The Adverse Effect of Internal Control on Governance and Leverage

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Abstract

We study the effect that improved management information has upon a firm's leverage and corporate governance choices. Corporate headquarters can create internal control systems that identify managerial opportunities to shirk, and can make governance interventions to prevent shirking. Governance interventions are unobservable, and only happen if the firm's leverage is not too high. An internal control system lowers governance costs by facilitating more targeted interventions. But it is also a source of information asymmetry between the headquarters and outside investors. Headquarters may attempt to use its capital structure to signal its inside information. In some circumstances, this results in high levels of leverage and a corresponding attenuation of incentives to intervene that reduces the quality of governance. Investors anticipate this effect and, when it obtains, it is inefficient ex ante to establish internal control systems. We consider an extension in which managerial project search is costly and the headquarters cannot commit to compensate the manager for project discovery. We show that in this case it may be optimal not to have an internal control system, so as to leave the manager with higher ex ante rents, and, hence, a stronger incentive to search.

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1. Introduction

Spurred by a number of high-profile and egregious cases of corporate fraud, legislators and regulators increasingly demand that firms implement adequate internal control systems. For example, Section 404 of the Sarbanes-Oxley Act requires publicly listed firms to implement adequate internal controls on financial reporting procedures. More generally, internal reporting and management accounting systems are used to identify risky operations, to prevent managerial misreporting, and to monitor managerial actions. In short, good internal reporting systems are intended to facilitate better corporate governance.

But it is much harder to stipulate the way that information generated by internal control systems is used. Section 404 of the Sarbanes Oxley Act requires firms to codify their reporting systems and to verify their use. In practice, however, many aspects of a firm's internal control system are very hard to communicate to outside stakeholders, because they use soft information, or context-specific reports that an outsider could not interpret, and whose interpretation is not subject to contract. Hence, while it is often clear to external stakeholders that a firm has implemented a control system, it may be impossible for those stakeholders to verify all of the information generated by that system.

In this paper, we analyse the impact that hard-to-communicate internal controls have upon the behaviour of headquarters and upon the risk profiles of the firms that they run. In our model, it is optimal to use high leverage when the information from the internal control system is favourable. Because of the favourable signal it implies, some firms assume higher levels of leverage than they would without this information. The consequence of this leverage is that incentives to good corporate governance are undermined, so that the internal control system has a counterproductive effect upon the phenomena that it is intended to manage.

We consider a multi-divisional firm run by a headquarters that aims to maximise shareholder value. The headquarters can make costly interventions to improve the governance of specific projects. Governance interventions absorb some of the returns of the project to which they are applied, and so impose a cost upon shareholders. For example, a headquarters could perform a governance intervention by giving its managers a compensation contract from which they generated some rent at the expense of the residual shareholder claimants. Governance interventions improve the returns of complex projects, which are hard-to-monitor. But, precisely because they are concerned with hard-to-monitor phenomena, governance interventions cannot be observed by outside stakeholders; interventions do not require verifiable additional investment, and nor do they require easily observed actions by the corporate headquarters or its managers. Simple projects are easy-to-monitor and generate superior returns without any governance intervention: a governance intervention in a simple project serves only to destroy shareholder value.

Because governance interventions are unobservable, the headquarters cannot commit ex ante to an intervention policy. Governance interventions will therefore occur ex post only if they increase shareholder value. Shareholders bear the costs of a governance intervention but, because they are residual claimants, they share its benefits with bondholders. It follows immediately that complex projects will receive a governance intervention only if leverage is sufficiently low. In contrast, there is no restriction upon the leverage of simple projects, which require no governance intervention.

In our model, there are deadweight costs to the use of equity that render it more expensive than debt. If the headquarters could contract upon the output of its control systems, it would commit to low levels of debt for complex projects, and so incentivise itself to intervene in the governance of complex projects. The headquarters would leave itself free to take advantage of the lower costs of debt by levering its investment in simple projects. However, in line with our opening remarks above, while the existence of an internal control system is verifiable, its outputs are not. As a result, the headquarters is better informed about the firm's prospects than the outside investors. Hence, a headquarters that has gleaned favourable project information from its internal control systems naturally attempts to signal this fact to its investors. This signalling is performed with the firm's capital structure.

Signalling occurs as follows. Simple projects are more valuable because they do not incur the costs of governance intervention. They are also better able to assume debt, and so headquarters attempt to signal their type by borrowing. Headquarters with complex projects have an incentive to pool with simple types—when they do so, they assume so much debt that they never perform governance interventions. The internal control system thus destroys value; welfare would be no lower without it, and, if governance interventions are unconditionally optimal ex ante, i.e., without information about the project's type, welfare might even be higher in a world without internal control systems.

Our model yields some empirical predictions about the relationship between internal control systems and corporate leverage. The model predicts that firms with limited internal control systems may have high or low leverage, according to whether they decide ex ante to intervene in every or no project. Firms with strong internal control systems have intermediate leverage so that, ceteris paribus, firms with strong internal control systems have less heterogeneity of leverage. Moreover, for firms with weak internal control systems, high leverage should be associated with low shareholder value (low success probability), while firms that implement internal control systems or that have low leverage should have high shareholder value (higher success probability).

We consider an extension to our model that is closer to some standard arguments against information production (see, for example, Rotemberg and Saloner (1994)). In the extension, managers must perform costly project search to identify a project. It is impossible to commit to compensate managers for project discovery, but firms are able to commit ex ante to a wage contract conditional upon project investment. Managers will search for projects only if they expect to earn sufficient ex post rents from project management to cover their search costs. In this set-up, internal control systems have two countervailing effects. On the one hand, as in the base case model, an internal control system allows the firm to allocate resources efficiently; on the other hand, a firm with an internal control system is able to condition its investment decision upon the project type. As a result, it may choose not to carry out complex projects that require costly governance intervention. This choice is anticipated ex ante, reduces the manager's incentives to search for a project, and so increases the rent that must be paid to the manager of a simple project. The effect may be to reduce the expected value of a project, and so to render a sophisticated internal control system undesirable.

Related literature

Our paper contributes to a large literature that demonstrates that more information can result in worse economic outcomes. This literature falls into two broad categories.

Work in the first category shows that more information can motivate undesirable actions in situations with incentive or commitment problems. For example, Crémer (1995) demonstrates that, when it is easier to gather information about an agent's performance, the principal may be unable to commit to threats that are ex ante useful. As a result, the principal may prefer a restricted monitoring technology. Similarly, Aghion and Tirole (1997) demonstrate that a principal may prefer to limit access to information so as to devolve real decision-making authority to an agent, who will work harder as a result. More recent work in this vein is due to Hermalin and Weisbach (2012), who analyse a model in which owners may elect to restrict information generation because managers capture some of its benefits in bargaining, and because it may induce managers to devote time to value-reducing activities that make them look more able. Hermalin and Weisbach's analysis therefore differs from ours in that it admits managerial manipulation of information.Arya, Fellingham, Glover, and Sivaramakrishnan (2000) present work related to our extension with costly project search. Like us, they consider a setting in which the firm commits to an information system before managers search for projects, and in which better information about project quality can reduce project search incentives. Dutta and Fan (2012) identify a similar problem in a model in which it is impossible for headquarters to commit ex ante to a managerial wage contract.

A second category of related research studies the effect that better information production has upon insider trading problems that derive from adverse selection between corporate insiders and outsiders. Pagano and Volpin (2012) demonstrate that more public disclosure may serve to exacerbate these problems if some market participants are better placed to interpret the information than others. Pae and Yoo (2001) analyse the interaction of internal audit system with auditor effort as a function of the auditor's liability in the event that its reports prove to be incorrect. In contrast to Pae and Yoo, we assume that auditors cannot verify the information that headquarters learns from an internal control system.

