

Carrasco, Vinicius

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## Corporate Board Structure, Managerial self-Dealing, and Common Agency

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TEXTO PARA DISCUSSÃO

No. 523

Corporate Board Structure, Managerial  
self-Dealing, and Common Agency.

Vinicius Carrasco



# Corporate Board Structure, Managerial Self-Dealing, and Common Agency

Vinicius Carrasco\*

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## Abstract

Corporate Boards usually come in two different shapes: unitary and dual. In the former, a single board/principal is responsible for monitoring and establishing performance targets; in the latter, these tasks are split between two boards/principals. This paper compares these two arrangements in terms of corporate performance and managerial self-dealing for a situation in which the CEO has private information. The equilibrium set of the common agency game induced by the dual board structure is fully characterized. Compared to a single board, a dual board demands less aggressive performance targets from the CEO, but exerts more monitoring. An unambiguous consequence of the first feature is that the CEO always exerts less effort toward production with a dual board. Due to the reduction in performance targets, the effect of a dual board on CEO's self-dealing is ambiguous: there are equilibria in which, in spite of the increase in monitoring, self-dealing is higher in a dual system.

“It would be a mistake for supervisory powers to be separated off in the boardroom.”  
(The Financial Times, January, 14, 2003)

“Another problem is that audit committees are evolving into mini-boards.” (The Economist,  
March 20, 2004)

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# 1 Introduction

Recent corporate scandals have drawn a great deal of attention to the potential lack of oversight over managers exercised by corporate boards. Indeed, scandals at Enron, Tyco, WorldCom among others have motivated both legislative (the Sarbanes – Oxley Act of 2002 in the U.S.) and regulatory (e.g., new corporate governance guidelines of the New York Stock Exchange) changes in corporate practice requirements, with special focus on the monitoring role to be exercised by boards of directors.

Despite the fact that monitoring the CEO is an important part of a board of directors' duties, it is widely acknowledged that, in addition to monitoring, directors also play a fundamental role in advising, developing strategy and establishing goals for the companies they serve (Lorsch and MacIver, 1989). An important question then is whether these roles are in conflict, and if so, how to design the board structure so as to maximize its effectiveness in both of these tasks.

This paper aims to provide a partial answer to this broad question by comparing the effects on corporate performance and managerial self-dealing of a switch from a situation in which the CEO reports to a single board that is responsible for both monitoring management and establishing performance targets to an alternative in which the CEO reports to two different boards, one that is responsible for monitoring the management and the other that is in charge of defining performance targets.<sup>1</sup>

Both types of arrangements are seen in practice. In fact, boards tend to be structured as either unitary or two-tiered. Unitary boards can be found in countries as the United States, England and Italy, while for countries such as Germany, Holland and Austria the two-tiered system is adopted. In the first system, all directors stand legally responsible for both managing the company's business and monitoring the CEO. In the model, this would correspond to a situation in which management reports to one principal. In a two-tier board, the managing and monitoring tasks are legally split between a board of managers and a supervisory board. A natural interpretation of this scheme is that the CEO is supposed to report to two different principals.

The relative merits of these arrangements have been the focus of much discussion among practitioners, scholars and legislators (see, for instance, Roe (1993) and Romano (1993)). The clear separation of tasks and its potential positive effect on the amount of oversight over the CEO is generally believed to be one of the most desirable features of a two-tiered system. Indeed, as there seems to be general consensus that boards tend to be too cozy with management, such a belief has induced a movement in the U.S. toward a system that resembles, *de facto*, a two-tiered one.

More concretely, in response to a string of corporate malfeasance scandals, the Sarbanes – Oxley

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<sup>1</sup>The establishment and review of performance are some of the most important duties credited to board of directors. As an example, the 2004 “OECD’s Principles of Corporate Governance” lists, as the first responsibility of a board, “the reviewing, and guiding of major plans of action, (...) and the setting of performance objectives.” (see [www.oecd.org/dataoecd/32/18/31557724.pdf](http://www.oecd.org/dataoecd/32/18/31557724.pdf))

Act of 2002 and the new Corporate Governance Rules of the NYSE specify that companies in the U.S. should have a committee exclusively responsible for the appointment, compensation and scrutiny of outside auditors.<sup>2</sup> Such a requirement is in its essence an assignment of monitoring and management activities to different entities in the boardroom. Some have been expressing concern regarding the implications of such changes in the effectiveness of corporate boards, but it is obvious that those changes have as a premise the belief that such task separation will induce more monitoring of the CEO.<sup>3</sup>

It is undeniable that, *fixing* the level of all other instruments available to align the CEO's interests to the shareholders', the more monitoring performed by the board, the better. Therefore, implicit in any argument that favors one structure over the other (in terms of the amount of monitoring it induces) is the assumption that all other "incentive" instruments are held constant. However, this is not necessarily true. In fact, it may be the case that in response to more monitoring exerted by one principal, the other principal decides to reduce the level of other instruments if they are substitutes in the provision of incentives.

Therefore, a thorough comparative analysis of the benefits and costs of making the CEO to report to one or two boards must take into account (i) the existence of a myriad of instruments to align his incentives with the shareholders', and, perhaps more importantly, (ii) that an institutional framework that assigns different roles to different principals may induce *strategic interaction* among them. These points – especially the second – seem to have been ignored on most of the theoretical and practical discussions about the optimal way to structure corporate boards.

This paper addresses explicitly some of these issues in a simple model in which a CEO can exert effort toward production (e.g., motivation of staff members, negotiation of important contracts for the company) and the pursuit of inefficient self-dealing operations (e.g., cash and asset diversion). In the model, effort toward production is unobservable. While the same is in principle true for self-dealing operations, upon monitoring/auditing the CEO, the board may find hard evidence of it with some probability. In those states, the amount of the operation can be fully recouped.

Monitoring, however, is a costly activity as it requires time, effort, and expertise. Additionally, and more related to the question the paper tries to answer, it is generally acknowledged that directors fear to be perceived as having a confrontational attitude towards the CEO.<sup>4</sup> It is reasonable, therefore, to assume that part of such cost is personal and hard to contract upon. Moreover, such an assumption

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<sup>2</sup>See, for instance, the new NYSE Corporate Governance guidelines at <http://www.nyse.com/pdfs/finalcorpgovrules.pdf>. Concomitantly, such movement has been accompanied by recommendations for, and implementation of, higher incentives for board members in charge of monitoring (see, for example, the A.T. Kearney's Corporate Governance Survey at [www.atkearney.com/shared\\_res/pdf/Corporate\\_Boards\\_S.pdf](http://www.atkearney.com/shared_res/pdf/Corporate_Boards_S.pdf)).

<sup>3</sup>Manifestations of concern abound in the popular press. See, for instance, the special report on Corporate Boards in the 03/20/2004 issue of *The Economist*.

<sup>4</sup>One of the directors interviewed by Mace (1986) puts it as follows: "You don't say everything you think at a board meeting. There is a certain amount of professional courtesy if you are going to be a good director."

incorporates the notion that the board is often “captured” by the CEO. From a modelling perspective, this cost introduces a misalignment between the shareholder’s and the board’s interests.

A measure of total revenues (which is affected by both types of efforts) is available so the board can also demand from the CEO the attainment of certain performance targets. Consequently, incentives can be “input” based (auditing/monitoring) or “output” based (Lazear (1995)). The paper analyzes how the use of both of these instruments changes when one moves from a unitary board structure to a two-tier structure.

It is often observed that the board of directors has to rely on information provided by the CEO to perform its duties (see Mace (1986), for example). As an example, if the CEO is better informed than the board about the current market conditions, it becomes harder for the board to establish performance targets that are compatible with the environment the firm is operating on (e.g., the CEO may claim to be in an adverse environment in order to justify a low output target). Hence, eliciting proper information from the management turns out to be also an important issue for corporate boards. This idea is captured in the model by assuming the CEO has private information regarding the quality of project the firm has access to.

The interaction of information asymmetry with the non-observability of effort and the possibility of the pursuit of self-dealing by management makes the problem of designing an optimal contract non-trivial for the boards. In particular, a contract that induces levels of effort and self-dealing that maximize the company’s profits will not be attained under neither of the structures.

A unitary board that decides both on monitoring and performance measures internalizes all benefits and costs of these choices. This is not optimal if they are to act on behalf of shareholders because of the non-contractible monitoring costs. In a two-tier board, each principal’s contract specifies the level of the variables under their control, and each contract must be a best response to the other. Neither board fully internalizes the effects of their choices on their peers’ payoff.

As it turns out, such externalities induce, for *all* possible equilibria of the game played among the boards, more monitoring of the CEO by the supervisory board when compared to the unitary board case. However, it is also the case that a dual structure induces less aggressive performance targets. These two features of a dual system (more monitoring and lower performance targets) are intrinsically related. This follows because, in the model, performance targets and monitoring levels are *complements* in the CEO’s utility. More monitoring, by reducing the marginal benefit of the pursuit of self-dealing, reduces his effort towards this activity. Such reduction, in turn, decreases his marginal cost to deliver more aggressive performance targets. Consequently, the supervisory board, when deciding on how much to monitor, perceives the increased performance targets the CEO is willing to deliver as an additional benefit of monitoring. This is the source of higher monitoring in a dual structure. Moreover, since targets and monitoring are *substitute* incentive instruments to preclude self-dealing, the management

board will reduce targets. Finally, this reduction reinforces the perception of an additional benefit of monitoring by the supervisory board, and the equilibrium features just described ensue.

The combination of more monitoring and lower performance targets have ambiguous consequences for self-dealing. On the one hand, for a fixed level of performance targets, the more monitored the manager is, the less self-dealing he will pursue. On the other hand, for a fixed level of monitoring, the less aggressive the demand for performance, the higher the incentive for the CEO to exert effort towards self-dealing rather than toward production. As a result, despite of the higher level of monitoring, there always exist equilibria in which the level of self-dealing *increases* for a (positive measure) set of projects in a two-tier board case relative to the unitary one.

