ is defined by

$$V_{GR}^{**} = V_{GS} + \frac{(1 - p)}{p} (V_{BS} - V_{BR}).$$  \hfill (13)

However, the manager will choose $R$ if and only if $V_{GR} > V_{GR}^{**}(\beta)$, where

$$V_{GR}^{**}(\beta) = V_{GS} + \frac{\beta(1 - p)}{\alpha(\beta)p} (V_{BS} - V_{BR}).$$  \hfill (14)

If $\beta < (>)\overline{\alpha}$, $V_{GR}^{**} < (>)V_{GR}^{**}$ and $R (S)$ is sometimes inefficiently selected. Project selection is optimal when $\beta = \overline{\alpha}$, but if $\frac{\partial e^*}{\partial \beta}|_{\beta = \overline{\alpha}} > 0$, there is a trade-off between project selection and effort. The optimal compensation scheme thus involves an equity bias ($\beta^* < \alpha^*$). Conversely, if $p$ is low and $b$ is high relative to $g$, $\frac{\partial e^*}{\partial \beta}|_{\beta = \overline{\alpha}} < 0$ and the compensation scheme involves a debt bias ($\beta^* > \alpha^*$).

Proposition 6 Optimal compensation involves an equity bias ($\beta^* < \alpha^*$) if $\frac{\partial e^*}{\partial \beta}|_{\beta = \overline{\alpha}} < 0$ and a debt bias ($\beta^* > \alpha^*$) if $\frac{\partial e^*}{\partial \beta}|_{\beta = \overline{\alpha}} > 0$. The optimal level of inside debt $\beta^*$ is
(i) Increasing in the productivity of effort in liquidation $b$, and decreasing in the productivity of effort in solvency $g$.

(ii) Increasing in the probability of bankruptcy $(1 - p)$ and leverage $F$.

(iii) Decreasing in the absolute value of $\frac{\partial V}{\partial g}$, the simultaneous reduction in inside equity.

(iv) Increasing in $(V_{BS} - V_{BR})$, the difference in liquidation values of the two projects, and

(v) Decreasing in $(V_{GRH} - V_{GS})$, the range of values for $V_{GR}$, the success payoff of the risky project.

The intuition behind each component of Proposition 6 is as follows. If $b >> g$, effort is relatively productive in improving liquidation value and so debt has a more positive impact on effort. In the extreme, there is no trade-off as $\frac{\partial e^*}{\partial g} > 0$.

If the probability of bankruptcy $(1 - p)$ rises, the benefits from effort are more concentrated in $\theta_B$ and the asset substitution issue is more severe. Both factors increase the optimal $\beta$. Bankruptcy risk also increases with leverage $F$ even if $p$ is unchanged. If $V_{BR} > F$, the probability of bankruptcy is zero and the asset substitution effect disappears. On the other hand, $V_{GS} < F$ represents the liquidation case considered by equation (7), where $\beta^*$ may exceed $\alpha$ in the absence of effort concerns.\footnote{In the current model, the probability of bankruptcy changes in a discontinuous manner, since I have assumed $V_{BR}$, $V_{BS}$ and $V_{GS}$ are constant. In a more complex model where all parameters are variable, bankruptcy risk would increase monotonically with $F$.}

\[ \frac{\partial \alpha}{\partial \beta} = 0 \] if the participation constraint (10) does not bind. This occurs either if it is optimal to give the manager rents, or his salary can be reduced by the value of the debt grant. The latter is particularly feasible if debt is relatively safe, and so the manager values debt at close to its expected value.\footnote{The manager is risk-neutral in this model. Introducing risk aversion would provide another justification for a trade-off between inside debt and inside equity. However, if inside debt is close to risk-free, a risk-averse manager will be willing to exchange it for salary.}

$V_{BS} - V_{BR}$ measures the extent of the asset substitution issue. $V_{BS} >> V_{BR}$ occurs if $R$ involves intangible investment with little payoff in bankruptcy or the firm has limited traditional debt capacity in the form of tangible assets. In this case it is particularly important for the manager to be sensitive to the liquidation payoff. Raising $\beta$ could increase the firm’s “effective debt capacity,” allowing the issuance of more debt without a deterioration in terms.

Increasing $\beta$ creates an extra range of $V_{GR}$ out-turns where $S$ will now be optimally chosen; reducing $V_{GRH} - V_{GS}$ raises the probability of $V_{GR}$ falling into this extra range. As with $p$ falling and leverage rising, a decline in $V_{GRH} - V_{GS}$ means that the asset substitution issue becomes more important.

In sum, the previous literature’s justification of primarily equity-linked incentives is warranted for firms where the agency costs of debt are low and effort considerations are first-order, such as start-ups with high growth opportunities. However, inside debt is desirable in compa-
nies with a significant risk of bankruptcy (high $p$); where effort primarily increases liquidation value (high $b$, low $g$); or where there is no debt-equity trade-off ($\frac{a}{b} = 0$).

LBOs often satisfy the first two criteria. LBOs are frequently undertaken in mature firms where the main agency problem is excessive investment. They are highly geared, but structured so that organic cash flow and asset sales will pay down the debt in normal market conditions. However, an unexpected economic downturn (a decline in $p$) may induce risk-shifting and deter effort. Indeed, the private equity firm can be considered the “manager” in LBOs, given its close involvement in operations, and typically holds strips of debt and equity to minimize conflicts.

The third criterion implies that solvent companies at the opposite end of the spectrum may also benefit from inside debt. Since debt is close to risk-free, and salaries are often substantial, inside debt may be exchangeable for salary, rather than equity. The benefit of the debt grant arises if the firm’s fortunes unexpectedly plummet and the value of the manager’s equity sharply declines, aligning him with creditors precisely when this is desirable.\textsuperscript{13}

\subsection*{1.5 Renegotiation}

Dybvig and Zender (1991) suggest that the Myers and Majluf (1984) “lemons” problem can be overcome by an optimal compensation contract, where the manager is either paid on the basis of profit (rather than stock price) or commits to subscribe to new equity offerings. This protects potential new shareholders from the CEO issuing overvalued equity. However, Persons (1994) points out that current shareholders may privately renegotiate the CEO’s contract to align it with the stock price, re-igniting incentives to issue overvalued equity. Rationally anticipating renegotiation, potential new investors will continue to discount new equity issues, and the Myers-Majluf underinvestment result is resurrected.

In this paper, shareholders may also wish to renegotiate the manager’s compensation after debt has been raised. However, renegotiation may be preventable by “locking up” the manager’s debt to prevent its sale (as often occurs with inside equity in practice) and imposing restrictions on additional equity awards in the debt contract. Such contracts can be written since the potential “victims” of renegotiation are bondholders, who are an identifiable party. Contracts may be less effective in the Dybvig-Zender case, since the renegotiation occurs before the equity issue: before any new equity has been awarded to the manager which can be locked up, and before new shareholders are in existence and can be contracted with. Similarly, the bonuses considered in Section 1.3 are not a security that can be easily locked up: they are a potentially renegotiable contract between shareholders and the manager.

\textsuperscript{13}It is necessary to give the CEO debt at the time of a debt issue, even if the firm is healthy at the time, as shareholders will internalize the agency costs of debt. Waiting until the firm runs into difficulties is suboptimal as the shareholders will still be in control and have no incentive to align the manager with creditors.
Contracts are not perfectly effective, since shareholders may be able to increase $\alpha$ through non-verifiable (albeit expensive) means such as perquisites. The counter-argument specific to this paper is the lock-up of debt, which plays multiple roles. First, it increases the cost of renegotiation. Increasing $\alpha$ cannot be accompanied by a reduction in $\beta$ and thus the new shares must be given for free, which is a direct cost to shareholders. Second, it reduces the benefits of renegotiation. It is $\alpha/\beta$ that determines shareholder alignment, and once $\beta > 0$ has been awarded, increases in $\alpha$ have a muted effect on $\alpha/\beta$. Indeed, full congruence with shareholders is only achieved by increasing $\alpha$ to $\infty$. Third, it limits bondholders’ losses from additional equity awards. Indeed, if

$$
(1 - p) hpg > \frac{\beta}{\alpha} \frac{(1 - p)^2 (V_{BS} - V_{BR})^2}{V_{GRH} - V_{GS}},
$$

creditors gain from the additional equity grant owing to increased effort.

The standard defenses to renegotiation in the literature also apply (see Hart (2001)). Shareholders may have reputational concerns that deter renegotiation or suffer from collective choice problems.\textsuperscript{14} Even if they do coordinate to lobby the board to renegotiate, the board may not pursue shareholders’ interests. This may either be because of shareholder-board agency problems, or because the board’s fiduciary duty is to all stakeholders (including creditors) as in some US states. Supporting these arguments, Zhou (2001) finds that managerial ownership evolves very slowly over time, which is inconsistent with opportunistic resetting.

\subsection*{1.6 Are Pensions Sufficient?}

This section discusses whether the substantial executive pensions, documented by Bebchuk and Jackson (2005) and Sundaram and Yermack (2006), can be considered inside debt. Sundaram and Yermack state that “pension liabilities represent unsecured, unfunded debt held by executives against the firm, and should the firm become insolvent, [CEOs] would stand in line with other creditors” and thus can be considered equivalent to debt. This contrasts with salary, which is zero if the manager is fired upon bankruptcy. Moreover, consistent with this model, they find that pension compensation rises with firm leverage, and high pension entitlements lead CEOs to manage their firms conservatively. The first finding offers some support to the view that pensions are deliberately used to mitigate the agency costs of debt, rather than being primarily tax-motivated.

If pensions indeed pay off like debt, and are sufficiently large in magnitude, they already

\textsuperscript{14}While collective action problems are minor for the LBOs discussed in Section 1.4, reputational concerns are likely to be significant. Reputational concerns for a single manager (Diamond (1989)) may be insufficient to deter risk-shifting, hence the need for a solution through compensation in the first place. However, reputational concerns are likely to be much greater for a private equity investor involved with several firms. If she renegotiates, the debt markets will punish her when this firm and all other firms owned by her attempt to raise debt again.
fulfill the role of debt advocated by the model. However, there may be a case for supplementing pensions with actual debt securities in two cases: if pensions are not sufficient in magnitude, or if their payoff is somewhat different from debt.

First, some CEOs have modest pension entitlements, and may not be managing the companies for which low inside debt is optimal as identified by Section 1.4. Sundaram and Yermack find that pensions are small for young CEOs; since their study focuses on the US, it has not yet been documented whether pensions are substantial overseas. In addition, pension entitlements increase in a smooth manner over time, since a principal determinant is length of service. If a firm undergoes a step-change in leverage such as an LBO, managerial co-investment in the new debt issue may be desirable to reduce the cost of the additional debt raised.

Second, the model illustrates that the payoff of a pension has to be very similar to debt for it to be effective: small departures may lead to pensions either not affecting or exacerbating the issue. If debt is secured, pensions are junior and can be folded into $J$; they may therefore encourage risk-shifting (Proposition 3). In other cases, the payoff may be close to risk-free and thus pensions do not affect managerial incentives. CEOs can put pension fund assets into a “secular” trust fund, ring-fenced from the reach of creditors, or a “springing” trust which converts into a secular trust upon trigger events, such as a credit downgrade.  

Executives frequently have the option to withdraw their entitlements early if they forgo 10% of the benefits, in which case 90% is riskless. In addition, Key Employee Retention Programs (“KERPs”) are often implemented upon bankruptcy, which can guarantee executives’ full pension entitlements even if financial creditors’ claims are only partly paid.

Finally, debt securities may potentially have a role even in companies where pensions are currently sufficient to mitigate risk-shifting. Such firms may have low agency costs of debt because they are addressing them by reducing leverage or inside equity. Since these measures are costly, the importance of the agency costs of debt in practice cannot simply be ascertained solely by looking at actual instances of risk-shifting. Debt grants may allow leverage or equity to increase, and thus be a less costly solution.

15Examples of major companies that have adopted such trusts include Delta Airlines, Motorola, Abbott Laboratories, TXU, Altria Group (formerly Philip Morris), Advanced Micro Devices and Owens-Illinois.

16There is a widely documented negative relationship between $\alpha$ and leverage (Friend and Lang (1988), Agrawal and Nagarajan (1990), Ortiz-Molina (2004)). One interpretation is that firms for which high debt is optimal or reducing the manager’s equity stake to attenuate risk-shifting (as predicted by John and John (1993)), or firms that require high $\alpha$ to induce effort are under-leveraging for the same reason. While Andrade and Kaplan (1998) find low costs of financial distress in their sample of highly leveraged transactions, they acknowledge that their results may be driven by sample selection: only firms with low distress costs choose to become levered in the first place.
1.7 Conclusion

The simplest theory of executive compensation would advocate aligning the manager with firm value. Since empiricists have long believed that managers are compensated exclusively with cash and equity in practice, theorists have focused on rationalizing such a scheme. However, recent research has shown that debt-like instruments such as pensions are in fact substantial components of CEO compensation. These findings suggest the need for new theories to explain why and when inside debt may have a role in an optimal compensation, and how much debt should be used.

This paper is a first step in this direction. Inside debt is a more effective solution to creditor expropriation than salaries, bonuses and private benefits, owing to its sensitivity to liquidation value. Addressing the agency costs of debt by moderating leverage loses some of the benefits of debt, such as tax shields and managerial discipline; reducing inside equity decreases effort.

As with the solutions currently practiced, inside debt is not without its costs. If inside debt must be traded off with inside equity, there are potential adverse effort implications. However, the role for inside debt typically remains. In particular, in highly levered firms where effort primarily increases liquidation value, the improved project selection that results from a debt-equity swap may be accompanied by increased effort.

In many cases, pensions adequately fulfill the role of inside debt advocated by the model. However, in the rare cases where pensions are substantially insufficient, there may be a case for supplementing them with actual debt securities.

1.8 Appendix

Proof of Proposition 1

Rearranging equations (2) and (3) yields

\[ p_R V_{GR} + (1 - p_R) V_{BR} \leq p_S V_{GS} + (1 - p_S) V_{BS}, \]

and

\[ p_R V_{GR} - p_S V_{GS} \leq F(p_R - p_S) + \frac{1}{\alpha} [p_S f(V_{GS}) - p_R f(V_{GR}) + (1 - p_S) f(V_{BS}) - (1 - p_R) f(V_{BR})]. \]

Equating the right-hand sides of each inequality leads to equation (4).

Proof of Equation (5)
Substitute \( f(V_{GS}) = f(V_{GR}) = \beta F + J; f(V_{BS}) = \beta V_{BS}; f(V_{BR}) = \beta V_{BR} \) into (4) to obtain equation (5). To prove that the denominator is positive, set set \( p_S = p_R + \Delta p \). Then

\[
F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR} = (V_{BS} - V_{BR})(1 - p_R) + \Delta p(F - V_{BS}) > 0.
\]

Proof of Proposition 2

To find the cheapest contract that satisfies equation (5), we must first calculate the cost of debt and the bonus. Under first-best project selection, \( R \) is chosen if \( V_{GR} \) exceeds a cutoff \( V^*_{GR} \), where

\[
V^*_{GR} = \frac{p_S V_{GS} + (1 - p_S) V_{BS} - (1 - p_R) V_{BR}}{p_R}.
\]

Let this occur with probability \( q \). Hence the firm is solvent with probability

\[
p = p_R q + p_S(1 - q).
\]

A bonus of \( J \) costs \( pJ \); debt of \( \beta \) costs

\[
\beta[pF + q(1 - p_R)V_{BR} + (1 - q)(1 - p_S)V_{BS}].
\]

Hence an incentive compatible contract will cost

\[
W = pJ + \left[ \alpha - \frac{J(p_S - p_R)}{F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR}} \right] \left[ pF + q(1 - p_R)V_{BR} + (1 - q)(1 - p_S)V_{BS} \right],
\]

where

\[
\frac{\partial W}{\partial J} = p - \frac{(p_S - p_R)[pF + q(1 - p_R)V_{BR} + (1 - q)(1 - p_S)V_{BS}]}{F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR}}.
\]

Since the derivative is constant, we have a corner solution. The manager is paid entirely with debt if \( \frac{\partial W}{\partial J} < 0 \), i.e.,

\[
p_R(1 - p_S)V_{BS} > p_S(1 - p_R)V_{BR}.
\]

Indeed, the difference in cost between an all-bonus and all-inside debt scheme is given by

\[
\frac{\alpha}{p_S - p_R} \left[p_S(1 - p_R)V_{BR} - p_R(1 - p_S)V_{BS}\right] \left[pS(1 - p_R)V_{BR} - p_R(1 - p_S)V_{BS}\right].
\]
Proof of Proposition 3
Following the same methodology as the proof of Proposition 1 leads to an incentive compatible contract involving
\[
\beta = \alpha + \frac{J}{V_L - p_R F - (1 - p_R)V_{BR}}.
\]
Since the bonus is both costly and increases the required \(\beta\), the optimal bonus is zero. Hence \(J^* = 0\) and \(\beta^* = \alpha\).

Proof of Proposition 4
The shareholders’ problem is given by
\[
\begin{align*}
\text{Min} & \quad q p R f(V_{GR}) + (1 - q) p S f(V_{GS}) + q (1 - p_R) f(V_{BR}) + (1 - q)(1 - p_S) f(V_{BS}), \\
\text{s.t.} & \quad p S f(V_{GS}) - p R f(V_{GR}) + (1 - p_S) f(V_{BS}) - (1 - p_R) f(V_{BR}) = Y, \\
\text{where} & \quad Y = \alpha \left[ F(p_S - p_R) + (1 - p_S)V_{BS} - (1 - p_R)V_{BR} \right].
\end{align*}
\]
f\((V_{BR})\) and \(f(V_{GR})\) should be decreased to their minimum levels of 0 and \(f(V_{GS})\) as this reduces the objective function and relaxes the constraint. Let \(f(V_{GR}) = f(V_{GS}) = X\). The problem becomes
\[
\begin{align*}
\text{Min} & \quad [q p R + (1 - q) p S] X + (1 - q)(1 - p_S) f(V_{BS}), \\
\text{s.t.} & \quad (p_S - p_R) X + (1 - p_S) f(V_{BS}) = Y.
\end{align*}
\]
In any incentive compatible contract,
\[
f(V_{BS}) = \frac{Y - (p_S - p_R)X}{1 - p_S}.
\]
There are two free parameters, \(f(V_{BS})\) and \(X\). The cost of the compensation scheme is
\[
[q p R + (1 - q) p S] X + (1 - q)[Y - (p_S - p_R)X] = (1 - q)Y + p_R X.
\]
Hence the cost is minimized by having \(X\) as low as possible, i.e., as low as \(f(V_{BS})\). Thus \(f(V_{BS}) = X\), leading to the contract in Proposition 4.

Proof of Proposition 5
Debt options are strictly preferred to debt, since they are a vertical translation and thus cheaper while achieving the same incentive effects. Hence the optimal contract comprises \(\gamma\)
debt options and a bonus of $J$. The incentive compatibility condition is

$$p_S[\gamma(F - V_{BR}) + J] - p_R[\gamma(F - V_{BR}) + J] + (1 - p_S)\gamma(V_{BS} - V_{BR}) = Y,$$

and so

$$\gamma = \frac{Y - (p_S - p_R)J}{F(p_S - p_R) + (1 - p)SV_{BS} - (1 - p)SV_{BR}}.$$

The cost of this compensation scheme is

$$W = [q_p + (1 - q)p_s][\gamma(F - V_{BR}) + J] + (1 - q)(1 - p_s)\gamma(V_{BS} - V_{BR}),$$

where

$$\frac{\partial W}{\partial J} = \frac{p_R(1 - p_s)(V_{BS} - V_{BR})}{F(p_S - p_R) + (1 - p)SV_{BS} - (1 - p)SV_{BR}} \geq 0.$$

Hence $J = 0$ regardless of parameter values. This result differs from Proposition 2. Debt options pay nothing $V = V_{BR}$, and so are sensitive to both liquidation value and achieving solvency. Therefore, they dominate bonuses even if $p_S >> p_R$ and the primary goal of the compensation scheme is to be sensitive to solvency. This leads to the contract in Proposition 5.