Our work is also related to papers that focus upon the impact that managerial incentive systems have upon capital structure and operating decisions. For example, when managerial compensation is observable and hard-to-change, John and John (1993) show that managers can use compensation policy to commit to the investment policy that maximises firm value. We depart from their analysis because we assume that the wage structures used to implement governance interventions cannot be observed by outside investors. Hence, in our model, the headquarters implements the optimal wage contract only if it has sufficient incentives, which is the case only when leverage levels are not too high. Our model predicts that the expected bonus paid to managers is negatively related to the firm's leverage. In our analysis, individual contracts are not observable. However, our predictions are consistent with the findings of Ortis-Monila (2007) that pay-performance sensitivity decreases in leverage.

2. Model

We consider the relationship between a firm that comprises a headquarters and management, and the firm's investors. All of the parties in our model are risk-neutral and have an outside option that yields an expected payoff of zero; we normalise the risk-free interest rate to zero.

2.1 *Project types and internal control systems*

The headquarters is endowed with a project that requires an investment of 1. The project succeeds or fails, with corresponding payoffs R and 0. The project's success probability depends upon its type, and upon the headquarters' governance choices after investment.

There are two types of project. *Simple* projects succeed with probability $\Pi > \frac{1}{2}$ and have positive net present value $\Pi R - 1 > 0$. *Complex* projects are hard to monitor and without any form of intervention by the headquarters, they succeed with probability $\frac{1}{2}$. The headquarters can improve the success probability of a complex project by making a *governance intervention*. Governance interventions reduce the expected rent that the headquarters receives from a project by k. Their impact depends upon project type: governance interventions do not alter the expected return of a simple project, but they increase the success probability of a complex project to Π. We denote the project type by $\tau \in \{s, c\}$. A fraction μ of all projects has type c.

We assume that a complex project's net present value is positive if and only if it receives a governance intervention:

$$\frac{1}{2}R - 1 < 0 < \Pi R - k - 1. \tag{1}$$

Hence, governance interventions are welfare-enhancing for complex projects, and not for simple ones.

The headquarters does not know the project's type at time 0, but it can use an *internal control system* to learn about the project's type. The control system uses detailed qualitative and quantitative information that ranges from tacit information imparted through face-to-face meetings to codified accounting data. Although the internal control system reveals the project type to the headquarters, we assume that this information cannot be credibly conveyed to outsiders.

If the headquarters does not have an internal control system then its investment choice and its decision to perform a governance intervention are taken without knowledge of project type; we assume that the expected NPV of a project of unknown type that receives no governance intervention is positive:

$$\left(\mu\frac{1}{2} + (1-\mu)\Pi\right) R - 1 > 0. \tag{2}$$

Note that, because governance intervention affects only complex projects, the expected value of a governance intervention in a project of unknown type is $\mu\left(\Pi - \frac{1}{2}\right) R$; this figure could be higher or lower than the cost k of intervention.

The headquarters decides at time 0 whether to deploy an internal control system. We denote this decision by $\rho \in \{0,1\}$. ρ is public knowledge, and we assume that there is no cost to the internal control system; provided the cost is not too high, our results continue to hold when this assumption is relaxed.

2.2 *Financing*

If the headquarters has an internal control system then it decides whether to invest after deploying it. If investment occurs, then the headquarters has to decide how to finance the project. We consider only equity and debt financing; in our two-state world this restriction is without loss of generality.

We denote the debt level (i.e., the amount of debt raised) by D and the promised debt repayment by B; both D and B are observed by bondholders. We assume that capital markets are competitive, so that bondholders' participation constraint is binding and they expect to break even in equilibrium. For $D < 1$, the level of equity required to finance the project is given by $E = 1 - D$. We assume that the headquarters can finance E with internal funds, but that equity financing has an associated opportunity cost of γE. For most of our model the precise nature of the cost γ of equity is not important: it could represent the deadweight cost of forgone alternative investment projects, or the investment banker fees incurred raising additional equity to fund the alternative investments; it also could reflect the differing tax treatments of debt and equity. Thus, debt is ceteris paribus a cheaper source of financing than equity.

2.3 *Governance interventions*

We assume that each project is run by a manager, who acts in his own interest. As discussed above, the managers of complex projects can find ways of shirking that can only be prevented if the headquarters performs an additional governance intervention. The intervention requires the headquarters to take actions that generate an ex post cost k; the headquarters acts in the interests of shareholders, and therefore performs an intervention only if it generates shareholder benefits greater than k.

The precise nature of the governance intervention is not important for most of our analysis. One simple way to think of the intervention is as the expenditure of additional monitoring resources equal to k.

A more involved way to model the intervention, which we employ in Section 4 below, is to assume that the manager of a complex project can extract a private benefit β from shirking on the job. In this case, the governance intervention involves the payment of a success bonus w. The bonus prevents shirking if the expected benefit $\left(\Pi - \frac{1}{2}\right) w$ that the manager derives from not shirking exceeds the opportunity cost β:

$$\left(\Pi - \frac{1}{2}\right) w \geq \beta. \tag{3}$$

The headquarters therefore pays the lowest bonus $w_M \equiv \frac{\beta}{\Pi - \frac{1}{2}}$ that satisfies Condition (3). The cost k of this governance intervention is then equal to the expected wage cost, Πw_M.

Governance interventions could take other forms. For example, in 2008 the French bank Société Générale incurred losses of € 4.9 bn when the Paris-based trader Jérôme Kerviel violated internal risk limits and manipulated the bank's internal reporting systems. Société Générale could have made a costly governance intervention in its trading business by investing to render it harder to manipulate its computer-based reporting systems. Whether such an investment is worthwhile depends in general upon the ease with which manipulation can be performed, and the difficulty of detecting it. Those pieces of information may be project-specific, and could be revealed through an internal audit. Of course, the firm need not have acted on an internal audit. Indeed, in the specific case of Kerviel's trading losses, top managers were alleged to have known that risk limits were violated, but decided not to act so as not to reduce the profit possibilities of Kerviel's trading. In general, a headquarters will make risk management governance interventions only if the returns from doing so are great enough.

In all of these cases, governance intervention involves a cost k that is borne by shareholders, cannot be the subject of an ex ante commitment, and cannot be observed by investors. In the case of monitoring it is natural to assume that investors cannot observe the governance intervention. However, we believe that the assumption is also plausible for the precise bonus structure that an individual manager receives for a specific project.

time 0	time 1	time 2	time 3
Headquarters selects $\rho \in \{0, 1\}$	If the headquarters has an internal control system then it uses it; it then decides whether to invest	If investment occurs capital structure is selected and funds are raised via a take-it-or-leave-it offer to investors	Headquarters decides whether to incur the cost k of a governance intervention

Figure 1: **Timing of the investment game**. The headquarters decides whether to deploy an internal control system up front. It then decides whether to invest, selects a capital structure, and decides whether to make a governance intervention.

2.4 *Timeline*

The timing of the game is illustrated in Figure 1. At time 0 the headquarters decides whether to implement an internal control system. At time 1 the headquarters deploys its internal control system, if it has one. It then decides whether or not to invest. If investment occurs, then the headquarters selects the debt level D for the investment at time 2 and decides whether to perform a governance intervention at time 3.[1]

3. Model Solution

In this Section we solve our model for Bayesian Nash equilibria. We therefore proceed from time 3 to time 0. Critically, the project's market value depends upon the expectations that bondholders form over project type, and over whether the headquarters will perform a governance intervention. These expectations are conditioned on the headquarters' capital structure choice and upon whether the headquarters has adopted an internal control system. We consider in turn the cases where the headquarters has, and does not have, an internal control system.

3.1 *No Internal Control System*

When the headquarters does not have an internal control system ($\rho = 0$), it cannot identify the project's type, and so cannot condition governance intervention on the project type. Hence, the most general headquarters strategy is to select a probability q with which a governance intervention occurs. The project's success probability with strategy q and $\rho = 0$ is

$$\pi_0(q) = \mu(1-q)\frac{1}{2} + (\mu q + (1-\mu))\,\Pi.$$

[1]The distinction between time 2 and time 3 is for expositional convenience. We could derive our models in a world in which wage contracts and capital structure choices were made simultaneously.