The effect of a switch from unitary boards to two-tiered boards on productive effort is unambiguous: in *all* possible equilibria, effort will decrease with a dual structure. Therefore, an inevitable cost of splitting the tasks in the boardroom is the reduction of the amount of effort towards production. Even worse news is that such a decrease in effort towards production may be accompanied by more self-dealing.

The set-up of the model and the timing of events are described in section 2. In section 3, the model is solved for the benchmark in which the quality of the project is known to the boards. Section 4 solves the model for the unitary board case under asymmetric information. Section 5 characterizes the set of equilibria induced by the two-tiered structure and shows that an immediate comparison between monitoring levels in dual and unitary structures can be made by only looking at the supervisory board's best response to any contract offered by the management board that may arise in equilibrium. Section 6 compares both arrangements in terms of their induced amount of self-dealing, performance targets, and productive effort. Section 7 discusses the related literature and section 8 draws the concluding remarks. All proofs are relegated to Appendix A. Appendix B analyzes the cases in which, in a dual structure, the boards move sequentially and can communicate the information extracted from the CEO.

## 2 Model

The first player in the model is a CEO who works for a company endowed with a project of quality  $\theta$ . He can exert productive effort and, by virtue of his control over the company's activities, can extract resources (self-deal) from the firm. The company's revenues are assumed to be contractible and are given by  $y = \theta + e_1 - e_2$ , where  $e_1$  is the CEO's unobservable effort towards production, and  $e_2$  is the amount of resources he can allocate for self-dealing operations. There are many ways – ranging from the purchase of a corporate jet to selling output below market prices to companies they (or some acquaintances) own, from investing in unprofitable projects with empire building purposes to outright cash and asset diversion – in which managers can use their discretion to derive private benefits at the expense of shareholders. These possibilities are captured by  $e_2$  in the model. The project's quality,  $\theta$ , is

assumed to be CEO's private information.

The other players are the principals to which the CEO reports. I analyze two different arrangements. The first one has the CEO reporting to only one principal (unitary board) who cares about results (revenues net of the payments made to the CEO) but dislike monitoring. In the other arrangement, he reports to two different principals (two-tier board). Both principals are assumed to care about results but to dislike monitoring the management. More specifically, each principal maximizes revenues net of the payments she makes to the CEO and the cost of monitoring.<sup>5</sup> Their difference stems from the tasks they are assigned, and the fact that each of them make (and care about) payments contingent solely on the variables under their control.

There are many ways to motivate such preferences. First, there is extensive evidence that board members tend to be captured by the CEO, or that directors fear to be perceived as having a confrontational attitude toward management (Mace (1971), Lorsch and MacIver (1989)), so it seems reasonable to assume they dislike monitoring.<sup>6</sup> Moreover, as specified in any Board Charter, board members should act on behalf of shareholders. This along with the fact that a huge chunk of director's benefit is related to morale, prestige and the possibility of being appointed as a board member for several companies (Mace (1986)) would justify their concern with the results of the firm. Finally, the justification for, in a dual board system, the principals caring solely about the payments they make could also be related to career concerns. The "market evaluation" of, say, a member of the management board will be relatively more sensitive to the outcomes of the variables he has a say on (performance targets in this case) so it seems natural to assume that he will be more willing to focus on providing incentives for that activity when compared to a Supervisory Board member, and vice-versa.<sup>7</sup>

Regarding the two types of effort the CEO can exert,  $e_1$  and  $e_2$ , a fundamental distinction between them is that, upon monitoring/auditing the CEO, the board can recoup part of the resources associated with the self-dealing operation. More specifically, I assume that there exists a continuum of auditor's types  $p \in [0, 1]$ . Upon hiring an auditor of type  $p$ , the board finds hard evidence of self-dealing operation

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<sup>5</sup>Note that this changes the social surplus when one moves from a unitary to a dual board. The same would happen, however, if both boards were to care about the sum of payments made to the CEO. The paper's focus is on the shareholders' welfare for which the relevant measure (profits) is – of course – invariant to the board structure. Additionally, the results would be the same for situations in which the social surplus is held fixed across arrangements and the supervisory board's stake on  $y$  is large enough. In fact, what is important for the results is that the supervisory board cares about output, which is in line with the trend towards providing steeper incentives for board members.

<sup>6</sup>The assumption that even the board who sets targets dislike monitoring can be justified in terms of directorship interlocking (Lorsch and MacIver, 1989). A director who has the CEO of the firm he is serving for as board member of the company he manages may dislike monitoring on the grounds that this may induce more watchful policies in the company he manages.

<sup>7</sup>Dewatripont et al (1999), for instance, argue formally about the potential benefits of "focus" in career concern models a la Holmstrom (1999).



with that probability. Moreover, if hard evidence is found, the resources can be fully recouped.<sup>8</sup>

The tougher the auditor hired by the board, the higher the (personal) cost incurred by the boards. For simplicity, I assume this cost to be given by  $\frac{p^2}{2}$ , and I take the monetary cost of hiring an auditor (e.g., payments to be made) as being the same irrespective of  $p$  and equal to zero. Throughout the paper, I will refer to the choice of the auditor type as the monitoring level proposed by the board.

Regarding the project, the boards view its quality as being distributed over the interval  $[\underline{\theta}, \bar{\theta}] \subseteq (0, 1]$  according to the c.d.f.  $F(\theta)$ , with corresponding density  $f(\theta)$ . Throughout the analysis, it will be assumed that the distribution satisfies

(A1)  $f(\theta)$  is strictly log concave and differentiable, and

(A2)  $f(\underline{\theta}) \geq 1$

The first part of (A1) implies that  $\frac{1-F(\theta)}{f(\theta)}$  is strictly decreasing in  $\theta$  (Bagnoli and Bergstrom, 1989), which guarantees the satisfaction of a monotonicity condition in the unitary board case. Differentiability is used to characterize the equilibrium set of the common agency game induced by the two-tier system. (A2) suffices to assure that, for the unitary board case, all non-negativity constraints are satisfied and to allow for a clear-cut global comparison of the policies induced by the two different arrangements under analysis.

The CEO's preferences over payments, efforts and monitoring levels are represented by

$$V(w, p, e_1, e_2) = w + (1 - p)e_2 - \frac{e_2^2}{2} - \frac{e_1^2}{2},$$

where  $w$  is the total pay made to him by the principals. There are two implicit assumptions in the specification of the manager's preferences that deserve being mentioned.

The first of them is that there are no exogenous outside punishments (e.g., going to jail) for being caught pursuing self-dealing operations. The realism of such assumption is clearly contingent on the nature of corporate malfeasance.<sup>9</sup> As argued above, there is a whole range of types of private benefits a manager can generate upon being in control. While for some of those it is unlikely that, even if caught, the CEO will incur in such penalties, for others (outright theft, for example) the same is not true. However, such outside punishments tend to be lump-sum. As I am concerned with the *level* of corporate malfeasance, as long as expected outside punishment is not big enough, such an assumption is inessential.

The second assumption, coming from the term  $-\frac{e_2^2}{2}$  in his preferences, is that effort towards corporate

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<sup>8</sup>With such hard evidence, shareholders could go to court and try and overturn the business decision associated with  $e_2$ . In fact, as described by Hopt (1992, p. 139), "the remedy most commonly sought against someone who is considered to have breached his fiduciary obligations to his company is an account and payment of the profits derived from his allegedly improper conduct. Sometimes a claim is laid to particular assets in his hands, or even to the entirety of a business developed from the infringing activity on the basis of a constructive trust."

<sup>9</sup>Although Hopt's (1992) quote again provides a justification for the assumption made.

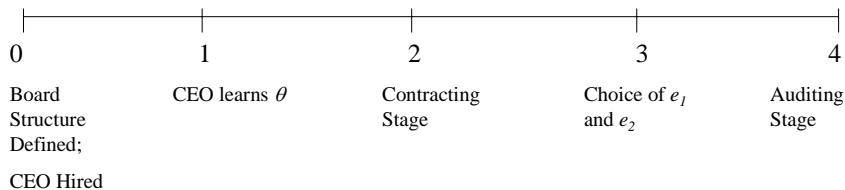
malfeasance is inefficient. If self-dealing was neutral from an efficiency point of view, the possibility of its pursuit by the CEO would pose no substantial problems for the board(s). Indeed, one could allow the CEO to perform as much self-dealing as he wanted and reduce his pay by the exact same amount.

## 2.1 Timing of Events and The Contract Space

The timing of the events is depicted in figure 1. Initially, at period zero, the firm is set, the board structure is defined, and a CEO is hired. In period 1, the CEO learns privately the quality,  $\theta$ , of the project.

In period 2, if the board structure is unitary, a unique set of contracts  $\{w(y, p), y, p\}_{y \in R, p \in [0,1]}$ , specifying payments, monitoring levels and performance targets, is offered to the CEO. In case the board structure is two-tier, two set of contracts are offered:  $\{t^m(y), y, \}_{y \in R}$  by the management board and  $\{t^s(p), p\}_{p \in [0,1]}$  by the supervisory board, where, respectively,  $t^m(y)$  and  $t^s(p)$  are the payments made to the CEO upon the latter compromising delivering  $y$  and accepting being monitored with intensity  $p$ .<sup>10</sup>

Figure 1: Sequence of Events



The CEO picks the contracts that fit him better in period 3 (in the two-tier structure, he *must* contract with both principals, i.e., the model is one of intrinsic common agency (Bernheim and Whinston (1986)) and then chooses how much to pursue of effort towards production and self-dealing taking into account his performance target compromise,  $y$  and the fact that he will be monitored with intensity  $p$ . Payments are made in the end of the period when  $y$  is made public.

In period 4, the auditor hired by the board monitors and finds hard evidence of corporate malfeasance with probability  $p$ . The amount self-dealt is fully recouped in such case.

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<sup>10</sup>Obviously, the supervisory board can, in principle, *impose* a certain monitoring level and make no payments whatsoever to the CEO as long as his participation constraint is kept satisfied.

