

Internal Controls and Collusion

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Abstract

This paper investigates the use of productive interdependency, or segregation of duties, as internal control in a hidden information setting with two productive agents and zero implementation costs. I show that, when the agents can collude and collusion is not too costly, implementing internal control reduces agency welfare even as it improves productive efficiency. When this is the case, the principal under certain conditions optimally chooses to use internal control as a threat instead of implementing it. I also show that lowering the accuracy of the accounting information system may increase the principal's expected payoff.

1 Introduction

Recent years have seen renewed interest in internal control as a means of improving corporate governance in publicly traded companies.¹ This interest is, at least in part, fueled by complaints about the burdens imposed on companies by Section 404 of Sarbanes-Oxley Act of 2002 (SOX) that requires managers to report on, and external auditors to attest to, the adequacy of internal controls over financial reporting. The discussion, which goes on in both the popular and academic press, has centered on the comparison of benefits and costs of internal control. For example, Committee on Capital Markets Regulation (2006, p. 115) states:

The key issue is not the statute’s underlying objectives but whether the implementation approach taken by the SEC and the PCAOB (the independent board established under SOX to set standards for auditors of public companies) strikes the right cost-benefit balance. There is widespread concern that the compliance costs of Section 404 are excessive.

The participants in the discussion — especially regulators and practitioners — appear to agree that internal control brings about significant benefits (e.g., in reducing the cost of capital: see Lambert, Leuz, and Verrecchia, 2007, and Ashbaugh-Skaife, Collins, Kinney, and LaFond, 2006) and focus on quantifying these benefits and comparing them with costs, which fall unto two broad categories: (i) the costs of implementing and operating internal control and (ii) the costs of reporting on, and auditing, its effectiveness. Examples of the former include resources expended on verification, ratification, approval, and similar activities; examples of the latter — auditors’ fees directly related to auditing internal controls. *Compliance costs* typically contain elements of both.

Even though the accurate measurement of these costs remains a challenging task, their nature is relatively well understood. Yet, as noted by Power (1997), there is still much confusion in practice about what effective internal controls really are. In a similar vein, Kinney (2000b) argues that the effect of internal control on the welfare of management, corporate directors, shareholders, trading partners,

¹Some authors use the terms *internal control* and *corporate governance* interchangeably. For example, Berkovitch and Israel (1996, p. 210) give the following definition: “External control refers to the market for corporate control where managers are replaced and disciplined via takeovers. Internal control refers to arrangements within the firm, like the control of the board of directors over the management team and contractual agreements such as bond covenants.” In this study, I use the term in its strict (accounting) sense, which will be made precise presently.

auditors, and society at large remains, to a large degree, unexplored by researchers. Kinney’s observation is echoed by Maijoor (2000) who also remarks that internal controls should be studied from a corporate governance perspective. To explicate the costs and benefits that may, in a cross-sectional empirical study, be obscured by the above-mentioned compliance costs, I present a model where internal control is costless to implement and study its effects on productivity and payoffs accruing to (productive) agents and shareholders.

Internal controls comprise a wide array of policies and procedures ranging from very traditional, such as installing locks in warehouses, to very innovative, such as monitoring employees’ computer use in real time (Allison, 2006). As diverse as they are, however, all known internal controls share one common shortcoming: they are susceptible to organizational corruption, which is also often referred to as collusion.² An internal control mechanism may be used for nefarious purposes, such as abuse of authority, or simply “overridden” by the persons entrusted with implementing it as a result of collusion (Kinney, 2000a). I leave the former problem for future research and, in this paper, investigate the latter.

To make the task manageable, I focus on one type of internal control: the often-used practice of *segregation of duties*, where a business is organized in such a way that no single person could carry out any process or transaction in its entirety. In this type of internal control, the actions of one individual affect the payoff(s) of his colleague(s). I study a stylized model of a company composed of a principal, representing shareholders or top management acting on their behalf, and two agents, representing individual workers or division managers. The agents engage in productive tasks that may be interdependent, in the sense that one agent’s productive effort affects the output of his colleague. The principal can use this *productive interdependency*, in combination with a sufficiently accurate accounting information system, as an internal control mechanism that makes it more difficult for the agents to shirk (i.e., collect information rents).

Productive interdependency is pervasive in organizations. For example, it is virtually always present when individuals are organized in teams: in fact, it often serves as the main reason to put the agents on a team so that shirking by one member creates negative externalities for everyone. Productive interdependency

²The latter term is most often used in the economics literature and has a more precise meaning than the former. I will use both terms interchangeably.

also occurs in other settings. Consider a factory where a purchasing manager may be bribed by a supplier to accept components of inferior quality. Even though the agreement between the manager and the supplier is not observable, the combination of unfavorable direct-material quantity and direct-labor efficiency variances in the manufacturing department (owing to additional scrap and rework) will point to the likely cause of the problem. In a similar fashion, the actions of the production manager will have a bearing on the outputs of his colleagues in other departments. In this example, a technological link between the purchasing and manufacturing departments provides information about the actions of both managers and thus acts as a natural internal control.

In many cases, the degree of productive interdependency can be varied within a certain range. In the example above, the principal who wishes to alter the extent to which the output of the production manager depends on the effort of the purchasing manager can do so by, say, investing in a quality control system to conduct incoming inspection of components entering the manufacturing department. In other cases, the properties of available technology will not allow the principal to eliminate technological interdependency completely. And, in settings where no natural interdependency exists, it may be introduced on purpose, which is precisely the point of segregation of duties.

The purpose of internal control is to reduce the negative consequences of information asymmetry between the principal and the agents. From the standpoint of consumers, the problem created by information asymmetry is that the expected level of output (or, equivalently, productive effort) that is produced when the principal hires the agents is lower than the the first-best level of output that obtains under symmetric information. *Productive efficiency*, defined as the expected level of the agents' productive effort, provides a measure of how close the outputs attainable under various organizational arrangements are to the first-best, or socially optimal, level. I show that, in the absence of implementation and reporting costs, (1) when collusion between the agents is relatively easy, internal control that increases productive efficiency decreases agency welfare, defined as the sum of the principal's and the agents' payoffs; (2) when this is the case, the principal, under certain conditions, prefers to use internal control as a threat instead of implementing it; and (3) lowering the accuracy of the accounting information system may increase the principal's expected payoff.

The first result is brought about by the principal's choice of productive efforts required of the agents, which involves a trade-off between inefficiently low effort levels and information rents. When the agents find it relatively easy to collude, the effort levels required of them are such that agency welfare is lower with internal control than without, i.e., the agents' loss from internal control exceeds the principal's gain. In other words, *not* implementing internal control creates a surplus that, under certain conditions, can be shared by the agents and the principal; hence the second result. I will call the loss in agency welfare from implementing internal control a *structural* cost.

One would expect that the threat of collusion can diminish, and potentially eliminate, the benefit from internal control. The model, however, demonstrates that, when the principal is required (e.g., by SOX) to implement internal control, collusion can actually cause her to sustain a *loss* — even though internal control itself is costless and improves productive efficiency.³ This result helps explain loud complaints by executives about high compliance costs associated with internal control: ample anecdotal evidence suggests that many companies that were required to implement internal control by regulations (e.g., the Foreign Corrupt Practices Act of 1977) preceding SOX had simply not done so and now must incur both reporting *and* implementation costs. The model also predicts that the principal may prefer to sever technological links that already exist, thus providing an additional explanation for decisions to decentralize by granting company divisions high levels of autonomy or spinning them off.

The third result is brought about by the crucial role of the accounting information system in implementing internal control. If the principal is better off using it only as a threat (and not implementing it) but available technology does not allow her to eliminate productive interdependency completely, she may instead be able to reduce the accuracy of the information system.

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) gives the following definition of internal control:

Internal control is broadly defined as a process, effected by an entity's board of directors, management and other personnel, designed to provide reasonable assurance regarding the achievement of objectives in the following categories:

³I use feminine gender to refer to principals and masculine gender to refer to agents throughout the paper.

- Effectiveness and efficiency of operations.
- Reliability of financial reporting.
- Compliance with applicable laws and regulations.⁴

The model developed in the paper can be interpreted either in terms of the first type, often referred to as operational internal controls, or the second, also known as controls over financial reporting. Indeed, productive units that are modeled in this study can represent both individual employees and separate divisions that report their financial results to the central office because, in this setting, the scale of production is irrelevant. Although SOX and, to a large extent, the current discourse on corporate governance have primarily focused on internal controls over financial reporting, both types appear to be important — and are, to a great degree, interlinked. For this reason, the term “internal control” is used here to denote both. I leave the explication of internal controls over compliance for future research.