Bondholders cannot observe q, but they form rational expectations, so that Equation (4) is satisfied in a competitive market:

$$D = \pi_0(q)B. \tag{4}$$

Given a debt level $D \leq 1$, the headquarters invests equity $E = 1 - D$ and incurs an opportunity cost $\gamma(1 - D)$. Hence, the shareholders derive value $V_0(q, D)$ from the project when $\rho = 0$:

$$V_0(q, D) = \pi_0(q)(R - B) - qk - (1 - D)(1 + \gamma). \tag{5}$$

The headquarters chooses q and D to maximise $V_0(q, D)$ subject to condition (4) and the following incentive compatibility constraint:

$$q \in \arg\max \pi_0(q)(R - B) - qk. \tag{6}$$

The right hand side of equation (6) is linear in q with coefficient

$$\left(\Pi - \frac{1}{2}\right) \mu (R - B) - k. \tag{7}$$

Hence, $q = 1$ if and only if Equation (7) is greater than 0. This requirement is satisfied whenever

$$D \leq \bar{D}_0 \equiv \Pi R - \frac{\Pi}{\mu \left(\Pi - \frac{1}{2}\right)} k. \tag{8}$$

We rule out uninteresting cases by assuming

$$0 < \bar{D}_0 < 1. \tag{9}$$

Condition (8) states that the headquarters performs a governance intervention when debt levels are not too high. The intuition for this result follows directly from Equation (7): the marginal benefit $\left(\Pi - \frac{1}{2}\right) \mu (R - B)$ of governance interventions is decreasing in B, because the returns from improved governance have to be shared with bond holders; in contrast, the marginal cost k of governance interventions is invariant to the capital structure, because it is borne entirely by shareholders.

Because debt is cheaper than equity, the headquarters picks the highest D consistent with its preferred q.[2] Hence, the headquarters chooses between $(D = \bar{D}_0, q = 1)$ and $(D = 1, q = 0)$.

When the headquarters sets $D = \bar{D}_0$ and $q = 1$ managers with complex projects never shirk. Hence, the shareholder value increases by

$$V_0^{ns} \equiv V_0\left(q = 1, D = \bar{D}_0\right) = \Pi R - 1 - k - \gamma\left(1 - \bar{D}_0\right). \tag{10}$$

[2] To see this formally, note that, for a given q, the value $V_0(q, D)$ of the project to shareholders is linear in D with coefficient $2 + \gamma > 0$.

V_0^{ns} comprises the project's net present value without shirking, $\Pi R - 1$, less the cost of the governance intervention and the deadweight cost of equity.

When the headquarters sets $D = 1$ and $q = 0$, managers with complex projects always shirk. Hence, the shareholder value increases by

$$\begin{aligned} V_0^s &\equiv V_0\left(q = 0, D = 1\right) = \pi_0(0)R - 1 \\ &= \left(\mu\frac{1}{2} + (1-\mu)\Pi\right) R - 1. \end{aligned} \tag{11}$$

Lemma 1 characterises the headquarters' optimal choices q^* and D^*.

Lemma 1. *Suppose that the headquarters does not have an internal control system. Then*

1. *If Condition* (12) *is satisfied, shirking does not occur. The headquarters performs a governance intervention ($q^* = 1$) and borrows $D^* = \bar{D}_0$ to finance the project.*

$$\mu\left(\Pi - \frac{1}{2}\right) R - k \geq \gamma\left(1 - \bar{D}_u\right) \tag{12}$$

2. *If Condition* (12) *is violated, then the manager of a complex project shirks. The headquarters does no perform a governance intervention ($q^* = 0$) and finances the project entirely with debt, i.e., $D^* = 1$.*

Proof The result follows immediately from a comparison of Equations (10) and (11). □

Condition (12) implies that the expected increase in the project's return when the headquarters performs a governance intervention without knowing the project's type exceeds not only the cost of the governance intervention but also the frictional cost $\gamma(1 - \bar{D}_0)$ of the necessary equity. The maximal shareholder value without an internal control system, V_0^*, is

$$V_0^* = \max\left\{V_0^s, V_0^{ns}\right\}, \tag{13}$$

which is strictly positive, since, given Assumption (2), $V_0^s = \pi_0(0)R - 1 > 0$. Thus, headquarters will always invest in the project.

3.2 *Internal Control System*

If the headquarters implements an internal control system, then it is able to establish whether shirking is possible. The only information upon which bondholders can condition their beliefs over the project's type and the probability with which the headquarters prevents shirking is the firm's capital structure. The capital structure is chosen by the headquarters given the information that it derives from the internal control system. Hence, the headquarters plays a signalling game with bondholders at the financing stage. We search for Bayesian Nash equilibria that are robust to the Cho and Kreps (1987) Intuitive Criterion.

Definition 1. *An equilibrium for the time 2 signalling game with an internal control system comprises the following elements:*

1. *A headquarters' decision $I_\tau \in \{0, 1\}$ to invest or not, predicated upon the headquarters' knowledge of project type τ;*
2. *A headquarters' capital structure choice D_τ and a bond face value B_τ that depend upon the project type τ;*
3. *A probability q with which the headquarters performs a governance intervention for a complex project;*
4. *Given the headquarters' choice D_τ and B_τ, an assessment by bondholders of the probability $b(D_\tau, B_\tau)$ that the project is complex;*

with the following properties:

1. *The probability assessment b is derived from the headquarters' choices D_τ and B_τ using Bayes' Law wherever possible;*
2. *B_τ is the repayment level at which bondholders with belief $b(D_\tau)$ expect to break even;*
3. *q, D_τ, and B_τ are a best response to the bondholders' belief b, given the project's type τ;*
4. *The bondholders' belief b satisfies the* intuitive criterion *on any off-equilibrium path. That is, it assigns zero probability to types that could not benefit from deviation under* any *possible bondholder belief.*

The key difference between a headquarters that has an internal control system and one that has not is that the former knows the project's type and can condition both the capital structure and the governance intervention on this information. Bondholders only observe the capital structure and, when observing the headquarters' capital structure choice D, form beliefs about the probability b that the project's type is complex. If headquarters had no information about τ, then bondholders would set $b = \mu$. This is the situation that obtains in Section 3.1. When the headquarters knows τ, bondholders must derive b from D and B using Bayes' Law where possible.

Lemma 2 demonstrates that, as in the case without an internal control system, the headquarters only performs a governance intervention if the debt level is not too high. However, with information from the internal control system, headquarters knows whether or not it has a complex project that requires a governance intervention.

Lemma 2. *When the headquarters has an internal control system ($\rho = 1$), it prevents shirking in complex projects whenever the following condition on its capital structure is satisfied:*

$$D \leq \bar{D}_1 \equiv \Pi R - \frac{\Pi}{\Pi - \frac{1}{2}} k. \tag{14}$$

Proof Given a complex project, the headquarters selects the probability q with which it prevents shirking to satisfy the following incentive compatibility constraint:

$$q \in \arg\max \left\{ \frac{1}{2} + q \left(\Pi - \frac{1}{2} \right) \right\} (R - B) - qk. \tag{15}$$

The curly-bracketed term in Equation (15) is a complex project's probability of success given q. The right hand side of Equation (15) is linear in q with coefficient $\left(\Pi - \frac{1}{2}\right)(R - B) - k$. The result follows immediately after setting $B = \frac{D}{\Pi}$. □

As in Section 3.1, the headquarters can convince bondholders that it will perform governance interventions by retaining a sufficiently high equity stake in the project. The maximal debt level $\bar{D}_1$ that is consistent with taking measures against shirking when the headquarters has an internal control system exceeds the corresponding debt level $\bar{D}_0$ when it does not. The reason is that it is possible for the headquarters to condition its governance intervention upon the information revealed by the control system. As a result, the internal control system increases the expected benefit of preventing shirking, and the debt level at which the headquarters is still prepared to prevent shirking is correspondingly higher. We assume that, given a complex project, the shareholder value is positive if the headquarters chooses $\bar{D}_1$ and prevents shirking. Otherwise, it would never be optimal for the headquarters with a complex project to retain equity and prevent shirking.