### 3 The CEO's Induced Cost Function and a Useful Benchmark

To solve the model, it is convenient to start with the CEO's problem of choosing the amount of efforts in period 3 once he has committed to deliver  $y$  in revenue and knows he will be monitored with intensity  $p$ . He chooses both efforts to minimize his total costs net of his expected self-dealing benefits subject to being able to deliver  $y$

$$\min_{e_1, e_2} \frac{e_1^2}{2} + \frac{e_2^2}{2} - (1-p)e_2$$

$$s.t. \ y = \theta + e_1 - e_2.$$

Substituting  $e_1$  from the constraint in the objective function, his induced cost to provide  $y$  in targets when the monitoring intensity is  $p$ , is

$$c(y, p; \theta) = \min_{e_2} \frac{(y + e_2 - \theta)^2}{2} + \frac{e_2^2}{2} - (1-p)e_2.$$

The amount of self-dealing pursued is given by

$$e_2(p, y; \theta) = \begin{cases} \frac{1-p+\theta-y}{2}, & \text{if } y \leq 1-p+\theta \\ 0, & \text{otherwise} \end{cases}$$

It follows that, in period 1, the board(s) can choose the incentive instruments treating the CEO as if he had utility function  $w - c(y, p; \theta)$ . An important feature for the analysis to follow is that the CEO's marginal cost of providing performance targets is decreasing in monitoring levels, i.e., targets and monitoring are *complements* in his (induced) preferences. This is because an increase in monitoring induces a lower pursuit of self-dealing which decreases the CEO's marginal cost to deliver  $y$ .

#### 3.1 Symmetric Information

In order to understand better the forces at play in the model, and, in particular, the difficulties faced by the boards in inducing both high effort and no self-dealing from the CEO, it is worth analyzing the model for the case in which the quality of the project is known by the boards. In this case, irrespective of its structure, the board(s) can contract with the CEO in a way that attains the highest possible level of profits despite of the costly monitoring. In fact, it turns out not to be necessary to monitor the CEO when  $\theta$  is known.

To see this, consider first the unitary board's case. When the quality of the project is known, normalizing the CEO's outside option to zero, its problem is one of maximizing  $y + pe_2(p, y; \theta) - w - \frac{e_2^2}{2}$  subject to  $w - c(y, p; \theta) \geq 0$ . It is optimal to set wages so that the constraint holds with equality. Hence,

the problem becomes

$$\max_{y,p \geq 0} y + pe_2(p, y; \theta) - c(y, p; \theta) - \frac{p^2}{2}.$$

The solution to this problem entails  $y = 1 + \theta$  and  $p = 0$ . Such combination, while sparing the boards from the cost of monitoring the CEO, induces no self-dealing and a profit maximizing level of productive effort. A widely known interpretation of this outcome is that the firm is “sold” to the CEO (for the wage that induces this combination of performance targets and monitoring and leaves no rents for the CEO is given by  $y - \theta - \frac{1}{2}$ ). Being the residual claimant of the firm’s revenues, he will decide not to self-deal, so the monitoring instrument will not have to be used. Intuitively, the possibility of selling the firm to the CEO should not depend on the way the board is structured. In fact, one can verify that  $y = 1 + \theta$  and  $p = 0$  also constitutes an equilibrium in a two-tier board system.

**Proposition 1** *If the quality of the project is known by the boards, the chosen contract by a unitary board attains the highest possible level of profits for the company, and no self-dealing. Moreover, for the two-tier board case, there is always an equilibrium that mimics the unitary board’s outcome.*

A setting with private information introduces two new effects. First, as the board is forced to rely on the CEO’s information to set targets, it is optimal to distort down the level of targets in a unitary system. This distortion introduces an endogenous motive for monitoring: for the same amount of monitoring exerted in the full information case, namely  $p = 0$ , a reduction in the demanded performance induces positive self-dealing and, as a consequence, a benefit for monitoring. Putting somewhat differently, as performance targets and monitoring are substitute instruments to preclude self-dealing, the reduction of the former introduces the need for the latter. Second, a structure that separates the board’s duties will always introduce a non-trivial strategic interdependence between the management and the supervisory boards. This will make the policies chosen under each structure different in all circumstances. Therefore, the board structure “irrelevance” result breaks down when the CEO has private information.

## 4 Asymmetric Information: The Unitary Board Case

Under asymmetric information, when the board structure is unitary, matters are relatively simple. By the Revelation Principle, one can restrict attention to direct mechanisms in which the CEO reports a project quality  $\hat{\theta}$  to the principal and is demanded to attain  $y(\hat{\theta})$ , monitored with intensity  $p(\hat{\theta})$ , and receive a payment of  $w(\hat{\theta})$ .

The board’s problem can be written as

$$\max_{\{y(\theta), p(\theta), w(\theta)\}} E(y(\theta) + p(\theta)e_2(p(\theta), y(\theta); \theta) - w(\theta) - \frac{p(\theta)^2}{2}), \text{ s.t.}$$

$$\begin{aligned}
U(\theta) &= w(\theta) - c(y(\theta), p(\theta); \theta) \geq w(\hat{\theta}) - c(y(\hat{\theta}), p(\hat{\theta}); \theta) \text{ for all } \theta, \hat{\theta} \\
U(\theta) &= w(\theta) - c(y(\theta), p(\theta); \theta) \geq 0 \text{ for all } \theta \text{ and } p(\theta) \in [0, 1].
\end{aligned}$$

When compared to the symmetric case, the board faces a new set of constraints: it must be in the CEO's best interest to report the true project quality rather than any other. An application of the Envelope Theorem (Milgrom and Segal, 2002) along with a single crossing condition that the CEO's utility satisfies allows one to replace these constraints by

$$U(\theta) = U(\underline{\theta}) + \int_{\underline{\theta}}^{\theta} (y(\tau) + e_2(p(\tau), y(\tau); \tau) - \tau) d\tau, \quad (1)$$

and  $y(\theta) - p(\theta)$  being non-decreasing in  $\theta$ .

Using (1), one can see that

$$w(\theta) = U(\underline{\theta}) + \int_{\underline{\theta}}^{\theta} (y(\tau) + e_2(p(\tau), y(\tau); \tau) - \tau) d\tau + c(y(\theta), p(\theta); \theta).$$

Substituting this in the objective function, integrating by parts, and noting that participation is guaranteed whenever the CEO with the worst project gets non-negative utility, the board's program becomes

$$\begin{aligned}
&\max_{\{y(\theta), p(\theta)\}, U(\underline{\theta})} E_{\theta}(y + pe_2(p, y; \theta) - c(y, p; \theta) - (U(\underline{\theta}) + \frac{(1 - F(\theta))}{f(\theta)}(y + e_2(p, y; \theta) - \theta) - \frac{p^2}{2}) \\
&\text{s.t. } U(\underline{\theta}) \geq 0, \quad y(\theta) - p(\theta) \text{ non-decreasing in } \theta \text{ and } p(\theta) \in [0, 1].
\end{aligned}$$

It is optimal to set  $U(\underline{\theta})$  equal to zero. Moreover, ignoring the other constraints and maximizing the objective pointwise, one has, using (A1), and (A2)

**Proposition 2** *Under a Unitary Board, the optimal contract specifies*

$$(i) \quad y(\theta) = 1 + \theta - \frac{(1 - F(\theta))}{f(\theta)}$$

$$(ii) \quad p(\theta) = \frac{(1 - F(\theta))}{3f(\theta)}$$

*The induced amount of self-dealing is  $e_2(p(\theta), y(\theta); \theta) = \frac{(1 - F(\theta))}{3f(\theta)} > 0$  for all  $\theta \in [\underline{\theta}, \bar{\theta}]$ .*

The contract offered by the board induces positive self-dealing whenever the project quality is not the highest one. The interpretation for this is that the eliciting of information requires the provision – through a higher wage – of some rents to the CEO. To reduce the size of such rents, the board demands from management less aggressive performance targets. This, in turn, reduces the CEO's marginal cost to pursue self-dealing. The remaining instrument to preclude self-dealing is monitoring. However, monitoring is costly from the board's perspective.

From the point of view of the shareholders, a unitary board exerts a sub-optimal amount of oversight over the CEO. If the shareholders were in charge of hiring the auditor themselves, they would rather, taking as fixed the performance targets set by the board, increase the monitoring to some level in the range  $[\frac{1-F(\theta)}{f(\theta)}, 1]$  to preclude self-dealing altogether.<sup>11</sup>

The latter point has triggered some discussion on the potential benefits of moving to a dual system, and, more importantly, a whole set of new rules intended to increase the oversight over the management in the U.S. Most of these changes have as a practical consequence the separation of management and supervisory tasks to different bodies in the boardroom, much as in a two-tier board scheme. The next section analyses, using the above model, some possible consequences of these changes.

## 5 Asymmetric Information: The Two-Tier Board Case

Solving the model for the two-tier board case involves some additional complications. The main issue is that the principals must be offering menus of contracts that are mutual best responses. The strategic link among boards comes from the preferences of the CEO; more specifically, from the induced cost function  $c(y, p; \theta)$ . Whenever the CEO's optimal choice of efforts involves positive self-dealing, his utility function depends in a non-separable way on both  $y$  and  $p$ . In such case, the contract he is willing to take from the supervisory board will depend on the contract offered by the management board and vice-versa. A slight complication in my setting is that whether or not the amount of self-dealing is positive *depends*, in turn, on the contracts offered by the boards. In other words, the possibility of strategic interaction is endogenous and related to the CEO's hidden actions. It turns out, however, that a two-tier structure does not preclude self-dealing.

**Proposition 3** *For (almost) all projects of quality  $\theta \in [\underline{\theta}, \bar{\theta})$ , the CEO will be pursuing self-dealing in equilibrium.*

Proposition 3 guarantees that, given an atomless density function  $f(\theta)$ , one can focus without loss on equilibria in which self-dealing is pursued for all  $\theta \in [\underline{\theta}, \bar{\theta})$ . The Proposition's result follows because any pair of contracts that induces no self-dealing from the CEO generates an incentive for at least one of the boards to "free-ride" on the other. As an illustration, the best response from the supervisory board to a menu of contracts offered by the management board that does not induce self-dealing is not monitor at all. But if the supervisory board does not monitor, it can never be optimal for the management board to demand targets that induces no corporate malfeasance, as this would imply that too much rent is left to the CEO.