**Proof of Lemma 1**

Regardless of which project is selected, the manager’s objective function for effort is:

$$pe(\beta)ge + (1 - p)\beta be - \frac{1}{2}e^2.$$  \hspace{1cm} (16)

Differentiating gives equation (11). Imposing equation (10) and differentiating yields

$$\frac{\partial \alpha}{\partial \beta} = \frac{E_0}{E_0^2} \left[ -D_0 - \beta \frac{\partial D_0}{\partial \beta} \right] - [U - \beta D_0] \frac{\partial E_0}{\partial \beta}.$$

Equity is worth

$$E_0(\beta) = p \frac{V_{GRH} + V_{GS} + \frac{\beta(1 - p)}{\alpha p} (V_{BS} - V_{BR})}{2} \times \frac{V_{GRH} - V_{GS} - \frac{\beta(1 - p)}{\alpha p} (V_{BS} - V_{BR})}{V_{GRH} - V_{GS}}$$

$$+ p V_{GS} \times \frac{\beta(1 - p)}{\alpha p} \frac{V_{BS} - V_{BR}}{V_{GRH} - V_{GS}} - pF + pg[p\alpha g + (1 - p)\beta b],$$

and debt is worth
\[
D_0(\beta) = [pF + (1 - p)V_{BR}] \times \frac{V_{GRH} - V_{GS} - \frac{\beta(1-p)}{\alpha p}(V_{BS} - V_{BR})}{V_{GRH} - V_{GS}} \\
+ [pF + (1 - p)V_{BS}] \times \frac{\beta(1-p)}{\alpha p} \frac{V_{BS} - V_{BR}}{V_{GRH} - V_{GS}} + (1 - p)b[p\alpha g + (1 - p)\beta].
\]

Differentiating and simplifying gives the stated expressions for \( \frac{\partial D_0}{\partial \beta} \) and \( \frac{\partial D_0}{\partial \gamma} \).

**Proof of Proposition 6**

For a given \( \beta \), firm value is given by equation (19) below:

\[
p(E[V_{GR} | V_{GR} > V_{GR}(\beta)]) + (1 - p)V_{BR} \times Pr(V_{GR} > V_{GR}(\beta)) \\
+ [pV_{GS} + (1 - p)V_{BS}] \times Pr(V_{GR} < V_{GR}(\beta)) \\
+ pg(e(\beta)) + (1 - p)b(e(\beta)).
\]

Noting that \( Pr(V_{GR} > V_{GR}(\beta)) = \frac{V_{GRH} - V_{GR}(\beta)}{V_{GRH} - V_{GS}} \) and \( Pr(V_{GR} < V_{GR}(\beta)) = \frac{V_{GR}(\beta) - V_{GS}}{V_{GRH} - V_{GS}} \), the marginal change in firm value from increasing \( \beta \) eventually simplifies to (21) below:

\[
V'(\beta) = \frac{(1 - p)^2 (V_{BS} - V_{BR})^2}{p} \cdot \frac{\alpha - \frac{\partial \alpha}{\partial \beta} \beta}{\alpha^2} \left(1 - \frac{\beta}{\alpha}\right) \\
+ [pg + (1 - p)b] \left[p \frac{\partial \alpha}{\partial \beta} g + (1 - p)b\right].
\]

The first term in (21) is the effect of increasing \( \beta \) on project selection. It starts off positive at \( \beta = 0 \) and declines monotonically in \( \beta \), reaching 0 at \( \beta = \bar{\alpha} \) and turning negative as \( \beta > \alpha \) leads to excessive conservatism. The second term is the effect of increasing \( \beta \) on effort, and its sign is ambiguous. If \( \frac{\partial e}{\partial \beta} |_{\beta = \bar{\alpha}} > 0 \), the manager will hold more debt than equity. However, \( \beta^* \) will be bounded as raising \( \beta > \bar{\alpha} \) leads to excessive conservatism. The more common case is \( \frac{\partial e}{\partial \beta} |_{\beta = \bar{\alpha}} < 0 \): increasing \( \beta \) improves project selection but reduces effort. At \( \beta = \bar{\alpha} \), the first term of (21) is zero and so \( V'(\beta) < 0 \). Since both terms in (21) are continuous and decreasing in \( \beta \), \( V'(\beta) \) is continuous and decreasing in \( \beta \). Thus, if \( V'(\beta) > 0 \) at \( \beta = 0 \), there exists an optimum \( \beta \) between 0 and \( \bar{\alpha} \) where \( V'(\beta) = 0 \), by the Intermediate Value Theorem. Only if \( V'(\beta) \leq 0 \) at \( \beta = 0 \) is all-equity compensation optimal.

Owing to the \( f(.) \) function, the optimal \( \beta \) cannot be derived in closed form. However, since \( V'(\beta) \) is continuous and decreasing, the optimum is greater if (21) is higher. This leads to the comparative statics of Proposition 6.

**Proof of Equation (15)**
Follows immediately from differentiating equation (18) with respect to $\alpha$. 
References


2 Sports Sentiment and Stock Returns

2.1 Introduction

This paper employs a novel mood variable, international soccer results, to investigate the effect of investor sentiment on asset prices. Using a cross-section of 39 countries, we find that losses in soccer matches have an economically and statistically significant negative effect on the losing country’s stock market. For example, elimination from a major international soccer tournament is associated with a next-day return on the national stock market index that is 38 basis points lower than average. We also document a loss effect after international cricket, rugby, and basketball games.\(^{17}\) On average, the effect is smaller in magnitude for these other sports than for soccer, but is still economically and statistically significant. We find no evidence of a corresponding effect after wins for any of the sports that we study. Controlling for the pre-game expected outcome, we are able to reject the hypothesis that the loss effect after soccer games is driven by economic factors such as reduced productivity or lost revenues. We also document that the effect is stronger in small stocks, which other studies find are disproportionately held by local investors and more strongly affected by sentiment. Overall, our interpretation of the evidence is that the loss effect is caused by a change in investor mood.

Our study is part of a recent literature that investigates the asset pricing impact of behavioral biases documented in psychology research. This literature, which has expanded significantly over the last decade, is comprehensively reviewed by Hirshleifer (2001) and Shiller (2000). The strand of the literature closest to this paper investigates the effect of investor mood on asset prices. The two principal approaches in this work link returns either to a single event or to a continuous variable that impacts mood. Examples of the event study approach are Kamstra, Kramer, and Levi (2000), who investigate the impact of disruption to sleep patterns caused by changes to and from daylight saving, and Frieder and Subrahmanyam (2004), who study nonsecular holidays. With respect to the continuous variable literature, Saunders (1993) and Hirshleifer and Shumway (2003) study the impact of sunshine, Cao and Wei (2005) examine temperature, Kamstra, Kramer, and Levi (2003) analyze daylight, and Yuan, Zheng, and Zhu (2006) explore lunar cycles. The main advantage of the event approach compared to the use of a continuous variable is that the former clearly identifies a sudden change in the mood of investors, which gives a large signal-to-noise ratio in returns. The main disadvantage of the event approach is that the number of observed signals tends to be low, which reduces

\(^{17}\)Ashton, Gerrard, and Hudson (2003) and Boyle and Walter (2002) study the stock market effect of soccer in England and rugby in New Zealand, respectively. Ashton, Gerrard, and Hudson (2003) argue that the effect of wins and losses is symmetric. Boyle and Walter (2002) conclude, with similar point estimates to those in this paper, that there is no evidence in favor of any effect of rugby on New Zealand’s stock market. Both conclusions stand in sharp contrast to our large-sample evidence.
Our main contribution is to study a variable, international soccer results, that has particularly attractive properties as a measure of mood. While extensive psychological evidence, which we review below, shows that sports in general have a significant effect on mood, TV viewing figures, media coverage, and merchandise sales suggest that soccer in particular is of “national interest” in many of the countries we study.\footnote{Several countries even require the public broadcaster to show national soccer games live and cable channels are not permitted to bid for the rights to the games. In countries such as Italy, Spain, Greece, and Portugal, the best-selling newspapers are dedicated exclusively to sports, particularly soccer.} It is hard to imagine other regular events that produce such substantial and correlated mood swings in a large proportion of a country’s population. These characteristics provide strong a priori motivation for using game outcomes to capture mood changes among investors. This is a key strength of our study, since such a measure of mood changes mitigates concerns about data mining.

The large loss effect that we report reinforces the findings of Kamstra, Kramer, and Levi (2000), who document a stock market effect of similar magnitude in response to the daylight saving clock change. While Pinegar (2002) argues that the “daylight saving anomaly” is sensitive to outliers, our effect remains economically and statistically significant even after removing outliers in the data and applying a number of robustness checks. Another contribution of this paper is that we are able to go a long way towards addressing the main disadvantage of the event approach. Our sample of soccer matches exceeds 1,100 observations, and exhibits significant cross-sectional variation across nations. In addition, we study more than 1,500 cricket, rugby, ice hockey, and basketball games. The full sample of 2,600 independent observations compares favorably to existing mood-event studies.

The rest of the paper is organized as follows. Section 2.2 explains the a priori motivations for investigating the link between sports and stock returns. In Section 2.3 we describe the data, and in particular the competitions that are the subject of our study. Section 2.4 documents an economically and statistically significant loss effect. Section 2.5 distinguishes between behavioral and economic explanations for this effect. Section 2.6 summarizes our findings and concludes.

### 2.2 Motivation

A number of recent papers document a link between mood and stock returns. Concerns that such results are the product of data mining call for investigating a new mood variable, or testing an existing mood variable on an independent sample to confirm results of previous studies. For example, Hirshleifer and Shumway (2003) confirm and extend the sunlight effect first documented by Saunders (1993). Since the null hypothesis is that markets are efficient, such investigations should include a clear unidirectional alternative hypothesis, limiting the
possibility of a rejection of the null in any direction. For example, Frieder and Subrahmanyam (2004) find abnormally positive returns around Yom Kippur and St. Patrick’s Day and negative returns around Rosh Hashanah, without specifying a priori why positive returns should arise with certain religious holidays and negative returns with others.

With the above in mind, we argue that a mood variable must satisfy three key characteristics to rationalize studying its link with stock returns. First, the given variable must drive mood in a substantial and unambiguous way, so that its effect is powerful enough to show up in asset prices. Second, the variable must impact the mood of a large proportion of the population, so that it is likely to affect enough investors. Third, the effect must be correlated across the majority of individuals within a country.

We believe that international soccer results satisfy these three criteria. An abundance of psychological evidence shows that sports results in general have a significant effect on mood. For example, Wann et al. (1994) document that fans often experience a strong positive reaction when their team performs well and a corresponding negative reaction when the team performs poorly. More importantly, such reactions extend to increased or decreased self-esteem and to positive or negative feelings about life in general. Hirt et al. (1992) find that Indiana University college students estimate their own performance to be significantly better after watching a win by their college basketball team than after watching a loss. Schwarz et al. (1987) document that the outcome of two games played by Germany in the 1982 World Cup significantly changed subjects’ assessments of their own well-being and their views on national issues. A related study by Schweitzer et al. (1992) shows that assessments of both the probability of a 1990 war in Iraq and its potential casualties were significantly lower among students rooting for the winning team of a televised American football game than among fans of the losing team. Changes in mood also affect economic behavior. Arkes, Herren, and Isen (1988) find that sales of Ohio State lottery tickets increase in the days after a victory by the Ohio State University football team. Given the evidence that sports results affect subjects’ optimism or pessimism about not just their own abilities, but life in general, we hypothesize that they impact investors’ views on future stock prices.

Note that as a testament to the fundamental importance of sports, the effects of sports results extend far beyond simple mood changes. For instance, in many cases sport results have such a strong effect that they adversely affect health. Carroll et al. (2002) show that admissions for heart attacks increased 25% during the three-day period starting June 30, 1998, the day England lost to Argentina in a World Cup penalty shoot-out. Further, White (1989) documents that elimination from the U.S. National Football League playoffs leads to a significant increase in homicides in the relevant cities following the games, and Wann et

19For other related studies see Sloan (1979), Wann and Branscombe (1995), Platow et al. (1999), and Bizman and Yinon (2002).
20See Berthier and Boulay (2003) and Chi and Kloner (2003) for more recent studies with similar conclusions.
al. (2001) list several cases of riots after disappointing sports results, citing a multitude of other papers on the same issue. Trovato (1998) also finds that suicides among Canadians rise significantly if the Montreal Canadiens are eliminated early from the Stanley Cup playoffs.

While a large body of the literature shows that sporting events in general impact human behavior, a significant amount of evidence suggests that soccer in particular is an important part of many people’s lives. For example, the cumulative number of television viewers that followed the 2002 World Cup in Korea/Japan exceeded 25 billion, the final between Brazil and Germany was viewed by more than 1 billion, and on average more than 20 (10) million viewers from Italy (Spain and England) watch their national team in the final stages of the World Cup or European Championship. Moreover, national soccer results influence the mood of an entire country in a similar way, whereas other popular sports, such as American football and baseball, are predominantly contested on a club rather than country level. The “home bias” documented by French and Poterba (1991) means that the individuals affected are also likely to be the marginal investors in the domestic stock market. Thus, international soccer matches are among the very few events that take place at regular intervals and that are perceived as important by a large fraction of the population in a broad range of countries, and as such are interesting to study. Accordingly, soccer serve as our primary sport for analysis.

To increase our sample size, we also investigate the impact of cricket, rugby, ice hockey, and basketball results. These sports also involve regular international competition and are important in a number of countries. However, we expect any results to be strongest in relation to soccer, given it is the number one sport in most of the countries we study, often by a substantial margin.

The psychology literature documents a significant difference in the behavior of fans following wins and losses. Specifically, while an increase in heart attacks, crimes, and suicides is shown to accompany sporting losses, there is no evidence of improvements in mood of a similar magnitude after wins. This asymmetry suggests that we should observe a greater effect after soccer losses than after soccer wins. A similar prediction follows from the prospect theory of Kahneman and Tversky (1979). At the heart of prospect theory is its reliance on gains and losses as carriers of utility, rather than wealth levels. That is, the reference point

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21 These figures are substantially greater than those for other sports. We obtained TV viewership data for England using news searches in factiva.com and google.com (extensive viewing figures are unavailable for other countries). These viewership figures show that all the top 30 sport events in England in 2000 were associated with soccer, with the exception of the Grand National (horse racing).

22 French and Poterba (1991) find that the domestic ownership shares of the world’s five largest stock markets lie between 79% and 96%. This is confirmed by a multitude of further studies, summarized by Karolyi and Stulz (2003).

23 The psychology literature also hints at the possibility of win effects being larger than loss effects. According to behavioral patterns known as “basking in reflected glory” (BIRGing) and “cutting off reflected failure” (CORFing), fans cut their association with losing teams and increase their association with winning teams. See, for example, the discussion in Hirt et al. (1992).
against which gains and losses are measured becomes an important determinant of utility. The natural reference point in our setting is that of supporters’ pre-game expectations of how their team will perform. A number of studies show that fans are subject to an “allegiance bias,” whereby individuals who are psychologically invested in a desired outcome generate biased predictions (see Markman and Hirt (2002), Wann et al. (2001)). Thus, if the reference point of soccer fans is that their team will win, we may find a greater stock price reaction after losses than after wins. A third reason to expect an asymmetric reaction to wins and losses, specific to elimination games, results from the inherent asymmetry of the competition format. While a win merely advances a country to the next stage, a loss immediately removes the country from the competition.

2.3 The Data

We collect international soccer results from January 1973 through December 2004 from the website www.rdasilva.demon.co.uk. The data include games from the World Cup and the main continental cups (European Championship, Copa America, and Asian Cup).

International soccer competitions have used slightly different formats throughout the last 30 years. With respect to the World Cup, as of 2004, national teams from different geographic regions play against each other to qualify for the Cup. We refer to games at this stage as “qualifying games.” Based on performance in the qualifying rounds, 32 teams are selected as competitors for the World Cup. The teams are divided into groups of four. We refer to games in this stage as “group games.” Teams in each group play against each other with the top two advancing to the “elimination stage.” In this stage, which starts with 16 teams, no ties are allowed. Thus, at each of the following stages, half of the remaining teams are eliminated. The team that survives all elimination matches wins the World Cup. The European Championship, Copa America, and Asian Cup follow a similar format to determine the winner.

The international soccer sample comprises matches played by 39 different countries (see the Appendix for country selection and Table IX for details). We classify a total of 1,162 soccer matches, 638 wins and 524 losses, as relevant “mood events.” This set of mood events includes all elimination and group games in the World Cup and the continental cups, that is 756 games, plus another 406 relevant qualifying games. Owing to the large disparity in skill across participating countries in a typical qualifying group, a national team will usually play only four to six matches that will be critical for its qualification and that in turn will have a significant mood impact. \(^{(24)}\)

\(^{(24)}\)To select games that have a reasonable chance of being important,
we use closeness in the ability of the two opponents as a proxy for importance, where ability is measured using Elo ratings (www.eloratings.net). 25 A qualifying game is defined as close if the Elo rating of the two opponents is within 125 points (after adding 100 points to the team with the home advantage) or if the game is played as part of the knock-out stage between the qualifying rounds and the group stage. As of October 31, 2005, the difference in Elo ratings between the top-ranked country (Brazil) and the 10th country (Portugal) is 122 points.

We collect the data on cricket, rugby, ice hockey, and basketball from various web sources. The cricket matches come from One Day Internationals played over the period 1975 to 2004, the rugby matches from the Six Nations (England, France, Ireland, Italy, Scotland, and Wales), Tri Nations (Australia, New Zealand, and South Africa), and World Cup competitions between 1973 and 2004, the ice hockey matches from the World Championships (1998 to 2004), Olympics (1980 to 2002), and World Cup/Canada Cup (1996 and 2004), and the basketball matches from the Olympics (1992 to 2004) and World Championships (1994 to 2002). The Appendix describes data sources and the details of the sample selection for all sports. The sample of cricket, rugby, ice hockey, and basketball matches contains 905 wins and 645 losses for 24 countries. This gives on average 388 games for each of these four sports. However, about 45% of the other-sport sample consists of rugby games, due to both longer time series of stock returns for rugby nations and the greater regularity of rugby games.

The market indices used in this study are from Datastream. We compute returns using a total return index (assuming that dividends are reinvested). If the total return index is not available, we use a price index instead. Index returns are measured in the local currency since the biases we have in mind are associated with domestic investors, for which local returns are the relevant benchmark. The Appendix reports the details on the indices used in this study.

2.4 Results

To measure the effect of international sports results on stock prices, we use the return on a broad stock market index on the first trading day following the game. While for some weekday games the market is open while the match is being played, we choose to use the first trading day after the match for all games to ensure that we have the return for a full day when the game outcome is known. If anything, this potential asynchrony attenuates our results since part of the reaction may have been incorporated in prices before our measurement day.

2.4.1 Descriptive Statistics

Table I provides information about the number of games included in the sample for each sport, as well as mean daily log stock market returns on days following game days and non-game
days. For the sample of soccer countries in Panel A, 181,796 trading days are not associated with a soccer match. The average return and standard deviation for these days are 5.8 and 144.9 basis points, respectively. The average return on days after an international soccer win is positive (5.0 basis points), but negative and significantly lower on days following a loss (−18.4 basis points). The standard deviation of returns is slightly higher after game days than for other days, but the difference is only minor. Looking across the different cups and stages in the competition, it is apparent that the loss effect is most pronounced for World Cup games and elimination games in general. A similar win-loss pattern shows up in the returns after other sports results in Panel B of Table I. For the 645 loss days, the average return is −15.3 basis points. The loss effect seems to be more pronounced for cricket and basketball, with the cricket point estimates consistent with the sport’s importance in South Asia. The average return on the 903 win days is −4.0 basis points, with positive point estimates only for the ice hockey and basketball subsamples.

In Panels A and B, we have a total of 10 independent subsamples of games. It is reasonable to assume that the stock returns associated with a game will be independent across these groups. In Panel A, the difference between average returns after win days and loss days is always positive, with a maximum of over 50 basis points for World Cup elimination games. In Panel B the differences are positive with the exception of the rugby subsample, for which the difference is negative, but by less than one basis point. Therefore, in nine of the 10 subgroups the point estimates show a positive difference between win and loss days. The probability that there are nine or more successes out of 10 equally likely Bernoulli trials is 1%. Thus, the null hypothesis of a similar return after wins and losses can be easily rejected at conventional levels of statistical significance. In sum, even ignoring the actual size of the differences, the evidence in Table I suggests that sports results are indeed correlated with stock returns.

An important property of the soccer events we study is that they are clustered around a few weeks, mostly in the months of June and July for the World Cup, European Championship, and Copa America. For example, even though we have 177 distinct elimination games with wins and 138 with losses, there are only 113 distinct days in our database for which at least one country won and only 96 days for which at least one country lost. To the extent there are common shocks to stock returns across different countries, return observations on event dates will not be independent. Moreover, for all the sports, because many matches are played between Friday afternoon and Sunday afternoon, we measure the daily return on Monday for all these games. This may introduce a spurious day-of-the-week relationship between soccer results and stock returns. The next section details the econometric approach we follow to deal with these and other issues that may influence our results.
2.4.2 Econometric Approach

Our null hypothesis is that stock markets are unaffected by the outcomes of soccer matches. This null hypothesis embeds the view that investors are rational, that markets are efficient, and that the economic benefits associated with winning an international soccer game are too small to influence the national stock market index. The alternative hypothesis is that wins lead to a positive stock market reaction and losses lead to a negative reaction. This is motivated by the findings from the psychology literature that suggest wins are associated with a good mood and losses with a bad mood.