A first important observation is that there exists no separating equilibrium where the headquarters chooses different capital structures depending on the type of project it has. The intuition for this result is that a headquarters that knows its project to be simple does not need to perform a governance intervention and, hence, it can use high leverage to avoid the dead weight costs of equity issuance without affecting its success probability. Hence, in any separating equilibrium, high leverage would be a positive signal about the project's type, which would therefore be associated with a low cost of debt. But, in such an equilibrium, a headquarters with a complex project could increase its value by increasing its leverage and pooling with the simple headquarters. If that happened, then the headquarters with a complex project would have no incentive to perform governance interventions. Thus, headquarters with simple projects cannot use their capital structure to separate themselves from those with complex projects. We show in the Appendix (Lemma 7) that separation is impossible even if a headquarters with a simple project leaves money on the table and offers debt at favorable terms to bondholders: even in this case, headquarters with a complex project prefers to pool with those that have a simple project.[3]

[3]The reason is that, in contrast to standard signaling problems where the types are exogenously given, the headquarters with a complex project can affect the success probability through governance intervention. Incentives to imitate the leverate of a firm with a simple project are also driven by the possibility to save the cost of governance intervention.

The headquarters can signal its intention to perform a governance intervention by reducing its leverage to $\bar{D}_1$; at this leverage, a headquarters with a complex project opts to perform a governance intervention, and so increase the project's success probability.[4] Headquarters with simple types can achieve the benefit of lower funding costs by setting $D = \bar{D}_1$; with appropriate investor beliefs for higher D a pooling equilibrium can therefore be sustained.

Propositions 1 and 2 confirm these intuitions formally.

Proposition 1 (Incentive Equilibrium). *When the headquarters has an internal control system, there exists a unique equilibrium in which it prevents shirking. In this equilibrium, the headquarters chooses $D = \bar{D}_1$ independent of its project type and prevents shirking for a complex project.*

The proof of Proposition 1 appears in the Appendix. The Incentive Equilibrium is sustained by bondholders' off-equilibrium belief $b = 1$ when $D > \bar{D}_1$. With this belief, the cost of funding for higher debt issuance is sufficiently high to deter higher levels of debt than $\bar{D}_1$.

Proposition 2 (Shirking Equilibria). *When the headquarters has an internal control system, there exists a $\hat{\mu}$ such that the Incentive Equilibrium of Proposition 1 is the only equilibrium if $\mu > \hat{\mu}$. If $\mu \leq \hat{\mu}$, there exist two categories of equilibria in which headquarters makes no governance intervention:*

1. *A continuum of pooling equilibria with $D > \bar{D}_1$;*
2. *A continuum of partially separating equilibria in which the headquarters chooses a debt level $D > \bar{D}_1$ to finance complex projects, and simple projects mix between D and a lower debt level.*

The proof of Proposition 2 appears in the Appendix, where we also demonstrate that there are no further equilibria.

In a pooling Shirking Equilibrium (part 1 of Proposition 2), bondholders assess probability μ that any project experiences shirking. Pooling increases the cost of funds above the level that obtains without shirking; this effect is increasing in the proportion μ of complex projects. When μ is low enough ($\mu < \hat{\mu}$) and the level D of leverage is high enough ($D > \bar{D}_1$), the funding cost effect of pooling at D is so low as to be more than offset by the associated reduction in the deadweight costs of equity issuance.

In a partially separating Shirking Equilibrium (part 2 of Proposition 2), every headquarters with a complex project selects a debt level $D > \bar{D}_1$, and those with simple projects mix between D and some $\tilde{D}$, with $D > \tilde{D} > \bar{D}_1$. In this equilibrium, firms with simple projects are indifferent between separation at $\tilde{D}$ and partial pooling at $D > \tilde{D}$; separation

[4] In our model, the success probability of a given type is endogenous. This distinguishes our set-up from a standard signalling model, in which all characteristics of a type are exogenously given.

at $\tilde{D}$ generates the same investor expectations as setting $D = \bar{D}_1$ and results in a lower dead weight cost of equity. Hence, firms with simple projects have no incentive to deviate to $\bar{D}_1$. Firms with complex projects achieve less benefit from partially pooling than from total pooling, because bond holders assess a probability greater than μ that a firm with debt D has a complex project. Nevertheless, the improved cost of funding from partial pooling at D, coupled with the resultant drop in the dead weight costs of equity, render partial pooling at D more attractive than the commitment that can be achieved at $\bar{D}_1$. Finally, given that firms with simple projects are indifferent between D and $\tilde{D}$, those with complex projects must strictly prefer the higher debt level D, because they do not monitor and so are less likely to repay their debt than firms firms with simple projects.

Note that, despite the dead weight costs of equity issuance, pooling Shirking Equilibria can be sustained for indebtedness levels that are strictly less than 1. These equilibria are sustained by the off equilibrium path belief $b = 1$. Note that this belief survives the intuitive criterion: that criterion allows any off equilibrium path belief that assigns zero probability to any type that could not possibly benefit from the associated deviation under any belief. Since *any* type would benefit from the belief $b = 0$ there are no restrictions in our model upon off equilibrium path beliefs and, as a result, there is a continuum of feasible pooling equilibria.

3.3 *Choice of Auditing Policy*

We now consider the time 0 decision to install an internal control system. The value that shareholders derive from a firm with an internal control system depends upon the equilibrium of the signalling game analysed in Section 3.2. We make the standard assumption that the headquarters knows ex ante which equilibrium will prevail in the continuation game. In the Incentive Equilibrium of Proposition 1, there is no shirking, and the time 0 expected increase in shareholder value is given by

$$V_1^{ns} \equiv \Pi R - \mu k - 1 - \gamma \left(1 - \bar{D}_1\right). \tag{16}$$

In any of the Shirking Equilibria of Proposition 2, no incentives are provided and managers of a complex project shirk. The only differences between shirking equilibria are the levels of debt employed and the degree of cross-subsidisation that complex projects receive from pooling with simple projects. At time 0, when types are unknown, the expected value of cross-subsidisation is zero. Let D_{si} be the ex ante expected level of debt employed given a Shirking Equilibrium, si. The expected shareholder value in this equilibrium is

$$V_1^s \equiv \pi_u(0)R - 1 - \gamma(1 - D_{si}). \tag{17}$$

Proposition 3 identifies the equilibria of the game that starts with the time 0 decision over internal control systems.

Proposition 3. *The game that starts at time* 0 *has three possible equilibria:*

1. *The headquarters implements an internal control system and intervenes in complex projects;*
2. *The headquarters does not implement an internal control system and never performs a governance intervention;*
3. *The headquarters does not implement an internal control system and it intervenes in every project.*

Proof First, suppose that a Shirking Equilibrium obtains with an internal control system. Then, by Equation (17), the equilibrium increase in sharholder value with an internal control system is $\pi_0(0)R-1-\gamma(1-D_{si}) \leq \pi_0(0)R-1 = V_0^s \leq V_0^*$, where the final inequality follows from Equation (13). Hence, the increase in sharholder value from any Shirking Equilibrium is dominated by the equilibrium increase in sharholder value without an internal control system. If Condition (12) is satisfied then, by Lemma 1, the firm performs a governance intervention for every project, so that the equilibrium of part (3) of the Proposition obtains; if Condition (12) is violated then the firm never performs a governance intervention, so that the equilibrium of part (2) of the Proposition obtains.

If an Incentive Equilibrium obtains with an internal control system, then the headquarters implements an internal control system, which corresponds to part (1) of the Proposition, if and only if the increase in sharholder value exceeds the increase in sharholder value without an internal control system and no governance action; this requirement reduces to Condition (18):

$$\mu\left[\left(\Pi-\frac{1}{2}\right)R-k\right] \geq \gamma\left(1-\bar{D}_1\right). \tag{18}$$

If Condition (18) is violated, then the headquarters does not obtain an internal control system and does not intervene in any project, as in the equilibrium of part (2) of the Proposition. □

The intuition for Proposition 3 is straightforward. For the first part, note that internal control systems create value because they enable the headquarters to make governance interventions conditional upon having a complex project. Hence, an internal control system adds no value when a Shirking Equilibrium obtains after learning. Indeed, shareholder value may in this case be lower with an internal control system, for two reasons. First, the Shirking Equilibrium has higher deadweight costs with an internal control than without whenever $D_{si} < 1$. Second, implementing an internal control system may cause the firm to shift from an equilibrium with governance interventions to one without.