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<sup>11</sup>There are many reasons why shareholders may not be able to monitor the CEO themselves (or, more realistically, impose contractually on the board auditing standards that would correspond to more monitoring of the top management). In my view, the most compelling are their potential lack of expertise and atomicity.

On top of the intrinsic difficulties related to finding a profile of mutual best responses, the strategic interdependence brings a major practical complication: the restriction to Direct Revelation Mechanisms is with loss of generality. However, as shown by Martimort and Stole (2002), an extension of the Taxation Principle (see, Salanie, 1997) – the Delegation Principle –, applies and the whole equilibrium set can be computed using a fairly simple methodology. The next section, by considering each of the boards' problem, describe briefly such methodology for the present model.

## 5.1 The Boards' Problems

The main idea is to consider individually each of the principal's problem for a fixed set of contracts offered by the other. In such case, under some assumptions that have to be checked in equilibrium, the methodology used in the single board case fully applies and the problem reads exactly as a single principal's one.

Consider the supervisory's board problem. Letting  $\{t^m(y), y\}_{y \in \mathfrak{R}_+}$  be a menu of contracts offered by the management board, the CEO will choose among them the one that maximizes his utility. As a consequence, it is as if the supervisory board had to deal with a CEO with preferences given by

$$\Phi(t^s, p; \theta) = t^s + \phi(p; \theta), \quad (2)$$

where  $\phi(p; \theta) = \max_y t^m(y) - c(y, p; \theta)$ , and  $y(p; \theta)$  is the solution to this program. Therefore, for a *fixed* set of contracts offered by the other board, the supervisory board's problem is exactly the same as the one of a single principal deciding *only* on monitoring and facing a manager with preferences described by (2). In particular, the Revelation Principle fully applies and attention can be restricted to Direct Mechanisms of the form  $\{p(\hat{\theta}), t^s(\hat{\theta})\}_{\hat{\theta}}$ .

Defining  $\Phi(\theta) = \max_{\hat{\theta}} \Phi(t^s(\hat{\theta}), p(\hat{\theta}), \theta)$ , and using the Envelope Theorem, incentive compatibility is, under the assumption that  $\phi_{\theta p} \geq 0$ , equivalent to

$$\Phi(\theta) = \Phi(\underline{\theta}) + \int_{\underline{\theta}}^{\theta} (y(p(\tau); \tau) + e_2(p, y(p(\tau); \tau); \tau) - \tau) d\tau \quad (3)$$

and  $\frac{dp(\theta)}{d\theta} \geq 0$ . It is important to notice that the single crossing condition ( $\phi_{p\theta} \geq 0$ ) needed to replace the incentive compatibility constraints by the above two conditions is now endogenous: it depends on the set of contracts offered by the management board, and has to be checked in equilibrium.

Ignoring this issue for now, and proceeding exactly in the same fashion as in the unitary board case (i.e., integrating condition (3) by parts and substituting  $t^s(\theta)$  in the objective function, as well as imposing  $\Phi(\underline{\theta}) = 0$ ), the board's problem becomes

$$\max_p E(y(p; \theta) + p e_2(y(p; \theta), p; \theta)) + \phi(p; \theta) - \frac{(1 - F(\theta))}{f(\theta)} (y(p; \theta) + e_2(y(p; \theta), p; \theta) - \theta) - \frac{p^2}{2}.$$

The first order necessary condition for optimality is given by

$$\frac{dy(p;\theta)}{dp} \left[ 1 - \frac{p}{2} - \frac{(1-F(\theta))}{2f(\theta)} \right] - \frac{3}{2}p + \frac{(1-F(\theta))}{2f(\theta)} = 0. \quad (4)$$

When compared to the unitary case, the expression  $\frac{dy(p;\theta)}{dp} \left[ 1 - \frac{p}{2} - \frac{(1-F(\theta))}{2f(\theta)} \right]$  is added to the optimality condition. The term  $\frac{dy(p;\theta)}{dp}$  is positive – since  $\frac{\partial^2 c(y,p;\theta)}{\partial y \partial p} < 0$  –, reflecting the fact that the CEO is willing to pick a more aggressive performance target from the menu offered by the management board if the supervisory board monitors more. This is perceived, from the supervisory board’s part as an additional benefit of monitoring. The term  $-\frac{dy(p;\theta)}{dp} \left[ \frac{p}{2} + \frac{(1-F(\theta))}{2f(\theta)} \right] < 0$  captures the overall increase in the costs incurred by the supervisory board due to the more aggressive targets induced by a higher monitoring. Under (A2), the costs are smaller than the benefits for all possible  $\theta$ .

**Proposition 4** *In response to any set of contracts  $\{t^m(y), y\}_{y \in \mathfrak{R}}$  offered by the management board that may arise in equilibrium, the monitoring exerted by the supervisory board will be strictly larger than the one in the unitary structure.*

Hence, the externalities introduced by the separation of tasks in the boardroom are such that the CEO is watched more closely in a dual structure in any possible equilibrium. Interestingly, this result is solely a consequence of the separation of tasks in the boardroom.

Now consider the management board’s problem. Following the same steps as the ones above,<sup>12</sup> its first order necessary condition for optimality when taking as fixed a menu of contracts  $\{t^s(p), p\}_{p \in [0,1]}$  is given by

$$1 - \frac{p(y, \theta)}{2} - (y + e_2(p(y, \theta), y); \theta) - \theta) - \frac{(1-F(\theta))}{2f(\theta)} + \frac{dp(y; \theta)}{dy} \left[ \frac{(1-F(\theta))}{2f(\theta)} + e_2(p(y, \theta), y); \theta) - \frac{3p(y, \theta)}{2} \right] = 0. \quad (5)$$

The externalities among the boards are reflected in  $\frac{dp(y; \theta)}{dy} \left[ \frac{(1-F(\theta))}{2f(\theta)} + e_2(p(y, \theta), y); \theta) - \frac{3p(y, \theta)}{2} \right]$ . In contrast to the supervisory board case, this term cannot be signed without additional equilibrium considerations.

## 5.2 Equilibrium

Equations (4) and (5) describe the optimality condition for each board given the set of contracts proposed by the other. The main steps to derive an equilibrium are (i) find the forms of both  $\frac{dy(p;\theta)}{dp}$  and  $\frac{dp(y;\theta)}{dy}$  – which measure, respectively, how the optimal choice of performance (monitoring) by the CEO responds to an increase in the monitoring (performance) level exerted (requested) by the supervisory (management)

<sup>12</sup>That is, fixing  $\{p, t^s(p)\}_{p \in [0,1]}$ , letting  $\psi(y; \theta) = \max_p t^s(p) - c(y, p; \theta)$ , and  $p(y; \theta)$  be its solution. One can proceed as if the CEO had preferences given by  $t^m(y) + \psi(y; \theta)$  and follow the steps just described.



board – when those are evaluated in equilibrium, and (ii) to verify whether the single crossing conditions *a priori* assumed to replace the incentive compatibility constraints by the “first order” and monotonicity conditions for truthtelling hold in the candidate equilibria. In Appendix A, the following characterization of the equilibrium set is derived.

**Proposition 5** *Any equilibrium in the two-principal game solves the system of differential equations defined by*

$$\frac{\dot{y}(\theta)}{\dot{p}(\theta) + 1} \left[ 1 - \frac{p}{2} - \frac{(1 - F(\theta))}{2f(\theta)} \right] - \frac{3}{2}p + \frac{(1 - F(\theta))}{2f(\theta)} = 0$$

$$1 - \frac{p}{2} - (y + e_2(p, y); \theta) - \theta - \frac{(1 - F(\theta))}{2f(\theta)} + \frac{\dot{p}(\theta)}{\dot{y}(\theta) - 1} \left[ \frac{(1 - F(\theta))}{2f(\theta)} + e_2(p, y); \theta - \frac{3p}{2} \right] = 0$$

for boundary conditions defined by  $e_2(\bar{\theta}) = 0$  and some  $p(\bar{\theta})$  bounded below by  $\frac{1}{2}$  and above by 1. Conversely, any solution of the system with such boundary conditions satisfying  $p(\underline{\theta}) \geq \frac{1}{2}$  is an equilibrium.

## 6 The Effects of Splitting the Board’s Duties

### 6.1 The Effects on Targets and Productive Effort

The different equilibria in the dual structure are indexed by the amount of monitoring exercised over the CEO with the best project,  $p(\bar{\theta})$ . In a unitary board, such a CEO is not monitored at all. This is so because, given the performance target demanded from the CEO who reports to have access to the highest quality project,  $1 + \bar{\theta}$ , monitoring is not needed. The reason is clear: for such a high performance target, the CEO’s marginal cost of pursuing self-dealing  $e_2$  is  $1 + 2e_2$ , while the marginal benefit is  $1 - p$ . The marginal cost is (weakly) larger than the benefit for all  $p$ , and  $e_2$ . Therefore, positive self-dealing will not be pursued irrespective of the monitoring exerted by the board. Since monitoring is costly, the board optimally chooses to give full discretion to the CEO.

In a two-tier system, on the other hand, the supervisory board will be watching the CEO with the highest quality project with intensity  $p(\bar{\theta}) > 0$ . It is illuminating to understand why this is so and interpret it as an implication of free-riding from the management board’s part. When facing a CEO of type  $\bar{\theta}$ , the supervisory board considers, as a benefit, that an increment in monitoring will induce the CEO to take a contract with the management board that demands more aggressive performance targets. This is captured by the expression  $\frac{dy(p(\bar{\theta}); \bar{\theta})}{dp} \left[ 1 - \frac{p(\bar{\theta})}{2} \right]$ . Such expression is strictly positive because the management board will demand, in any equilibrium, exactly  $y(\bar{\theta}) = 1 - p(\bar{\theta}) + \bar{\theta}$ , so that a CEO with a project of quality  $\theta$  close to  $\bar{\theta}$  will be pursuing positive self-dealing. Put somewhat differently, the perceived benefit that induces positive monitoring from the type  $\bar{\theta}$  CEO exists only because the

management board free-rides on monitoring and demands less aggressive results in the first place. If the boards could move to a situation in which higher performance targets, say  $y(\bar{\theta}) = 1 + \bar{\theta}$ , were demanded of (and, accordingly, less oversight were exerted on) the type  $\bar{\theta}$  CEO, some of the effects discussed below would not prevail. Yet such an outcome cannot happen in equilibrium because this would require, for types nearby  $\bar{\theta}$ , a combination of policies inducing no self-dealing. Proposition 3 rules this out.