1.1 Related Literature

The central trade-off in the model is between the benefits of internal control, which makes it more difficult for the agents to shirk, and potential losses from collusion that internal control induces. Organizational collusion has been studied extensively in formal economic models. Tirole (1986, 1992) and Laffont and Tirole (1991) investigate a three-tier principal–supervisor–agent hierarchy where collusion takes the form of an agreement between the supervisor and the agent to conceal information about the agent’s type that is valuable to the principal. These authors show that, absent contracting frictions (such as restrictions on contract types or costly communication), collusion, both actual and potential, is harmful to the principal. For the most part, the subsequent literature has followed the Laffont–Tirole tradition and focused on settings where a supervising agent, who may or may not exert productive or monitoring effort, observes some information about a productive agent and may be paid by the latter to distort (usually, conceal) this information. The general results are that a threat of collusion may reduce, but does not eliminate, the benefits of supervision (Kofman and Lawarrée, 1993) and that a better supervision technology increases welfare (Laffont, 2001, Proposition 2.3).

In the presence of contracting frictions, however, these results may no longer hold. For example, in Laffont and Meleu (1997) two productive agents engage in

⁴See COSO (1994, p. 13).

mutual monitoring and can enter a side-contract (i.e., collusive agreement) with non-linear transaction costs. This property of their side-contract, in effect, imposes a restriction on the set of admissible contracts available to the principal, who may, as a result, find that increasing the quality of monitoring reduces her payoff. In Khalil and Lawarrée (2006) the principal's inability to commit to conducting a costly *ex post* investigation may render the supervision by a collusive monitor useless.

Several studies demonstrate that, in some settings, collusion can actually have a beneficial effect. Olsen and Torsvik (1998) show that the principal can benefit from collusion between the supervisor and the agent because it alleviates the problem of limited commitment. Chen (2003) demonstrates that collusion may be beneficial for the principal because it introduces an incentive for the agents to communicate their private information. In his model, the restriction on the type of admissible contracts takes the form of sequential contracting: the principal has to make an investment decision before she contracts with the agent, whose private information is pertinent to the decision. In Lawarrée and Shin (2005), the principal benefits when she enriches the agent's action space by allowing them to choose their productive tasks and thus make a better use of their private information, even though by so doing she, in effect, restricts her own action space.⁵ Papers demonstrating, in the hidden information framework, that collusion may have beneficial effects when the principal's action or information space is restricted also include Che (1995), Strausz (1997), and Shin (2006).

The focus in this paper, however, is not on collusion *per se* but on internal control, with collusion emerging as byproduct of implementing the latter as the agents' attempt to minimize its effect on their information rents. One of the two potential benefits of internal control is that, with it in place, an agent cannot shirk unilaterally: in order to collect his information rent he now has to collude with his colleague. Collusion always reduces the agents' expected information rent relative to the benchmark case with no internal control and, in that sense, is beneficial to the principal. But collusion also brings about the shortcoming of internal control. In the models mentioned above the agent's decision with respect to his effort is separable from his decision to collude with the supervisor. In contrast, in this paper, when internal control is implemented, the agent's decision with respect to effort level is *inseparable* from his decision to collude. As a result, the principal's response to the

⁵Itoh (1993) obtains a similar result in a moral hazard setting.

threat of collusion involves requiring the agents to exert effort levels that reduce agency welfare relative to the benchmark case.

Internal control provides a second benefit to the principal. Without it, she has to know the types of both agents if she wants to extract their information rents. In the presence of internal control she only has to know the type of one agent: she can then deduce the type of his colleague by observing the output levels. If transfers between the agents entail transaction costs, the principal can take advantage of this useful property by choosing one agent and paying him the amount that is (weakly) greater than what he can gain by colluding with the colleague.

The desirability of merging what otherwise would be independent operations to make one agent's compensation a function of the actions of his colleague was first pointed out, in a different setting, by Demski and Sappington (1984), who propose a direct revelation mechanism that is useful to the principal but is costly to operate. Ma, Moore, and Turnbull (1988) show that the principal can do better by offering the agents an indirect mechanism that gives one of the agents a choice of additional output levels: by choosing one of these levels, the agent communicates information about his colleague to the principal (or, in other words, turns his colleague in). The mechanism is further refined by Glover (1994) who demonstrates that, by offering just one additional output level that can be used to communicate private information, the principal can approximate the second-best solution.

The desirability, from the principal's standpoint, of implementing internal control is thus a function of the magnitude of the above-mentioned cost and benefits, as well as the principal's ability to share with the agents the surplus that obtains when internal control is not implemented and the costs of collusion are relatively low. Under certain conditions that are often observed in practice, such as sequential contracting with the agents or contracting mediated by a third party, the principal is, indeed able to extract the surplus and as a result obtains a higher expected payoff when internal control is not implemented than when it is. It should be noted here that, unlike the two benefits, the loss in agency welfare is discontinuous at zero. In that sense, it behaves very much like a fixed cost: the principal incurs it the moment she "switches on" internal control. As its intensity increases, so does the benefit from reducing the agents' information rent, until the benefit is just equal to the cost. Only when the intensity of internal control is above this "break-even" value is the principal's payoff increased when she implements it.

The paper proceeds as follows. The model is introduced in Section 2. In Section 3, I solve the model and characterize the principal’s decision to implement internal control. Her choice of the accounting information system is discussed in Section 4; Section 5 concludes.

2 The Model

Consider a firm composed of three risk-neutral parties: a principal and two agents, labeled A and B. The principal owns the firm but does not possess the requisite expertise to operate it, while the agents are capable of operating the firm but lack financial resources to buy it from the principal. Agent i exerts effort $e^i \geq 0$ at a cost $c(e^i) = \frac{1}{2} (e^i)^2$, $i = A, B$. Agents’ efforts determine outputs produced by their respective divisions according to the following production function:⁶

$$\begin{aligned} x^A(e^A, e^B) &= \theta^A + (1 - \alpha) e^A + \alpha e^B, \\ x^B(e^A, e^B) &= \theta^B + \alpha e^A + (1 - \alpha) e^B, \end{aligned} \tag{1}$$

where θ^i are efficiency parameters that characterize the “fit” between agent i and the division that he operates and can take one of two values, θ_l and θ_h , with $\Delta\theta = \theta_h - \theta_l > 0$. It is common knowledge that, with probability ν (resp., $1 - \nu$), agent i is efficient (resp., inefficient) in the sense that his productivity parameter θ^i is equal to θ_h (resp., θ_l). I assume that $0 < \nu < 1$. Agent i ’s effort and efficiency parameter are his private information.

Only the agents observe the output given by (1); the principal observes a verifiable report, $\mathbf{r}(\mathbf{x}) \in \mathbb{R}^2$, generated by the company’s accounting system.⁷ For simplicity, assume that the report function $r: \mathbb{R}_+^2 \mapsto \mathbb{R}_+^2$ admits the following representation: $\mathbf{r}(\mathbf{x}) = (r^A(x^A), r^B(x^B))$. The accuracy of the accounting system is

⁶This can be seen as a special case of a more general production function given by

$$\begin{aligned} x^A(e^A, e^B) &= \theta^A + \alpha_{11}e^A + \alpha_{12}e^B, \\ x^B(e^A, e^B) &= \theta^B + \alpha_{21}e^A + \alpha_{22}e^B. \end{aligned}$$

Setting $\alpha_{11} = \alpha_{22}$ and $\alpha_{12} = \alpha_{21}$ simplifies the exposition considerably without changing the qualitative nature of the results. The normalization $\alpha_{11} = 1 - \alpha_{21} \equiv 1 - \alpha$ is adopted to facilitate comparisons across various regimes. Very similar results obtain with three agents.

⁷I will occasionally denote the two-dimensional output by $\mathbf{x} = (x^A, x^B)$, using boldface letters to represent (row) vectors.

characterized by the (scalar) margin of error of the report function, $m(r)$, which is defined as follows:

$$m(r) \equiv \max_{\mathbf{x} \in \mathcal{X}} | \mathbf{x} - \mathbf{r}(\mathbf{x}) |,$$

where $\mathcal{X} \in \mathbb{R}_+^2$ is the set of all possible realizations of output \mathbf{x} . In most of the paper I assume that the principal has at her disposal an accounting system characterized by a perfect reporting function (i.e., the one with $m(r) = 0$); the case of a positive margin of error is considered in Section 4.

Production function (1) can be interpreted as a stylized model of segregation of duties, where the principal's goal is to make sure that no process or transaction is carried out by a single agent. The principal attains this goal by setting $\alpha > 0$. The above formulation also captures the effect of positive externalities that often exist across divisions and firms. For example, high-quality blueprints produced by a design engineer make the production engineer's job easier, and a qualified production engineer may be able to spot the designer's errors and expedite the process of correcting them. It is likely that in real-life situations the agent's expertise, represented by the efficiency parameter θ , will have a stronger effect on the productivity of his own division than on that of his colleague's. Production function (1) captures this fact in the simplest possible manner by focusing on the case where the output of a given division is only affected by the efficiency parameter of the agent operating it. One would also expect that the effect of an agent's effort on the productivity of his division would be greater than its effect on the division operated by another agent: assuming otherwise would beg a question of why he was not assigned to the other division in the first place. In terms of the model, this means that $\alpha < \frac{1}{2}$.