Proposition 3 generates some additional insights into the relevance of *commitment* to the headquarters' decision to implement an internal control system. In the equilibria of parts (1) and (2) of the Proposition, commitment is not an issue. In the equilibrium of part (1), the headquarters' decision to obtain information and to use it to prevent shirking is efficient, and the intervention policy is time consistent. The equilibrium of part (2) results in zero equity financing, which destroys incentive to invest in governance actions. Thus, headquarters has no incentives to become informed and it is optimal to not implement an internal control system ex post. Part (2) can arise for two reasons. First, it occurs if the Incentive Equilibrium obtains when the headquarters implements an internal control system, but the associated dead weight equity costs render it inefficient. Second, the Shirking Equilibrium obtains when the headquarters implements an internal control system. In both cases it is ex ante optimal not to implement an internal control system and no time consistency problem arises.

When it is optimal for headquarters to invest in governance actions, it is a dominant strategy to implement an internal control system if the Incentive Equilibrium prevails with internal control, as it allows headquarters to avoid unnecessary costs of governance interventions on simple projects. Hence, the equilibrium of part (3) of Proposition 3 can only arise when a Shirking Equilibrium would obtain with an internal control system: The headquarters would be better off if it could achieve an Incentive Equilibrium with an internal control system, but it is unable at time 0 to commit not to engage in the value-reductive signalling that results in a Shirking Equilibrium in the continuation game. The only way it can achieve this commitment is by denying itself the informational advantage that gives rise to signalling. In short, in part (3) of Proposition 3, the decision not to implement an internal control system serves to *commit* the headquarters not to attempt to signal its type, and so to ensure that governance interventions occur.

3.4 *Empirical predictions and implications*

The three possible equilibrium outcomes generate specific empirical predictions. First, firms without an internal control system can have both high or low leverage, according to whether or not governance interventions occur; firms that implement an internal control system have intermediate levels of leverage. For firms without an internal control system, high leverage is associated with low success probability and weaker corporate governance. In contrast, firms without an internal control system and low leverage, as well as firms with an internal control system, have a higher success probability and better corporate governance.

Our paper also has interesting implications for the regulation of internal control. Forcing firms to implement a control system can be detrimental when a Shirking Equilibrium obtains. In this case, the costs of financing increase and firms may increase their leverage and have weaker corporate governance than those without control systems. Thus, the effect of requiring internal control systems may be the opposite of that intended. The problem arises because firms might not use their improved information to strengthen their governance, but to lever up to signal their type.

We assume in our model that governance interventions are not observable. This renders it hard to test our model's implications for managerial compensation. Nevertheless, some interesting implications emerge from our analysis. If governance interventions involve providing managers with monetary incentives against shirking, the expected wage payment to management decreases with leverage, because the headquarters has very weak incentives to prevent shirking at high levels of indebtedness. The expected wage costs are highest for firms with low leverage that do not have an internal control system, because their managers receive a bonus irrespective of whether it is needed to motivate them. Firms with an internal control system choose an intermediate level of debt and implement monetary incentives only when they are needed.

4. Extension: Managerial Compensation and Costly Project Search

In this section we analyse an extension of our model in the specific case where governance interventions involve the payment of a success bonus w_M in order to incentivise the manager to give up the private benefit β of shirking, as outlines in Section 2.3. In this case, the cost k of governance intervention is equal to Πw_M. With this set-up we extend our previous analysis by requiring managers to search for projects at time 0.5, after the headquarters has decided whether to implement an internal control system. The manager finds a project with probability 1 if he incurs a private search cost $c > 0$, and does not find a project otherwise.

4.1 *Commitment / Complete Contracts*

We assume in this subsection that the headquarters is able to write a wage contract at time 0 that is contingent on both project discovery and project success. We write w_P for the *discovery bonus* that the manager is paid upon finding a project. The manager searches for a project if his total ex ante expected payoff from finding and carrying out a project exceeds his search cost c. Because the manager anticipates earning some rent from projects that he manages, the required discovery bonus is less than c. We consider in turn the three equilibria identified in Proposition 3.

1. **Incentive Equilibrium with Control System**. The manager is paid a success bonus when managing a complex project. This bonus results in an ex ante expected wage of μk if the manager finds a project. Hence, the minimum discovery bonus that incentivises project search is $w_P^{1,ns} = \max\{0, c - \mu k\}$.
2. **Shirking and No Control System**. The manager does not receive a success bonus, but derives a private benefit β from running a complex project, so that his time 0.5 expected benefit is $\mu\beta$. The minimum discovery bonus w_P that induces managerial

search is therefore $w_P^{0,s} = \max\{0, c - \mu\beta\}$.

3. **No Shirking and No Control System**. The manager receives a success bonus irrespective of the project's type and does not shirk. His expected income after finding a project is therefore k. The minimum discovery bonus that induces project search is now $w_P^{0,ns} = \max\{0, c - k\}$.

Note that, since $k > \beta$, $w_P^{0,s} > w_P^{1,ns} > w_P^{0,ns}$, so that the discovery bonus is decreasing in the expected ex post bonus for project success. As a result, the range of parameters for which it is optimal for the headquarters to pay a bonus to prevent shirking is greater with project search than without project search.

If the Incentive Equilibrium obtains with an internal control system, the headquarters prefers to implement a control system if and only if

$$V_0^s - \max\{0, c - \mu\beta\} \leq V_1^{ns} - \max\{0, c - \mu k\}.$$

If the Shirking Equilibrium obtains with a control system, the headquarters now prevents shirking if and only if

$$V_0^s - \max\{0, c - \mu\beta\} \leq V_0^{ns} - \max\{0, c - k\}.$$

Thus, it is now optimal to prevent shirking for a larger set of parameters whenever $c - \mu\beta > 0$.

Proposition 4. *When search is costly and the headquarters is able to commit to a contract at time* 0*, the headquarters is more likely to prevent shirking and to implement an internal control system than without costly search.*

4.2 *No Commitment / Incomplete Contracts*

In this section we introduce two contracting frictions that were absent from the discussion in Section 4.1.

Assumption 1. *It is not possible to write a compensation contract that is conditional upon project returns before the project has been identified or that is contingent upon project discovery or investment.*

The project's payoffs (0 and R), its success probability (Π or $\frac{1}{2}$), and the private benefit β of monitoring are known at time 0. However, Assumption 1 states that contracting on project returns is impossible at time 0. This Assumption is appropriate in situations where contextual information about the project will be established only when search occurs. This type of information concerns the metrics that can be written into a contract and enforced. For example, the appropriate way to identify "success" depends significantly upon the nature of the project: an overseas expansion will most likely use very different metrics to a new manufacturing plant which, in turn, will be viewed in a different way to a joint venture or a new product range. Simple cash flow metrics are unlikely to be sufficient: it is well-understood that cash flow can be generated by selling products too cheaply, and the present value of investments is notoriously hard to measure ex post. Perhaps no contract can perfectly capture the difference between success and failure in a complex corporate financial setting, but a contract that is written with a more complete understanding of the underlying business will be more effective. Hence, in addition to facts about an investment's present value, we view the discovery of a project as generating specific information about how to contract upon it, and we therefore assume in this Section that the headquarters can contract with the manager only at time 3.

When investment occurs, it is observable and could be the basis of a contract. But, for such a contract to provide effective search incentives, the agent who originated it must be easily identifiable by a court to enforce the compensation contract. In many corporate settings, new projects are difficult to define and might include the development of new markets or new product launches. In these cases it is hard to prove ex post that a particular individual was responsible for "originating" or "finding" them. Hence, we also assume that it is not possible to write contracts that explicitly reward individuals for finding new projects.