This free-riding problem does not impede the boards to preclude self-dealing from a CEO with project  $\bar{\theta}$ . However, as performance targets is the only force able to induce effort towards production for a CEO with project  $\bar{\theta}$ , such CEO will be exerting less effort in a two-tier board than in a unitary board. It turns out that the level of performance targets in a two-tier system is, in any equilibrium, always smaller than for a unitary board. As consequence, the effort towards productive activities will always be smaller for a two-tier board. More explicitly, letting,  $y^{1P}$  and  $y^{2P}$ , and  $e_1^{1P}$  and  $e_1^{2P}$  be, respectively, the levels of performance targets and effort towards production in the unitary and two-tiered structures

**Proposition 6** *Irrespective of the equilibrium considered in the two-principal case,  $y^{1P}(\theta) \geq y^{2P}(\theta)$  for all  $\theta$ . The latter implies that  $e_1^{2P}(\theta) < e_1^{1P}(\theta)$  for all  $\theta$ .*

Therefore, the model suggests that an unavoidable outcome of splitting the tasks in the boardroom is the demand of lower performance targets and the resulting reduction of the amount of effort towards production.

## 6.2 The Effects on Self-Dealing

One could argue that the resulting reduction in the level of productive effort exerted by the CEO in a dual system is an unfortunate, but necessary, cost to be incurred in order to reduce the amount of inefficient corporate malfeasance. In fact, it could be claimed that the cost in terms of lower performance targets has as a positive counterpart the increase in the amount of monitoring exerted by the directors.

This reasoning, however, ignores that the demanded performance targets affect the marginal cost of pursuing self-dealing. On the one hand, for a fixed level of monitoring, the less aggressive the demand for performance, the higher the incentives for the CEO to pursue self-dealing. On the other hand, by Proposition 4, the Supervisory Board monitors more the CEO and for a fixed level of performance target, the more monitored the manager is, the less self-dealing he has incentives to pursue. On intuitive grounds, it seems that the overall effect on self-dealing should be ambiguous.

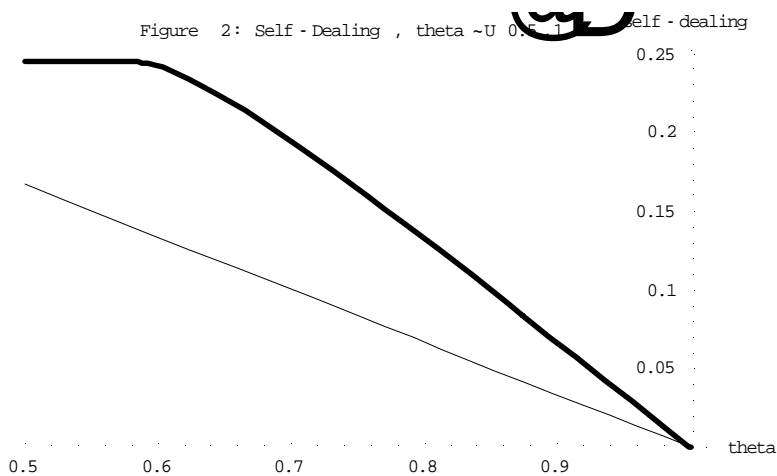
**Proposition 7** *In any equilibrium in which  $p(\bar{\theta}) > \frac{3}{5}$ , there exists  $\theta^* \in [\underline{\theta}, \bar{\theta}]$  such that  $e_2^{2P}(\theta) > e_2^{1P}(\theta)$  for  $\theta \in (\theta^*, \bar{\theta}]$ . For equilibria in which  $p(\bar{\theta}) \leq \frac{3}{5}$ , the amount self-dealt in a two-tier system is smaller than in a unitary one for at least a subset of projects.*

The interesting fact about the above result is that equilibria associated with *higher* monitoring levels are the ones that seem to induce more corporate malfeasance. This indicates that a thorough analysis

of the benefits of having the CEO being monitored more closely must necessarily take into account the induced (equilibrium) responses in the use of other instruments available to align his interests to the shareholders'. This point is particularly relevant for an institutional framework that assigns the control over different incentive instruments to different and independent bodies as in a dual board system, or as has been the case in the U.S. regarding transforming the audit committees into “mini-boards” as suggested by the quote in the beginning of the paper.

As an illustration of Proposition 7, Figure 2 plots the levels for corporate malfeasance for the case in which  $\theta$  is uniformly distributed over  $[0.5, 1]$  and the monitoring of the CEO with project quality 1 is  $p(1) = \frac{2}{3}$ . Note that, for such case, the amount self-dealt in a two-tier structure (the darker line) is higher than the amount self-dealt in a unitary system for *all* projects.

The discussion so far has focused on the induced amounts of productive effort and self-dealing under both institutional frameworks. Regarding profits, it is easy to see that when the project quality is  $\bar{\theta}$ , the profit induced by a one-principal structure is higher than the one in a two-principal as both structures induce no self-dealing and the former induces the profit maximizing amount of productive effort. A continuity argument guarantees that the same is true for all  $\theta$  close to  $\bar{\theta}$ . Unfortunately, as of yet, I have not been able to characterize the relationship of profit levels for the other possible  $\theta$ 's, in order to make a global ranking of expected profits.



However, I conjecture that the unitary board always fares better than the two-tiered one regarding profits. In fact, I have not been able to provide a numerical example for  $\theta$  uniformly distributed in which a two-tier board generates higher expected profits.

## 7 Related Literature

This section compares my findings to the ones in related papers. Starting with the common agency literature, my model differs from Bernheim and Whinston (1986) in two ways. First, it is assumed that the principals cannot make side-payments contingent on all the relevant variables. This assumption implies that, in the full information benchmark, the outcome that maximizes the principals' surplus cannot be attained in equilibrium. In particular, the outcome which is the closest to the one associated with "truthful equilibrium" in their paper is the one that resembles the unitary board's outcome in Proposition 1. Second, the bulk of the analysis of the present paper departs from theirs (and from a series of papers that followed as Grossman and Helpman (1994), Dixit et al (1997), and others) by analyzing the case in which the agent possesses private information.

The analysis of common agency games with asymmetric information was pioneered by Martimort (1996), Stole (1991), and Martimort and Stole (2002, 2003). Focusing on non-linear pricing games, these papers aim to understand how direct and indirect externalities among principals affect the size and the direction of the distortions in the allocations when compared to monopolistic settings. The objective of the present paper is obviously analogous in the sense that it compares how the use of incentive instruments is affected by their control being in the hands of one or two principals. There are two aspects in which the paper's setting differ from theirs however. First, the agent in the model can take hidden *actions* on top of being better informed than the principal about a hidden *characteristic*. In fact, the externalities among the principals arise *endogenously* as consequence of the model's multi-task structure. Second, the two incentive instruments enter both the principals' and the agent's utility function in an asymmetric fashion. The analysis of asymmetric equilibria is, therefore, the only natural one. The asymmetric equilibria analysis yields as distinguishing results (i) the level of the incentive instruments moves in different directions when compared to a single principal case, and, more interestingly, (ii) the input based instrument is the one which is used more intensely.

In the theoretical literature on corporate boards, most of the papers seek to understand why passive boards arise so their focus is mainly on the boards' monitoring task. Hermalin and Weisbach's (1998) seminal paper provides a setting in which the board's independence is endogenously determined in a bargaining game with the CEO. A "high ability" CEO has greater bargain power, and can impose a less independent board which exerts a lower amount of monitoring. In their paper – as in all others that follow – monitoring refers to inferring the manager's (ex-ante unknown to all players, including the CEO) ability to run the company's business. In my setting, the equivalent of the information regarding the CEO's ability is extracted through the offered menu(s) of contracts. Also, monitoring refers to finding out about a particular action taken by the CEO. In contrast to their paper, I take as given the degree of the boards' independence, and focus on the analysis of how the use of monitoring and performance targets to align the CEO's interests with the shareholders' interact in a unitary system, and how the use

of those instruments changes when one moves to a dual board structure.

In Almazan and Suarez (2003), a weak board is complementary to low incentive pays to the CEO and may thus arise as the overall cost minimizing incentive structure of a company. In my model, less monitoring is complementary to a *higher* incentive pay. A dual structure, by increasing monitoring induces (through the demand of less aggressive targets) less powerful incentive pay. While saving on accounting costs, low incentive pay diverts the CEO's effort from production to self-dealing operations which are costly for the firm.

Adams and Ferreira (2004) analyze the board's dual role as advisors and monitors of management. In their model, the board may pre-commit to a reduced amount of monitoring to induce information sharing which improves the decision regarding the pursuit of a project. In my model, in contrast, the monitoring activity, by reducing the CEO's marginal cost of delivering targets, improves the managerial activities – productive effort – so that a pre-commitment of a *unitary* board to perform more monitoring can only improve matters. The possibility of assigning the right to fire the manager (the monitoring task) to an entity who does not have an advisory role – a dual structure – is considered in their paper. This assignment solves the information disclosure problem but brings the possibility of a less effective monitoring policy since a signal regarding the CEO's ability becomes unavailable to the monitoring entity. The opposite holds in this paper: separation harms the executive activity the board performs, but increases monitoring.

Finally, Hermalin (2004) considers the potential implications of a trend toward more diligent boards on variables as the CEO tenure and compensation, and the external hires as CEOs. In this paper, I consider how the trend towards a separation of tasks in the boardroom affects the CEO's monitoring, the company's performance and the pursuit of self-dealing activities.

## 8 Concluding Remarks

This paper aimed to provide a first step towards answering the question of how one should optimally design corporate boards by comparing a setting in which the CEO reports to a single principal who is responsible for both monitoring management and establishing performance targets to one in which the CEO reports to two different principals, one who is responsible for monitoring the management and the other who is in charge of defining performance targets.