The limiting case $\alpha = 0$ corresponds to a setting where both divisions are independent and thus the output of agent i is uninformative about the effort of agent j , $i \neq j$. On the other hand, when $0 < \alpha < \frac{1}{2}$, each of the two outputs provides information about both agents' efforts. In effect, the agents are now organized in a team: if either of them wants to collect information rent, he has to ensure cooperation of (i.e., collusion with) his colleague to do so. The principal can, therefore, use technological interdependency as an internal control that allows her to increase her expected payoff by (i) making sure that the agents have to collude if they want to shirk, and (ii) making collusion costlier for the agents. Indeed, an increase in α increases the agents' cost of collusion and makes it easier for the principal to prevent it. It is, therefore, natural to interpret α as a measure of intensity of internal

control, with $\alpha = 0$ corresponding to the case of no internal control.

Owing to available technology, the principal may only be able to change the degree of productive interdependency within a certain range. Sometimes, as in the example with a purchasing manager on p. 3, by increasing the accuracy of the incoming inspection the principal can change α continuously. In other cases, as in the example with design and production engineers, she may not be able to alter it at all. To capture this possibility, I make the following assumption about the upper ($\bar{\alpha}$) and lower ($\underline{\alpha}$) bounds on α that are given exogenously:⁸

Assumption 1. $\alpha \in [\underline{\alpha}, \bar{\alpha}]$, where $0 \leq \underline{\alpha} \leq \bar{\alpha} < \frac{1}{2}$ and $\underline{\alpha} = \bar{\alpha} \Rightarrow \underline{\alpha} > 0$.

The upper bound on α may also reflect the benefits to specialization (not modeled here), which, in real-life situations, would prevent the principal from introducing too much of productive interdependency.

The principal chooses the intensity of internal control, determined by α and $r(\cdot)$. Under the standard assumption that prices of the outputs are normalized to unity so that x^A and x^B represent both outputs and revenues, the principal's payoff is equal to the sum of the outputs net of monetary transfers, t^i , to the agents and is given by

$$\begin{aligned} \Pi(e^A, e^B) &= x^A(e^A, e^B) + x^B(e^A, e^B) - t^A(\mathbf{r}(\mathbf{x})) - t^B(\mathbf{r}(\mathbf{x})) \\ &= \theta^A + \theta^B + e^A + e^B - t^A(\mathbf{r}(\mathbf{x})) - t^B(\mathbf{r}(\mathbf{x})). \end{aligned}$$

Under complete information, the principal requires both agents to exert the first-best effort levels of $e_{fb}^A = e_{fb}^B = 1$ and sets the transfers t^i such that the agents receive their reservation utility levels, which are normalized to zero. Under the first-best allocation, the agents' combined expected information rent, R_{fb} , is zero and agency welfare, $W \equiv R + \Pi$, is given by

$$W_{fb} = \Pi_{fb} = 1 + 2(\theta_l + \nu\Delta\theta).$$

Following the tradition established in the literature on collusion, I assume that the agents can enter into a binding side contract that may be supported, for example,

⁸The requirement that $\alpha \neq \frac{1}{2}$ guarantees that simultaneous equations (1) have a non-degenerate solution; it is similar to Condition (C.2) in Ma (1988). The requirement that $\underline{\alpha} = \bar{\alpha} \Rightarrow \underline{\alpha} > 0$ rules out the uninteresting case where internal control is impossible. Otherwise, Assumption 1 is just a labeling convention and, as such, is made without loss of generality.

by a mechanism that makes such contract self-enforcing. I also assume that side transfers between the agents may involve transaction costs, i.e., the agents can make side transfers at a rate of $\frac{1}{1+\delta}$, $\delta \geq 0$.⁹ Notice that, in this setting, transfers do not have to take monetary form: since both agents are productive, one can simply work in the other's division. The case of $\delta > 0$ then corresponds to a situation where, e.g., an agent is not as efficient working in his colleague's division as in his own.

The timing of the game is as follows:

0. Nature chooses the type of each agent.
1. The principal chooses α and $r(\cdot)$ that will be implemented.
2. Each agent learns his type. If internal control is implemented (i.e., $\alpha > 0$), he also learns his colleague's type.
3. The principal, who has all the bargaining power, offers the agents a grand contract specifying, for each agent, the action that should be taken and the corresponding compensation.
4. The agents may enter a side-contract.
5. The agents simultaneously produce their outputs.
6. Transfers are executed.

I assume that at time 1, when the principal makes a decision whether or not to implement internal controls, she can sign a binding agreement with the agents with respect to this decision only. That is, the agents negotiate with the principal in two stages, with the grand contract specifying effort levels and transfers being signed at time 3. Sequential contracting of this sort, where decisions with respect to organizational structure and agents' compensation are made at different times, are often observed in practice. For example, many contracts for lower-level employees stipulate a trial period that may range from several weeks to several years. The usual explanation is that in the course of the trial period employees have an opportunity to better learn the job; in terms of the model, it is during this period that the employee learns his type. It is also not uncommon for employment contracts with higher-level employees, such as top executives, to be negotiated over prolonged periods of time, with several stages of offers and counteroffers. Commitments made at earlier stages are then supported by reputation concerns. I discuss one way of relaxing this assumption on page 21.

Applying the *collusion-proofness* principle (Tirole, 1992), I solve for optimal

⁹The reader is referred to Tirole (1992) for an extended discussion of both assumptions.

collusion-proof allocations. Since, according to the collusion-proofness principle, any final allocation that can be achieved by the agents under a side contract can also be achieved by the principal, the model can be represented, without loss of generality, by a direct mechanism in which after the collusion stage (time 4) the agents simultaneously announce their private information and the principal specifies their effort levels and monetary transfers.

3 Results

3.1 Benchmark Case: No Internal Control

As a benchmark, consider the case with no internal control (i.e., with $\alpha = 0$) where the principal faces two agents whose outputs are independent. The agents do not interact in the course of production and do not learn each other's types; therefore, they cannot engage in mutual monitoring. In this section, I assume that the principal has access to a perfect accounting information system (i.e., that $m(r) = 0$). The optimal contract offered to the agents specifies effort levels, e_l and e_h , and transfers, t_l and t_h , required of both types. Since the principal observes the outputs but does not observe the agents' efficiency parameters θ , the efficient agent can produce the output required of his inefficient colleague at a lower cost by exerting the effort of $e_l - \Delta\theta$. Define

$$\Phi(e) \equiv \frac{1}{2}(e)^2 - \frac{1}{2}(e - \Delta\theta)^2 \geq 0.$$

That is, $\Phi(e_l)$ is the amount of information rent collected by the efficient agent when he claims to be inefficient. Since this information rent, which represents a loss to the principal, is increasing in the level of effort required of the inefficient agent, e_l , she can increase her payoff by decreasing e_l . Her expected payoff can be written as follows (the subscript stands for no control):

$$\Pi_{NC} = \underbrace{2 \left[\nu \left(\theta_h + e_h - \frac{1}{2}(e_h)^2 \right) + (1 - \nu) \left(\theta_l + e_l - \frac{1}{2}(e_l)^2 \right) \right]}_{\text{Expected agency welfare}^{10}} - \underbrace{2\nu\Phi(e_l)}_{\text{Expected information rent}}. \quad (2)$$

¹⁰Some authors use the term *allocative efficiency* instead of *agency welfare*: see, e.g., Laffont and Martimort (2002).

A social utility maximizer putting equal weights on all parties' expected payoffs would ignore the distribution of information rents between the principal and two agents (viewed as a group) and maximize expected agency welfare only. In this case, asymmetric information would have no effect on the output level because the first-best levels of effort would be chosen. In contrast, the principal maximizes her expected payoff — and, therefore, is willing to accept some downward distortion away from the socially efficient effort level in order to decrease the agent's expected information rent. As a consequence, the two measures that characterize the resultant allocation — productive efficiency and agency welfare — are both lower than the socially efficient levels.

The above-mentioned measures capture different properties of the principal–agent relationship. Productive efficiency, E , measures the expected level of output but ignores the cost of producing it. In settings with asymmetric information, consumers suffer from underproduction and thus benefit from any increase in productive efficiency. The important limitation of this measure, however, is that the model, set in the partial equilibrium framework, is silent about the value that consumers derive from this increase. On the other hand, agency welfare, W , accounts for expected output net of the technological cost and, therefore, characterizes the social value of the contractual relationship.

Maximizing (2) with respect to the agents' effort levels yields the following solution (see, e.g., Laffont and Tirole, 1993, Chapter 1):

$$e_h^i = 1 = e_{fb}, \quad t_h^i = \frac{1}{2} (e_h^i)^2 + \Phi(e_l^i), \quad (3)$$

$$e_l^i = 1 - \Delta\theta \frac{\nu}{1 - \nu}, \quad t_l^i = \frac{1}{2} (e_l^i)^2, \quad (4)$$

where $i = A, B$. An efficient agent exerts the first-best level of effort and collects his information rent, regardless of the type or actions of his colleague: there is no scope for collusion. An inefficient agent exerts effort that is strictly lower than the first-best and collects no information rent. In what follows I assume that $e_l > 0$, i.e., shutdown is never optimal and the principal employs agents of both types. It is straightforward to show that productive efficiency, the principal's payoff, the agents'

information rent, and agency welfare under this contract are given by

$$E_{NC} = 2(1 - \nu\Delta\theta), \quad (5)$$

$$\Pi_{NC} = 1 + 2\theta_l + (\Delta\theta)^2 \frac{\nu}{1 - \nu}, \quad (6)$$

$$R_{NC} = \Delta\theta\nu \left(2 + \Delta\theta - \frac{2\Delta\theta}{1 - \nu} \right), \quad (7)$$

$$W_{NC} = 1 + 2\theta_l + 2\nu\Delta\theta - (\Delta\theta)^2 \frac{\nu^2}{1 - \nu}, \quad (8)$$

where the subscripts stand for no control.