Assumption 1 implies that it is impossible to contract to reward the manager for project search. As a result, he will exert search effort only if he expects to earn a sufficiently high rent from managing the project. We again consider the three possible equilibria of Proposition 3.

1. **Incentive Equilibrium with Control System**. The manager searches for a project if $\mu k \geq c$. When this condition is satisfied, the shareholder value increase is V_1^{ns}; when it is violated, the increase in shareholder value is zero.
2. **Shirking and No Control System**. The manager searches for a project when $\mu\beta \geq c$. If this condition is satisfied, the shareholder value increase is V_0^s. Otherwise, the increase in shareholder value is zero.
3. **Shirking and No Control System**. The manager searches for a project if $k \geq c$. When this condition is satisfied, the shareholder value increase is V_0^{ns}; if it is violated the increase in shareholder value is zero.

The following Proposition is an immediate consequence of the above analysis:

Proposition 5. *Suppose that Condition* (12) *is satisfied and that*

$$\mu k < c < k. \tag{19}$$

Then, with Assumption 1, the manager exerts search effort when the headquarters does not have an internal control system but not if an internal control system is in place. Hence, it is optimal for headquarters to not have an internal control system.

Proposition 5 identifies conditions under which it could be optimal for headquarters not to implement an internal control system and to provide incentives against shirking even when the Incentive Equilibrium prevails with an internal control system. As discussed in part 2 of Proposition 3, this situation could never obtain in the absence of costly project search. It arises with costly project search if headquarters cannot commit to paying wages ex ante. In the absence of commitment to wages, the headquarters decides to not implement an internal control system in order to guarantee a sufficient managerial rent to incentivise project search. Note that this situation is more likely to arise for lower μ.

Proposition 5 describes a situation in which search costs combined with limitations on contractual commitment induce the headquarters to switch from a policy of implementing to one of not implementing an internal control system. A switch from not implementing to implementing an internal control system is also conceivable. Suppose that, absent search costs, the headquarters would not prevent shirking when it has no internal control system. With search costs, this strategy would generate a smaller rent for the manager and, as a result, search might not occur and the headquarters would earn no income. If the Incentive Equilibrium obtains when the firm has an internal control system, then, provided Condition (12) is satisfied, search occurs and the headquarters earns a positive expected income.

5. Conclusion

This paper demonstrates that internal control systems can have perverse incentive effects that arise because they generate asymmetric information between corporate insiders and outside bondholders. These problems arise because insiders may attempt to use capital structure to signal their type to outsiders. The consequence may be an equilibrium in which the easiest-to-manage projects pool with the harder-to-manage at high levels of indebtedness. The indebtedness renders it uneconomic for shareholders to prevent managerial shirking and, as a result, shirking increases in equilibrium.

This analysis flags a potential pitfall in internal control, but we do not conclude from it that internal controls should be curbed. On the contrary: as in this paper, an effective internal control system ensures that corporate resources are more efficiently channelled towards the projects where shirking and other agency costs are most problematic. But our paper does point towards approaches that could reduce the agency costs of internal controls. For example, our analysis demonstrates that perverse signalling equilibria can arise when the proportion μ of complex projects in which shirking could occur is sufficiently low. Hence, we conclude that firms in which there is a small chance of dangerous complexity might wish to tie their hands by committing in their corporate charter to a maximum level of indebtedness.

References

Aghion, Philippe, and Jean Tirole, 1997, Formal and real authority in organizations, *Journal of Political Economy* 105, 1–29.

Arya, Anil, John Fellingham, Jonathan Glover, and K. Sivaramakrishnan, 2000, Capital budgeting, the hold-up problem and information system design, *Management Science* 46, 205–216.

Cho, In-Koo, and David M. Kreps, 1987, Signaling games and stable equilibria, *Quarterly Journal of Economics* 102, 179–221.

Crémer, Jacques, 1995, Arm's length relationships, *Quarterly Journal of Economics* 110, 275–295.

Dutta, Sunil, and Qintao Fan, 2012, Incentives for innovation and centralized versus delegated capital budgeting, *Journal of Accounting and Economics* 53, 592–611.

Hermalin, Benjamin E., and Michael S. Weisbach, 2012, Information disclosure and corporate governance, *Journal of Finance* 67, 195–233.

John, Teressa A., and Kose John, 1993, Top-management compensation and capital structure, *Journal of Finance* 48, 949–974.

Ortis-Monila, Herman, 2007, Exective compensation and capital structure: The effects of convertible and straight debt, *Journal of Accounting and Economics* 43, 69–93.

Pae, Suil, and Seung-Weon Yoo, 2001, Strategic interaction in auditing: An analysis of auditors' legal liability, internal control systen quality, and audit effort, *Accounting Review* 76, 333–356.

Pagano, Marco, and Paolo Volpin, 2012, Securitization, transparency, and liquidity, *Review of Financial Studies* 25, 2417–2453.

Rotemberg, Julio J., and Garth Saloner, 1994, Benefits of narrow business strategies, *American Economic Review* 84, 1330 – 1349.

APPENDIX

Proof of Propositions 1 and 2.

We prove Propositions 1 and 2 by identifying every equilibrium of the signalling game studied in Section 3.2. To do so, it is convenient to establish our notation.

Definition 2.

1. *ζ is the probability that bondholders assign to the event that the manager will shirk:*

$$\zeta = b(1-q); \tag{20}$$

2. *Given a bondholder assessment* ζ,

$$\pi_\zeta = \zeta\frac{1}{2} + (1-\zeta)\,\Pi \tag{21}$$

is the bondholders' assessment of the project's success probability.

3. $E = 1 - D$ *is the equity investment in the project;*

Given the assessment ζ and level of equity E, the shareholders derive expected value $I_s \equiv \Pi\left(R - \frac{1-E}{\pi_\zeta}\right) - E\,(1+\gamma)$ from a simple project, $I_c^s \equiv \frac{1}{2}\left(R - \frac{1-E}{\pi_\zeta}\right) - E\,(1+\gamma)$ from a complex project if the headquarters does not prevent shirking, and $I_c^{ns} \equiv \Pi\left(R - \frac{1-E}{\pi_\zeta}\right) - k - E\,(1+\gamma)$ if the headquarters does prevent shirking. The headquarters' optimal strategy q^* depends on the level E of equity and the bondholders' assessment ζ of project success probability as follows:

When there is no internal control system in place, the bondholder assesses the probability ζ of project success probability to be Π when $E \geq \bar{E}_1$, and to be $\mu\frac{1}{2}+(1-\mu)\Pi$ otherwise. This relationship is straightforward, and we therefore did not need to define ζ when considering the case without internal control system. In contrast, in the signalling game with internal control system, ζ could assume a range of values, and the headquarters' incentives depend critically upon ζ. Hence, in this Appendix, we consider explicitly the relationship between E, ζ, and the headquarter's strategy. We start by examining the dependence of the headquarter's internal control system upon ζ and E:

Lemma 3. *The headquarters sets* $q^* = 1$ *for complex projects, and so prevents shirking, if and only if Condition* (22) *is satisfied:*

$$E > \bar{E}_1(\zeta) = 1 - \frac{\pi_\zeta}{\Pi - \frac{1}{2}}\left\{R\left(\Pi - \frac{1}{2}\right) - k\right\}. \tag{22}$$

If $E < \bar{E}_1(\zeta)$ *then the headquarters sets* $q^* = 0$ *and so does not prevent shirking. If* $E = \bar{E}_1$ *then the headquarters is indifferent between q-values between* 0 *and* 1.

Proof The headquarters sets $q^* = 1$ and prevents shirking if and only if the corresponding value I_c^{ns} exceeds the value I_c^s when it sets $q^* = 0$ and so does not prevent shirking. This requirement is equivalent to Condition (22). The remainder of the result follows similarly. □

The complexity in the signalling game arises because ζ depends upon E. To understand this dependency, it is convenient to examine the headquarters indifference curves in (E,ζ) space.