The main results are as follows. When compared to the unitary board case, a two-tier system will result in (i) more monitoring and (ii) less aggressive performance targets demanded from the CEO. The latter result implies that (iii) in all possible equilibria, productive effort will be smaller in a dual system. Finally, (i) and (ii) imply that (iv) the impact of a dual system on managerial self-dealing is ambiguous: there are equilibria in which the amount self-dealt is *higher* in a two-tier system. Therefore,

the separation of tasks in the boardroom and the concomitant provision of incentives for the monitors may have perverse consequences on both productive effort and self-dealing in spite of the increase in monitoring.

A few final words about the robustness of these results seem in order. First, the main force behind the results is the complementary fashion in which the incentive instruments enter the CEO's induced preferences. Arguably, this feature should be present in most incentive problems: the more residual claimant of a firm's results a manager is made, the more willing he is to be monitored. In other words, the monitoring instrument only goes against a manager's interests if his interests and the firm's are apart. Hence, the results don't seem too dependent on the specific functional forms assumed for the effort costs. In particular, as long as the marginal cost of one effort is not too decreasing in the other, targets and monitoring levels would still be complements in the CEO's preferences. Second, no assumption regarding a possible technological advantage in monitoring brought by a dual structure was made. So long as the marginal cost of positive monitoring is kept positive, such an assumption would only *reinforce* the results. In fact, due to the additional technological motive for monitoring, it would be more likely that equilibria as in Proposition 7 would arise. Finally, Appendix B shows that, neither by making the boards move sequentially, nor by allowing one of the boards to communicate the information extracted from the CEO to the other, matters can improved for the two-tier structure when compared to the unitary case.

## 9 Appendix A: Proofs

**Proof of Proposition 1:** The first order (necessary and sufficient) optimality conditions for the program in the text are

$$\begin{aligned} e_2(p, y; \theta) - \frac{p}{2} - e_2(p, y; \theta) - p &= 0 \\ 1 - \frac{p}{2} - (y + e_2(p, y; \theta) - \theta) &= 0 \end{aligned}$$

where the above conditions use the fact that, by the Envelope Theorem,  $-\frac{dc(y, p; \theta)}{dp} = -e_2(p, y; \theta)$ , and  $-\frac{dc(y, p; \theta)}{dy} = -(y + e_2(p, y; \theta) - \theta)$ . It is clear that both equations imply the  $y$  and  $p$  in the text for the unitary board case. Moreover, such  $y$  and  $p$  induce productive effort of 1, and no self-dealing. Those two features along with no monitoring imply that the firm's profits are maximized. As, for all  $\theta$ , the CEO is left with no rents, the outcome stated in the proposition holds.

For the two-tier system, consider first the Supervisory's Board Problem for a given  $\{y, t^m(y)\}_y$  offered by the Management Board. Let  $y^*(p; \theta)$  be the solution to

$$\max_y t^m(y) - c(y, p; \theta)$$

The Supervisory's Board problem is to maximize, upon choosing  $p$  and  $t^s(p)$ ,

$$y^*(p; \theta) + pe_2(p, y^*(p; \theta); \theta) - t^s(p) - \frac{p^2}{2}$$

subject to

$$t^s(p) + t^m(y^*(p; \theta)) - c(y^*(p; \theta), p; \theta) \geq 0$$

By the very same token, for a fixed set of contracts offered by the supervisory board, the management board solves

$$\max_{y, t^m(y)} y + p^*(y; \theta) e_2(p^*(y; \theta), y; \theta) - \frac{p^*(y; \theta)^2}{2} - t^m(y)$$

subject to

$$t^s(p^*(y; \theta)) + t^m(y) - c(y, p^*(y; \theta); \theta) \geq 0$$

where  $p^*(y; \theta)$  is the solution to  $\max_p t^s(p) - c(y, p; \theta)$ .

Clearly, both constraints bind at an optimum. It is easy to see that  $y^*(p; \theta) = 1 + \theta$  for all  $p$ , and  $p^*(y; \theta) = 0$  for all  $y$  form an equilibrium: if the supervisory does not monitor the CEO irrespective of its type and the level of  $y$ , the solution to the management board entails  $y = 1 + \theta$  and the converse. ■

**Proof of Proposition 2** For ease of notation I will be denoting  $\frac{1-F(\theta)}{f(\theta)}$  by  $H(\theta)$  throughout this and the other proofs. The first order conditions with respect to  $y$  and  $p$  for pointwise maximization of the program in the text yield:

$$\begin{aligned} 1 - \frac{p}{2} - (y + e_2 - \theta) - \frac{H(\theta)}{2} &= 0 \\ e_2 - \frac{p}{2} - e_2 + \frac{H(\theta)}{2} - p &= 0 \end{aligned}$$

(where, again, the above equalities use the fact that, by the Envelope Theorem,  $-\frac{dc(y, p; \theta)}{dp} = -e_2$  and,  $\frac{dc(p, y; \theta)}{dy} = (y + e_2 - \theta)$ ). It is easy to see that the solution to this system yields (i) and (ii) in the Proposition. The amount of self dealing follows because  $e_2(y, p; \theta) = \frac{1-p+\theta-y}{2}$ . ■

**Proof of Proposition 3:** Assume, towards a contradiction, that there exists an equilibrium so that, for some open set  $(\theta', \theta'') \subset [\underline{\theta}, \bar{\theta}]$ ,  $e_2(p(\theta), y(\theta); \theta) = 0$  for all  $\theta$  in  $(\theta', \theta'')$ . Fix the equilibrium  $\{t^s(p), p\}_p$  and consider the management board's problem. As argued in the text, it as if the Management Board was facing a CEO with preferences given by  $\psi(y, \theta) = \max_p t^s - c(y, p; \theta)$ . Proceeding as in the text, its problem becomes to maximize the following objective pointwise:

$$\max_y y + p(y; \theta) e_2(y, p(y; \theta); \theta) + \psi(y, \theta) - H(\theta)(y + e_2(y, p(y; \theta); \theta) - \theta) - \frac{p(y; \theta)^2}{2}$$

By assumption, for all types  $\theta$  in  $(\theta', \theta'')$ , given their equilibrium choice of  $p$ , the Management Board will optimally choose  $y$  in the range of the domain so that so that  $e_2(p(\theta), y(\theta); \theta) = 0$ , i.e.,  $y \geq 1 + \theta - p$ . Therefore, there is a  $\theta^* \in (\theta', \theta'')$  so that for all  $\theta \in (\theta^*, \theta'')$  not only the CEO will not self-deal, but

also *no* explicit strategic interaction will ensue<sup>13</sup> and the Management's objective will read (note that I dropped the  $y$  in the monitoring level as no dependence ensues for such  $\theta'$ s)

$$y - \frac{1}{2}(y - \theta)^2 - H(\theta)(y - \theta) - \frac{p^2}{2}$$

Hence, in response to the equilibrium menu offered by the supervisory board, it must be the case that  $y(\theta) = 1 + \theta - H(\theta)$  which calls for  $p(\theta) \geq H(\theta) > 0$  for all  $\theta \in (\theta^*, \theta'')$ . However, proceeding in exactly the same fashion for the supervisory board, we see that, as monitoring is costly, the best response for any  $y$  that do not induce self-dealing is  $p(\theta) = 0$ , which generates a contradiction. Therefore, there can be at most a zero measure set of projects in  $[\underline{\theta}, \bar{\theta}]$  in which the CEO does not self-deal. ■

**Proof of Proposition 4:** In the text. ■

**Proof of Proposition 5:** I proceed in several steps. The necessity part follows from Steps 1,3, and 4. Sufficiency follows by combining Steps 3, 5, and 6.

STEP 1 : Deriving the form of the system of differential equations: the equilibrium values of  $\frac{dp(y(\theta);\theta)}{dy}$ ,  $\frac{dy(p(\theta);\theta)}{dp}$ .

**Proof:** I will show that  $\frac{dp(y(\theta);\theta)}{dy} = \frac{\dot{p}(\theta)}{\dot{y}(\theta)-1}$ . The derivation of  $\frac{dy(p(\theta);\theta)}{dp} = \frac{\dot{y}(\theta)}{\dot{p}(\theta)+1}$  is analogous. Note that  $p(y; \theta) = \arg \max_p t^s(p) - c(y, p; \theta)$ . By the Implicit Function Theorem, using interiority (which is a necessary condition for a differentiable equilibrium), we have that

$$\frac{dp(y; \theta)}{dy} = -\frac{1}{2t^{s''}(p) + 1}$$

Additionally, in equilibrium, from the first order condition of the above program, it must be the case that for all  $\theta$

$$t^{s'}(p(\theta)) - [e_2(p(\theta), y(\theta); \theta)] = 0, \tag{6}$$

Totally differentiating this expression, one finds

$$t^{s''}(p(\theta))\dot{p}(\theta) + \frac{\dot{p}(\theta)}{2} + \frac{\dot{y}(\theta)}{2} - \frac{1}{2} = 0, \text{ which implies}$$

$$\frac{dp(y(\theta); \theta)}{dy} = \frac{\dot{p}(\theta)}{\dot{y}(\theta) - 1}. \blacksquare$$

STEP 2: In any differentiable equilibrium in which  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , one must have  $\dot{p}(\theta) \geq 0$  for all  $\theta$ .