3.2 The Case with Internal Control

Consider now the case where the principal uses internal control (i.e., $\alpha > 0$). Since output \mathbf{x} is now a function of both agents' efforts, the contract offered by the principal specifies effort levels and transfers for each of the four possible combinations of agents' types (recall that, since the agents are now "on a team," they learn each other's types prior to contracting with the principal). Formally, the contract offered to agent i , $i = A, B$, is a set of eight pairs (e_{jk}^i, t_{jk}^i) where the subscripts $j, k = l, h$ denote the types of agents A and B respectively.

Agents' individual rationality constraints are given by

$$t_{jk}^i - \frac{1}{2} (e_{jk}^i)^2 \geq 0. \quad (9)$$

With $\alpha > 0$, incentive compatibility constraints take different forms depending on whether or not the agents are of the same type. First, consider the case where both agents are efficient: I will call it the *hh*-case since both productivity parameters take their high values. Production function (1) allows the agents to pretend that both of them are inefficient and collect the amount given by $\Phi(e_{ll})$ each. In contrast to the case without internal control, however, each agent's payoff now depends on his colleague's action, which means that the agents can collect information rents only if they coordinate their actions (i.e., collude).

Notice that, for any given pair of realizations (θ^A, θ^B) , production function (1) is a one-to-one mapping $x: \mathbb{R}_+^2 \mapsto \mathbb{R}_+^2$ from the set of effort pairs (e^A, e^B) into the set of division outputs (x^A, x^B) . That is, in contrast to the benchmark case where the

principal has to know both efficiency parameters to extract the agents' information rents, she now only has to know one. Therefore, with positive transaction costs δ , internal control gives her an additional advantage by making it easier to prevent collusion. Specifically, she can randomly choose one of the agents (for determinacy, I will assume in the remainder of the paper that she chooses agent A) and offer a contract that, for *hh*-case, specifies the first-best levels of effort for both agents and the transfers that satisfy the following incentive-compatibility constraints, which will hold with equality at the optimum:

$$t_{hh}^A \geq \frac{1}{2} (e_{hh}^A)^2 + \Phi(e_{ll}^A) + \frac{1}{1+\delta} \Phi(e_{ll}^B), \quad t_{hh}^B \geq \frac{1}{2}. \quad (10)$$

If they want to shirk, *both* agents have to claim that they are inefficient and exert efforts of $e^i = e_{ll}^i - \Delta\theta$, $i = A, B$. Recall that the agents negotiate their collusive agreement under symmetric information. Knowing the contents of agent A's grand contract (from, e.g., observing a copy signed by the principal), agent B will be willing to transfer to his colleague the amount up to $\Phi(e_{ll}^B)$, of which agent A will only receive $\frac{1}{1+\delta} \Phi(e_{ll}^B)$. He, therefore, will be indifferent between colluding and adhering to the grand contract. Following the tradition established in the contracting literature, I will assume that, whenever an agent is indifferent between two actions, he chooses the one preferred by the principal (who can always make the preference strict if she increases the agent's payoff by a small amount $\varepsilon > 0$). Thus agent A will exert the first-best effort level. This leaves agent B no choice but to supply the effort of $e^B = 1$ specified in the grand contract because, with $e^A = 1$, he cannot shirk without being detected.

Consider now the case where only one agent, i , is efficient: I will call it the *hl*-case regardless of the identity of agent i . If agent i claims to be inefficient and decreases his level of effort by de , the output of division j will decrease, but only by $\alpha de < \frac{1}{2} de$; he can then ask agent j to exert additional effort to make up for the deficiency and compensate him for the inconvenience. Since the levels of output under this collusive agreement should be the same as in the *ll*-case, the new effort levels, \hat{e}^i and \hat{e}^j , must satisfy the following conditions:

$$\begin{aligned} \Delta\theta + (1 - \alpha)\hat{e}^i + \alpha\hat{e}^j &= (1 - \alpha)e_{ll}^i + \alpha e_{ll}^j, \\ \alpha\hat{e}^i + (1 - \alpha)\hat{e}^j &= \alpha e_{ll}^i + (1 - \alpha)e_{ll}^j, \end{aligned} \quad (11)$$

where $i, j = A, B$ and $i \neq j$. The solution to (11) is given by

$$\begin{aligned}\hat{e}^i &= e_{il}^i - \Delta\theta \frac{1-\alpha}{1-2\alpha}, \\ \hat{e}^j &= e_{il}^j + \Delta\theta \frac{\alpha}{1-2\alpha}.\end{aligned}$$

Notice that, for $\alpha < \frac{1}{2}$, the decrease in agent i 's effort is greater than the increase in effort required of his inefficient colleague.

Changing variables, define

$$\begin{aligned}\Psi(e) &\equiv \frac{1}{2}e^2 - \frac{1}{2}\left(e - \Delta\theta \frac{1-\alpha}{1-2\alpha}\right)^2, \\ \psi(e) &\equiv \frac{1}{2}\left(e + \Delta\theta \frac{\alpha}{1-2\alpha}\right)^2 - \frac{1}{2}e^2.\end{aligned}$$

Here, $\Psi(\cdot)$ denotes the cost saved by the efficient agent when he claims to be inefficient and $\psi(\cdot)$ denotes additional cost incurred by the inefficient agent for which he has to be compensated. To simplify the analysis, I make the following assumption:¹¹

Assumption 2. $e_{il}^i - \Delta\theta \frac{1-\alpha}{1-2\alpha} \geq 0$, where $i = A, B$.

Since transaction costs increase in the amount of transfer, the agents' aggregate expected information rent in the hl -case is maximized when the efficient agent i holds all bargaining power in negotiation over the side contract and only transfers to the inefficient colleague the amount, $\psi(e_{il}^j)$, needed to cover his additional cost. To maximize her payoff, the principal, therefore, prefers to transfer all bargaining power in the negotiations over the side contract to the inefficient agent (regardless of his identity). Internal control allows her to do this by offering a contract that, in the hl -case, specifies the first-best effort level for both agents and the transfers that satisfy the following (binding) incentive compatibility constraints:

$$t_{ih}^A \geq \frac{1}{2}(e_{ih}^A)^2 + \frac{1}{1+\delta}\Psi(e_{il}^B) - \psi(e_{il}^A), \quad t_{ih}^B \geq \frac{1}{2}; \quad (12)$$

$$t_{hl}^B \geq \frac{1}{2}(e_{hl}^B)^2 + \frac{1}{1+\delta}\Psi(e_{il}^A) - \psi(e_{il}^B), \quad t_{hl}^A \geq \frac{1}{2}. \quad (13)$$

¹¹This assumption can be relaxed at the expense of introducing additional nonnegativity conditions in the appropriate incentive compatibility constraints. Doing so complicates the analysis without changing the qualitative nature of the results.

As before, the inefficient agent gains nothing from colluding and the efficient agent cannot shirk unilaterally. Notice that, with $\delta = 0$, collusion is costless for the agents in the *hh*-case — but is still costly in the *hl*-case, with the cost of collusion increasing in the intensity of internal control, α . Clearly, with $\delta = 0$ the principal does not gain anything by altering the amount that has to be transferred between the agents under the side contract and sets $e^i = e^j$, $i, j = A, B$, i.e., both agents are treated symmetrically. For determinacy, I assume that, with $\delta = 0$, they both receive identical transfers in the *hh*-case and in the *hl*-case the efficient agent collects all information rent.

Since the agents will not engage in collusion if their payoffs are reduced as a result, two additional individual rationality constraints emerge:

$$\frac{1}{1+\delta}\Psi(e_{ll}^B) - \psi(e_{ll}^A) \geq 0, \quad (14)$$

$$\frac{1}{1+\delta}\Psi(e_{ll}^A) - \psi(e_{ll}^B) \geq 0. \quad (15)$$

3.3 The Principal's Problem

The optimal contract takes one of three distinct types, depending on the values of parameters. When the cost of collusion, as determined by α and δ , is sufficiently low so that constraints (14) and (15) are not binding, collusion occurs in both *hh*- and *hl*-cases, i.e., whenever at least one of the agents is efficient; I will call the corresponding set of parameters the *full collusion* (FC) region. It is shown in the Appendix that, in this region, the following condition holds:

$$\frac{1}{1+\delta}\Psi(e_{ll}^B) - \psi(e_{ll}^A) - \left[\frac{1}{1+\delta}\Psi(e_{ll}^A) - \psi(e_{ll}^B) \right] \geq 0,$$

with strict inequality for $\delta > 0$. That is, as the cost of collusion increases, constraint (15) becomes binding first. I will call the set of parameters where constraint (15) is binding and constraint (14) is not the *partial collusion I* (PCI) region: in this region, collusion may occur only if agent B is efficient. When both constraints (14) and (15) are binding, the agents collude only in the *hh*-case; I call the corresponding set of parameters the *partial collusion II* (PCII) region. Figure 1 shows that, for intermediate values of probability ν , the FC region becomes smaller as transaction cost δ increases.