Under the null hypothesis, soccer outcomes are uncorrelated with asset prices. This in turn implies that the effects of soccer should be consistently estimated with any model of stock returns—even one that is completely misspecified. To estimate the impact of wins and losses on stock returns while controlling for the Monday effect and other confounding effects, we first estimate the following model for each country $i$:

$$ R_{it} = \gamma_{0i} + \gamma_{1i} R_{it-1} + \gamma_{2i} R_{mt} + \gamma_{3i} R_{mt+1} + \gamma_{4i} D_t + \gamma_{5i} Q_t + \epsilon_{it}, \tag{22} $$

where $R_{it}$ is the continuously compounded daily local currency return on a broadly based stock market index for country $i$ on day $t$, $R_{mt}$ is the continuously compounded daily U.S. dollar return on Datastream’s world market index on day $t$, $D_t = \{D_{1t}, D_{2t}, D_{3t}, D_{4t}\}$ are dummy variables for Monday through Thursday, and $Q_t = \{Q_{1t}, Q_{2t}, Q_{3t}, Q_{4t}, Q_{5t}\}$ are dummy variables for days for which the previous one through five days are non-weekend holidays.

The model specification in (1) is motivated by previous studies of the time-series variability of stock returns. The lagged index return, $R_{it-1}$, is included to account for first-order serial correlation. To the extent that international stock markets are integrated, the return on local indices will be correlated across countries. The contemporaneous return on the world market portfolio, $R_{mt}$, is included to control for this correlation. Since some local markets may be lagging the world index while other may be leading the index, the model also includes $R_{mt-1}$ and $R_{mt+1}$. We estimate the model simultaneously for all countries by interacting each independent variable with a set of country dummies. For the sample of 39 soccer nations, the adjusted-$R^2$ for this regression is 15%.

Let $\hat{\epsilon}_{it}$ denote the residuals from regression (1). We estimate the effect of the outcome of international soccer matches using the regression model

$$ \hat{\epsilon}_{it} = \beta_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it}, \tag{23} $$

where $W_{it} = \{W_{1it}, W_{2it}, \ldots\}$ are dummy variables for wins in different game subgroups and

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26This follows from the fact that omitted variables do not bias coefficient estimates in a regression when the omitted variable is independent of other regressors.
Let \( L_{it} = \{L_{1it}, L_{2it}, \ldots \} \) are loss dummies for the same set of game subgroups. The number of game subgroups will vary depending on the setting. More specifically, \( W_{git} \) is a dummy variable that equals one if country \( i \) wins a soccer match in game subgroup \( g \) (e.g., a World Cup elimination game) on a day that makes \( t \) the first trading day after the match and zero otherwise; \( L_{git} \), a dummy variable for losses, is defined analogously to the win dummy. As in Hirshleifer and Shumway (2003), we estimate the above model using panel-corrected standard errors (PCSE), which assumes that the error terms \( u_{it} \) are mean zero and uncorrelated over time, but allows for heteroskedasticity and contemporaneous correlation across countries.

One possible concern regarding the above statistical specification is its constant-volatility assumption. French, Schwert, and Stambaugh (1987) and Bollerslev, Engle, and Nelson (1994), among others, show that stock index returns have time-varying volatility. Thus, if any of our international competitions occurred during periods of high volatility, the magnitude of our standard errors would be biased downward. To address this issue we model stock return volatility using a GARCH model as developed by Engle (1982) and generalized by Bollerslev (1986). Specifically, after modelling stock returns using equation (1), we model the volatility of the error term from this regression as the GARCH(1,1) process \( \sigma^2_{it} = \lambda_0 + \lambda_1 \varepsilon^2_{it-1} + \lambda_2 \sigma^2_{it-1} \), where \( \sigma^2_{it} \) is the index return volatility for country \( i \) on day \( t \). We then use the time series \( \sigma^2_{it} \) to form the new time series of normalized stock index returns \( R^0_{it} = a_i + b_i (1/\sigma^2_{it}) R_{it} \), where \( a_i \) and \( b_i \) are chosen so that the mean of \( R^0_{it} \) is equal to zero and the standard deviation is equal to one. By normalizing all index returns we eliminate the heterogeneity in volatility across countries in addition to the time-series variation adjustment of the GARCH model. The normalized returns, \( R^0_{it} \), are then used in the model specification (1), from which we obtain a second set of normalized residuals, which we denote by \( \hat{\varepsilon}_{it} \). For the most part, we conduct our analysis on the normalized residuals \( \hat{\varepsilon}_{it} \). To distinguish these residuals from the residuals \( \varepsilon_{it} \), we refer to the latter as “abnormal raw returns” and the former as “abnormal normalized returns.”

### 2.4.3 The Loss Effect

Table II reports the main findings of this paper. Panel A details results using abnormal raw returns for matches played in the eight World Cups and all continental cups between 1974 and 2004. Focusing first on the results for losses on the right-hand side of Panel A, the most striking finding is that national stock markets earn a statistically and economically significant negative return on the day after a loss by the national soccer team. The ordinary least squares (OLS) coefficient on the loss dummy is \(-38.4\) basis points for the 138 elimination games, and a staggering \(-49.4\) basis points for the 56 World Cup elimination games. The point estimates are consistently negative for all six subsets of games.

The point estimate for the loss effect is increasing in game importance. First, the World
Cup games show a bigger loss effect than the continental cup games for all three game groups. Second, the loss effect for elimination games is larger than for group games, which in turn show a larger loss effect than close qualifying games. It seems natural to argue that elimination games in the final stages of a soccer competition should have the strongest mood effect, as such games receive the greatest media coverage and a loss in an elimination game immediately sends a national team home. Moreover, some losses in group or qualifying games may be irrelevant (because a team already qualified or no longer has a chance of qualification due to performance in earlier group games) or may not yield immediate elimination (since a team can recover by winning subsequent group games).

For the full sample of 524 soccer losses, the point estimate is −21.2 basis points, highly significant both in economic and statistical terms. We reject the null hypothesis of $\beta_L = 0$ at any conventional level using panel-corrected standard errors. The win coefficient is a positive 1.6 basis points for the overall sample and a positive 9.0 basis points for World Cup elimination games. However, these estimates are not statistically distinguishable from zero. The large negative effect for losses and smaller positive effect for wins is consistent with the inherent asymmetry between elimination wins and losses. While a loss leads to instant exit, a win merely advances the team to the next round. Thus, the attention of fans after a win may quickly turn to the next stage of matches. This may be exacerbated by an allegiance bias in fans’ expectations regarding the game outcome. If fans overestimate the probability of a national team win, losses will have a particularly dramatic effect.

Panel B in Table II reports the results using the abnormal normalized returns described in Section 2.4.2. Since the estimates on these normalized returns give less weight to observations in countries with volatile stock markets, game-day observations that come from extreme returns in highly volatile markets will have a smaller impact on the point estimate. The results on the right-hand side of Panel B confirm the findings from Panel A. The loss effect is unaffected by the GARCH(1,1) volatility adjustment; if anything, the GARCH adjustment and the normalization of returns increase the statistical power to reject the null hypothesis. In order to interpret the size of the coefficient estimates, and thereby measure economic significance, notice that $\beta_L = −0.157$ for all games implies an average return that is 0.157 standard deviations below its mean. For a stock market index with daily volatility of 1.449 basis points (see Panel A Table I), this translates into an abnormal raw return of $0.157 \times 1.449 = 0.23$, which is almost identical to the point estimate for raw abnormal returns from Panel A. Turning to the left-hand side of Panel B, the results from Panel A are again confirmed. There is no evidence of any abnormal stock market returns after wins. The win coefficients are virtually zero for all game subsets and are statistically indistinguishable from zero.\(^{27}\)

\(^{27}\)We also find moderate evidence that the market bounces back after the initial drop. The point estimate
When comparing across competitions and stages in Panel A of Table II, it appears that the loss effect is increasing in game importance. In Table III we explore this issue further by investigating whether the effect is stronger in countries in which soccer is of greatest importance. We split the sample into “Top Seven soccer nations” and “Other soccer nations.” The Top Seven soccer nations are: Argentina, Brazil, England, France, Germany, Italy, and Spain. The remaining 32 countries are referred to as Other soccer nations. Panel A of Table III contains the results for the Top Seven countries while Panel B contains results for the Other countries. Comparing corresponding point estimates in the two panels, the point estimates for the Top Seven are larger in magnitude for all wins and all losses except for continental group games. However, an economically and statistically significant loss effect still exists for Other countries, so the effect documented in Table II is not driven purely by the Top Seven. The strength of the effect in Other countries, coupled with the high standard errors, prevents us from statistically rejecting the hypothesis that all point estimates in Panel A are equal to the corresponding point estimates in Panel B.

2.4.4 Statistical Robustness Checks

This section investigates the robustness of the loss effect by controlling for the clustering of games on certain dates and by eliminating the effect of outliers in the data. For brevity we report results only on normalized returns—the results using raw returns are virtually identical.

A potentially important problem with our data is the time-clustering of observations. Although equation (1) controls for market movements, we may be overstating the statistical significance of our estimates if the model does not fully capture the correlations among different countries’ returns on a given date. For example, shocks to emerging markets are likely to be inadequately captured by the Datastream world index, which is mostly composed of returns from developed nations. To mitigate the problems created by time-clustering, we form “portfolios” of winners and losers for each game date. For each date $t$ for which either $W_{it} = 1$ or $L_{it} = 1$ for some $i$, we average $\tilde{e}_{it}$ over all countries with $W_{it} = 1$, and average $\tilde{e}_{it}$ over all countries with $L_{it} = 1$. This yields two time series of abnormal normalized portfolio returns, $\tilde{w}_{Lt}$ and $\tilde{w}_{Wt}$, for losing countries and winning countries, respectively. Under our null hypothesis, these time series should both have zero means.

for the second trading day after the game is 7.2 basis points for all soccer losses (controlling for first-order autocorrelation) and is statistically significant at close to 5% using a one-sided test. The point estimate is 5.6 basis points for elimination games and not statistically significant. These results are not reported for brevity but are available from the authors upon request.

28The professional soccer leagues of England, France, Germany, Italy, and Spain collectively account for 80% of soccer revenues in Europe, which in turn is by far the most dominant continent for global soccer income. These countries are known throughout the industry as the “Big Five.” Together with Argentina and Brazil, these seven countries systematically occupy the top world rankings.

29This test is not reported in a table but is available from the authors upon request.
Panel A of Table IV presents the number of win days and loss days, the average returns on the win and loss portfolios, and standard \( t \)-values for a test of zero mean. Consistent with all our earlier findings, there is a statistically significant loss effect as well as a negligible effect for wins. The point estimates are very similar to those in Panel B of Table II, aside from a small decrease in the statistical significance of the tests since we are dropping all cross-sectional information on a given day. However, the loss effect remains statistically significant at levels close to 5% or better for all final-stage game subsets (both elimination and group games). The results for the full sample of 524 losses, which is reduced to 358 date observations, remain highly significant, with a point estimate of \(-14.9\) basis points and a \( t \)-statistic of \(-3.3\).

We also investigate the sensitivity of our result to outliers. This test is motivated by Pinegar (2002), who shows that the clock change results of Kamstra, Kramer, and Levi (2000) are sensitive to outliers in their data. We define outliers as observations for which the dummy variables \( W_{it} \) or \( L_{it} \) equal one and the absolute value of the abnormal normalized returns, \( \tilde{\epsilon}_{it} \), is “large.” In other words, we identify observations with large negative or large positive returns on a win day or a loss day. Effectively, this approach identifies the observations that have the greatest influence on the estimates of \( \beta_W \) and \( \beta_L \).

Panel B in Table IV reports trimmed means, where 20% of the game-day observations are removed (10% extreme negative observations and 10% extreme positive observations). The \( t \)-statistics reported are calculated using standard asymptotic approximations for trimmed means (see Huber (1996), chapter 3). Again, we find that the loss effect documented in Table II is remarkably robust. After trimming the data, the point estimate after losses in international soccer matches is \(-12.6\) basis points with a \( t \)-statistic of \(-3.50\). The trimmed means for losses are slightly less negative than the untrimmed means, revealing that negative outliers tend to be somewhat larger in absolute value than positive outliers, especially for the qualifying games subset. However, both the economic and statistical significance of the results remain strong. Consistent with our previous analysis, these robust estimates fail to uncover any positive effect after wins.

### 2.4.5 Evidence from Other Sports

Panel B of Table II shows that the loss effect is statistically significant in all three mutually exclusive groups of the 524 soccer losses games (elimination, group, and close qualifiers). However, from Panel A of Table II, it is clear that the loss effect is strongest in the subsamples of 138 elimination games and 81 World Cup group games. To increase our sample of sports-related mood events, we investigate whether the loss effect documented for soccer exists in other international sports. To ensure that each sport is important in a reasonable number of countries, the sports we study are cricket, rugby, ice hockey, and basketball. The Appendix details country selection for each sport.
Since soccer is the main sport for the vast majority of the 39 countries we define as soccer nations, we expect that other sports will exhibit a weaker effect. A possible exception may be cricket, as this is the main sport for around half (India, Pakistan, Sri Lanka, and possibly South Africa) of the seven countries included as cricket nations. For example, approximately 75% of the sports-related advertising revenues in India are generated through cricket events, and the Indian government considered moving the 2004 elections to avoid a conflict with a cricket series against Pakistan, fearing a sporting defeat would severely impact electorate mood.

Table V reproduces the analysis in Tables II and IV for our sample of other sports. Somewhat surprisingly, given the lesser importance of these sports, Panel A of Table V shows a similar pattern to that reported for the soccer sample. In particular, the point estimate after losses in these other competitions is negative, −8.4 basis points, and statistically significant at conventional levels. The effect is negative for all subsamples but ice hockey, and is particularly large for cricket and basketball. As for soccer, there is no significant effect after wins in the overall sample. Although smaller in magnitude compared to the soccer point estimates from Table II (consistent with the other sports being a weaker mood variable), the data support the hypothesis that these other sporting events are also associated with stock market movements.

The last two panels of Table V perform robustness checks along the lines of those in Section 2.4.4. The point estimate for the full sample of games is virtually unchanged by either pooling the cross-sectional returns over dates (Panel B) or computing trimmed means (Panel C). The t-statistic drops to −1.88 for the portfolio approach and increases to −2.53 for trimmed means. The cricket subsample is the most robust of the four, showing even larger point estimates and stronger statistical significance using either portfolio returns or trimmed means, partly because the trimming removes an extreme positive outlier for India after a cricket loss.\(^{30}\) This finding is consistent with the fact that cricket is the number one sport, and therefore a strong mood proxy, in half of the seven countries included as cricket nations. The evidence is marginal for the rugby and basketball subsamples, and only the ice hockey games do not seem to have point estimates consistent with our previous analysis. Again, this could be related to the fact that these sports are second in importance when compared to soccer, implying that a smaller proportion of the population is influenced by game outcomes.

To sum up, the results reported in Tables II through V show a striking loss effect. Stock markets exhibit a statistically and economically significant negative return on days after a loss by the national team in a sport the country views as important. The effect is especially strong after international soccer losses but is also significant after losses in other sports. The

\(^{30}\)On March 3, 1992, the stock market index for India rose 29%. This can be attributed to a market deregulation that authorized foreign institutional investors to make investments in all securities traded on the primary and secondary markets. The Indian cricket team experienced a loss on March 1; since March 2 is coded as a holiday for India, March 3 is the first trading day after the cricket game.
following section investigates competing interpretations of the loss effect.

2.5 Soccer, Mood, and Economics

Our study is motivated by the behavioral alternative hypothesis that soccer results affect stock returns through their impact on investor mood. However, the loss effect may be a result of efficient markets rationally reacting to the negative economic consequences of losing a game. This includes direct economic effects such as lower sales of related merchandise and advertising, the negative impact on productivity, and a potential reduction in consumer expenditure resulting from mood changes. The main goal of this section is to distinguish between these competing explanations for the loss effect. One simple argument that casts doubt on a pure economic explanation is the sheer size of the effect. To put the results in perspective, 40 basis points of the U.K. market capitalization as of November 2005 is $11.5 billion. This is approximately three times the total market value of all the soccer clubs belonging to the English Premier League.

We further investigate the competing explanations for the loss effect in three ways. First, rational asset pricing suggests that market declines should be particularly strong for losses that are unexpected under objective probabilities. To test this implication we add data on the ex ante probability of a win in a particular game. Second, we study whether the effect is stronger in small versus large stocks since the former are held more by local investors and their valuations are more likely to be affected by sentiment. Third, we study trading volume around our event dates to rule out potential stock market liquidity effects.

2.5.1 The Loss Effect and Expected Game Outcome

Even if the negative effect of a soccer loss is due to irrationality, investors could still be perfectly rational when pricing financial assets. In particular, market efficiency predicts that investors should price in the expected economic impact of soccer results before the game. Therefore, the loss effect should be stronger for losses that are more unexpected. To test this conjecture, let $V_{W_{it}}$ denote the value of the stock market in country $i$ at time $t$ following a soccer win, and let $V_{L_{it}}$ denote the corresponding value after a loss. A negative economic effect of soccer losses suggests that $V_{W_{it}} > V_{L_{it}}$.

If investors have assigned a probability $p_{it}$ to a national team win, the economic effect priced into the index level of the national stock market will be $p_{it}V_{W_{it}} + (1 - p_{it})V_{L_{it}}$. Let $I_{it}$ be the index level that includes the expected soccer effect. After controlling for other factors that move the national index, the soccer-related realized return on the index is

$$
\epsilon_{it} = \frac{(V_{W_{it}} - V_{L_{it}})}{I_{it}}W_{it} - \frac{(V_{W_{it}} - V_{L_{it}})}{I_{it}}p_{it} + v_{it},
$$

(24)
where $W_{it}$ is a dummy variable that equals one (zero) if country $i$ wins (loses) a soccer match on a day that makes $t$ the first post-game trading day, and $v_{it}$ is a mean zero error term.

We can generate testable predictions of a rational story as follows. Since the index level $I_{it}$ is large relative to the soccer effect, $\partial I_{it}/\partial p_{it}$ is approximately zero. This implies that $\partial \epsilon_{it}/\partial p_{it}$ is approximately equal to $-(W_{it} - V_{t0})/I_{it}$. Thus, if we study returns on game dates only, the soccer-related realized return can be written as a cross-sectional regression:

$$\epsilon_{it} = \alpha_0 + \alpha_1 W_{it} + \alpha_2 p_{it} + v_{it}. \quad (25)$$

Comparing equation (4) to equation (3), the above economic arguments imply the following three restrictions on the parameters: $\alpha_0 = 0$, $\alpha_1 > 0$, and $\alpha_1 = -\alpha_2$.

While the above arguments clearly predict a more negative impact of an unexpected loss (i.e., $\alpha_2 < 0$), there are no unambiguous predictions under the behavioral explanation. First, as we discuss in Section 2.2, the allegiance bias suggests that agents’ beliefs may not be closely related to expectations computed under objective probabilities. That is, under an allegiance bias, losses are nearly always unexpected. For example, 86% of fans surveyed thought that England would beat Brazil in the 2002 World Cup quarter final, even though Brazil was the world’s top-ranked team; this contrasts with the 42% probability that bookmakers assigned to a victory (Brazil eventually won the competition). Second, even if data on subjective probabilities were available, it is not clear that we would expect a negative coefficient on the subjective probability in equation (4). On the one hand, losses to strong opponents may be less painful as they are less unexpected. On the other hand, formidable opponents tend to be historic rivals and so a loss against them (e.g., England losing to Germany or Spain to Italy) may be as emotionally painful as an “embarrassing” loss to weak opposition.

We test the restrictions on the coefficients of equation (4) using probabilities derived from Elo ratings. Let $E_H$ and $E_A$ be the Elo rating for the “home team” and the “away team,” respectively. The probability that the home team wins is\(^{31}\)

$$P(\text{Home-team wins}) = \frac{1}{10^{-(E_H + 100 - E_A)/400} + 1}. \quad (26)$$

The probabilities implied by the Elo ratings have a correlation of 0.929 with betting odds data that we obtain for slightly less than 60% of the overall sample. Evidence surveyed in Hausch and Ziemba (1995) shows that odds data coincide closely with objective probabilities, implying that our Elo-based ex ante probabilities should proxy well for expected game outcomes.

\(^{31}\)For the games for which there is no home team (i.e., most final-stage games), we use

$$P(\text{Team H wins}) = \frac{1}{10^{-(E_H - E_A)/400} + 1}. $$

49
The estimation of equation (4) is conducted in two stages. First, we estimate $\hat{\varepsilon}_{it}$ as described in Section 2.4.2. Second, the game date residuals from the first-stage regression are used as the dependent variable in the cross-sectional regression in equation (4).