**Proof:** First, note that, in any differentiable equilibria, a CEO with type  $\theta$  has to choose from the Supervisory Board (given the equilibrium contract he picked from the Management Board) a contract that satisfies (FCOS). A second order necessary condition for that being optimal is  $t^{s''}(p(\theta)) + \frac{1}{2} \leq 0$ . As

<sup>13</sup>The qualifier is needed. As an example, note that there may be equilibria for the dual board in the symmetric information case in which the CEO does not self-deal but *there is* strategic dependence among the boards.



derived in Step 1,  $t^{s''}(p(\theta)) + \frac{1}{2} = \frac{1-\dot{y}(\theta)}{\dot{p}(\theta)}$  so that necessarily the sign of  $\dot{p}(\theta)$  has to be the same as the one of  $\dot{y}(\theta) - 1$ . Therefore, if it was the case that  $\dot{p}(\theta) < 0$  for some  $\theta \in [\underline{\theta}, \bar{\theta}]$  one would have  $\dot{y}(\theta) - 1 < 0$ . The fact that  $e_2(y(\theta), p(\theta); \theta) > 0$  for all  $\theta \in [\underline{\theta}, \bar{\theta}]$  assures that this cannot happen at  $\bar{\theta}$  (for, otherwise,  $\dot{e}_2(\bar{\theta}) > 0$  along with  $e_2(\bar{\theta}) = 0$  would imply that for some  $\theta$  close to  $\bar{\theta}$  the amount of self-dealing would be negative). If this happens for some  $\theta$  bounded away from  $\bar{\theta}$ , by continuity of  $\dot{e}_2$  in  $\theta$ , there must exist a  $\theta' \in (\theta, \bar{\theta})$  so that  $\dot{e}_2(\theta') = 0$  which, in turn, implies that  $\dot{y}(\theta') - 1 = -\dot{p}(\theta')$ , contradicting the fact that the sign of  $\dot{p}(\theta)$  has to be the same as the one of  $\dot{y}(\theta) - 1$ . ■

STEP 3: Given steps 1 and 2, one must have in any equilibrium  $\dot{y}(\theta) - 1 \geq \dot{p}(\theta)$ .

**Proof:** Note that  $\dot{p}(\theta) \geq 0$  along with the integral representation of the CEO's utility is equivalent to the contract offered by the supervisory board being incentive compatible if, and only if,  $\phi_{\theta p}(p, \theta) > 0$ . Applying twice the Envelope Theorem, one has that  $\phi_{\theta} = (y(p; \theta) + e_2(y(p; \theta), p; \theta) - \theta)$ . Hence,  $\phi_{\theta p} = \frac{1}{2}(\frac{dy(p; \theta)}{dp} - 1)$ . Therefore, one needs to have  $\frac{dy(p; \theta)}{dp} - 1 \geq 0$  when this expression is evaluated at the equilibrium  $p$  and  $y$ . As  $\frac{dy(p; \theta)}{dp}$  when evaluated at the equilibrium is  $\frac{\dot{y}(\theta)}{\dot{p}(\theta)+1}$ , this can hold if, and only if,  $\dot{y}(\theta) - 1 \geq \dot{p}(\theta)$ .

By the very same token,  $\dot{y}(\theta) > 0$  (which is implied by  $\dot{y}(\theta) - 1$  having the same sign as  $\dot{p}(\theta)$ ) along with the integral representation of the CEO's utility being incentive compatible calls for  $\psi_{y\theta}(y, \theta) > 0$  (where  $\psi(y, \theta)$  was defined in footnote 13). Proceeding as above, this happens if only if  $1 - \frac{dp(y(\theta); \theta)}{dy} \geq 0$ . In equilibrium,  $\frac{dp(y(\theta); \theta)}{dy} = \frac{\dot{p}(\theta)}{\dot{y}(\theta)-1}$  and the result follows. ■

STEP 4: The Boundary Conditions must be as in the text.

**Proof:** Fix  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ . That  $p(\bar{\theta})$  is bounded away from 1 follows because, otherwise, for  $\theta$  close enough to  $\bar{\theta}$ ,  $e_1(\theta)$  would be negative which cannot hold. As for  $p(\bar{\theta})$  being larger than  $\frac{1}{2}$ , this follows because at  $\bar{\theta}$ , using the second equation of the system and  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , it must be the case that

$$\frac{\dot{p}(\bar{\theta})}{\dot{y}(\bar{\theta}) - 1} = \frac{1}{3}.$$

Substituting this in the first equation, one has

$$\dot{p}(\bar{\theta}) = \frac{2p(\bar{\theta}) - 1}{3(1 - p(\bar{\theta}))}.$$

Therefore,  $\dot{p}(\bar{\theta}) > 0$  whenever  $p(\bar{\theta}) > \frac{1}{2}$ . Additionally, so to guarantee that  $p(\underline{\theta}) \geq \frac{1}{2}$ , as  $\dot{p}(\theta) \geq 0$ , it must be the case that  $p(\bar{\theta})$  is bounded away and from below by  $\frac{1}{2}$ . To show that  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , note that, given the equilibrium profile offered by the supervisory board, at  $\bar{\theta}$ , any  $y$  satisfying the second equation in the system is a potential candidate for optimum (as the first order condition is met). Among those, given  $p(\bar{\theta})$ , the one that sets  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$  is the best as the management's objective can be written as

$$\bar{\theta} + e_1 - \frac{1}{2}e_1^2 - \frac{e_2^2}{2} - \frac{p^2}{2},$$

and (i)  $e_1 - \frac{1}{2}e_1^2$  is increasing in the range  $[0, 1)$ , (ii)  $e_1$  is increasing in  $y$ , (iii) the expression is decreasing in  $e_2$ , which, in turn, is decreasing in  $y$ . ■

STEP 5: If there is a solution to the system of differential equations so that (i)  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , (ii)  $\dot{p}(\theta) \geq 0$  for all  $\theta$ , and (iii)  $\frac{\dot{y}(\theta)}{\dot{p}(\theta)+1} \geq 1$ , then  $\dot{y}(\theta) - 1 \geq \dot{p}(\theta)$  for all  $\theta$

**Proof:** It is easy to see that, whenever  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ ,  $\frac{\dot{p}(\bar{\theta})}{\dot{y}(\bar{\theta})-1} = \frac{1}{3}$  so that the claim is true at  $\bar{\theta}$ . By assumption, the same is true at  $\underline{\theta}$ . To complete the proof, it suffices to show that  $\frac{\dot{y}(\cdot)}{\dot{p}(\cdot)+1} - 1$  (which is continuous in  $\theta$ ) cannot cross zero (strictly) more than once. Suppose that was the case. There would exist  $\theta' < \theta''$  so that  $\frac{\dot{y}(\theta')}{\dot{p}(\theta')+1} = 1 = \frac{\dot{y}(\theta'')}{\dot{p}(\theta'')+1}$ . From the first equation of the system,  $p(\theta') = p(\theta'') = \frac{1}{2}$ . Since  $\dot{p}(\theta) \geq 0$ ,  $p(\theta) = \frac{1}{2}$  for all  $\theta \in [\theta', \theta'']$ , implying that  $\dot{p}(\theta) = 0$  for all such  $\theta$ . Plugging the latter in the second equation, one has

$$y(\theta) = 1 + \theta - H(\theta), \text{ for all } \theta \in [\theta', \theta'']$$

Thus,  $\dot{y}(\theta) = 1 - H'(\theta) > 1$ , for all  $\theta \in [\theta', \theta'']$  which contradicts  $\frac{\dot{y}(\theta')}{\dot{p}(\theta')+1} = \frac{\dot{y}(\theta'')}{\dot{p}(\theta'')+1} = 1$ . ■

So whenever  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , and  $p(\underline{\theta}) \geq \frac{1}{2}$ , the endogenous single crossing conditions hold when  $\dot{p}(\theta) \geq 0$  for all  $\theta$ . Moreover, one has that the local concavity of the agent's problems when dealing with the CEO is guaranteed in such case. Finally, when  $p(\underline{\theta}) \geq \frac{1}{2}$ , one can show through simple calculations that  $e_1(\underline{\theta}) \geq 0$ . It turns out that by imposing some additional conditions on the distribution and on the value of  $\underline{\theta}$ , a solution to the system of differential equations with the properties required by Step 5 always exist. This, on its turn, assures the existence of equilibrium for the common agency game. I impose these conditions "implicitly" in the next step.

STEP 6: Assume that  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ , and  $p(\bar{\theta})$  is bounded below by  $\frac{1}{2}$ . Take any  $\tilde{F}(\cdot)$  so that the corresponding density satisfies (A1) and (A2), and consider an interval of the form  $[a, \bar{\theta}]$ . For any solution of the system of differential equations for "projects"  $[a, \bar{\theta}] \subset (0, 1]$  with distribution  $\tilde{F}(\cdot)$ , there is a  $\underline{\theta} \geq a$ , and  $F(\cdot)$  (whose density also satisfies (A1), and (A2)) so that, for the projects  $[\underline{\theta}, \bar{\theta}]$  with distribution  $F(\cdot)$ , the conditions in Step 5 hold.

**Proof:** If  $e_2(y(\bar{\theta}), p(\bar{\theta}); \bar{\theta}) = 0$ ,  $\frac{\dot{p}(\bar{\theta})}{\dot{y}(\bar{\theta})-1} = \frac{1}{3}$ . Moreover, if  $p(\bar{\theta})$  is bounded below by  $\frac{1}{2}$ ,  $0 < \dot{p}(\bar{\theta})$  (see step 4). If, under  $\tilde{F}(\cdot)$  and  $[a, \bar{\theta}]$ ,  $\frac{\dot{p}(\cdot)}{\dot{y}(\cdot)-1}$  never crosses zero strictly, the result follows trivially by letting  $F(\cdot) = \tilde{F}(\cdot)$ , and  $a = \underline{\theta}$ . Otherwise, let  $\theta' \in (a, \bar{\theta})$  be the smallest project so that  $\dot{p}(\theta') = 0$ , and  $\dot{p}(\theta) \geq 0$  for all  $\theta > \theta'$ . It is easy to see that at such  $\theta'$ ,  $\dot{y}(\theta') - 1 > 0$  so that, by the first equation in the system,  $p(\theta') > \frac{1}{2}$ . Therefore letting  $\underline{\theta} = \theta'$ , and  $f(\theta) = \frac{\tilde{f}(\theta)}{1 - \tilde{F}(\theta')}$  for  $\theta \geq \underline{\theta}$ , and zero otherwise, the result follows (it is easily seen that  $f(\theta)$  is log concave and that (A2) is also satisfied). Note that this "sufficient" condition can be replaced by one that states that the (endogenous) monitoring of the CEO with the least productive project is larger than  $\frac{1}{2}$ , as stated in the Proposition. ■