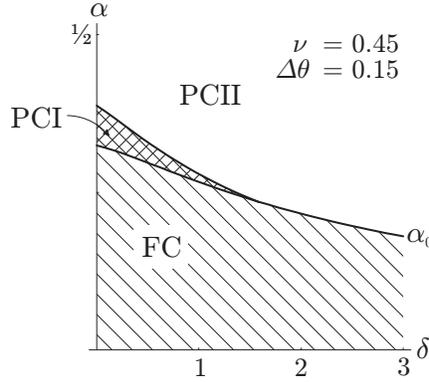


Figure 1: Three regions in δ - α space; α_0 solves (15) written with equality.

The principal's problem, labeled C (which stands for internal control), is to choose e_{jk}^i and t_{jk}^i , where $i = A, B$ and $j, k = h, l$, so as to maximize

$$\begin{aligned}
\Pi_C = & \nu^2 (2\theta_h + e_{hh}^A - t_{hh}^A + e_{hh}^B - t_{hh}^B) \\
& + \nu(1 - \nu) (\theta_h + \theta_l + e_{hl}^A - t_{hl}^A + e_{hl}^B - t_{hl}^B) \\
& + \nu(1 - \nu) (\theta_l + \theta_h + e_{lh}^A - t_{lh}^A + e_{lh}^B - t_{lh}^B) \\
& + (1 - \nu)^2 (2\theta_l + e_{ll}^A - t_{ll}^A + e_{ll}^B - t_{ll}^B)
\end{aligned} \tag{16}$$

subject to (9), (10), and (12)–(15).

The solution to (16) is given in the Appendix. Under the contract with no internal control (NC) the principal trades off her benefit from reducing the information rent accruing to the efficient agents against the loss from setting the efforts required of the inefficient agents below the first-best level. When the principal implements internal control, she requires the first-best effort of both agents not only in the hh -case, which occurs with probability ν^2 but, in addition, in the hl -case, which occurs with probability $2\nu(1 - \nu)$. That is, lowering e_{ll}^i reduces information rents in both of these cases and requires inefficiently low effort levels of both agents only in the ll -case, which occurs with probability $(1 - \nu)^2$. One would, therefore, expect the principal to be better off when she implements internal control. The following result demonstrates that this conjecture is correct — but, under certain conditions, she can do even better by offering the agents a different contract.

Proposition 1. *The allocations attainable under the contract with no internal control (NC) and the contract with internal control (C) have the following properties:*

i. With respect to productive efficiency:

(a) *In the FC region: $E_C - E_{NC} \geq 0$, with strict inequality for $\delta > 0$;*

(b) *In the PCI and PCII regions: $E_C - E_{NC} > 0$.*

ii. With respect to the principal's expected payoff: $\Pi_C - \Pi_{NC} > 0$.

iii. With respect to agency welfare:

(a) *In the FC region: $W_C^{FC} - W_{NC} \geq 0 \Leftrightarrow H(\alpha, \delta, \nu) \geq 0$, where*

$$H(\alpha, \delta, \nu) = 2\delta(1 - \alpha)(2 + \delta - \alpha(4 + 3\delta)) - \delta^2\nu^2(1 - 2\alpha(1 - \alpha)) \\ - 2\nu[1 + 4\alpha^2(1 + \delta)^2 + \delta(3 + \delta) - \alpha(4 + 5\delta(2 + \delta))];$$

(b) *In the PCI region: $W_C^{PCI} - W_{NC} \geq 0 \Leftrightarrow H_I(\alpha, \delta, \nu) \geq 0$, where*

$$H_I(\alpha, \delta, \nu) = (1 + \delta)^2(1 - 2\nu - \nu^2(1 - 2\alpha)) + 2\alpha^2(3 - \nu(6 + \nu)) \\ - 6\alpha(1 - 2\nu) + (2 + \delta)[\delta - 2\alpha\delta(4 - 5\nu(1 - \alpha)) + \alpha^2\delta(7 - \nu^2)];$$

(c) *In the PCII region:*

$$W_C^{PCII} - W_{NC} \geq 0 \Leftrightarrow 2(1 + \delta)^2(1 - \nu) - \nu^2(2 + \delta(2 + \delta)) \geq 0.$$

Proof. See Appendix. □

According to Proposition 1, internal control (weakly) improves productive efficiency and the principal is better off using it, so long as she offers a contract described on pp. 14 – 17. In fact, it can be shown that, whenever she chooses to implement internal control, she always prefers to increase its intensity to the maximum level, $\bar{\alpha}$, allowed by the available technology. If, however, $\bar{\alpha}$ is not too high and collusion is relatively costly to prevent, internal control *decreases* agency welfare. The result highlights the difficulty of the task faced by the regulator: implementing internal control always benefits one group of a company's stakeholders — consumers — by increasing productive efficiency (provided $\delta > 0$) but sometimes

is harmful for two other important groups, shareholders and employees, because it decreases the company’s profit accruing to these two groups collectively.

The loss in agency welfare given by $W_{NC} - W_C$ is a *structural cost*, which obtains even in the absence of implementation costs. As collusion becomes costlier for the agents (i.e., as α and δ increase), so does agency welfare — until, at some point (denoted α^* : see Figure 2), the principal chooses to implement internal control. That is, the easier it is for the agents to collude, the more likely is internal control to decrease agency welfare. The following corollary states the result formally.

Corollary 1. *Under Full Collusion (FC), the size of the region where $W_{NC} > W_C$ is decreasing in α and δ .*

Proof. See Appendix. □

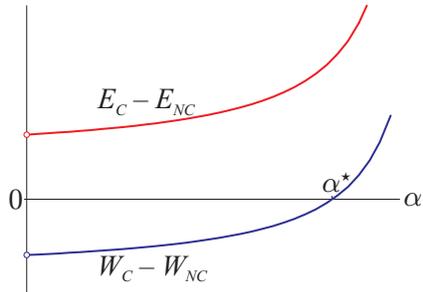


Figure 2: The effect of internal control on productive efficiency E and agency welfare W in the FC region with $\delta > 0$. The value α^* solves $H(\alpha, \delta, \nu) = 0$.

It follows immediately from Proposition 1 that, when agency welfare is lower with internal control than without (i.e., $W_C < W_{NC}$), the principal can increase her expected payoff relative to the contract with internal control if she can share with the agents the surplus that obtains when internal control is not implemented. As shown in the proof of Proposition 2 in the Appendix, the agents’ expected information rent is always strictly less with internal control than without, i.e., $R_{NC} > R_C$. Therefore, at time 1 when the principal makes a decision with respect to internal control and the agents have not yet learned their types, each of them is willing to pay the principal up to the amount of $\frac{1}{2}(R_{NC} - R_C) > 0$ — or, equivalently, agree to make salary concession in the same amount at time 3 when they negotiate over

the grand contract — if she does not implement internal control. When $W_C < W_{NC}$ (i.e., when $\bar{\alpha}$ is in the MNC region: see Figure 3), the agents' expected loss from internal control outweighs the principal's expected gain and she prefers to accept their offer, provided the agents' commitment is credible. I will call this contracting arrangement the modified no-control contract (MNC).

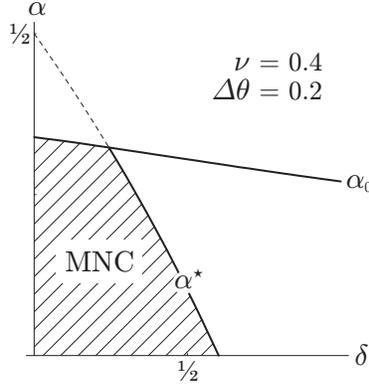


Figure 3: The region, in δ - α space, where the principal offers the modified no-control contract; α^* solves $H(\alpha, \delta, \nu) = 0$.

It should be noted that sequential contracting is not necessary for the principal to be able to extract the above-mentioned surplus. One mechanism that results in the same allocation involves a third party whose role is to negotiate the agreement about implementing internal control between the agents and the principal. Suppose that all contracting takes place at time 3 when the agents know their own and each other's types. The agents will be willing to reveal their types to a third party, who makes sure that, when the principal effects transfers, every efficient agent does, indeed, make the salary concession he has promised to make.¹²

In contracting with top executive, the role of the third party can be played by the compensation committee of the board of directors. Notice that, for the contracting mechanism to be feasible, the compensation committee should be independent of the management. In contracting with employees at lower levels of the organization, the role of the third party role can be played by a supervisor, or, more likely, by a trade union or a Works Council (in some European countries). The model thus presents a setting where the presence of such a third party is potentially valuable for

¹²Laffont and Martimort (1997) use a third party to model side contracting between the agents. In contrast, here the third party does not take any part in collusive activity.

both employers and employees. The formal result that obtains when the principal extracts the surplus is stated below.