Panel A of Table VI reports the results from the estimation of equation (4) without any restrictions on the coefficients. To ensure that point estimates in Panel A are comparable to our earlier findings, we normalize $p_{it}$ to have zero mean. Thus, since $W_{it}$ is zero on loss days, the intercept picks up the loss effect controlling for the ex ante probability that country $i$ will win the match. Focusing first on the sample of all games, the intercept is negative, close to the point estimate for losses from Table II, and is statistically significant. The effect after wins can be computed by summing the coefficient estimates for $\alpha_0$ and $\alpha_1$. This sum is close to zero, confirming our earlier findings. In the last column of Panel A, we observe that there seems to be no relationship between ex ante probabilities and stock market reactions. Thus, the main implication of models that assume rational investors is not borne out in our data.

To further test this implication, Panel B of Table VI reports results from the estimation of the model in equation (4) under the restricted parameters. Since the model implies both equality and inequality restrictions, we estimate the model using quadratic programming. In particular, we estimate the model under the parameter restrictions above and we test the null hypothesis that these restrictions jointly hold against the alternative hypothesis that the restrictions do not hold. Kodde and Palm (1986) develop a Wald test for joint equality and inequality restrictions. The last column of Table VI reports the Kodde-Palm “Wald-D” test statistic. For all games taken together the Wald-D statistic is 9.274. Under the null, the probability of observing a Wald-D statistic of 9.274 or larger is 0.018.

The fundamental reason the economic explanations are rejected in our data is that the loss effect picked up by the intercept in equation (4) is too large to be explained by the win probability. To see this, consider a model in which investors are rational. This implies that $E(W_{it})$ should be identical to $p_{it}$, and thus the average number of wins in the sample (i.e., the average of $W_{it}$) should converge to the average $p_{it}$ as the sample size increases. Since the large soccer nations are overrepresented in our sample, the average $p_{it}$ is 0.62. One immediate implication of this result is that the loss effect should be of opposite sign, and approximately $0.62/0.38 = 1.6$ times the magnitude, of the win effect. This implication has already been rejected by the evidence in Table II, which shows that the loss effect is 13 times as large as the win effect.

2.5.2 Portfolio Characteristics and Local Ownership

To the extent the mood of local investors drives our results, we would expect stocks with especially high local ownership to be more sensitive to soccer results. The models of Merton (1987) and Gehrig (1993) predict that foreigners underweight stocks for which their infor-
mational disadvantages are greatest. It seems reasonable to believe that foreigners are at a
greater informational disadvantage in small stocks, which have low analyst and media cov-
ereage (Bhushan (1989)), and in growth firms, where “hard” accounting information is a less
important driver of firm value. This prediction finds support in Kang and Stulz (1997) and
Dahlquist and Robertsson (2001), who document that small firms are underweighted by for-
eign investors in Japan and Sweden, respectively. Dahlquist and Robertsson (2001) also find
that foreigners prefer firms with large cash positions on their balance sheets, which is a fea-
ture of value stocks. Moreover, even holding local ownership constant, investor sentiment is
more likely to affect small stocks as they are disproportionately held by individual investors
(Lee, Shleifer, and Thaler (1991)) and are less interesting to potential arbitrageurs who would
act to eliminate any mispricing. Indeed, many market “anomalies,” such as the January and
Monday effects are stronger in small stocks, and Baker and Wurgler (2006) find that small
stocks are more strongly affected by investor sentiment. Hence, differences in both the extent
of local ownership and the effect of sentiment given a particular ownership structure lead to
the cross-sectional prediction that soccer results should have a greater effect on a small stock
index than a large stock index, and on a growth index than a value index.

Panel A of Table VII reports the results from estimating the model in equation (2) using
pairs of small/large or value/growth indices. The Appendix describes our index selection.
The results show that the loss effect is stronger in small-cap indices. The point estimate
after losses is $-0.245$ basis points, two-and-a-half times the estimate of $-0.093$ for large-cap
indices. The $-15.2$ basis point difference is statistically significant at below the 10% level
using a one-sided test. By contrast, the loss effect is of the same magnitude in both value and
growth indices. The value-growth loss effect is the same as the effect for the overall market
index. Thus, the result could possibly be explained by foreigners having equal access to the
individual firms that constitute the value-growth indices.

2.5.3 Liquidity

This section investigates whether the loss effect is driven by changes in liquidity. If investors
are “hung over” on the day after a match, they may not want to participate in the stock
market that day, causing a reduced order flow. If sufficiently many local investors stay away
from the market, the greater execution time for a trade may induce sellers to accept a lower
price. To investigate the liquidity hypothesis, we use data on aggregate trading volume on
the stocks in the national index.

To measure abnormal trading volume, we model expected volume using a filtering pro-
cedure similar to the one in Gallant, Rossi, and Tauchen (1992). In particular, expected
volume is constructed in the following way. Let $V_{it}$ be the log of aggregate trading volume for
the constituent shares of country $i$’s stock index (from Datastream). We run the regression
\[ V_{it} = \gamma_0 x_{it} + u_{it}, \] where \( x_{it} \) is a set of explanatory variables. Next, we estimate variance according to \( \log(\hat{\sigma}^2_{it}) = \gamma_1 y_{it} + \epsilon_{it}, \) where \( y_{it} \) is a second set of explanatory variables. Finally, we define \( \hat{w}_{it} = a_i + b_i y_{it} / \exp(\gamma_i y_{it}/2), \) where \( a_i \) and \( b_i \) are chosen so that \( \hat{w}_{it} \) has zero mean and unit variance. For the mean volume regression, \( x_{it} \) includes day-of-the-week and month dummies, two lags of volume, a time trend, and the time trend squared. For the variance equation, \( y_{it} \) includes the variables in \( x_{it} \) except the two lags of volume. The procedure essentially generates, for each country, a mean zero time series of abnormal volume with unit variance. The normalization of all the time series eliminates the heterogeneity in volatility across countries. The effect of soccer match outcomes on volume is estimated using the model

\[ \hat{w}_{it} = \gamma_0 + \beta W_{it} + \beta L L_{it} + \epsilon_{it}. \]

The sample includes 34 countries from the original sample for which Datastream provides volume data.\(^{32}\) For most countries Datastream volume data do not start until the beginning of the 1980s, which reduces the number of soccer matches that can be included in the sample. Table VIII reports results using the abnormal volume time series. If the loss effect is caused by a reduction in market liquidity on the days after a soccer game, we would expect to see a reduction in volume on these days. For elimination games, the point estimates are positive but insignificant for both wins and losses. For the sample of all games, the point estimates of abnormal volume are all negative but again insignificant. Thus, there does not seem to be any reliable decrease in volume on the loss days. We therefore conclude that the loss effect is not related to a reduction in market liquidity, at least when liquidity is measured using trading volume.

By contrast, under a behavioral story there are no clear predictions as to the effect of mood changes on volume. Although one might expect a bad mood to cause inactivity and inertia in traders, it is equally plausible that investors may trade more to take their minds off the soccer defeat. Indeed, there is ample psychological evidence that agents engage in “mood regulation,” taking actions to fix their mood. For example, Erber and Tesser (1992) note that “exerting effort on a task may be one way to successfully overcome sad moods” and find evidence that a negative mood is attenuated by performing challenging tasks. Trading is a plausible example of such a task: Not only is it a cognitively intense activity, but it also has the potential of generating profits to negate the negative mood.

### 2.6 Conclusion

Motivated by the abundance of psychological evidence showing that sports results have a strong effect on mood, this paper investigates the stock market effect of international soccer results. We document a strong negative stock market reaction to losses by national soccer

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\(^{32}\)Compared to the 39 countries in Table IX, the missing countries are Bahrain, Croatia, Jordan, Nigeria, and Saudi Arabia.
teams. The size of the loss effect is economically significant—in monthly terms, the excess returns associated with a soccer loss exceeds 7%. We find a statistically significant but smaller loss effect for international cricket, rugby, and basketball games. There is no evidence of a corresponding reaction to wins in any of these sports.

The finding that the effect is not priced into the index when a loss is highly expected leads us to reject the view that the loss effect stems from the reaction of rational investors to cash flow relevant information. Instead, we interpret the effect as resulting from the impact of sports results on investor mood. There are several justifications for this interpretation. First, soccer results have been demonstrated to impact mood but have little direct economic impact. Second, the effect is more pronounced in countries where soccer is especially important, for games in the World Cup, and for elimination games. These important matches are precisely the games with greatest mood impact. Third, the effect is especially large in small stocks. Small stocks have been previously found to be especially sensitive to investor sentiment, and are predominantly held by local investors, whose mood is affected by the performance of the national soccer team.

The magnitude of the loss effect, and its concentration in Western European countries with developed stock markets, suggests that investors may obtain large excess returns by trading on these mood events, for instance, by shorting futures on both countries’ indices before an important match to exploit the asymmetry of the effect. However, the events we cover do not occur with enough frequency to justify a portfolio fully dedicated to trading on them. Moreover, because the effect seems to be particularly strong in small stocks and involves shorting, even traders that face low transaction costs would find it challenging to take advantage of the price drop. Our principal contribution is not to identify a profitable trading strategy, however, but to document that mood can have a large effect on stock returns. In light of our findings, this paper significantly expands the existing evidence linking mood to asset prices.

2.7 Appendix

2.7.1 Stock Index Returns and Index Volume

Returns are obtained from Datastream, and are computed using a total return index (assuming that dividends are reinvested). If the total return index is unavailable, we use a price index instead. Index returns are measured in the local currency. The starting date of the index for country $i$ is selected to ensure that the market is reasonably liquid at the time of the starting date. The starting date is the first date for which the five-day average number of firms in the index is at least 10 and the average number of firms (over a five-day period) that experienced a price change is greater than 50%.
We use the total return indices with a Datastream mnemonic that starts with “TOTMK.” Datastream does not provide TOTMK indices for seven countries in our sports data. For Croatia, Slovakia, and Lithuania we use the Nomura price index. For Bahrain, Jordan, Nigeria, and Saudi Arabia we use the S&P/IFCG indices from Standard & Poor’s Global Index Series. The index returns for Argentina, Czech Republic, Indonesia, Poland, Romania, and Russia are very volatile and contain extreme returns in the first few months of the series. Based on a visual inspection we trim the beginning of these time series. Only four basketball wins are lost because of this trimming. The return time series for South Korea, Indonesia, and Nigeria exhibit a persistent and dramatic increase in volatility in September 1997, August 1997, and April 1999, respectively. Whenever we use these time series in our analysis, we include a dummy variable that takes the value one before these dates and zero otherwise. None of our reported results are influenced by the trimming or the inclusion of the time dummies. The second column of Table IX reports the starting date for the returns time series.

For the analysis in Table VII we use data on large indices for 18 countries out of the 39 soccer countries listed in Table IX. Namely, we include as large-cap indices the Australia ASX-20, Austria ATX Prime, Belgium BEL-20, Denmark Copenhagen KFX, England FTSE-100, France CAC-40, Germany DAX-30, Greece Athens SE General, Ireland ISEQ, Italy Milan Comit-30, Japan Nikkei-225, Netherlands AEX, Norway OBX, Portugal PSI-20, South Korea Kospi-200, Spain IBEX-35, Sweden OMX-30, and Switzerland MSCI. The small indices are those provided by HSBC via Datastream for the list of countries for which we have a large index. The growth and value indices are from Standard and Poor’s, both available from Datastream for 34 out of the 39 soccer countries listed in Table IX. Owing to data limitations with the return series, we use the price series for all of these indices.

DataStream uses the same calendar for all countries and does not provide information about holidays. To avoid computing returns for holidays, we identify holidays as days on which the price of fewer than three of the stocks in the index moved and there was no trading volume. This procedure identifies more than 95% of the holidays. We identify the remaining holidays using the same two criteria separately.

Volume data is available for all countries for which Datastream provides a TOTMK index. For some countries, the volume data contain multiple zero-volume days at the beginning of the time series. We set the start date of the time series as the first date on which volume exceeds 100 for five consecutive days.

2.7.2 Soccer

We obtain international soccer results from 1973 through 2004 from the website www.rdasilva.demon.co.uk. We manually check the data for errors using various sources, including the
websites of the Fédération Internationale de Football Association (FIFA) and the Union des Associations Européennes de Football (UEFA).

To enter our sample, Datastream must provide a national stock market index with daily returns and a country needs to be recorded with at least one win or one loss (over the time period for which we have return data) in either the World Cup or the continental cups. These criteria result in a sample of 41 countries. However, given the large number and strong popularity of club sports (baseball, basketball, American football, and ice hockey) in Canada and the U.S., these countries are excluded. Table IX lists the 39 countries that are included.

In the 1974 and 1978 World Cups, eight teams proceeded from the group stage to a second-round playoff series. The winner and runner-up from this playoff stage qualified for the final. We define all games in the second-round series as elimination games. A similar format was used in the 1982 World Cup, but 12 teams proceeded to the second round and the four top teams played in the semi-finals. For this year we also define the second-round games as elimination games.

2.7.3 Cricket

Traditionally, cricket is played over multiple days (with a maximum of five). This does not lend itself easily to a study that relates game outcome to stock market response because it is not obvious when the outcome of the game became clear. However, since cricket is the main sport in many South Asian countries, we include One Day International (ODI) cricket matches in our sample of other sports. The International Cricket Council (ICC) World Championship is played as ODIs and we collect game results for eight World Championships played between 1975 and 2003. We obtain the cricket results from the website of the ICC, www.icc-cricket.com. We define as cricket nations those that were ranked in the top 10 countries every year between 2002 and 2005 (the top 10 do not change over this period). When we restrict the sample countries to those that have stock market data on Datastream, we are left with seven cricket nations: Australia, England, India, New Zealand, Pakistan, South Africa, and Sri Lanka. Table IX reports the number of cricket wins and losses.

2.7.4 Rugby

We obtain international rugby data from the website www.rugbyinternational.net. Data for Australia from 2001 and for South Africa were unavailable from the website owing to a broken link and were obtained directly from the website owners. We study all games in the Six Nations, Tri Nations, and the final stages of the World Cup. Rugby nations are defined as the countries that participate in the Tri Nations (Australia, New Zealand, and South Africa) or Six Nations (England, Wales, Scotland, Ireland, France, and Italy). Scotland and Wales
are excluded because they have no independent stock market, leaving us with seven rugby nations. Table IX reports the number of rugby wins and losses.

2.7.5 Ice Hockey

We collect ice hockey data from the website www.iihf.com of the International Ice Hockey Federation (IIHF) and the independent website www.hockeynut.com. The hockey matches consist of the World Championships (1998 to 2004), Olympics (1980 to 2002), and World Cup/Canada Cup (1996 and 2004) competitions. We define ice hockey nations as the top 10 countries based on performance in the 2004, 2003, 2002, and 2001 World Championships and the 2002 Olympics. As for soccer, the U.S. is excluded: Not only does hockey lag behind baseball, American football, and basketball, but also any hockey interest is focused on the National Hockey League rather than international matches (the NHL playoffs occur at the same time as the World Championships, meaning many top players do not participate in the latter). Latvia is excluded because of no stock market data. This leaves us with the following eight hockey nations: Canada, Czech Republic, Finland, Germany, Russia, Slovakia, Sweden, and Switzerland. Table IX reports the number of ice hockey wins and losses.

2.7.6 Basketball

We obtain World Championship and Olympic basketball results from www.fiba.com. The website contains, for each tournament, the names of the two opponents, the round, and the result. Unfortunately it does not contain dates, so these have to be obtained from a variety of other sources. Olympic dates are obtained from sports.espn.go.com/oly/index for 2004 and 2000, and www.sunmedia.ca/OlympicsBasketball/sked.html for 1996. World Championship dates are obtained from www.insidehoops.com/wbc.shtml for 2002 and the Associated Press headlines for 1998; see amarillo.com/sports/index080498.html as an example of headlines for a particular day. For the 1992 Olympics and the 1994 World Championships, the U.S.’ dates are obtained from www.usocpressbox.org. Since games in each round take place on the same day, we could then work out the dates for all other teams' matches for the entire 1994 World Championships and the quarter-finals onward for the 1992 Olympics.

To define basketball nations, we follow the same approach as for soccer and require that a country participated in a significant number of basketball events. This requirement eliminates Japan, Turkey, Venezuela, South Korea, Croatia, and Nigeria. A total of 27 games are lost because of this requirement. We also remove Australia and New Zealand because at least two other sports (cricket and rugby) are more important in terms of attention in these countries. Again, we remove the U.S. owing to the substantially greater focus on club sports and college basketball. Many top American NBA players do not participate, in contrast to
other countries which are at close to full strength. This is consistent with the limited media coverage of international basketball in the U.S. These removals leave us with 11 basketball nations: Argentina, Brazil, Canada, China, France, Germany, Greece, Italy, Lithuania, Russia, and Spain. Table IX shows reports the number of basketball wins and losses for these eleven countries.

2.7.7 Multiple Games on One Day

If a country plays an international game in more than one of the sports (soccer, cricket, rugby, ice hockey, and basketball) on a single day, we remove the observation if the country wins in one sport and loses in another. If the outcome is the same in all sports, we keep the observation. For example, England won a cricket match and a rugby match on February 17th and 24th, 2003. All four of these observations are kept. This adjustment affects less than 1% of our sample of games.
References


Table I
Number of Wins and Losses in International Team Sport Matches and Percent Mean Daily Return on the First Trading Day After Matches

The table reports the number of wins and losses in international soccer, cricket, rugby, ice hockey, and basketball matches. The soccer matches are played over the period 1973 to 2004 in the World Cup, European Championship, Copa America, Asian Cup, World Cup qualifying stages, and European Championship qualifying stages. The cricket matches are One Day Internationals played over the period 1975 to 2004. The rugby matches are Six Nations, Tri Nations, and World Cup matches between 1973 and 2004. The ice hockey matches are the World Championships (1998 to 2004), Olympics (1980 to 2002), and World Cup/Canada Cup (1996 and 2004) competitions. The basketball matches are the Olympics (1992 to 2004) and World Championships (1994 to 2002) tournaments. The mean returns reported in the table are computed from the log daily return on national stock market indices (from Datastream) on the first trading day after wins and losses. The Appendix details the country selection for each sport. Elimination matches are matches in which the loser is eliminated from further play in the tournament. Group games are played during the championship and qualifies teams for the elimination stage. Close qualifying games are played to qualify for the championship by two teams with a difference in Elo rating below 125 points, after adding 100 points to the team with home advantage.

<table>
<thead>
<tr>
<th></th>
<th>No games</th>
<th>Wins</th>
<th>Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>Std.</td>
</tr>
<tr>
<td>No games</td>
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<tr>
<td>All games</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>World Cup elimination games</td>
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<td>1.306</td>
</tr>
<tr>
<td>World Cup group games</td>
<td>115</td>
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<td>1.535</td>
</tr>
<tr>
<td>World Cup close qualifying games</td>
<td>137</td>
<td>−0.067</td>
<td>2.089</td>
</tr>
<tr>
<td>Continental cups elimination games</td>
<td>101</td>
<td>−0.044</td>
<td>1.021</td>
</tr>
<tr>
<td>Continental cups group games</td>
<td>128</td>
<td>0.164</td>
<td>1.186</td>
</tr>
<tr>
<td>European Champ. close qualifying games</td>
<td>81</td>
<td>0.239</td>
<td>1.121</td>
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</table>

Panel A. International Soccer (39 countries)

<table>
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<th></th>
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<th>Losses</th>
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<tbody>
<tr>
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<td>Std.</td>
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<td></td>
<td></td>
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<tr>
<td>Cricket</td>
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<td>2.008</td>
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<tr>
<td>Rugby</td>
<td>403</td>
<td>−0.161</td>
<td>1.117</td>
</tr>
<tr>
<td>Ice hockey</td>
<td>238</td>
<td>0.139</td>
<td>1.707</td>
</tr>
<tr>
<td>Basketball</td>
<td>111</td>
<td>0.071</td>
<td>2.166</td>
</tr>
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Table II
Abnormal Daily Stock Market Performance After International Soccer Matches

The analysis is based on soccer wins and losses for 39 countries (see the Appendix). The average time series has 4,690 trading days, which gives a total of 182,919 daily return observations. The table reports the ordinary least squares (OLS) estimates of $\beta_W$ and $\beta_L$ from

$$\epsilon_{it} = \beta_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it},$$

where $u_{it}$ is an error term that is allowed to be heteroskedastic and contemporaneously correlated across countries, $W_{it}$ is a dummy variable that takes the value one if country $i$ wins a soccer match on a day that makes $t$ the first trading day after the match and zero otherwise, and $L_{it}$ is a dummy variable for losses defined analogously. If games are mutually exclusive (such as elimination games, group games, and qualifying matches), $W_{it}$ and $L_{it}$ are vectors, where each element corresponds to a game type. In Panel A the $\epsilon_{it}$’s are the “raw residuals” $\hat{\epsilon}_{it}$ defined by the regression

$$R_{it} = \gamma_0 + \gamma_1 R_{it-1} + \gamma_2 R_{mt-1} + \gamma_3 R_{mt} + \gamma_4 R_{mt+1} + \gamma_5 D_t + \gamma_6 Q_t + \hat{\epsilon}_{it},$$

where $R_{it}$ denotes the continuously compounded local return on date $t$ in country $i$, $R_{mt}$ is the continuously compounded daily U.S. dollar return on Datastream’s world market index on day $t$, $D_t = \{D_{1t}, D_{2t}, D_{3t}, D_{4t}\}$ are dummy variables for Monday through Thursday, and $Q_t = \{Q_{1t}, Q_{2t}, Q_{3t}, Q_{4t}, Q_{5t}\}$ are dummy variables for days for which the previous one through five days are non-weekend holidays. Panel B reports the estimates for $\beta_W$ and $\beta_L$ when the “abnormal normalized returns” defined in Section III.B are used in the panel regression. These normalized residuals are the second-stage residuals of a panel regression such as the one for $\hat{\epsilon}_{it}$ after a GARCH correction and normalizing them to have unit variance. The reported $t$-statistic is computed by allowing the variance of $u_{it}$ to be country specific (i.e., $\sigma^2_{it}$ is estimated for all countries) and by allowing for contemporaneous cross-country correlations ($\sigma_{ij}$ is estimated for all pairs of countries.) See the caption in Table I and the Appendix for sample details.