Lemma 4.

1. *A complex headquarters has downward-sloping and concave indifference curves in* (E,ζ) *space for* $E < \bar{E}_1(\zeta)$*; for* $E > \bar{E}_1(\zeta)$ *they are downward-sloping and concave for* $\zeta < \zeta^+ \equiv \frac{\gamma\Pi}{(1+\gamma)\left(\Pi-\frac{1}{2}\right)}$*, and they are upward-sloping and convex for* $\zeta > \zeta^+$*;*

2. *Simple headquarters have downward-sloping and concave indifference curves for* $\zeta < \zeta^+$*, and have upward-sloping and convex indifference curves for* $\zeta > \zeta^+$*;*
3. *Indifference curves for all headquarters are continuous.*

Proof The expected income of a headquarters with a simple project is I_s. By Lemma 3 the expected income of a headquarters with a complex project is I_c^{ns} when $E > \bar{E}_1(\zeta)$, and is I_c^s otherwise. Mechanical differentiation of these results yields the results of Lemma 4. □

The indifference curves derived in Lemma 4 are illustrated in Figure 2. Headquarters with complex projects prevents shirking only when (E, ζ) lies to the right of the line $\bar{E}_1(\zeta)$: this is the reason that complex headquarters indifference curves changes along this line. To the left of $\bar{E}_1(\zeta)$ indifference curves for complex headquarters slope down faster than those for simple headquarters. The reason is that, because complex headquarters incurs governance costs and hence extract less of the returns from a successful project, they experience a lower cost from an increase in the bond market's assessment ζ of the probability that they shirk. Note that the cost of funding is increasing in E and also in the probability ζ that bondholders assign to shirking. Hence, the headquarters prefers indifference curves to the left and bottom of the Figure. The following result follows immediately:

Lemma 5. *The only possible equilibrium with* $E \geq \bar{E}_1$ *is at point* M *on Figure 2, where* $\zeta = 0$ *and* $E = \bar{E}_1$*.*

Proof Note from Lemma 3 that, if the headquarters sets $E = \bar{E}_1$ then there will never be shirking on complex projects, so that $\zeta = 0$. Hence, the headquarters can always elect to situate itself at the *commitment point* M on Figure 2. This point is preferred to every other point to the right of $\bar{E}_1(\zeta)$ and, hence, it is the only possible equilibrium with $E \geq \bar{E}_1$. □

We write $\zeta_s(E)$ and $\zeta_m(E)$ for the respective simple and complex indifference curves through M. These curves are indicated as thicker lines in Figure 2.

Lemma 6. *There exist no separating equilibria.*

Proof The proof proceeds in two steps. We first consider the case where the participation constraint of bondholders is binding, which we assume throughout the paper. Let E_s and $E_c \neq E_s$ be the respective equity levels of simple and complex projects in a separating equilibrium. We must have $E_c \geq \bar{E}_1(\zeta)$, since otherwise complex projects, whose type is revealed in equilibrium, have negative value and, hence, do not attract funding. Hence, by Lemma 5, $E_c = \bar{E}_1 > E_s$, and the equilibrium assessment ζ must be zero for both types of project. But, for fixed ζ, welfare is decreasing in the equity level E. Hence, a headquarters with a complex project will choose to imitate one with a simple project, thus violating the separating assumption.

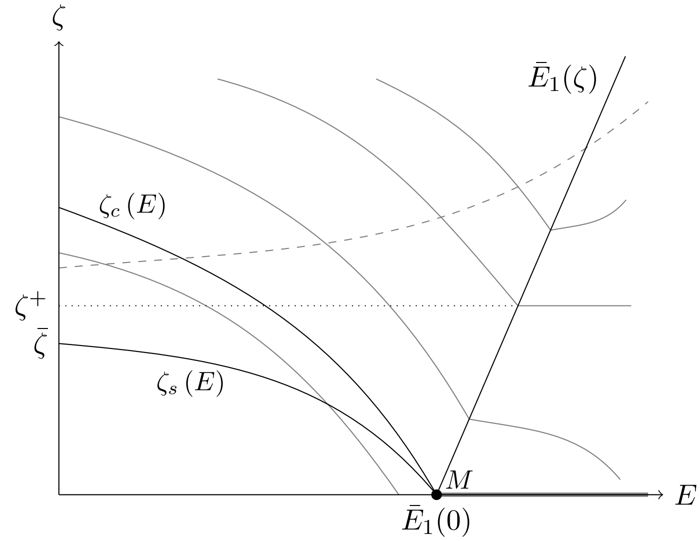

Figure 2: **Headquarters indifference curves**. The line $\bar{E}_1(\zeta)$ along which the headquarters with a complex project is indifferent between preventing shirking and not doing so slopes upwards. Hence, because the headquarters prefers lower indifference curves, there will never be an equilibrium along this line: the headquarters never randomises over the management of complex projects. The only possible equilibrium with $E \geq \bar{E}_1(0)$ is at point M.

We now show that there exists no separating equilibrium where the simple type leaves money on the table to signal a high probability of success. Assume, on the contrary, that the simple type chooses $E = 0$ and $B > \frac{1}{\Pi}$ (with bondholders' belief $\zeta = 0$) and the complex type chooses $\bar{E}_1$ (fairly priced $B_1 = \frac{1-\bar{E}_1}{\Pi}$; belief $\zeta = 0$) and prevents shirking; bondholders' off-equilibrium belief are $\zeta = 1$ if $0 < E < \bar{E}_1$. B must satisfy the self-selection constraint of the complex type who must have no incentive to choose $E = 0$ over $\bar{E}_1$, which implies $\frac{1}{2}(R - B) \leq \Pi R - 1 - \gamma \bar{E}_1 - k$. The minimal B that satisfies the constraint is $B^{\min} = 2\left(1 + \gamma \bar{E}_1 - (\Pi - \frac{1}{2})R + k\right)$. The simple type must prefer $E = 0$ over $\bar{E}_1$, which implies $\Pi R - 1 - \gamma \bar{E}_1 \leq \Pi(R - B)$. The maximal B that satisfies the constraint is given by $B^{\max} = \frac{1}{\Pi}\left(1 + \gamma \bar{E}_1\right)$. For a separating equilibrium to exist is must be that $B^{\min} \leq B^{\max}$, which implies $2\left(1 + \gamma \bar{E}_1 - (\Pi - \frac{1}{2})R + k\right) \leq \frac{1}{\Pi}\left(1 + \gamma \bar{E}_1\right)$. Rearranging terms yields $(1 + \gamma)\bar{E}_1 \leq 0$, which is not possible. Thus, there cannot be a separating equilibrium in pure strategies. □

Lemma 7. *There exists a pooling equilibrium with $E = \bar{E}_1$.*

Proof The pooling equilibrium is sustained by a posterior bondholder belief $\zeta = 1$ for any $E < \bar{E}_1$. This belief ensures that any deviation by a headquarters with a complex project renders its bonds fairly priced so that, by Equation (1), its participation constraint is violated.

The headquarters with a simple project also does not deviate since the expected increase in shareholder value is then negative: If the headquarters deviates, it is optimal to choose $E = 0$, which yields an increase in shareholder value $\Pi(R-2) < 0$ given (1).