Proposition 2. *When internal control decreases agency welfare, the principal's expected payoff is higher under the modified no-control (MNC) contract than under the contract with internal control (C). That is,*

$$W_{NC} > W_C \Rightarrow \Pi_{MNC} > \Pi_C.$$

Proof. See Appendix. □

In other words, the *ability* to implement internal control is always valuable to the principal, but the decision to actually implement it depends on transaction costs, the properties of available technology, and the characteristics of feasible contractual arrangements. In particular, the easier it is for the agents to enter into a collusive agreement, the *less* likely is the principal to implement internal control.

It can also be shown that, as ν increases, the principal is more likely to find herself either in the full collusion (FC) region where $W_{NC} > W_C^{FC}$ and she offers the MNC contract, or in the partial collusion II (PCII) region, where for sufficiently high values of ν she again offers the MNC contract. That is, the more likely it is that an agent is efficient, the less likely is the principal to use internal control. Situations with relatively high values of ν will be observed, e.g., when there exists an effective but imperfect mechanism of screening the agents for high productivity.

To summarize, implementing internal control has markedly different consequences for shareholders and managers depending on the technological characteristics of the firm and the pool of job candidates. This result provides one more argument against the “one size fits all” approach that has so far been espoused by the regulators. More specifically, it demonstrates that company characteristics other than size can have a direct bearing on the type of internal controls that best serve the interests of shareholders. External and internal auditors, whose position allows them to evaluate these characteristics, should, therefore, be given greater authority in determining the adequacy and effectiveness of internal controls. Furthermore, requiring companies to implement internal control (e.g., by regulation) provides them with incentives to reduce implementation costs but has very limited effect, if at all, on the magnitude of structural costs that stem from the organizational arrangement and informational

structure. In fact, to the extent that better information technology facilitates side contracting and reduces transaction costs (δ), the number of companies that prefer not to implement internal control may increase over time.

4 The Role of Accounting Information System

Consider now the case where $W_{NC} - W_C^{FC}(\bar{\alpha}) > 0$ and $\underline{\alpha} > 0$, i.e., the principal prefers not to implement internal control but available technology does not allow her to get rid of productive interdependency completely. The agents will only agree to make salary concessions and sign the MNC contract if she can credibly commit to ignore all information provided by the internal control system. Specifically, when she observes $x^i = \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} \pm \alpha\Delta\theta$, the levels of output in the *hl*-case when the efficient agent claims to be inefficient, she has to act as if she has observed $x^i = \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu}$, the level of output in the *ll*-case when both agents exert the level of effort given by (4). If commitment of this sort cannot be made, the agents will collude and the principal's expected payoff will be Π_C . Sometimes, however, she may be able to overcome the lack-of-commitment problem and strictly increase her expected payoff by *decreasing* the accuracy of the accounting information system, as the following result demonstrates.¹³

Proposition 3. *There exists a set of parameters with non-empty interior and reporting functions r_0, r_1 such that $m(r_1) > m(r_0)$ and $\Pi(r_1) > \Pi(r_0)$.*

Proof. See Appendix. □

Here, again, the principal uses her ability to install a more accurate information system as a threat in negotiating with the agents but in fact installs a less accurate one. If a more precise system is more expensive to operate, cost savings will come from two sources: the agents' salary concessions and a reduction in operating costs. Notice that reducing the accuracy of the information system predictably leads to a loss in productive efficiency because the effort level required of the agents when both of them are inefficient is lower than the corresponding effort level in the benchmark case.

¹³The principal cannot install an information system that simply reports the aggregate output of $x^A + x^B$ because in this case one of the agents can shirk and blame the deficiency on his colleague.

It follows immediately from Proposition 3 that, if a more accurate information system is not available, the principal will be willing to invest up to the amount given by (A.12) in the Appendix in a more accurate system that will only be used as a threat and never actually installed. This investment is a deadweight loss because it does not improve productive efficiency (the effort levels are the same under both systems) and is only used to redistribute the agents' information rent.

The result has implications for the problem of establishing materiality thresholds in financial reporting. In the Statement of Financial Accounting Concepts No. 2, FASB argues that the degree of precision of the accounting information system is a factor in materiality judgments (FASB, 1980, §130). In this model, the degree of precision (i.e., the margin of error) is determined endogenously.

Proposition 3 is related to the result reported in Arya, Glover, and Sunder (1998), who show, in a moral hazard framework, that an accounting information system with earnings management may help the principal overcome the lack-of-commitment problem by delaying her decision to fire an under-performing agent and thereby providing him with a stronger *ex ante* incentive to work hard. One difference, aside from the setting, between the model by these authors and the one studied here concerns the properties of the accounting information system in question. In Arya *et al.* (1998), in the managed earnings setting the information system *aggregates* earnings over two periods: the principal observes the sum of the two earnings figures at the end of the second period. That is, information is delayed but none of it is lost. In contrast, in my model the information system *distorts* (or garbles) the output figures and some information is lost as a result.

5 Conclusion

All internal controls share the property that, when implemented, they create a scope for collusion between (or among) the agents. In this paper I investigate the model where the agents do not abuse internal control for personal gains but may collude to minimize its effect on their ability to shirk. I focus on the practice of organizing a business in such a way that no employee is responsible for any given process or transaction in its entirety — i.e., I study settings characterized by productive interdependency. The practice so defined includes segregation of duties, a textbook

example of internal control where productive interdependency is introduced on purpose, as well as many other organizational arrangements characterized by productive interdependency such as teams.

Internal control studied in this paper provides two potential benefits to the principal: (i) it forces the agents to collude if they want to collect information rents and thereby reduces their benefit from shirking and (ii) it serves as an additional source of information about their effort levels. As a result, internal control makes it easier for the principal to reduce the agents' information rents. However, it also comes at a cost of reducing agency welfare (I call it *structural* cost) that does not disappear even if implementing internal control is costless. When collusion is relatively easy (and, therefore, difficult to prevent), this cost outweighs both of the above-mentioned benefits.

Under certain conditions, the principal is able to share with the agents the surplus that obtains when internal control is not implemented and increase her expected payoff relative to the case with internal control. That is, internal control is always valuable to the principal — but she sometimes prefers to use it as a threat without actually implementing it. The model demonstrates that, the easier it is for the agents to collude, the *less* likely is the principal to implement internal control.

I also show that the principal may benefit from reducing the accuracy of the accounting information system. Even though the role of the aggregation property of accounting information systems in contracting has been investigated in the literature, the effect of their *accuracy* has not received the attention it deserves. This paper provides a natural setting where the problem of the principal's inability to commit to ignore the information provided by the internal control system can be remedied by reducing its accuracy.

One limitation of the model studied in this paper is that it only applies to settings where agents exert productive effort. The purpose of the study, however, is to show that *there exist* conditions where implementing internal control reduces the principal's expected payoff even in the absence of implementation costs. It should also be noted that the model abstracts from team synergy, learning, and similar effects. In settings where, with some probability, either of the agents is honest and refuses to collude, both allocative and productive efficiencies will also be higher. In that sense, the study provides the lower bound on the value of internal control.

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Appendix

Solution to Problem C

The problem has the following Lagrangian:

$$\begin{aligned}
\mathcal{L} = & \nu^2 (2\theta_h + e_{hh}^A - t_{hh}^A + e_{hh}^B - t_{hh}^B) \\
& + \nu(1-\nu) (\theta_h + \theta_l + e_{hl}^A - t_{hl}^A + e_{hl}^B - t_{hl}^B) \\
& + \nu(1-\nu) (\theta_l + \theta_h + e_{lh}^A - t_{lh}^A + e_{lh}^B - t_{lh}^B) \\
& + (1-\nu)^2 (2\theta_l + e_{ll}^A - t_{ll}^A + e_{ll}^B - t_{ll}^B) \\
& + \lambda_1 \left(t_{hh}^A - \frac{1}{2}(e_{hh}^A)^2 - \Phi(e_{ll}^A) - \frac{1}{1+\delta}\Phi(e_{ll}^B) \right) \\
& + \lambda_2 \left(t_{lh}^A - \frac{1}{2}(e_{lh}^A)^2 - \frac{1}{1+\delta}\Psi(e_{ll}^B) + \psi(e_{ll}^A) \right) \\
& + \lambda_3 \left(t_{hl}^B - \frac{1}{2}(e_{hl}^B)^2 - \frac{1}{1+\delta}\Psi(e_{ll}^A) + \psi(e_{ll}^B) \right) \\
& + \mu_1 (t_{hh}^A - \frac{1}{2}(e_{hh}^A)^2) + \mu_2 (t_{hl}^A - \frac{1}{2}(e_{hl}^A)^2) \\
& + \mu_3 (t_{lh}^A - \frac{1}{2}(e_{lh}^A)^2) + \mu_4 (t_{ll}^A - \frac{1}{2}(e_{ll}^A)^2) \\
& + \mu_5 (t_{hh}^B - \frac{1}{2}(e_{hh}^B)^2) + \mu_6 (t_{hl}^B - \frac{1}{2}(e_{hl}^B)^2) \\
& + \mu_7 (t_{lh}^B - \frac{1}{2}(e_{lh}^B)^2) + \mu_8 (t_{ll}^B - \frac{1}{2}(e_{ll}^B)^2) \\
& + \xi_1 \left(\frac{1}{1+\delta}\Psi(e_{ll}^B) - \psi(e_{ll}^A) \right) + \xi_2 \left(\frac{1}{1+\delta}\Psi(e_{ll}^A) - \psi(e_{ll}^B) \right)
\end{aligned}$$

with the additional nonnegativity constraints. There are four (potential) cases to consider.