<table>
<thead>
<tr>
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<th>Losses</th>
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<td></td>
<td>Num. games</td>
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<tr>
<td>All games</td>
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<tr>
<td>Elimination games</td>
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<tr>
<td>Group games</td>
<td>243</td>
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<tr>
<td>World Cup group games</td>
<td>115</td>
<td>0.007</td>
</tr>
<tr>
<td>Continental cups group games</td>
<td>128</td>
<td>0.092</td>
</tr>
<tr>
<td>Close qualifying games</td>
<td>218</td>
<td>-0.049</td>
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<tr>
<td>World Cup close qualifying games</td>
<td>137</td>
<td>-0.095</td>
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<td>European Championship close qualifying games</td>
<td>81</td>
<td>0.029</td>
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<table>
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<th>Losses</th>
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<td></td>
<td>Num. games</td>
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<tr>
<td>All games</td>
<td>638</td>
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<td>177</td>
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<td>Group games</td>
<td>243</td>
<td>-0.034</td>
</tr>
<tr>
<td>Close qualifying games</td>
<td>218</td>
<td>-0.038</td>
</tr>
</tbody>
</table>

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Table III
Abnormal Daily Stock Market Performance After International Soccer Matches for the Top Seven Soccer Nations

The table reports the ordinary least squares (OLS) estimates of $\beta_W$ and $\beta_L$ from

$$\tilde{\epsilon}_{it} = \beta_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it},$$

where $\tilde{\epsilon}_{it}$ are the “abnormal normalized returns” defined in Section III.B and described in Table II. $W_{it}$ is a dummy variable that takes the value one if country $i$ wins a sports match on a day that makes $t$ the first trading day after the match and zero otherwise, and $L_{it}$ is a dummy variable for losses defined analogously. If games are mutually exclusive (such as elimination games, group games, and qualifying matches), $W_{it}$ and $L_{it}$ are vectors, where each element corresponds to a game type. In Panel A, the Top Seven soccer nations are: Argentina, Brazil, England, France, Germany, Italy, and Spain. Panel B reports results for the remaining 32 soccer nations in our sample. The table reports results for soccer matches played over the period 1973 to 2004 in the World Cup, European Championship, Copa America, Asian Cup, World Cup qualifying stages, and European Championship qualifying stages. The reported $t$-statistics are computed by allowing the variance of $u_{it}$ to be country specific (i.e., $\sigma_i^2$ is estimated for all countries) and by allowing for contemporaneous cross-country correlations ($\sigma_{ij}$ is estimated for all pairs of countries.)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Num. games</td>
<td>$\beta_W$</td>
<td>$t$-val</td>
<td>Num. games</td>
</tr>
<tr>
<td>All games</td>
<td>251</td>
<td>0.056</td>
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<td>121</td>
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<tr>
<td>World Cup games</td>
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<td>67</td>
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<td>69</td>
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<td>-1.42</td>
<td>192</td>
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<td>86</td>
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<tr>
<td>Group games and close qualifiers</td>
<td>311</td>
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<td>-0.92</td>
<td>317</td>
</tr>
</tbody>
</table>

64
Let \( \tilde{\xi}_{it} \) be the “abnormal normalized returns” defined in Section III.B and described in Table II. For each date \( t \) for which either \( W_{it} = 1 \) or \( L_{it} = 1 \) for some \( i \), we average \( \tilde{\xi}_{it} \) over all countries with \( W_{it} = 1 \) and average \( \tilde{\xi}_{it} \) over all countries with \( L_{it} = 1 \). This yields two time series of (normalized) portfolio returns, \( \tilde{\xi}_{Lt} \) and \( \tilde{\xi}_{Wt} \), for losing countries and winning countries, respectively. Panel A in the table reports the average over all dates of \( \tilde{\xi}_{Lt} \) and \( \tilde{\xi}_{Wt} \) under the mean column. In Panel A, column “N” reports the number of dates for which the above portfolios can be constructed. The \( t \)-statistics reported are obtained by using \( \text{SD}(\tilde{\xi}_{jt})/\sqrt{N - 1} \) as an estimate of the standard error of the mean. Panel B reports 10%-trimmed means of the residuals \( \tilde{\xi}_{it} \). Observations for which variable \( L_{it} \) equals one and the residual is smaller than the 10th percentile or larger than the 90th percentile are removed from the sample. Observations for which \( W_{it} \) equals one are removed in a similar way. Compared to Table II this removes 20% of the sample. In Panel B, column “N” reports the number of games. The \( t \)-statistics for the trimmed means are based on standard asymptotic approximations to the distribution of trimmed means (Huber (1996)).

<table>
<thead>
<tr>
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<th></th>
<th>Losses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>( \beta )</td>
<td>t-val</td>
<td>N</td>
</tr>
<tr>
<td><strong>Panel A. Portfolio Returns</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>All games</td>
<td>389</td>
<td>-0.033</td>
<td>-0.79</td>
<td>358</td>
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<td>Group games</td>
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<td>0.56</td>
<td>125</td>
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<tr>
<td>Close qualifying games</td>
<td>155</td>
<td>-0.096</td>
<td>-1.37</td>
<td>149</td>
</tr>
<tr>
<td><strong>Panel B. Trimmed Means</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All games</td>
<td>512</td>
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<td>420</td>
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<tr>
<td>Elimination games</td>
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<td>Group games</td>
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<td>Close qualifying games</td>
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<td>-0.85</td>
<td>152</td>
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</table>
Table V
Abnormal Daily Stock Market Performance After International Cricket, Rugby, Ice Hockey, and Basketball Matches

The analysis is based on wins and losses for 24 countries (see the Appendix). The average time series has 5,081 trading days, which gives a total of 121,940 daily return observations. The table reports the ordinary least squares (OLS) estimates of $\beta_W$ and $\beta_L$ from

$$\tilde{\epsilon}_{it} = \beta_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it},$$

(27)

where $\tilde{\epsilon}_{it}$ are the “abnormal normalized returns” defined as in Section III.B. $W_{it}$ is a dummy variable that takes the value one if country $i$ wins a sports match on a day that makes $t$ the first trading day after the match and zero otherwise, and $L_{it}$ is a dummy variable for losses defined analogously. If games are mutually exclusive (cricket games, rugby games, etc.), $W_{it}$ and $L_{it}$ are vectors, where each element corresponds to a game type. The table reports results for One Day International cricket matches played over the period 1975 to 2004, Six Nations, Tri Nations, and World Cup rugby matches played between 1973 and 2004, World Championships (1998 to 2004), Olympics (1980 to 2002), and World Cup/Canada Cup (1996 and 2004) ice hockey matches, and Olympics (1992 to 2004) and World Championships (1994 to 2002) basketball matches. The Appendix details the country selection for each sport. Panel A reports the estimates using the full cross-section of countries. The $t$-statistics are computed by allowing the variance of $u_{it}$ to be country specific (i.e., $\sigma^2_i$ is estimated for all countries) and by allowing for contemporaneous cross-country correlations ($\sigma_{ij}$ is estimated for all pairs of countries). Panels B and C replicate the analysis in Table IV for the data on these four other sports. In Panels A and C, column “N” reports the number of games. In Panel B, column “N” reports the number of dates for which there is at least one win (left side of the table) or at least one loss (right side of the table).

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<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>Wins</td>
<td>Losses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\beta_W$</td>
<td>$t$-val</td>
<td>$\beta_L$</td>
<td>$t$-val</td>
</tr>
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<td>-0.013</td>
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<td>Cricket</td>
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<tr>
<td>All games</td>
<td>-0.073</td>
<td>-1.68</td>
<td>-0.083</td>
<td>-1.88</td>
</tr>
<tr>
<td>Cricket</td>
<td>-0.146</td>
<td>-1.08</td>
<td>-0.331</td>
<td>-2.26</td>
</tr>
<tr>
<td>Rugby</td>
<td>-0.123</td>
<td>-2.23</td>
<td>-0.087</td>
<td>-1.55</td>
</tr>
<tr>
<td>Ice hockey</td>
<td>0.099</td>
<td>1.30</td>
<td>0.125</td>
<td>1.50</td>
</tr>
<tr>
<td>Basketball</td>
<td>0.061</td>
<td>0.73</td>
<td>-0.101</td>
<td>-1.06</td>
</tr>
<tr>
<td>All games</td>
<td>0.019</td>
<td>0.66</td>
<td>-0.088</td>
<td>-2.53</td>
</tr>
<tr>
<td>Cricket</td>
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<td>0.50</td>
<td>0.301</td>
<td>-3.02</td>
</tr>
<tr>
<td>Rugby</td>
<td>-0.058</td>
<td>-1.25</td>
<td>-0.083</td>
<td>-1.65</td>
</tr>
<tr>
<td>Ice hockey</td>
<td>0.112</td>
<td>1.99</td>
<td>0.079</td>
<td>1.08</td>
</tr>
<tr>
<td>Basketball</td>
<td>0.067</td>
<td>0.93</td>
<td>-0.167</td>
<td>-1.91</td>
</tr>
</tbody>
</table>

Panel A. Abnormal Returns

Panel B. Abnormal Portfolio Performance

Panel C. Trimmed Means

66
Table VI  
Predicted Outcomes and Abnormal Daily Stock Market Performance After International Soccer Matches, 1993 to 2004

The table reports the ordinary least squares (OLS) estimates for the model

\[ \tilde{\epsilon}_{it} = \alpha_0 + \alpha_1 W_{it} + \alpha_2 p_{it} + v_{it}, \]

where \( \tilde{\epsilon}_{it} \) is the error term from estimating equation (1) without the soccer dummy variables and using normalized stock index returns, \( W_{it} \) is a dummy variable that equals one if country \( i \) wins a soccer match on a day that makes \( t \) the first trading day after the match and zero if a game is lost, \( p_{it} \) is the ex ante probability that country \( i \) wins the game, and \( v_{it} \) is an error term with mean zero and variance \( \sigma_v^2 \). The analysis is based on 39 countries (see the Appendix). The sample period is January 1993 through November 2004. Panel A reports results for matches played in the World Cup. Panel B reports results for matches played in the World Cup, the European Championship, the Asian Cup, and Copa America. The probabilities \( p_{it} \) are computed using Elo ratings employing the methodology detailed in Section IV.A. Elimination matches are matches in which the loser is eliminated from further play in the tournament. The parentheses contains t-statistics. The last column reports the Kodde and Palm (1986) Wald test statistic for the test of a null hypothesis that involves inequality restrictions.

<table>
<thead>
<tr>
<th></th>
<th>Num. games</th>
<th>( \alpha_0 ) (t-value)</th>
<th>( \alpha_1 ) (t-value)</th>
<th>( \alpha_2 ) (t-value)</th>
<th>Wald-D (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Unrestricted Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All games</td>
<td>1,118</td>
<td>-0.162 (-3.06)</td>
<td>0.142 (2.18)</td>
<td>-0.004 (-0.03)</td>
<td></td>
</tr>
<tr>
<td>Elimination games</td>
<td>297</td>
<td>-0.192 (-1.97)</td>
<td>0.223 (1.88)</td>
<td>0.041 (0.13)</td>
<td></td>
</tr>
<tr>
<td>Group games</td>
<td>420</td>
<td>-0.195 (-2.18)</td>
<td>0.153 (1.33)</td>
<td>-0.041 (-0.17)</td>
<td></td>
</tr>
<tr>
<td>Close qualifying games</td>
<td>401</td>
<td>-0.110 (-1.16)</td>
<td>0.077 (0.72)</td>
<td>0.005 (0.01)</td>
<td></td>
</tr>
<tr>
<td><strong>Panel B. Restricted Model</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All games</td>
<td>1,118</td>
<td>0.138 (2.11)</td>
<td>-0.138 (-2.11)</td>
<td>9.274 (0.018)</td>
<td></td>
</tr>
<tr>
<td>Elimination games</td>
<td>297</td>
<td>0.215 (1.81)</td>
<td>-0.215 (-1.81)</td>
<td>2.643 (0.358)</td>
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</tr>
<tr>
<td>Group games</td>
<td>420</td>
<td>0.150 (1.30)</td>
<td>-0.150 (-1.30)</td>
<td>5.263 (0.112)</td>
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</tr>
<tr>
<td>Close qualifying games</td>
<td>401</td>
<td>0.074 (0.69)</td>
<td>-0.074 (-0.69)</td>
<td>2.007 (0.469)</td>
<td></td>
</tr>
</tbody>
</table>
Table VII

The table reports the ordinary least squares (OLS) estimates of $\beta_W$ and $\beta_L$ from

$$\tilde{\epsilon}_{it} = \beta_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it},$$

where $u_{it}$ is an error term that is allowed to be contemporaneously correlated between countries, $W_{it}$ is a dummy variable that takes the value one if country $i$ wins a soccer match on a day that makes $t$ the first trading day after the match and zero otherwise, and $L_{it}$ is a dummy variable for losses defined analogously. $\tilde{\epsilon}_{it}$ are the “abnormal normalized returns” defined in Section III.B and described in Table II, where the stock market indices are now a large-cap index, small-cap index, growth index, or a value index. The small indices are those provided by HSBC via Datastream for the list of 18 countries for which we have a large index (see the Appendix for details). The growth and value indices are from Standard and Poor’s, both available from Datastream for 34 out of the 39 countries in Table IX.

<table>
<thead>
<tr>
<th></th>
<th>Wins</th>
<th></th>
<th>Losses</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Num. games</td>
<td>$\beta_W$</td>
<td>$t$-val</td>
<td>Num. games</td>
</tr>
<tr>
<td>Small stocks</td>
<td>243</td>
<td>-0.141</td>
<td>-2.50</td>
<td>157</td>
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<tr>
<td>Large stocks</td>
<td>243</td>
<td>-0.007</td>
<td>-0.12</td>
<td>157</td>
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<tr>
<td>Test of difference</td>
<td></td>
<td>-0.134</td>
<td>-1.67</td>
<td></td>
</tr>
<tr>
<td>Growth stocks</td>
<td>391</td>
<td>-0.096</td>
<td>-2.10</td>
<td>290</td>
</tr>
<tr>
<td>Value stocks</td>
<td>391</td>
<td>-0.085</td>
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<tr>
<td>Test of difference</td>
<td></td>
<td>-0.011</td>
<td>-0.16</td>
<td></td>
</tr>
</tbody>
</table>
Table VIII
Abnormal Trading Volume After International Soccer Matches

The table reports the ordinary least squares (OLS) estimates of $\beta_W$ and $\beta_L$ from

$$\hat{w}_{it} = \gamma_0 + \beta_W W_{it} + \beta_L L_{it} + u_{it},$$

where $\hat{w}_{it}$ is abnormal volume constructed in a way that follows Gallant, Rossi, and Tauchen (1992). Specifically, let $V_{it}$ be the log of aggregate trading volume for the constituent shares of country $i$’s stock index (from Datastream). Run the regression $V_{it} = \gamma_0 x_{it} + u_{it}$, where $x_{it}$ is a set of explanatory variables. Next, estimate variance according to $\log(\hat{\sigma}_u^2) = \gamma_1 y_{it} + \epsilon_{it}$, where $y_{it}$ is a second set of explanatory variables. Finally, define $\hat{w}_{it} = a_i + b_i \hat{u}_{it} / \exp(\gamma_3 y_{it}/2)$, where $a_i$ and $b_i$ are chosen so that $\hat{w}_{it}$ has zero mean and unit variance. For the volume regressions, $x_{it}$ include day-of-the-week and month dummies, two lags of volume, a time trend, and the time trend squared. For the variance equation, $y_t$ includes the variables in $x_{it}$ except the two lags of volume. Elimination matches are matches for which the loser is eliminated from further play in the tournament. The sample includes all countries for which Datastream provides volume data, which leaves us with a sample of 34 countries. Compared to the 39 countries in Table AI, the missing countries are Bahrain, Croatia, Jordan, Nigeria, and Saudi Arabia. For most countries Datastream volume data do not start until the beginning of the 1980s. The $t$-statistics are computed by allowing the variance of $u_{it}$ to be country specific, and $u_{jt}$ and $u_{it}$ to be contemporaneously correlated.

<table>
<thead>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Num.</td>
<td>$\beta_W$</td>
<td>$t$-val</td>
<td></td>
<td>Num.</td>
</tr>
<tr>
<td></td>
<td>games</td>
<td></td>
<td></td>
<td></td>
<td>games</td>
</tr>
<tr>
<td>All games</td>
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<td>-0.90</td>
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<td>379</td>
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<tr>
<td>Elimination games</td>
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<tr>
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<td>-1.54</td>
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<tr>
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<td>149</td>
<td>-0.001</td>
<td>-0.02</td>
<td></td>
<td>122</td>
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<td>Country</td>
<td>Time series begins</td>
<td>Mean log return</td>
<td>Soccer</td>
<td>Cricket</td>
<td>Rugby</td>
</tr>
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<td>--------------</td>
<td>-------------------</td>
<td>----------------</td>
<td>--------</td>
<td>---------</td>
<td>-------</td>
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<td>Argentina</td>
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<td>28</td>
<td>16</td>
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<tr>
<td>Australia</td>
<td>19730109</td>
<td>0.047</td>
<td>5</td>
<td>9</td>
<td>40</td>
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<tr>
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<td>19830427</td>
<td>0.056</td>
<td>8</td>
<td>11</td>
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<td>3</td>
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<td>30</td>
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<td>19940711</td>
<td>0.072</td>
<td>37</td>
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<td>0.041</td>
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<td>19890711</td>
<td>0.089</td>
<td>12</td>
<td>24</td>
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<tr>
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<td>9</td>
<td>11</td>
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<tr>
<td>Colombia</td>
<td>19920116</td>
<td>0.061</td>
<td>30</td>
<td>17</td>
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<td>0.055</td>
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<td>9</td>
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<td>England</td>
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<td>26</td>
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<td></td>
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<tr>
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<td>0.050</td>
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<td>20</td>
<td>109</td>
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<td>19730109</td>
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<td>54</td>
<td>19</td>
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<tr>
<td>Greece</td>
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<td>0.073</td>
<td>12</td>
<td>12</td>
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<tr>
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<td>19900109</td>
<td>0.071</td>
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<td></td>
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<tr>
<td>Ireland</td>
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<td>0.061</td>
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<td>15</td>
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</tr>
<tr>
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<td>19940201</td>
<td>0.045</td>
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<td>6</td>
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<td>15</td>
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<tr>
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<tr>
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<td>13</td>
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<tr>
<td>All countries</td>
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<td>0.056</td>
<td>638</td>
<td>524</td>
<td>153</td>
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</table>

Table IX
Mean Daily Percent National Index Return and Number of Wins and Losses in International Team Sport Matches
3 Leverage, Ownership Concentration, and the Tension Between Liquidity and Investment

3.1 Introduction

Investors wish managers to pursue the best available projects, but would also like the option to liquidate the firm if only loss-making projects will be undertaken. This paper studies the fundamental tension between these two objectives. By retaining the option to liquidate early upon weak interim performance, investors can minimize their losses if the manager turns out to be unskilled. Furthermore, if managerial quality is ex ante heterogeneous, this threat can screen out incompetent managers. However, if the manager turns out to be skilled, the threat of liquidation may deter him from undertaking optimal long-term projects that risk short-term turbulence.