**Proof of Proposition 6:** Noting that  $e_1 = y + e_2 - \theta = \frac{(y+1-p-\theta)}{2}$  and that, by Proposition 3,  $p^{2P}(\theta) > p^{1P}(\theta)$  for all  $\theta$ , the second part is trivially true whenever  $y^{1P}(\theta) \geq y^{2P}(\theta)$  for all  $\theta$ . Towards

a proof for the latter, note that if there is  $\theta' \in (\underline{\theta}, \bar{\theta})$  so that  $y^{2P}(\theta') = y^{1P}(\theta') = 1 + \theta' - \frac{(1-F(\theta'))}{f(\theta')}$  one must have, by the second equation of the system,

$$\frac{\dot{p}(\theta')}{\dot{y}(\theta') - 1} \left[ \frac{H(\theta')}{2} + e_2(p, y); \theta' - \frac{3p}{2} \right] = 0$$

For this to hold, one must have either  $\dot{p}(\theta') = 0$ , or  $[\frac{H(\theta')}{2} + e_2(p, y); \theta' - \frac{3p}{2}] = 0$ . To rule out the second possibility, note that if

$$\frac{H(\theta')}{2} + e_2(p, y); \theta' - \frac{3p}{2} = 0, \text{ one has } p(\theta') = \frac{H(\theta')}{2}.$$

Using this in the first equation, one would have

$$\frac{\dot{y}(\theta')}{\dot{p}(\theta') + 1} = \frac{3p(\theta') - H(\theta')}{2 - p(\theta') - H(\theta')} < 1,$$

contradicting the fact that, necessarily, in equilibrium,  $\dot{y}(\theta) - 1 \geq \dot{p}(\theta)$  for all  $\theta$ .

Therefore, it must be the case that  $\dot{p}(\theta') = 0$ . As necessarily  $\dot{y}(\theta') - 1 \geq 0$ , one must have  $p(\theta') \geq \frac{1}{2}$ . Using this fact it can be readily concluded, by continuity, that for all  $\epsilon > 0$  sufficiently small<sup>14</sup>

$$\frac{H(\theta' - \epsilon)}{2} + e_2(p(\theta' - \epsilon), y(\theta' - \epsilon)); \theta' - \epsilon - \frac{3p(\theta' - \epsilon)}{2} < 0$$

whenever  $y^{2P}(\theta') = y^{1P}(\theta')$ . Using this in the second equation of the system, along with  $\frac{\dot{p}(\theta)}{\dot{y}(\theta) - 1} \geq 0$  for all  $\theta$  in equilibrium, one has that,

$$y^{2P}(\theta' - \epsilon) \leq 1 + \theta' - \epsilon - H(\theta' - \epsilon) = y^{1P}(\theta' - \epsilon)$$

This, along with the fact that  $y^{2P}(\bar{\theta}) < y^{1P}(\bar{\theta})$ , implies that necessarily  $y^{2P}(\theta) \leq y^{1P}(\theta)$  for all  $\theta$ , as otherwise there would exist  $\theta'$  and  $\epsilon'$  so that  $y^{2P}(\theta') = y^{1P}(\theta')$  and  $y^{2P}(\theta' - \epsilon) > y^{1P}(\theta' - \epsilon)$  for all  $\epsilon < \epsilon'$ . ■

**Proof of Proposition 7:** At  $\bar{\theta}$ ,

$$\frac{\dot{p}(\bar{\theta})}{\dot{y}(\bar{\theta}) - 1} = \frac{1}{3}, \text{ which implies}$$

$$\dot{y}(\bar{\theta}) = 3\dot{p}(\bar{\theta}) + 1$$

Noting that  $e_2^{2P}(\bar{\theta}) = \frac{(-\dot{p}(\bar{\theta}) + 1 - \dot{y}(\bar{\theta}))}{2} = -2\dot{p}(\bar{\theta})$ ,  $\dot{p}(\bar{\theta}) = \frac{2p(\bar{\theta}) - 1}{3(1 - p(\bar{\theta}))}$  and  $e_2^{1P}(\bar{\theta}) = -\frac{1}{3}$ , we have that whenever  $p(\bar{\theta}) > \frac{3}{5}$ ,  $e_2^{2P}(\bar{\theta}) < e_2^{1P}(\bar{\theta})$ . Therefore, as  $e_2^{2P}(\bar{\theta}) = e_2^{1P}(\bar{\theta})$ , for  $\theta$  close enough to  $\bar{\theta}$ ,  $e_2^{2P}(\theta) > e_2^{1P}(\theta)$ . So a  $\theta^*$  as stated in the Proposition exists. For the second part, it suffices to note that whenever  $p(\bar{\theta}) < \frac{3}{5}$ ,  $e_2^{2P}(\bar{\theta}) > e_2^{1P}(\bar{\theta})$ , so that  $e_2^{2P}(\theta) < e_2^{1P}(\theta)$  for  $\theta$  close enough to  $\bar{\theta}$ . ■

<sup>14</sup>As  $\frac{H(\theta')}{2} + e_2(p(\theta'), y(\theta')); \theta' - \frac{3p(\theta')}{2} < 0$

## 10 Appendix B: Sequential Moves and Communication

This appendix investigates the model for the cases in which the boards move sequentially, and they can communicate the information they extracted from the CEO.

To address the first point, I add a period between 3 and the time at which the CEO decides upon  $e_1$  and  $e_2$ , and assume that the choice of  $p$  by the Supervisory Board is made in such period after the demanded  $y$  by the management board are set (and accepted by the CEO). A relevant issue is whether the Supervisory Board can infer the project quality from the performance target specified by the Management Board. I will be assuming throughout this is the case and show that it will happen in equilibrium.

At the new period, as the decision regarding  $y$  is sunk, the supervisory board chooses the amount of monitoring to solve the following program<sup>15</sup>

$$\max_{p \in [0,1]} p e_2(p, y; \theta) - \frac{p^2}{2} \quad (7)$$

The solution to this problem is given by

$$p(y; \theta) = \begin{cases} \frac{(1+\theta-y)}{4} & \text{if } y \leq 1 + \theta \\ 0 & \text{otherwise} \end{cases}$$

In period 2, the Management Board anticipates that, upon correctly inferring  $\theta$ , this will be the amount of monitoring exerted by the Supervisory Board and will then (proceeding as in section 2, just replacing  $p$  by  $p(y; \theta)$ ) choose  $y$  so to

$$\max_{y \geq 0} y + p(y; \theta) e_2(p(y; \theta), y; \theta) - c(y, p(y; \theta); \theta) - \left( \frac{1-F(\theta)}{f(\theta)} \right) (y + e_2(p(y; \theta), y; \theta) - \theta) - \frac{p(y; \theta)^2}{2} \quad (8)$$

The solution to this program yields

**Proposition 8** *If, in a two-tier board system, the supervisory board chooses on monitoring after the management board sets its target the resulting unique equilibrium has*

$$(i) \ y(\theta) = 1 + \theta - \frac{20}{19} \left[ \frac{1-F(\theta)}{f(\theta)} \right]$$

$$(ii) \ p(\theta) = \frac{5}{19} \left[ \frac{1-F(\theta)}{f(\theta)} \right]$$

*The induced amount of self-dealing is given by  $e_2(\theta) = \frac{15}{38} \left[ \frac{1-F(\theta)}{f(\theta)} \right]$ . Moreover, profits under a unitary board are (pointwise) higher than in a dual board.*

**Proof:** Follows trivially from the first order conditions for the Program in the text and the expressions for  $p(y; \theta)$  and  $e_2(p, y; \theta)$ . For the second part of the Proposition, it is easy to see, using  $e_1 = y + e_2 - \theta$  that profits can be written as

$$\theta + e_1 - \frac{1}{2} e_1^2 - \frac{1}{2} e_2^2 - H(\theta)(e_1)$$

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<sup>15</sup>Note that, as it is assumed (and verified in equilibrium) that the Supervisory Board correctly infers the project's quality  $\theta$ , it can optimally impose the monitoring level  $p$  without making any payment to the CEO.

Note that this expression is strictly decreasing in  $e_1$  in the range  $(1 - H(\theta), \infty)$  and strictly decreasing in  $e_2$ . As  $1 - H(\theta) < 1 - \frac{2H(\theta)}{3} = e_1^{1P} < 1 - \frac{25H(\theta)}{38} = e_1^{2P}$  and the amount self-dealt is higher under a two-tier system, the result follows. ■

Note that, under (A1), performance targets are strictly increasing in the project's quality so that the supervisory board, upon observing  $y$ , can indeed infer the type of the project as assumed in the derivation of the equilibrium. Moreover, one sees that, when compared to the Unitary System, a Dual Board System in which the monitoring decisions are taken by the supervisory board after the establishment of performance targets will reduce the level of *both* instruments. As a first consequence, the amount self-dealt by the CEO will be higher than in a Unitary System. Secondly, when compared with a unitary system, profits under a dual system are, for all  $\theta$ , lower.

Interestingly, the sequential moves' analysis yields the same outcome as when the supervisory board communicates the information extracted from the CEO to the supervisory board. To see that, note first that in order to infer the project's quality the management board has to screen the different CEO's "types". This screening has to be done through the offer of a menu of performance targets which depends on the CEO's announcement of  $\theta$ . Therefore, when the information – or, more precisely, the CEO's announcement – is communicated to the supervisory board, the target is sunk. Hence, the supervisory's board maximization problem is, on the equilibrium path (i.e., when the CEO reports truthfully), the same as in (7). The management board anticipates this and maximizes the same program as (8). This proves

**Proposition 9** *The model when the management board communicates the CEO's announcement to the supervisory board yields the same outcome as in which boards move sequentially. Therefore, a dual system induces (pointwise) lower profits and more self-dealing than a unitary system.*

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Departamento de Economia PUC-Rio  
Pontificia Universidade Católica do Rio de Janeiro  
Rua Marques de São Vicente 225 - Rio de Janeiro 22453-900, RJ  
Tel.(21) 35271078 Fax (21) 35271084  
[www.econ.puc-rio.br](http://www.econ.puc-rio.br)  
[flavia@econ.puc-rio.br](mailto:flavia@econ.puc-rio.br)