Case 1 ($\xi_1 = 0, \xi_2 = 0$): **Full Collusion.** The Kuhn-Tucker conditions for e_{hh}^A and t_{hh}^A are

$$\frac{\partial \mathcal{L}}{\partial e_{hh}^A} = \nu^2 - e_{hh}^A (\lambda_1 + \mu_1) \leq 0, \quad e_{hh}^A \frac{\partial \mathcal{L}}{\partial e_{hh}^A} = 0, \quad (\text{A.1})$$

$$\frac{\partial \mathcal{L}}{\partial t_{hh}^A} = -\nu^2 + \lambda_1 + \mu_1 \leq 0, \quad t_{hh}^A \frac{\partial \mathcal{L}}{\partial t_{hh}^A} = 0. \quad (\text{A.2})$$

From (A.1), it follows that $e_{hh}^A > 0$. Individual rationality constraint (9) then implies that $t_{hh}^A > 0$ and, therefore, by (A.2) $\lambda_1 + \mu_1 = \nu^2$. Thus $e_{hh}^A = 1$. Proceeding in a

similar fashion, we obtain:

$$\begin{aligned}
e_{hl}^A &= e_{lh}^A = e_{hh}^B = e_{hl}^B = e_{lh}^B = 1, \\
\lambda_2 + \mu_3 &= \lambda_3 + \mu_6 = \mu_2 = \mu_7 = \nu(1 - \nu), \\
\mu_4 &= \mu_8 = (1 - \nu)^2, \\
\mu_5 &= \nu^2.
\end{aligned}$$

By Assumption 2, $\Phi(e_{ll}^A) > 0$ and $\Phi(e_{ll}^B) > 0$, hence $t_{hh}^A > \frac{1}{2}(e_{hh}^A)$ and, therefore, $\mu_1 = 0$. Also, since in the FC region individual rationality constraints (14) and (15) are satisfied with equality, the corresponding constraints (9) are not binding and thus $\mu_3 = \mu_6 = 0$. It follows that the Kuhn-Tucker conditions for e_{ll}^A and e_{ll}^B are given by:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial e_{ll}^A} &= (1 - e_{ll}^A)(1 - \nu)^2 - \nu \Delta \theta \frac{1 - 2\alpha - \delta(\alpha - \nu(1 - \alpha))}{(1 - 2\alpha)(1 + \delta)} = 0, \\
\frac{\partial \mathcal{L}}{\partial e_{ll}^B} &= (1 - e_{ll}^B)(1 - \nu)^2 - \nu \Delta \theta \frac{1 - 2\alpha - \delta\alpha(1 - \nu)}{(1 - 2\alpha)(1 + \delta)} = 0,
\end{aligned}$$

and the optimal effort levels are

$$e_{ll}^A = 1 - \Delta \theta \frac{\nu}{(1 - \nu)^2} \frac{1 - 2\alpha - \delta(\alpha - \nu(1 - \alpha))}{(1 - 2\alpha)(1 + \delta)}, \quad (\text{A.3})$$

$$e_{ll}^B = 1 - \Delta \theta \frac{\nu}{(1 - \nu)^2} \frac{1 - 2\alpha - \delta\alpha(1 - \nu)}{(1 - 2\alpha)(1 + \delta)}. \quad (\text{A.4})$$

Denote by α_0 the smaller of the two solutions to $\frac{1}{1+\delta}\Psi(e_{ll}^A) - \psi(e_{ll}^B) = 0$ with the effort levels (A.3) and (A.4); it is given by

$$\alpha_0 = \frac{(1 + \delta)(4 + \delta)(1 - \nu)^2 - \Delta \theta (\delta + 3\delta\nu^2 + (1 - \nu)^2) - \sqrt{M_1}}{4(1 + \delta)(2 + \delta)(1 - \nu)^2 - \Delta \theta [(2 + \delta)(1 + \delta + 2\nu) + \nu^2(2 - \delta(\delta - 3))]},$$

where

$$\begin{aligned}
M_1 &= (1 - \nu)^4(1 + \delta) (\delta^2 + 4\Delta\theta(1 + \delta)) \\
&\quad - (\Delta\theta)^2(1 + \delta)(1 - \nu) [(1 + \delta)^2 + \nu(1 - \nu)(1 - \delta^2) - \nu^3(1 - \delta)(1 + 3\delta)].
\end{aligned}$$

The Full Collusion (FC) region is then characterized by $\alpha \leq \alpha_0$.

Case 2 ($\xi_1 > 0, \xi_2 = 0$). From (A.3) and (A.4), we obtain

$$e_{ll}^B - e_{ll}^A = \Delta\theta \frac{\delta}{1+\delta} \frac{\nu^2}{(1-\nu)^2} \geq 0,$$

with strict inequality for $\delta > 0$; hence

$$\frac{1}{1+\delta} \Psi(e_{ll}^B) - \psi(e_{ll}^A) - \left[\frac{1}{1+\delta} \Psi(e_{ll}^A) - \psi(e_{ll}^B) \right] = \frac{\Delta\theta}{1+\delta} \frac{1+\alpha\delta}{1-2\alpha} (e_{ll}^B - e_{ll}^A) \geq 0.$$

That is, $\xi_2 = 0$ implies $\xi_1 = 0$ and, therefore, it cannot be the case that $\xi_1 > 0$ and $\xi_2 = 0$.

Case 3 ($\xi_1 = 0, \xi_2 > 0$): **Partial Collusion I.** Now, constraint (15) is satisfied with equality and thus individual rationality constraint (13) takes the form of the corresponding incentive compatibility constraint, $t_{hl}^B \geq \frac{1}{2}(e_{hl}^B)^2$. The optimal effort levels e_{ll}^A and e_{ll}^B are given by:

$$e_{ll}^A = 1 - \Delta\theta \frac{\nu}{(1-\nu)^2} \frac{(1-\alpha)\nu - \alpha}{(1-2\alpha)(1+\delta)}, \quad (\text{A.5})$$

$$e_{ll}^B = 1 - \Delta\theta \frac{\nu}{(1-\nu)^2} \frac{1 - \alpha(1+\nu)}{(1-2\alpha)(1+\delta)}. \quad (\text{A.6})$$

Denote by α_1 the smaller of the two solutions to $\frac{1}{1+\delta} \Psi(e_{ll}^B) - \psi(e_{ll}^A)$ where the effort levels are (A.5) and (A.6); it is given by

$$\alpha_1 = \frac{(1+\delta)(4+\delta)(1-\nu)^2 - \Delta\theta [1+\delta - 2\delta\nu + \nu^2(3+\delta(3+\delta))] - \sqrt{M_2}}{4(1+\delta)(2+\delta)(1-\nu)^2 - \Delta\theta [2+\delta(3+\delta) - 2\delta\nu + \nu^2(6+\delta(7+3\delta))]},$$

where

$$\begin{aligned} M_2 = & \left[(1+\delta)(4+\delta)(1-\nu)^2 - \Delta\theta (1+\delta - 2\delta\nu + \nu^2(3+\delta(3+\delta))) \right]^2 \\ & + \left[2(1+\delta)(1-\nu)^2 - \Delta\theta (1+\delta(1-\nu)^2 + \nu^2) \right] \times \\ & \times \left[4(1+\delta)(2+\delta)(1-\nu)^2 - \Delta\theta (2+\delta(3+\delta) - 2\delta\nu + \nu^2(6+\delta(7+3\delta))) \right]. \end{aligned}$$

The Partial Collusion I (PC I) region is characterized by $\alpha_0 < \alpha \leq \alpha_1$.

Case 4 ($\xi_1 > 0, \xi_2 > 0$): **Partial Collusion II.** The Partial Collusion II (PC II) region is characterized by $\alpha > \max\{\alpha_0, \alpha_1\}$. Now, both constraints (14) and (15)

are satisfied with equality and can be replaced by the corresponding individual rationality constraints. The optimal effort levels e_{ll}^A and e_{ll}^B are given by:

$$e_{ll}^A = 1 - \Delta\theta \frac{\nu^2}{(1-\nu)^2}, \quad (\text{A.7})$$

$$e_{ll}^B = 1 - \Delta\theta \frac{\nu^2}{(1-\nu)^2} \frac{1}{1+\delta}. \quad (\text{A.8})$$

Since the objective function is (weakly) concave and the constraint set is convex, the Kuhn-Tucker conditions are sufficient as well as necessary.