This paper analyzes two roles of debt that allow it to mitigate this tension. First, leverage passes control to creditors if short-term earnings are low. This is a credible commitment to liquidate since creditors’ convex claims make them biased towards shut-down (Aghion and Bolton (1992), Dewatripont and Tirole (1994)). However, debt is not the only method of achieving such a “control shift.” The same effect could be achieved by imposing a mandatory dividend schedule and contracting that the manager is fired if the required dividend payments are not met. Such a threat is credible if there is a sufficiently high likelihood that low earnings result from managerial incompetence rather than a temporary downturn in a profitable project. Indeed, in many corporate finance models concerned with signaling (Ross (1977)) or managerial discipline (Stulz (1990), Zwiebel (1996)), total payout is the critical variable and so debt and dividends are interchangeable substitutes. Similarly, in theories of outside equity finance (e.g. Myers (2000)), the requirement to make regular dividend payments renders equity similar to debt.

In this paper, debt differs from dividends as it plays a second role: motivating information acquisition. Leverage allows a given dollar investment to translate into a higher percentage of the outstanding equity. This “concentration effect” gives shareholders strong incentives to acquire costly information on the underlying cause of poor performance. If it results from desirable long-term investment, they can persuade the creditor not to shut down the firm. If information is hard, they can disclose it to the creditor; if it is soft, they can buy out the creditor, renegotiate, or write credit protection. In sum, returns to investment depend on the intensity of ex post monitoring; information acquisition by investors attenuates managerial myopia. Debt is a means of inducing information acquisition. If the only role of debt is to shift control, borderline risky debt is optimal as strictly risky debt leads to the debt overhang effect of Myers (1977). Where debt also concentrates equity, strictly risky debt is preferred.
By contrast, an equityholder in an unlevered firm has insufficient incentives to gather information: in the absence of leverage, her gains from optimal continuation of a poorly performing firm are too small. Anticipating that they may be fired upon interim losses, managers inefficiently shun long-term projects. This problem is suffered whether or not the firm is publicly traded. The root cause of myopia is not the manager’s concern with the short-term stock price, but firing decisions being taken on the basis of short-term earnings because shareholders have insufficient incentives to investigate the firm’s fundamental value. Taking the firm private but maintaining dispersed ownership will not solve the issue. Giving the manager a long-term contract that safeguards him from interim firing will address myopia, but at the same time prevent desirable liquidation: there is no “control shift.” I therefore demonstrate that a levered structure (“LEV”) is optimal as it allows both liquidation and long-term investment, compared to an unlevered firm with a short-term contract (“STU”), which suffers from myopia, and an unlevered firms with a long-term contract (“LTU”), which prohibits desirable liquidation.

I then extend the analysis to heterogenous manager and investor types. Good managers have a higher chance of becoming “inspired” and being able to choose between a profitable long-term project and a less profitable, but still positive-NPV, short-term project. Bad managers will likely become “uninspired” and invest in value-destroying projects, in which case early firing is optimal. Professional investors have more funds to invest than households, and thus may monitor if their stakes are sufficiently concentrated.

I show that a separating equilibrium is sustainable where good managers run LEVs and are financed by professional investors; bad managers run STUs and are owned by households. This equilibrium can be interpreted in two ways. First, it applies to entrepreneurs seeking financing for the first time: the highest quality ones choose greater leverage. Second, it can be applied to a situation where all firms are currently publicly traded, and only the good managers choose to seek private equity financing. The equilibrium approximates reality, where only a small proportion of firms are financed by private equity, but typically exhibit superior performance. Other explanations for the high leverage used in private equity focus on it either imposing discipline on the manager and/or being a credible signal of quality. However, mandatory dividends can be used for both of these purposes.

The two purposes of debt identified above, which render an all-LEV equilibrium efficient, also lead to the sustainability of a separating equilibrium. The control-shift effect of debt renders it a credible signal of managerial quality. In an STU, the manager is only sometimes fired upon interim losses. The default decision is for the manager’s employment to continue, and it requires an active action by the board to terminate his employment, which is not always forthcoming. However, in a LEV, creditors automatically liquidate a bankrupt firm, in the absence of further information. This deters bad managers from taking on leverage. The
concentration effect (not a feature of mandatory dividends) renders debt a desirable signal: good managers are willing to signal even if it leads to fewer funds, because the funds they receive are from professional investors who monitor, thus allowing them to engage in long-term projects. For the same reason, total surplus may also increase, relative to an all-STU pooling equilibrium, even if good managers receive fewer funds. This result contrasts with standard separating equilibria, in which an increased fund allocation to good managers is necessary to induce them to signal, and for signaling to increase total surplus. Rather than being a signal to obtain more funds at the cost of constraining future investment, leverage increases investment yet may lead to fewer initial funds. While shareholder returns are higher in LEVs, households are restricted to investing in STUs. LEVs establish minimum investment requirements to prevent households from free-riding on professional investors’ monitoring investments, and to ensure that they are not entirely held by households who do not monitor.

In a number of theories of debt, the manager prefers to be unlevered as debt forces him to pay out cash flows that he would rather invest in pet projects (e.g. Stulz (1990), Zwiebel (1996)). However, he is forced to take on leverage to raise financing in the first period: debt either signals high quality, or commits him to pay out future cash flows. As Zwiebel points out, some of these models are dynamically inconsistent. Since the only benefit of debt is as a signal or commitment device, once funds have been raised, the manager has an incentive to replace the debt with new equity, thus re-enabling him to invest in pet projects. Zwiebel achieves dynamic consistency by introducing an ever-present potential raider, so that the manager retains leverage to continuously commit to paying out cash flows. Debt is still personally costly to the manager, but forced upon him by takeover threats.

By contrast, in this paper, debt is dynamically consistent because it has other benefits than signaling. Once the manager has signaled his quality in the first period, he has incentives to retain leverage (even in the absence of external pressure) to maintain concentrated ownership and monitoring incentives. In traditional models of effort conflicts, the monitor reduces the manager’s utility by forcing him to exert effort or preventing him from enjoying private benefits. Here, an inspired manager wishes to retain the monitor, even after financing has been raised, because she protects him from liquidation if the long-term project suffers interim turbulence. Indeed, since signaling high quality may lead to fewer total funds being raised, its only benefit is to attract potential monitors, and it is necessary to maintain leverage, and thus monitoring incentives, to enjoy this benefit.

This paper proceeds as follows. Section 3.2 briefly discusses related literature. Section 3.3 presents the model, and illustrates that LEVs may dominate STUs and LTUs owing to the dual benefits of debt. Section 3.4 analyzes a separating equilibrium whereby sophisticated investors hold the equity of LEVs managed by high-quality managers and household investors choose STUs run by lower-quality managers. This closely approximates reality. Section 3.5
discusses wider applications of the key features of the model as well as empirical implications, and Section 3.6 concludes. The Appendix in Section 3.7 confirms the robustness of the result to a different formulation of the manager’s payoffs and contains proofs.

3.2 Related Literature

The central result of this paper is that leverage can both signal managerial quality, by allowing the potential for liquidation, and mitigate myopia through incentivizing monitoring. It is thus related to both the signaling and information acquisition literatures, both of which have been extensively developed, but with few interactions. Moreover, the effects of signaling and monitoring are different from previous papers, as will be shown.

Commencing with the signaling literature, Ross (1977) illustrates that debt can signal quality. Managers of bad firms are unwilling to mimic the signal owing to bankruptcy fears. As in the canonical signaling model of Spence (1973), the signal is directly costly to both types due to liquidation risk, but especially costly to the bad type. The signal reduces total surplus owing to bankruptcy costs; signaling is similarly costly in Stein (1989) and Miller and Rock (1985) as it involves a myopic reduction in investment. There are no offsetting positive real effects as separation merely achieves a redistribution from bad to good managers. Extending these models to incorporate an investment decision would generate real benefits, but the gains hinge on good managers obtaining more funds than in a pooling equilibrium, as the per dollar productivity of investment is unchanged.

In this paper, signaling raises total surplus even if good managers do not obtain more funds. Instead, the role of signaling is to attract a more desirable type of funds: professional investors who have the ability and incentive to monitor. Thus the per dollar productivity of a good firm’s investment increases. This added benefit of leverage stems from the combination of different managerial skill levels, differing investor types and multiple investment opportunities featured in this paper.

Moving to the monitoring literature, to my knowledge, Gümbel and White (2005) is the only other paper that also uses debt to incentivize information acquisition. Their paper is the first to advocate the separation of monitoring (undertaken by equityholders) from decision making (undertaken by creditors), and to point out that equityholders’ convex claims render them more likely monitors than creditors who have concave payoffs. However, the mechanism through which debt incentivizes monitoring is quite different. In this paper, leverage increases the percentage of total equity owned by a given shareholder; there is no such concentration effect in Gümbel and White as there is a single shareholder. Instead, debt works entirely via a control shift: allocating control to a “tough” agent (a “bad cop”) with a natural bias towards

\footnote{In Harris and Raviv (1990), debt leads to information acquisition but this is not through changing incentives. They assume that an audit automatically takes place in bankruptcy.}
shut-down. Since liquidation leaves the equityholder with nothing, she has strong incentives to gather information to allow the firm to continue (become a “good cop”). In the absence of leverage, the firm is sufficiently profitable that the unlevered shareholder chooses not to gather information. That it is not in the aggregate claimant’s interests to monitor implies that the information acquisition induced by leverage is ex post inefficient, but committing to monitor has ex ante benefits by encouraging managerial effort. In my model, introducing debt into an STU does not lead to a control shift: an unlevered investor in an STU is already tough and biased towards closure (the essence of the myopia issue), so only the concentration effect is at work. As in prior literature, Gümbel and White study an effort issue where the monitor is an adversary of the manager who deters shirking. In this paper, the monitor is an ally of the manager, supporting long-term investment and thus providing a dynamic reason for why the manager may wish to retain her.

The literature features other mechanisms than capital structure to encourage information gathering, albeit again to overcome an effort conflict. In Aghion and Tirole (1997), the principal provides information-gathering incentives to an agent by delegating formal authority in decision making, so that the agent can act on her acquired information. In a similar vein, Burkart, Gromb and Panunzi (1997) show that dispersed equity ownership may provide a credible commitment for shareholders not to intervene and overrule management decisions, which in turn provides managers with a greater incentive to gather information. Allen, Bernardo and Welch (2000) posit that managers pay dividends to attract particular investors to monitor them.

Two recent papers are closest to this theory. Stein (2005) also analyzes the tension between liquidation and long-term decisions, within the context of arbitrageurs contemplating convergence trades. A closed-end fund prevents interim withdrawals and thus alleviates the Shleifer and Vishny (1997) “limits to arbitrage” issue, but prevents desirable liquidation if the manager indeed turns out to be unskilled. Moreover, even if the benefit of long-term investment exceeds this cost, an equilibrium where all funds are closed-end may not be sustainable as it fails the Cho and Kreps (1987) intuitive criterion. A bad manager will not deviate by open-ending as her fears early liquidation; thus a good manager can signal his ability by making such a deviation. This paper builds on Stein by adding leverage and a monitoring technology. Even absent sustainability issues, an all closed-end unlevered equilibrium may not be optimal. Leverage may allow both long-term investment and liquidation.

Edmans (2007a) also considers the effect of concentrated ownership on ex post monitoring and ex ante investment decisions. In that paper, monitoring is incentivized by large blockholdings; there is no special role for debt and no signaling. However, the motivation for monitoring is very different. There is no threat of liquidation; instead the source of myopia is the manager’s concern with the interim stock price. Informed shareholders are valuable not
because they intervene to save the manager from liquidation, but because their trading decisions impound information into the stock price, so that it more closely reflects fundamental value rather than current earnings. Specifically, if the blockholder does not sell upon weak earnings, the market infers that the firm is fundamentally sound and the stock price is supported. Another difference is that Edmans (2007a) exogenously assumes that the manager cares places weight on the short-term stock price. Here, liquidation upon interim losses is endogenized as optimal.

3.3 The Model

The core model is based on Stein’s (2005) framework for open- and closed-end funds, but applied to corporations. The key additions are a monitoring technology and debt financing, which lead to markedly different results.

A pool of penniless entrepreneurs seek financing of up to $y$ for a project. Total firm size is limited by factors such as diseconomies of scale. Potential investors can each invest up to $x \ll y$ in either debt or equity. There are four periods. At $t = 0$, the manager sets up a corporation which can adopt one of three different structures. The first (STU) is an unlevered firm where the manager can be (costlessly) fired at any stage, which approximates the majority of public firms in reality. The second (LTU) is an unlevered firm where the manager has a long-term contract which guarantees his employment until $t = 3$. The third (LEV) is a private, levered firm where the manager can be costlessly fired at any stage, which approximates the majority of firms funded by private equity. A LEV is financed partly by debt with face value $f$ and initial market value $d$, and the remainder by equity. For simplicity, I normalize the interest rate to zero and assume all agents are risk-neutral.

At $t = 1$, with probability $\pi$ the manager is “inspired”, i.e. obtains a good investment idea. An inspired manager can choose to invest in either a Short-Term (ST) or a Long-Term (LT) investment project. An uninspired manager invests in unprofitable projects that lose money over time. It is therefore optimal to fire him early or liquidate the firm. As will become clear, firing and liquidating have the same effects, and so these terms will be used interchangeably.

At $t = 2$, interim performance is observed. In a LTU, the manager can never be fired. In a levered firm, creditors have control if the firm’s asset value is less than the face value of debt, and may decide to liquidate the firm. In a STU, the board can choose to fire the manager. If it is in shareholders’ interest to fire the manager, based on $t = 2$ performance, the board takes the required action with probability $\lambda$. $\lambda < 1$ reflects imperfect alignment

---

$x$ is finite either because investors have limited funds or self-imposed limits on how much they can allocate to one particular investment. These are often stated as an absolute dollar amount or a percentage of their overall portfolio. The assumption of a maximum investment amount is standard in the literature: see, for example, Boot and Thakor (1993) and Fulghieri and Lukin (2001).
of board and shareholder interests, e.g. Mace (1971). It will be shown that it is optimal to fire an underperforming manager: creditors in a LEV will always fire the manager, the board in a STU occasionally fire the manager. Hence the only consequence of assuming \( \lambda < 1 \) is a loss-making manager is more likely to be fired if his firm is also bankrupt, which is realistic.

Since the \( t = 2 \) performance is an imperfect signal, an investor may choose to spend \( \theta \) to learn the firm’s value at \( t = 3 \), the final period.\(^{35}\) In effect, she finds out whether poor performance results from bad luck or bad management. The monitoring technology is imperfect: with probability \( \phi \), no investor can find information.\(^{36}\)

Both shareholders and creditors have access to this monitoring technology; it will be shown that only shareholders have the incentive to use it, given their convex claims. Once shareholders have learned that the manager is inspired, they can disclose this signal to creditors (in a LEV) or to the board (in a STU) and thus persuade them not to liquidate. This procedure is straightforward if information is “hard”, i.e. codifiable. If information is instead “soft” and unverifiable, shareholders can renegotiate with creditors, for example by writing credit protection on the outstanding debt, or buying out or refinancing the debt for \( \$f \) as often happens in private equity workouts. Either way, creditors receive the full face value of \( \$f \) if an inspired manager is continued. If shareholders learn that the manager is uninspired, they have the option to destroy the bad news and pretend that their monitoring efforts were unsuccessful.\(^{37}\)

As in Stein (2005), the manager’s objective function consists purely of private benefits, which are increasing in both shareholder value and the longevity of the manager’s tenure. One natural interpretation is the manager’s reputation. Stein uses this formulation rather than seemingly more natural performance-related pay, since perfect competition for funds would reduce the manager’s pay to his reservation wage. Private benefits are inalienable and so are not competed away. Appendix A shows that the results of this paper continue to hold if private benefits are replaced by performance-related pay.

\(^{35}\)The cost of \( \theta \) is borne even if managers are voluntarily revealing as much information as possible: outside investors have to bear the costs of meeting with the management, processing and analyzing the information, and investigating if there is additional relevant information that they have not disclosed. This is similar to how fundamental and technical security analysis is costly, even though much of the information is freely available.

\(^{36}\)This formulation assumes that the success of monitoring efforts depend on the firm’s availability of information: hence, if multiple investors monitor, with probability \( \phi \) all of them obtain information, else none become informed. The results remain the same if we assume the success depends on the “luck” of each monitor and thus, if multiple investors monitor, in expectation \( \phi \% \) of them obtain information and the others do not. In both cases, debt must be sufficiently high so that it is individually rational for an investor to gather information, else no investor would become informed. The later analysis in Section 3.4 considers the case where investors can co-ordinate to share the monitoring costs.

\(^{37}\)While shareholders and creditors’ interests may conflict, the interests of shareholders and the board are aligned (albeit imperfectly). Thus I assume that the board believes a shareholder’s claim to have received positive “soft” information and thus does not fire the manager. Introducing frictions in shareholders’ communication with the board will strengthen my results, by providing fewer incentives to monitoring in the STU.
The returns per dollar invested are given in the table below (cash $C$, private benefits $B$). The figures given are cumulative, not incremental: for example, an manager pursuing $ST$ generates cash of $J$ at $t = 2$ and an extra $R^{ST} - J$ at $t = 3$ if allowed to continue, giving a total cash position of $R^{ST}$.

### Table X: Payoffs to Investment Strategies

<table>
<thead>
<tr>
<th></th>
<th>Uninspired</th>
<th>Inspired, $ST$</th>
<th>Inspired, $LT$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continue until $t = 3$</td>
<td>$K, Tz$</td>
<td>$R^{ST}, Tz$</td>
<td>$R^{LT}, Tz(1 + \alpha)$</td>
</tr>
<tr>
<td>Fire at $t = 2$</td>
<td>$L, z$</td>
<td>$J, z$</td>
<td>$r, z, r = L$ with probability $\gamma$, $J$ w.p. $1 - \gamma$</td>
</tr>
</tbody>
</table>

The manager is assumed to be essential to the project in which he has invested. Therefore, shareholders can recover $L$ rather than $K$ by firing an uninspired manager early. However, if the manager has invested in $LT$ and is fired, they only recover $L$ not $R^{LT}$. I assume $K < L < 1$: the uninspired manager loses money slowly but surely. Moreover, $L + z > K + Tz$ so early firing maximizes total surplus. $R^{LT} > R^{ST} > J > 1$: $LT$ is better than $ST$ if the manager is not fired, else $ST$ is better. $T > 1$ denotes that the manager prefers not to be fired. $\alpha > 0$ ensures incentive alignment: the manager prefers $LT$ to $ST$ if he is sure he will not be fired, as investors would like him to.

The remainder of this section compares the investor and manager returns generated by the three available structures.

#### 3.3.1 Unlevered Firms, Short-Term Contracts

The advantage of short-term contracts is that they allow a poorly performing manager to be fired. However, the benefit of allowing liquidation comes at the expense of deterring inspired managers from pursuing $LT$. Throughout this paper, I make the following assumptions:

\[
\frac{1 - \pi}{1 - \pi + \pi \gamma} K + \frac{\pi \gamma}{1 - \pi + \pi \gamma} R^{LT} < L, \tag{29}
\]

\[
\frac{1}{\theta} \frac{\pi \gamma}{1 - \pi + \pi \gamma} R^{LT} - L < \frac{1}{\phi}, \tag{30}
\]

\[
Tz > \lambda \gamma z + (1 - \gamma \lambda) Tz(1 + \alpha). \tag{31}
\]

Equation (29) means that, in the absence of information, shareholders prefer to fire a manager upon observing $C_2 = L$ – even if all inspired managers always choose $LT$ and there is thus a $\frac{\pi \gamma}{1 - \pi + \pi \gamma}$ probability that poor performance results from $LT$ rather than an uninspired manager. Equation (30) means that a shareholder will choose not to acquire

\footnote{Throughout this paper, subscripts will refer to the time period. For example, $C_2$ refers to the firm’s cash in period 2.}
information upon poor performance: the potential gains from continuation if the manager turns out to be inspired are insufficient to outweigh the cost of obtaining information. As will be demonstrated, this stems from the investor’s share of equity being too low. Equation (31) means that an inspired manager will choose $ST$ if he knows that shareholders wish him to be fired if $C_2 = L$. In this eventuality, the board fires him with probability $\lambda$.

**Lemma 2** If all managers establish STUs, the unique Nash equilibrium is given as follows:

(i) All inspired managers choose $ST$,

(ii) If $C_2 = L$, shareholders do not monitor and managers are fired with probability $\lambda$.

Part (i) stems from equation (31). Since all inspired managers choose $ST$, $C_2 = L$ automatically reveals the manager as being uninspired and therefore it is rational to fire him without gathering additional information. There is no alternative Nash equilibrium where inspired managers always choose $LT$ or play a mixed strategy: equations (29) and (30) mean that shareholders prefer the manager to be fired rather than investing in information.