We must also demonstrate that the pooling equilibrium is robust to the Intuitive Criterion. This is true because any type could benefit from deviation under the belief $\zeta(E) = 0$, so that the Intuitive Criterion places no restriction upon off-equilibrium beliefs in this case. □

Throughout the paper we assume that the bondholders' participation constraint is binding. In Lemma 7 we proof that this is indeed optimal. Proposition 1 follows immediately from Lemma 7:

Corollary 1 (Proposition 1: Incentive Equilibrium). *The equilibrium of Lemma 7 is the unique equilibrium in which shirking is prevented.*

Proof We need only demonstrate uniqueness. By Lemma 6, any equilibrium in which shirking is prevented must be a pooling equilibrium, with $E \geq \bar{E}_1$. And by Lemma 5, there is no equilibrium with $E > \bar{E}_1$. □

We now establish the conditions under which a pooling equilibrium could exist for $E < E^*$. In any such equilibrium we must have $\zeta = \mu$, and, to ensure that simple headquarters do not defect to point M, the equilibrium must be at a point below $\zeta_s(\cdot)$ in (E, ζ) space; this is the case whenever μ lies below $\bar{\zeta} \equiv \zeta_s(E)$, as illustrated in Figure 3. Then there is a pooling equilibrium at any point (E', μ) along the horizontal dashed line from $(0, \mu)$ to $\zeta_c(E)$, which is sustained by the bondholder belief that $\zeta = 1$ for every $E < E'$. We have therefore established Lemma 8:

Lemma 8. *There exist pooling equilibria with equity levels below E^* if and only if $\mu < \bar{\zeta}$. When $\mu < \bar{\zeta}$, let $E_\mu = \zeta_s^{-1}(\mu)$; there is a continuum of pooling equilibria for every $E \in [0, E_\mu]$.*

We now consider possible mixed equilibria. Our first observation is that there cannot be an equilibrium in which a complex headquarters adopts a mixed strategy. The intuitive reason for this result is that in such an equilibrium at least one of the complex headquarters' possible actions would reveal its type, and so ensure that it could not be individually rational.

Lemma 9. *There is no equilibrium in which complex headquarters adopts a mixed strategy.*

Proof Suppose for a contradiction that such an equilibrium exists. The complex headquarters must mix amongst points on a single indifference curve. Let x and y be points on the curve that the complex type selects with positive probability, as in Figure 4. The simple agent strictly prefers y because, as illustrated, it lies on a lower indifference curve. Hence

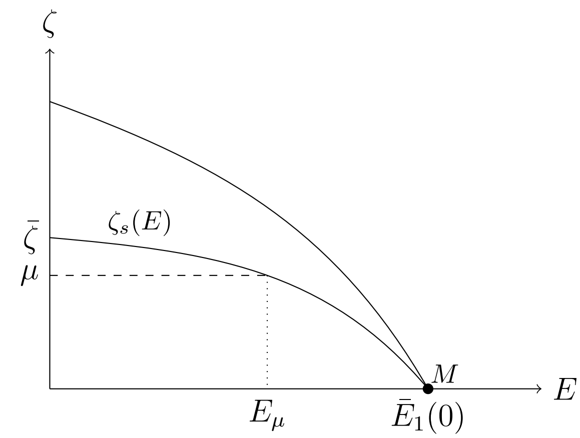

Figure 3: **Pooling equilibria with** $E < \bar{E}_1$. In any pooling equilibrium with $E < \bar{E}_1(0)$, the assessment ζ must equal the population proportion μ of complex projects. Headquarters with simple projects will not deviate to M only if the pooling equilibrium lies below $\zeta_c(\cdot)$; hence, pooling equilibria exist only if $\mu < \zeta$. They can then be sustained anywhere along the dashed line.

a capital choice K_x reveals the headquarters to be complex, so that $\zeta_x = 1$. The indifference curve along which marginal agents mix therefore violates the marginal headquarters' participation constraint, which is the desired contradiction. □

Lemma 9 implies that, if there is a partially separating equilibrium, it must involve mixing by simple headquarters. Such mixing can only occur on an indifference curve below $\zeta_s(E)$, along which the outside option associated with the commitment point M is achieved. Such an indifference curve is illustrated as a bold curve in Figure 5. If a simple headquarters mixes between at least two points on this curve then the complex headquarters will select the leftmost point, since this lies on the leftmost complex-type indifference curve. All other points must therefore have $\zeta = 0$ and, hence, the simple headquarters can mix between only two points, illustrated in Figure 5 with capital levels $\hat{E}$ and $\bar{E}$. The market belief $\hat{\zeta}$ when $E = \hat{E}$ at the left hand point must lie above μ (because all marginal and not all strong headquarters select this capital requirement) and below $\bar{\zeta}$ (since the bold indifference curve must lie below the outside option $\zeta_s(\cdot)$). Hence, partially separating equilibria are feasible only if $\mu < \bar{\zeta}$. If this condition holds then a partially separating equilibrium can be sustained along any indifference curve below $\zeta_s(\cdot)$ with $\bar{E}$ and $\hat{E} < E_\mu$ as illustrated, with off-equilibrium beliefs $\zeta = 1$. We have therefore established Lemma 10.

Lemma 10. *There exist partially separating equilibria in which simple headquarters mix if and only if $\mu < \bar{\zeta}$. In that case, there is a partially separating equilibrium for any $\tilde{E} \leq \bar{E}_1$ for which the indifference curve through $(\tilde{E}, 0)$ intersects the ζ-axis above μ. Given such an $\tilde{E}$, let $\tilde{E}_\mu$ be the capital structure at which the simple headquarters indifference curve through*

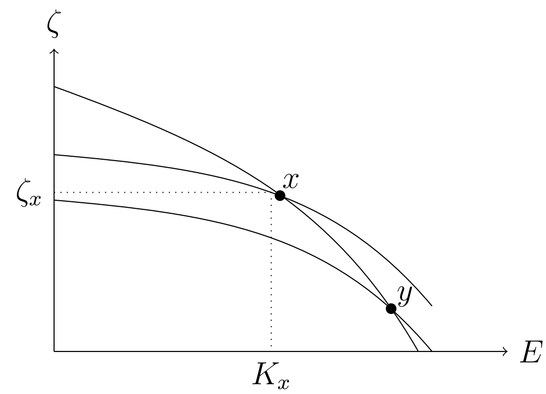

Figure 4: **Non-existence of equilibria in which complex headquarters mix**. If complex types mixed between x and y then both points would have to lie on a common complex headquarters indifference curve. The lower would be strictly preferred by simple headquarters, so that choosing capital K_x would reveal an agent to be complex and, so, because $K_x < \bar{E}_1$,would ensure that x violated the participation constraint.

$(\tilde{E}, 0)$ intersects the line $\zeta = \mu$. Then there is a continuum of mixed strategy equilibria for each $\hat{E} \in [0, \tilde{E}_\mu]$; in every such equilibrium, complex headquarters set $E = \hat{E}$ and simple headquarters mix between $\tilde{E}$ and $\hat{E}$.

Lemmas 8 and 10 together imply Proposition 2:

Corollary 2 (Proposition 2: Shirking Equilibria). *Let $\hat{\mu} = \hat{\zeta}$. If $\mu > \hat{\mu}$ then the only equilibrium of the signalling game is the pooling equilibrium of Lemma 7. If $\mu < \hat{\mu}$ then there is a continuum of pooling equilibrium with $D > \hat{D}_1$, described in Lemma 3 and a continuum of partially separating equilibria in which complex headquarters select a common $D > \hat{D}_1$, described in Lemma 10.*

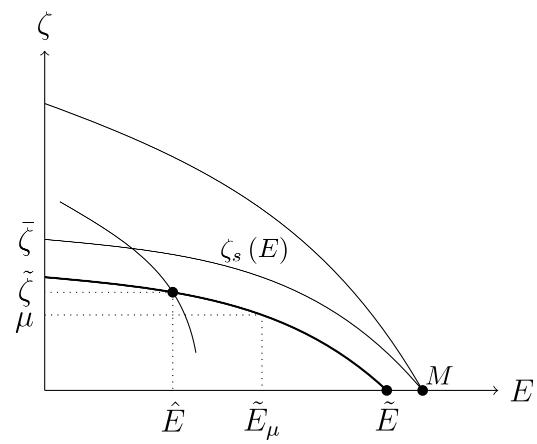

Figure 5: **Partially separating equilibria**. Headquarters in which simple headquarters mix exist if and only if there is a simple-type indifference curve below $\zeta_s(\cdot)$ that intersects the ζ-axis above μ, as illustrated by the bold line in the Figure. In such equilibria simple headquarters mix between the E-axis intercept $\tilde{E}$ and any $\hat{E} < \tilde{E}$; complex headquarters always set $E = \hat{E}$.