The expected per dollar return to an investor and manager are given by

$$\pi R^{ST} + (1 - \pi)(\lambda L + (1 - \lambda)K),$$  \hspace{1cm} (32)$$

and

$$\pi Tz + (1 - \pi)(\lambda z + (1 - \lambda)Tz).$$  \hspace{1cm} (33)$$

From the shareholders’ perspective, there are two problems with this financing structure. First, the manager’s employment continues by default and it requires an active decision from the board to fire the manager. Since the board only fires with probability $\lambda$, uninspired managers are sometimes allowed to continue with the firm. Second, the risk of firing deters inspired managers from choosing $LT$ and thus shareholders only earn $R^{ST}$ if the manager is inspired. Managerial myopia is frequently attributed to firms being publicly traded and thus facing pressures to maximize the stock price. However, underinvestment occurs regardless of whether the $STU$ is private or public. The essence of the underinvestment issue is not being publicly traded, but shareholders having insufficient incentives to investigate the firm’s fundamental value. This leads to firing decisions being taken on the basis of short-term earnings. Even though these decisions are ex post rational (it is optimal to fire a manager upon $C_2 = L$), they lead to underinvestment ex ante. Taking the firm private but maintaining dispersed ownership will not solve the issue.
### 3.3.2 Unlevered Firms, Long-Term Contracts

A solution to underinvestment is to give the manager a long-term contract which guarantees his job until \( t = 3 \), so that he is unconcerned by short-term performance. Again, this can occur regardless of whether the firm is public or private. An inspired manager will therefore choose \( LT \). However, this comes at the expense of prohibiting potentially desirable liquidation upon poor performance. Per dollar invested, a shareholder receives

\[
\pi R^{LT} + (1 - \pi)K, \tag{34}
\]

and the manager has an expected per dollar return of

\[
\pi Tz(1 + \alpha) + (1 - \pi)Tz. \tag{35}
\]

### 3.3.3 Levered Firms

Each firm is now partially financed by debt with face value \( f \) and current value \( d \), and equity of \( y - d \). Let \( D = d/y \) and \( F = f/y \) refer to the value of debt per dollar of the firm’s assets. Hence capital letters \( (D, F, R^{LT}, R^{ST}, K, L) \) refer to per dollar values, small letters \( (d, f, x, y) \) refer to values for the overall firm or for an investor’s overall stake. The debt matures at \( t = 3 \), but is protected by a covenant which gives the creditors control at \( t = 2 \) if debt is worth less than or equal to par.\(^{39} \) \( F \geq L \) is required so that control shifts upon interim losses; tighter bounds will be derived later.

If the \( t = 2 \) per-dollar asset value is \( L \), creditors have control. The posterior probability that the manager is inspired is \( \frac{\pi \gamma}{1 - \pi + \pi \gamma} \) and so creditors will liquidate the firm (in the absence of any further information) if

\[
\frac{1 - \pi}{1 - \pi + \pi \gamma} K + \frac{\pi \gamma}{1 - \pi + \pi \gamma} F < L. \tag{36}
\]

This is the “control-shift” effect of debt. Since an underperforming firm is bankrupt at \( t = 2 \), the default decision now switches to liquidation, which occurs with probability 1 in the absence of information. A particular creditor will choose not to become informed if\(^{40} \)

\(^{39}\)As is standard in the literature (e.g. Aghion and Bolton (1992) and Dewatripont and Tirole (1994)), control rights allow the creditor to take decisions but not put the firm into bankruptcy, force out the equity-holders and then continue the firm as the aggregate claimant. I assume that if debt is worth exactly par at \( t = 2 \), creditors obtain control. In addition, if a creditor is indifferent between continuation and liquidation, she chooses to continue. This is merely to economize on notation, avoiding the need to write “plus epsilon” throughout the document.

\(^{40}\)This condition assumes collective action problems among creditors in coordinating to acquire information. This is consistent since a later condition will assume collective action problems among shareholders.
\[ \frac{1}{\theta} \frac{1 - \pi}{1 - \pi + \pi \gamma} \frac{x}{D} (F - L) < \frac{1}{\phi}. \]  

(37)

As in Dewatripont and Tirole (1994), the concavity of the creditor’s claim leads to her taking conservative actions. By contrast, \( P \) has stronger incentives to become informed given her convex claim: her incentives are a function of \( (R^{LT} - F) \) rather than \( (F - L) \). If \( P \) obtains information that the \( t = 3 \) payoff will be \( R^{LT} \) and reveals this to creditors, they will continue if \( F \geq L \). For simplicity, I assume that creditors receive the full face value of \( F \) under continuation of an inspired manager, and that the market value of debt is priced so that its expected return is zero. These do not affect the results, as all returns will be stated on an overall investor basis, and thus are robust to the distribution of gains between shareholders and creditors.

\( P \)'s payoff is zero if creditors liquidate, but under continuation with an inspired manager it is

\[ x \frac{y}{y - d} (R^{LT} - F). \]  

(38)

**Lemma 3** An investor in a LEV will choose to become informed if

\[ a = \frac{1}{\theta} \frac{1 - \pi}{1 - \pi + \pi \gamma} \frac{x}{y - d} [R^{LT} - F] > \frac{1}{\phi}. \]  

(39)

The market value of debt is given by

\[ d = (\pi - \pi \gamma (1 - \phi)) f + (1 - \pi + \pi \gamma (1 - \phi)) Ly. \]  

(40)

Substituting both \( F = f/y \) and (40) into (39) gives the lower bound to \( f, f_L \). Increasing \( f \) has two conflicting effects on \( P \)'s incentives to obtain information. On the one hand, \$x becomes a higher proportion of the firm’s total equity. This is denoted the “concentration effect” and illustrated by \( \frac{y}{y - d} > 1 \). This echoes Jensen and Meckling (1976), where debt concentrates a manager’s equity holding, directly providing incentives to exert costly effort. In the present paper, leverage magnifies an outside shareholder’s stake, leading to monitoring. This indirectly incentivizes managers to undertake long-term projects. On the other hand, as debt becomes risky, creditors obtain some of the benefits from continuation which is the Myers (1977) “debt overhang” effect. The marginal effect of increasing \( f \) on \( P \)'s incentives to gather information is given by

81
\[
\frac{\partial a}{\partial f} = \frac{1}{\theta} \frac{\pi \gamma}{1 - \pi + \pi \gamma} \left[ \frac{y(R^{LT} - F)(\pi - \pi \gamma(1 - \phi)) - (y - d)}{(y - d)^2} \right].
\]

which is positive, as proven in the Appendix. Thus the concentration effect outweighs the debt overhang effect.

The signaling and contingent control literatures exclusively employ the control shifting feature of debt. Therefore, borderline risky debt is optimal: debt should be just sufficient to achieve the control shift. In this paper, risky debt is optimal to maximize the concentration effect. However, debt cannot be too risky, otherwise creditors’ claims are sufficiently convex that they continue the firm even without information, and thus fail to liquidate an uninspired manager. Since the absence of good news can stem either from failed monitoring or the equityholders uncovering bad news but choosing not to disclose it, the probability that the manager is inspired if no information is received is

\[
\zeta = \frac{\pi \gamma}{1 - \pi + \pi \gamma} \left[ 1 - \phi \right].
\]

Hence the upper bound to \( f \) is given by

\[
f \leq f_U = \frac{L - (1 - \zeta)K}{\zeta} y,
\]

where \( d \) is as given by equation (40). For the rest of this paper, I assume that \( f_L \leq f \leq f_U \).

As is standard in the literature (see, e.g., Bolton and von Thadden (1998)), (39) assumes that multiple \( P \)'s cannot coordinate to share the costs of information acquisition and so they must be borne individually. There is no free-rider issue in the model as it is not a Nash equilibrium for no-one to be informed: one \( P \) can become strictly better off by becoming informed, and it is sufficient for just one \( P \) to obtain information for an inspired manager not to be shut down. This model thus differs from standard free-rider problems (e.g. Grossman and Hart (1980)) where no agent is pivotal, and so there may be equilibria where all parties are inactive.

Results are qualitatively unchanged if we assume milder costs of collective action, where equityholders can coordinate to split the cost \( \theta \), but \( \theta \) is increasing in the number of shareholders owing to greater coordination costs. The concentration effect continues to exist: debt facilitates monitoring by reducing the number of agents and thus coordination costs. Shareholders can now be considered a group which invests \( y - d \) and bears total costs of \( \theta \). Since \( \theta \) is decreasing in \( f \), I write \( \theta(f) \) where \( \theta'(f) \leq 0 \) and \( \theta''(f) \leq 0 \). The group of equityholders will become informed if

\[
\tilde{a} = \frac{\pi \gamma}{1 - \pi + \pi \gamma} \frac{R^{LT} - F}{\theta(f)} > \frac{1}{\phi},
\]
where

$$\frac{\partial \tilde{a}}{\partial f} = \frac{\pi \gamma}{1 - \pi + \pi \gamma} \frac{-\theta(f) - (yR^{LT} - f)\theta'(f)}{[\theta(f)]^2}. \quad (45)$$

Owing to concavity of $\theta(f)$, (45) will start off positive but then turn negative. Hence $\tilde{a}$ will hit $\frac{1}{\phi}$ at two points, so the lower and upper bounds to $f$ are given by

$$\frac{\pi \gamma}{1 - \pi + \pi \gamma} \frac{yR^{LT} - f^L}{\theta(f)} - \frac{1}{\phi} = \frac{\pi \gamma}{1 - \pi + \pi \gamma} \frac{yR^{LT} - f^U}{\theta(f)} - \frac{1}{\phi} = 0, \quad (46)$$

where $f^U > f^L$. Unless otherwise stated, I assume full costs of collective action so that an equityholder will only invest if she finds it individually rational. The algebra is more tractable than the more general $\theta(f)$ case, and the results are unchanged.

Each firm has $\frac{y_d}{x}$ shareholders each bearing cost $\theta$, i.e. spending $\theta\frac{y_d}{x}$ per dollar. Hence the return to the overall investor community, per dollar invested, is

$$(\pi - \pi \gamma(1 - \phi))R^{LT} + (1 - \pi + \pi \gamma(1 - \phi))L - (1 - \pi + \pi \gamma)\theta\frac{y_d}{x}. \quad (47)$$

The first coefficient arises since $\pi$ is the probability of the manager being inspired, and $\pi \gamma(1 - \phi)$ is the likelihood that he is inspired but $C_2 = L$ and information acquisition attempts fail. Conversely, $(1 - \pi + \pi \gamma(1 - \phi))$ is the probability that the manager is liquidated at $t = 2$ through being uninspired, or $C_2 = L$ and no information being acquired. The information costs of $\theta$ are borne whenever $C_2 = L$, i.e. with probability $(1 - \pi + \pi \gamma)$.

I now compare shareholder returns and managerial private benefits with the other possible equilibria, to illustrate the value created by the levered structure. First I compare LEVs to LTUs. Comparing (47) to (34), the per dollar investor return is higher under a LTU by

$$(1 - \pi)(L - K) - \pi \gamma(1 - \phi)(R^{LT} - L) - (1 - \pi + \pi \gamma)\theta\frac{y_d}{x}. \quad (48)$$

The first term represents the savings from optimal liquidation of uninspired managers. The second term is the loss from inefficient liquidation of inspired managers, if monitoring does not succeed, and the third term represents monitoring costs.

The expected per dollar return to a manager is

$$(\pi - \pi \gamma(1 - \phi))Tz(1 + \alpha) + (1 - \pi + \pi \gamma(1 - \phi))z. \quad (49)$$

The per-dollar managerial surplus is lower than under a LTU (see equation (35)) since some managers are now liquidated. Overall, total surplus (returns to all investors and managers) is greater than under an all-LTU equilibrium if $(L - K)$ (the gains from optimal liquidation of an uninspired manager) are sufficiently high, $T$ and $\alpha$ (the manager’s private benefits) are
low, the effectiveness of monitoring $\phi$ is high and the cost of monitoring $\theta$ is low. A sufficient condition is:

$$
(1 - \pi)(L - K) - \pi \gamma (1 - \phi)(R^{LT} - L) - (1 - \pi + \pi \gamma)\theta \frac{y - d}{yx} > \pi \gamma (1 - \phi)(Tz(1 + \alpha) - z) + (1 - \pi)(Tz - z).
$$

(50)

Now comparing a levered firm to an STU, the manager is unambiguously better off in a levered firm ((49) exceeds (33)), given his ability to undertake $LT$. Investors are better off if

$$
(\pi - \pi \gamma (1 - \phi))(R^{LT} - R^{ST}) + (1 - \pi)(1 - \lambda)(L - K) > \pi \gamma (1 - \phi)(R^{ST} - L) - (1 - \pi + \pi \gamma)\theta \frac{y - d}{yx}.
$$

(51)

The first term represents the value gains in an all-LEV equilibrium from choosing $LT$ if the manager is inspired and allowed to continue if $C_2 = L$. The second term represents the gains from optimal liquidation of an uninspired manager, since the board only fires with probability $\lambda$. The third term is the loss resulting from $C_2 = L$ and monitoring attempts failing; the fourth is the cost of information. (51) will hold if $R^{LT}$ is sufficiently higher than $R^{ST}$, $\phi$ is high, $\theta$ is low and $(L - K)$ is high, in which case the all-LEV equilibrium is Pareto superior to the all-STU equilibrium.

The two problems with the STU are the board’s occasional failure to liquidate an uninspired manager, and the inspired manager’s unwillingness to pursue $LT$. The levered firm’s greater returns stem from addressing both of these issues: achieving optimal liquidation without inducing myopia. This in turn results from the two roles of debt.

The control-shift effect allows the manager to be liquidated upon poor short-term performance. Debt changes the default decision to firing, thus leading to the liquidation of all underperforming managers in the absence of information. However, debt is not the only possible method of achieving a control shift. An alternative method would be to keep the firm unlevered but impose mandatory dividends: force the manager to pay a dividend in excess of $L$ at $t = 2$, and fire him if the payment is not made (similar to Myers (2000)). By changing the default decision upon poor performance to firing, such a structure also earns the $(1 - \pi)(1 - \lambda)(L - K)$ term in equation (51). Indeed, in many corporate finance models, mandatory dividends and debt are interchangeable, as total payout is the key variable. This is particularly the case since dividends decreases are punished by a strongly negative market reaction, and so raising the dividend is a credible commitment to maintaining higher payouts in the future, similar to increasing leverage. The interchangeability is true both for signaling and overinvestment models. Ross (1977) shows how debt can signal high quality since bad
firms are unable to meet the debt repayments, but dividends can have the same effect (Bhattacharya (1979)). Stulz (1990) and Zwiebel (1996) demonstrate how debt can force managers to pay out cash rather than overinvesting, but mandatory dividends would also be feasible.

However, in this model, ensuring optimal liquidation is not the only issue. Dividends are not a satisfactory substitute for debt because they do not solve the second problem of short-termism. Only debt leads to the concentration effect, which incentivize equityholders to gather information about the firm’s fundamental value, thus addressing the root cause of myopia: decisions being taken on the basis of current earnings.\footnote{Dewatripont and Tirole (1994) identify a second reason why debt may be preferred to a dividend schedule. Under certain parameter values, equityholders will not discipline the manager if he fails to pay dividends as they have a convex claim; therefore, it is necessary to shift control to the creditor. In this paper, as in Myers (2000), uninformed shareholders will wish to fire the manager upon poor performance, which is the essence of the myopia issue.}

In Gümbel and White (2005), debt also elicits information gathering but exclusively through a control shift, rather than concentration.\footnote{In this paper, when an LTU becomes levered, control shifts from the manager to creditors. In Gümbel and White, the control shift is different as it is from shareholders to creditors. Control rights never rest with the manager in their paper.} In their model, (29) is reversed and shareholders prefer to continue a firm with poor interim performance in the absence of information. The purpose of monitoring is to find out if the firm should be liquidated, thus saving \((L - K)\). With leverage, control now shifts to a creditor whose default decision is to close the firm. The purpose of monitoring is now to find out if the firm should be continued, thus earning the shareholder \((R^{LT} - F)\) compared to zero if it is liquidated. Since \((R^{LT} - F)\) may be much greater than \((L - K)\), a levered shareholder may have incentives to monitor.

In this model, a control shift from shareholders to creditors has little effect, as shareholders prefer liquidation anyway, owing to (29). Indeed, if \(\lambda = 1\), there would be no control shift. Instead, debt works predominantly through the concentration effect, which does not feature in Gümbel and White (2005) as there is a single shareholder. In their model, borderline risky debt is optimal: debt has to be large enough so that control shifts if \(C_2 = L\), but increasing \(F\) above \(L\) merely leads to debt overhang. In this paper, increasing \(F\) (so that debt is strictly risky) is beneficial as it leads to greater concentration. This is consistent with the risky debt seen in private equity portfolio companies.

The results of this subsection are summarized in Proposition 7 below:

**Proposition 7** An all-LEV equilibrium leads to higher shareholder returns than an all-LTU equilibrium. Total surplus is higher if (50) is satisfied. An all-LEV equilibrium leads to higher managerial surplus than an all-STU equilibrium. Returns to investors are higher if (51) is satisfied.
3.4 Separating Equilibrium With Heterogeneous Types

The above section suggests that the optimal corporate structure is a LEV. However, in reality, a large proportion of companies are publicly traded with dispersed ownership and little bankruptcy risk, and private equity-financed firms are relatively rare. This section introduces heterogeneous manager and investor types, and shows the sustainability of a separating equilibrium which closely approximates reality.

There now exists two types of managers. There are \( n_B \) bad managers (type \( B \)) which have a probability \( p_B \) of becoming inspired. In addition, there are \( n_G \) good managers (type \( G \)) with probability \( p_G > p_B \) of becoming inspired. The manager’s type is private information. The ex ante probability that a manager is good is \( q = n_G/(n_B + n_G) \), and the ex ante probability that a manager is inspired is \( \pi = qp_G + (1 - q)p_B \). There are \( n_P \) professional investors (type \( P \)) each with \( \$x > \$1 \) to invest, which act in the same way as the investors considered thus far (providing either equity or debt).\(^{43}\) In real life, they correspond to institutions such as private equity funds and university endowments, which have the time, expertise and incentive to closely monitor the companies they invest in. In addition, there are \( n_H > n_P \) households which each have \$1 of equity to invest. It can easily be shown that they do not monitor, given their small stakes.

The previous analyses can be interpreted as comparing three pooling equilibria. The separating equilibrium analyzed here involves bad managers establishing STUs and being held by households, and good managers establishing LEVs and being held by professional investors. This can be interpreted in two ways. First, taken literally, the equilibrium applies to entrepreneurs seeking financing for the first time: the highest quality ones choose greater leverage. Second, it can be applied to a situation where all firms are currently publicly traded, and only the good managers choose to seek private equity financing.

LEVs run the risk of being held entirely by type \( H \) and being liquidated upon interim losses. They therefore impose minimum investment requirements (“MIRs”) in excess of \$1. In reality, minimum investments of several million dollars are typically needed to acquire an equity stake in a private firm. As well as being in \( G \)’s interest, MIRs also benefit type \( P \), as households can no longer free-ride on their monitoring activity. For instance, in the model variant where shareholders can coordinate to split the monitoring costs, MIRs maximize the number of \( P \)s in each fund, thus minimizing their individual monitoring expenses. Bad managers may also benefit from MIRs: since households can no longer hold LEVs, type \( B \) now has a captive investor base if they set up STUs, despite being revealed to be of low quality.

\(^{43}\)Results are unchanged if types \( P \) and \( H \) invest only equity, and debt finance is achieved from a third source. This alternative assumption was made in a previous draft of the paper. The concentration effect is replaced by a “magnification effect”. Debt induces monitoring since total firm size rises. Therefore, shareholders are now the residual claimants of a greater total value of assets, which increases incentives. All the results of the paper go through: for example, \( \frac{y}{y^d} > 1 \) is replaced by \( \frac{y + d}{y} > 1 \).
In turn, this ensures that LEVs are run only by good managers, which further benefits $P$.

In the analysis of Section 3.3, control shifting and concentration together led to LEV being the most efficient structure. Here, the same two features allow a separating equilibrium to be feasible: control shifting means that debt is a \textit{credible} signal of managerial quality, and concentration renders it a \textit{desirable} signal which good managers are willing to emit.

First, $\lambda < 1$ means that an uninspired STU manager is only occasionally fired, whereas an uninspired LEV manager is definitely shut down. Thus debt leads to a partial control shift. This difference makes STUs particularly attractive to bad managers, as they are relatively likely to produce $C_2 = L$, and so establishing a LEV can credibly signal managerial quality.

Second, good managers desire to give the signal even if it does not lead to higher initial funds. Being revealed good attracts professional investors who monitor, thus allowing the manager to undertake $LT$ if he becomes inspired. This makes LEVs particularly attractive to good managers, as they are likelier to be inspired. Hence neither type of manager wishes to deviate.

I now demonstrate this mathematically. Assume that the myopia problem exists even with a good manager, as there is a sufficient probability that he turns out uninspired, i.e.

$$\frac{1 - p_G}{1 - p_G + p_G\gamma} K + \frac{p_G\gamma}{1 - p_G + p_G\gamma} R^{LT} < L. \quad (52)$$

If this is not satisfied, the problem is uninteresting as signaling high quality automatically solves the myopia issue.

Under a separating equilibrium, each $G$ has $\frac{x_p}{n_G} < y$ of assets, of which $\frac{x_p - dn_G}{n_G}$ is equity and the remainder is debt. There are $\frac{x_p - dn_G}{n_G}d$ equityholders who each bear cost $\theta$, and so the average cost per dollar of assets is $\frac{\theta x_p - dn_G}{x_p n_p}$. Hence the expected return to a $P$ investor (pooling across debt and equity) is:

$$(p_G - p_G\gamma(1 - \phi))R^{LT} + (1 - p_G + p_G\gamma(1 - \phi))L - (1 - p_G + p_G\gamma)\theta \frac{x_p - dn_G}{x_p n_p}. \quad (53)$$

Each $B$ receives $\frac{n_B}{n_P} < y$ of assets. Since they choose $ST$ if they become inspired, the expected per dollar return to a household investor is

$$p_B R^{ST} + (1 - p_B) (\lambda L + (1 - \lambda)K). \quad (54)$$

This return is less than (53) since $(47) > (34)$ and $p_G > \pi$. Hence $P$ will choose to hold entirely LEVs. However, households do not meet the minimum investment requirements to hold LEVs and so only hold STUs despite the lower returns (which may exceed 1 so investing in STUs need not be irrational). Comparing (53) with (54), $P$ is strictly better off than under a LEV pooling equilibrium, as she invests exclusively with good managers. $H$ is strictly worse
off for three reasons: she invests exclusively with bad managers; such managers pursue ST rather than LT if they become inspired; and uninspired managers are only liquidated with probability $\lambda$.\textsuperscript{44}

The per-dollar return to the overall investor community is

$$\left[ (p_G - p_G\gamma(1 - \phi))R_{LT} + (1 - p_G + p_G\gamma(1 - \phi))L - (1 - p_G + p_G\gamma)\theta \frac{xn_P - dG}{x^2 n_P} \right] \frac{xn_P}{xn_P + n_H}.$$  
(55)

The total returns to good LEV managers and bad STU managers are respectively given by

$$[(p_G - p_G\gamma(1 - \phi))TZ(1 + \alpha) + (1 - p_G + p_G\gamma(1 - \phi))z] \frac{xn_P}{n_G}$$
(56)

and

$$[p_B Tz + (1 - p_B)(\lambda z + (1 - \lambda)TZ)] \frac{n_H}{n_B}.$$  
(57)

\textbf{Proposition 8} Consider a separating equilibrium where good managers establish LEVs, impose a MIR in excess of $\$1$ and engage in LT if they become inspired; bad managers establish STUs, impose no MIR and engage in ST if they become inspired. Such an equilibrium is sustainable if the following two conditions are satisfied:

$$[(p_G - p_G\gamma(1 - \phi))TZ(1 + \alpha) + (1 - p_G + p_G\gamma(1 - \phi))z] \frac{xn_P}{n_G}$$
$$> [p_G Tz + (1 - p_G)(\lambda z + (1 - \lambda)TZ)] \frac{n_H}{n_B},$$  
(58)

and

$$[(p_B - p_B\gamma(1 - \phi))TZ(1 + \alpha) + (1 - p_B + p_B\gamma(1 - \phi))z] \frac{xn_P}{n_G}$$
$$< [p_B Tz + (1 - p_B)(\lambda z + (1 - \lambda)TZ)] \frac{n_H}{n_B}.$$  
(59)

\textsuperscript{44}In the context of this model, where there is only one managerial decision, mandatory dividends would solve the fourth problem (but not the first three) by ensuring all uninspired managers are fired. In a more general model, uncertainty may affect ST and lead to underperformance even if the bad manager turns out inspired and chooses the safe project. Thus mandatory dividends would be undesirable; in practice, CEOs of public companies are not automatically fired upon poor performance. Therefore this paper instead features occasional firing by the board.
The first (second) condition ensures that \( G \) (\( B \)) does not deviate. It is possible for both inequalities to be satisfied if \( p_G \) is sufficiently greater than \( p_B \). \( G \)'s desire to be revealed good does not require \( \frac{r_G}{n_G} > \frac{r_B}{n_B} \): separation can be sustained even if being revealed good leads to fewer initial funds. This result is in contrast to existing signaling models. Instead, the “reward” comes in the type of investors attracted invested: ones that are able to monitor and bail out managers whose strategies suffer interim turbulence.

This difference further leads to dynamic consistency of leverage in this paper. Zwiebel (1996) notes that some theories of debt are “setup models”, where it is only individually rational for the manager to choose debt financing when the firm is initially set up. The manager would prefer not to raise debt financing, since it forces him to pay out cash flows that he would rather invest in pet projects. He will voluntarily adopt leverage when raising funds for the first time, to commit not to overinvest or to signal high quality. However, once funds have been raised, the manager has incentives to delever to allow him to pursue his pet projects and so the initial choice of debt financing is dynamically inconsistent. This problem arises because debt’s only role is to act as a signal / commitment device, and signaling is only useful in the first period. Zwiebel solves this issue by introducing a raider who is present in every period, and so it is individually rational for the manager to signal in every period.

In this paper, dynamic consistency is instead achieved because debt has two roles. The control shift effect credibly signals high quality, but this signal is only relevant in the first period, when funds are raised. The concentration effect gives the manager an ongoing incentive to maintain high leverage. Delevering would reduce shareholders’ incentives to acquire information. Indeed, if \( \frac{r_H}{n_G} < \frac{r_B}{n_B} \), the only benefit of signaling is the type of funds raised, and the manager can only benefit from being financed by professional investors if he maintains leverage to give them incentives to monitor. In many agency models, the manager dislikes monitors since they discipline the manager and force him to exert effort or forgo private benefits. In this model, the monitor is an ally of the manager, providing a dynamically consistent reason for the manager to retain the monitor through leverage.

The surplus and welfare analysis depends on which pooling equilibrium is the alternative to the separating equilibrium. Since private equity is a reasonably recent phenomenon, history is most similar to an all-STU pooling equilibrium. Good managers have an incentive to initiate the move to a separating equilibrium by setting up LEVs with MIRs. \( P \) also benefits, but \( B \) and \( H \) are worse off. Overall, total surplus can rise since long-term projects are now undertaken. Unlike previous signaling models, we do not require the good time to receive more funds for total surplus to rise.

Although the previous comparison more closely reflects history, I now compare the separating equilibrium with an all-LEV pooling equilibrium for completeness. Comparing (56) with (49), \( G \) is better off only if he receives more funds. \( G \) does not benefit from improved
project choice, since he can choose LT under the all-LEV pooling equilibrium anyway. Interestingly, B now may receive higher returns, since he is now only partially liquidated upon poor performance. Comparing (55) with (47), total investor returns rise only if \( \frac{x_{PB}}{n_G} > \frac{n_B}{n_B} \), i.e. G receives more funds.\(^{45}\)

### 3.5 Discussion

The primary application of the core model is to explain the high leverage in private equity: the combination of control shifting and concentration allows debt to achieve optimal liquidation and screen out bad managers without inducing myopia. This benefit of leverage is intended to be complementary to existing justifications for the debt-financing of buyouts, rather than an exclusive alternative. One oft-cited justification for leverage is to allow the PE fund to achieve double-digit returns, but this has no effect in a Modigliani-Miller world: PE investors’ high expected returns are no more than fair compensation for greater financial risk. A second cited reason is that debt forces the manager to work hard to avoid bankruptcy (Jensen (1989)). However, as argued previously, this may be achievable by equity-financing acquisitions and threatening to fire the manager if he does not pay dividends according to a strict schedule.

Third, Axelson, Stromberg and Weisbach (2005) provide an alternative story for why buyouts are leveraged and why PE firms sometimes raise capital on a deal by deal basis, based on agency problems rather than uncertainty about managerial ability. This paper offers an explanation for these phenomena even when agency issues are small, which is likely to be the case if investors are concentrated and sophisticated.

The model has a number of additional extensions outside of private equity. In these applications, either control shifting or concentration may be sufficient to add value; in such cases, mechanisms other than debt can be used to achieve the desired effect. This section considers these extensions.

#### 3.5.1 Hedge Funds

With few changes, the model can be extended to analyzing the capital structure of investment companies, the focus of Stein (2005). The two fund types analyzed by Stein have natural analogies in this model. The closed-end fund is very similar to the LTU, which allows long-term investment but not liquidation. The open-end fund is analogous to the STU: similar to short-term contracts or mandatory dividends, open-ending achieves a control shift that

\(^{45}\)Even if total investor returns are lower under separation, the industry may move away from an all-LEV pooling equilibrium since \( P \) has a strong incentive to change the equilibrium: under a separating equilibrium, she invests only with \( G \) and thus earns higher returns. Professional investors may achieve a shift by offering part of their gains to persuade good managers to establish MIRs. As described earlier, \( B \) switches to STUs and receives the currently uninvested household funds. In turn, this ensures that LEVs (and thus \( P \)’s investments) are only run by \( G \).
allows liquidation (through permitting investor withdrawals), but at the expense of deterring long-term arbitrage trades since it has no concentration effect. The LEV structure is not considered by Stein (2005) and is the principal contribution of this paper. The analogy in the investment world is hedge funds, which are both closed-ended and levered.

3.5.2 Blockholders in Public Corporations

In the core model, the firm is sufficiently levered that control shifts to creditors upon poor interim performance. Shareholders’ information helps the manager by persuading creditors not to close down the firm. However, even if debt is insufficient to lead to a control shift, it can still encourage shareholder monitoring by creating blockholders via the concentration effect. Edmans (2007a) analyzes how blockholders have strong incentives to gather information about the firm’s fundamental value. Informed shareholders do not help the manager by staving off liquidation, since there is no such threat in the first place. Instead, their support comes through their trading decisions. If earnings are low, but total order flow is sufficiently high that it is unlikely that the blockholder has sold, the market maker infers that she has uncovered favorable private information and the negative price impact of interim losses is significantly lessened. Since the manager cares about the current stock price (the underlying cause of myopia), monitoring encourages him to select long-term projects ex ante.

As in the core model, the manager has ongoing incentives to maintain the blockholder. One purpose of debt-equity buybacks may therefore be to create a concentrated shareholder who acts as an “ally” of the manager when earnings are depressed.

3.5.3 Venture Capital

A third extension is to the relationship between venture capital (“VC”) funds and their portfolio companies. The latter are very rarely financed with debt owing to limited debt capacity. Instead, round financing creates the control shift and thus potential for liquidation that debt provides. While the central model illustrates the benefits of debt financing, this sub-section shows an advantage of round financing. Whereas the previous application considered concentration with no control shift, this subsection considers control shift without a concentration effect.

Since round financing does not lead to concentration, I can simplify by allowing a single VC fund to be able to finance the entire equity. One feature of VC-financed companies is that the

46 Although investors in hedge funds have some withdrawal rights, Stein (2005) notes that “most hedge funds put some restrictions on withdrawals”. He classifies them as a half-way house between an open-end and a closed-end fund. This paper’s results only rely on limited withdrawal rights for equity investors.
liquidation value from early termination is very small, and so I assume that the termination payoff is \( L \) regardless of firm quality, where \( L \) is very low. A second is that interim financial performance is relatively meaningless, given the long-term nature of investments, and it is nearly never the case that VC investors automatically roll over financing on the basis of short-term earnings. I therefore no longer incorporate the release of a financial performance measure at \( t = 2 \).

There are two main financing options. One is for the VC fund to invest all of its funds at \( t = 1 \), as in the core model. Under pooling, the investor will continue automatically at \( t = 2 \) if

\[
\pi R^{LT} + (1 - \pi)K > L. \tag{60}
\]

The VC investor will not gather information if

\[
\pi(L - K)y < \frac{\theta}{\phi}. \tag{61}
\]

Both of these inequalities are satisfied if \( L \) is small: there is little to be gained from early liquidation. Since there is no interim shut-down, both good and bad managers will seek VC financing, and the investor will earn a per dollar surplus of

\[
\pi R^{LT} + (1 - \pi)K - 1. \tag{62}
\]

The alternative financing option is for the VC to invest only \( v \) at \( t = 1 \), and the remaining \( (1 - v) \) at \( t = 2 \) if it chooses to continue the firm. \( v > L \) else the investor would be able to make money for certain by initially investing \( v \) per dollar and liquidating for \( L \). To deter bad managers, the default decision in the absence of information is termination. Per dollar, continuation costs an additional investment of \( 1 - v \), plus the \( L \) foregone from termination. Hence, \( v \) must be low enough such that

\[
1 - v + L > p_G R^{LT} + (1 - p_G)K. \tag{63}
\]

The equity investor will gather information if

\[47\] If the interim performance measure is instead retained, it would lead to similar results to the main paper. The analysis in the text thus focuses on the case with no interim performance, as this is more different from the core model. If the company generates strong interim performance, it will be able to obtain financing at \( t = 2 \) with little difficulty as the market will know it is high quality. If interim cash generation is low, the company will ask the VC for additional funds as no outside investor will finance it. The VC can then investigate whether the poor financial performance is due to incompetence or sound investment which has not yet paid off (e.g. biotechnology R&D is close to producing a commercializable drug) and thus decide whether to inject additional financing. Long-term investments are particularly important for VC-backed companies, which may partly explain the staged financing (and consequent intensive information gathering) that is a feature of this industry.
\[ p_G(R^{LT} - (1 - v + L))y > \frac{\theta}{\phi}, \]  

and earn a per-dollar surplus of

\[ \phi p_G(R^{LT} - 1) + (1 - \phi p_G)(L - v) - \frac{\theta}{y}. \]

This surplus is higher than under (62) if \( p_G \) is sufficiently greater than \( \pi \), i.e. there is sufficient uncertainty about manager quality. This variant of the core model differs from standard signaling models in a subtle way. In Ross (1977), an unlevered firm cannot go bankrupt even if interim performance is poor: without leverage, there is simply no option to terminate. Here, the option to obtain information and shut down a bad manager is present under both financing structures, but is not exercised under the first scenario - the default decision is to continue the firm, and the gains from early shut-down are only \( L - K \). The role of the financing round is to change the default decision to termination, and the gains from monitoring depend on \( R^{LT} - L \) which are sufficient to encourage information gathering. In Dewatripont and Tirole (1994) and Gümbel and White (2005), the commitment to ex post inefficient monitoring induced by the control shift is desirable to maximize ex ante effort incentives. In this model, there is no effort decision, but the role of the financing rounds is to screen out bad managers.

Finally, the absence of publicly available financial performance at \( t = 2 \) means that automatic monitoring occurs at \( t = 2 \). The core model featured contingent monitoring, which only occurs under short-term losses. The interim performance measure thus reduces monitoring costs, at a cost of potentially deterring long-term trades if managers are focused upon securing good \( t = 2 \) performance. This comparison may shed light on the debate over mandatory reporting requirements. An advantage of greater financial disclosure is reduced cost to investors of obtaining information: in many states of nature, the freely available information is sufficient. On the downside, the information that can be disclosed is incomplete, as only tangible information can be accurately reported. Forcing companies to disclose tangible performance measures can distort investment incentives towards projects which will boost such measures. This issue is explored further in Edmans (2007b).

### 3.5.4 Empirical Predictions

The equilibrium in Section 3, has a number of predictions that are consistent with empirical facts. First, private equity portfolio companies are indeed financed by a substantial amount of debt. This contrasts with models of total payout, which would suggest that mandatory dividends would be an adequate substitute, and “control shift” models which would advocate borderline risky debt.
Second, the separating equilibrium suggests that levered structures should outperform because they attract high-quality managers and allow them to invest optimally. Ljungqvist and Richardson (2003) find that private equity generates excess returns of 5-8% per year relative to the aggregate public equity market. Even on a risk-adjusted basis, the excess value of the typical private equity fund is on average 24% of the present value of the invested capital. Ackermann et al (1999) find that the average hedge fund consistently outperforms mutual funds, even after risk and fees are taken into account. The average Sharpe ratio is 21% higher than for comparable mutual funds. The outperformance occurs in nearly every time horizon, further implying that it is a result of superior managerial ability.

Third, models such as Stulz (1990) and Zwiebel (1996) models predict that leverage constrains managers and reduces investment: this can apply to both profitable and empire-building projects. However, this paper suggests that there is an opposing force: debt can encourage desirable projects which do not pay off until the long-run. Whether this outweighs the traditional effect is an empirical question that has not been tested, to my knowledge.

3.6 Conclusion

This paper addresses a fundamental dilemma in corporate governance: how can investors ensure that bad managers are liquidated, without inducing good managers to take suboptimal actions to avoid liquidation? Mandatory dividends and short-term contracts achieve liquidation at the expense of myopia; long-term contracts allow far-sighted investment but prevent optimal shut-down.

The model introduces a novel benefit of debt that can alleviate this tension: the concentration of equityholders’ stakes and the consequent elicitation of information gathering. Monitoring is desirable even in the absence of an effort problem as it allows long-term project choice. As a result, debt may have significant advantages other control-shift mechanisms as a means of achieving optimal liquidation, as it does not suffer the side-effect of encouraging myopia. Dividends and debt are not interchangeable substitutes.

In addition, the monitoring induced by leverage allows a separating equilibrium to be sustainable: good managers are willing to signal quality by assuming debt. Even if such signaling leads to fewer initial funds, the good manager benefits from the ability to undertake long-term projects. Once the signal has been given and initial finance has been raised, the manager has continued incentives to maintain leverage and thus a concentrated monitor.
3.7 Appendix

3.7.1 Performance-Related Pay

Stein (2005) aligns managers with investors via private benefits, since incentive fees should be driven to zero under perfect competition. This section shows that the results of the main paper continue to hold if private benefits are replaced by incentive compensation. The manager now receives a fraction $\beta$ of the firm’s assets in each period. Assuming no discounting for simplicity, his payoff at $t = 3$ if the firm is not liquidated is proportional to the sum of assets at $t = 2$ and $t = 3$. Table X is now replaced by Table XI below:

<table>
<thead>
<tr>
<th>Table XI: Payoffs to Investment Strategies, Incentive Fees</th>
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</thead>
<tbody>
<tr>
<td>$t = 3$</td>
</tr>
<tr>
<td>$t = 2$</td>
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</table>

The expected per dollar return to a manager of type $i$ in a LTU and a LEV are respectively

$$\beta[p_i(R^{LT} + \gamma L + (1 - \gamma)J) + (1 - p_i)(K + L)], \quad (66)$$

and

$$\beta[(p_i - p_G\gamma(1 - \phi))(R^{LT} + \gamma L + (1 - \gamma)J) + (1 - p_i + p_G\gamma(1 - \phi))L], \quad (67)$$

which replace equations (35) and (49) respectively. A manager of a STU now expects to earn

$$\beta[p_i(R^{ST} + J) + (1 - p_i)(\lambda z + (1 - \lambda)Tz)], \quad (68)$$

which replaces equation (33). As in the main model, this is less than under a LEV.

The separating equilibrium of Section (3.4) holds if neither $G$ nor $B$ deviate, i.e. the following two conditions are met:

$$[(p_G - p_G\gamma(1 - \phi))(R^{LT} + \gamma L + (1 - \gamma)J) + (1 - p_G + p_G\gamma(1 - \phi))L]\frac{xn_p}{n_G}$$

$$> [p_G(R^{ST} + J) + (1 - p_G)(\lambda z + (1 - \lambda)Tz)]\frac{nx}{n_B}, \quad (69)$$

and
\[(p_B - p_B \gamma (1 - \phi))(R^{LT} + \gamma L + (1 - \gamma)J) + (1 - p_B + p_B \gamma (1 - \phi))L \frac{x h p}{n_G} \leq p_B(R^{ST} + J) + (1 - p_B)(\lambda z + (1 - \lambda)Tz) \frac{n_H}{n_B}. \] (70)

### 3.7.2 Proofs

**Proof that \(P\)’s monitoring incentives are increasing in \(f\)

The marginal effect of increasing \(f\) on \(P\)’s incentives to gather information is given by equation (41):

\[
\frac{\partial a}{\partial f} = \frac{1}{\theta} \frac{\pi \gamma}{1 - \pi + \pi \gamma} \left[ \frac{y(R^{LT} - F)(\pi - \pi \gamma (1 - \phi)) - (y - d)}{(y - d)^2} \right].
\]

This is positive if the term in square brackets is positive. Substituting for \(d\) using equation (40) and rearranging, the term in square brackets is positive if

\[(\pi - \pi \gamma (1 - \phi))R^{LT} + (1 - \pi + \pi \gamma (1 - \phi))L - 1 > 0.\] (71)

The left-hand side is the NPV of investing in a firm with unknown quality which pursues \(R^{LT}\) if the manager is inspired. Since an all-LTU equilibrium exists, it is NPV-positive to finance such a firm. Hence (71) and thus (41) are positive: the concentration effect outweighs the debt overhang effect.
References