Proof of Proposition 1

i. Full Collusion Region. Productive efficiency is given by

$$E_C^{FC} = 2\nu^2 + 4\nu(1-\nu) + (1-\nu)^2 (e_{ll}^A + e_{ll}^B).$$

Substituting the values from (A.3) and (A.4) and simplifying, we obtain

$$E_C^{FC} - E_{NC} = \Delta\theta\delta\nu \frac{2(1-\alpha) - \nu}{(1-2\alpha)(1+\delta)} \geq 0,$$

where E_{NC} is given by (5), with strict inequality for $\delta > 0$.

To evaluate the principal's expected payoff, consider first the case of $\delta = 0$. Substituting (A.3) and (A.4) into the principal's objective function (16) and simplifying yields

$$\Pi_C^{FC} \Big|_{\delta=0} - \Pi_{NC} = \frac{(\Delta\theta)^2\nu}{(1-2\alpha)^2(1-\nu)^2} [\nu^2 + 2\alpha(1-\alpha)(1-3\nu + \nu^2(1-\nu))] > 0,$$

where Π_{NC} is given by (6). Since in the FC region the principal's expected payoff with internal control, Π_C^{FC} , is clearly increasing in δ while Π_{NC} is not a function of δ , we have $\Pi_C^{FC} - \Pi_{NC} > 0$ for all $\delta \geq 0$.

Since both agents supply the first-best levels of effort in the hh - and hl -cases, agency welfare under the contract with internal control is given by

$$\begin{aligned} W_C = & \nu^2 (2\theta_h + 1) + 2\nu(1-\nu) (\theta_l + \theta_h + 1) \\ & + (1-\nu)^2 \left(2\theta_l + e_{ll}^A - \frac{1}{2} (e_{ll}^A)^2 + e_{ll}^B - \frac{1}{2} (e_{ll}^B)^2 \right). \end{aligned} \quad (\text{A.9})$$

After substituting the values of e_{ll}^A and e_{ll}^B given by (A.3) and (A.4) and simplifying, we obtain

$$W_C^{FC} - W_{NC} = \frac{(\Delta\theta)^2 \nu^2}{2(1-2\alpha)^2(1+\delta)^2(1-\nu)^2} H(\alpha, \delta, \nu),$$

where

$$\begin{aligned} H(\alpha, \delta, \nu) &= 2\delta(1-\alpha)(2+\delta-\alpha(4+3\delta)) - \delta^2\nu^2(1-2\alpha(1-\alpha)) \\ &\quad - 2\nu[1+4\alpha^2(1+\delta)^2 + \delta(3+\delta) - \alpha(4+5\delta(2+\delta))] \end{aligned}$$

and W_{NC} is given by (8). This establishes part *iii.(a)*.

ii. Partial Collusion I Region. Substituting the values from (A.5) and (A.6) into the expression for technological efficiency and simplifying, we obtain

$$E_C^{PCI} - E_{NC} = \frac{\nu\Delta\theta}{(1-2\alpha)(1+\delta)} [1 - 2\alpha(1-\nu) - \nu + (2 - 3\alpha - \nu(1-\alpha))].$$

Since

$$\frac{\partial}{\partial\nu} [1 - 2\alpha(1-\nu) - \nu + (2 - 3\alpha - \nu(1-\alpha))] = -(1 - 2\alpha + \delta(1-\alpha)) < 0,$$

we can write

$$1 - 2\alpha(1-\nu) - \nu + (2 - 3\alpha - \nu(1-\alpha)) > \delta(1-2\alpha) \geq 0,$$

and thus $E_C^{PCI} - E_{NC} > 0$.

After simplification, we also obtain

$$\begin{aligned} \Pi_C^{PCI}|_{\delta=0} - \Pi_{NC} &= \Delta\theta \left\{ (1-\nu)\nu + \frac{\nu\Delta\theta}{4} \left[\left(5 + \frac{1}{(1-2\alpha)^2} \right) + 4 \left(\nu - \frac{2-3\nu}{(1-\nu)^2} \right) \right] \right\} \\ &> \Delta\theta \left\{ (1-\nu)\nu - \frac{\nu\Delta\theta}{2} \left[\frac{(1-2\nu)(1+\nu^2)}{(1-\nu)^2} \right] \right\}. \end{aligned}$$

The above expression is clearly positive for $\nu \geq \frac{1}{2}$. By Assumption 2, $\Delta\theta < 1$, and

thus for $\nu < \frac{1}{2}$ we can write

$$(1 - \nu)\nu - \frac{\nu\Delta\theta}{2} \left[\frac{(1 - 2\nu)(1 + \nu^2)}{(1 - \nu)^2} \right] > \frac{\nu(1 + \nu(5\nu - 4))}{2(1 - \nu)^2} > 0.$$

It follows that $\Pi_C^{PCI}|_{\delta=0} - \Pi_{NC} > 0$. Since the principal's payoff is increasing in δ in the PCI region, we have $\Pi_C^{PCI} - \Pi_{NC} > 0$ for all $\delta \geq 0$.

Substituting (A.5) and (A.6) into (A.9), we find that agency welfare is characterized by

$$W_C^{PCI} - W_{NC} = \frac{(\Delta\theta)^2\nu^2}{2(1 - 2\alpha)^2(1 + \delta)^2(1 - \nu)^2} H_I(\alpha, \delta, \nu),$$

where

$$\begin{aligned} H_I(\alpha, \delta, \nu) &= (1 + \delta)^2 (1 - 2\nu - \nu^2(1 - 2\alpha)) + 2\alpha^2 (3 - \nu(6 + \nu)) \\ &\quad - 6\alpha(1 - 2\nu) + (2 + \delta) [\delta - 2\alpha\delta(4 - 5\nu(1 - \alpha)) + \alpha^2\delta(7 - \nu^2)]. \end{aligned}$$

iii. Partial Collusion II Region. Substituting the values from (A.7) and (A.8) into the expression for technological efficiency and simplifying yields

$$\begin{aligned} E_C^{PCII} - E_{NC} &= 2 \left[(1 - \nu)^2 + \nu\Delta\theta \left((1 - \nu) - \frac{\nu}{1 + \delta} \right) \right] \\ &\geq 2 [(1 - \nu)^2 + \nu\Delta\theta(1 - 2\nu)]. \end{aligned}$$

The above expression is positive for $\nu \leq \frac{1}{2}$. Since, by Assumption 2, $e_{II}^A - \Delta\theta \geq 0$, the following condition on $\Delta\theta$ must be satisfied:

$$\Delta\theta \leq \frac{(1 - \nu)^2}{1 - 2\nu(1 - \nu)}. \quad (\text{A.10})$$

For $\nu > \frac{1}{2}$ we can, therefore, write:

$$(1 - \nu)^2 + \nu\Delta\theta(1 - 2\nu) \geq \frac{(1 - \nu)^3}{1 - 2\nu(1 - \nu)} > 0.$$

This establishes part (i).

Next, after substitution of (A.7) and (A.8) into the principal's objective function

and simplifying, we obtain

$$\Pi_C^{PCII}|_{\delta=0} - \Pi_{NC} = \frac{\nu\Delta\theta}{(1-\nu)^2} \{2(1-\nu)^3 + \Delta\theta [2\nu(1-\nu(1-\nu)) - 1]\},$$

which is positive when $2(1-\nu)^3 + \Delta\theta [2\nu(1-\nu(1-\nu)) - 1] \geq 0$. When the latter expression is negative, we can, by (A.10), write

$$2(1-\nu)^3 + \Delta\theta [2\nu(1-\nu(1-\nu)) - 1] \geq \frac{(1-\nu)^2 [1 - 2\nu(2-\nu)(1-\nu)]}{1 - 2\nu(1-\nu)} > 0.$$

As before, the principal's expected payoff is increasing in δ in the PCII region, hence $\Pi_C^{PCII} - \Pi_{NC} > 0$ for all $\delta \geq 0$. This establishes part (ii).

After substitution of (A.7) and (A.8) into (A.9) and simplification, we obtain:

$$W_C^{PCII} - W_{NC} = \frac{(\Delta\theta)^2\nu^2}{2(1+\delta)^2(1-\nu)^2} [2(1+\delta)^2(1-\nu) - \nu^2(2+\delta(2+\delta))].$$

This establishes part (iii). □

Proof of Corollary 1

Since

$$W_C^{FC}|_{\delta=0} - W_{NC} = -\frac{(\Delta\theta)^2\nu^3}{(1-\nu)^2} < 0,$$

it suffices to show that $W_C^{FC} - W_{NC}$ is increasing in α and δ . After simplification, we obtain:

$$\frac{\partial}{\partial\alpha} (W_C^{FC} - W_{NC}) = (\Delta\theta)^2\delta\nu^2 \frac{2 - 2\alpha(2+\delta) + \delta\nu}{(1-2\alpha)^3(1+\delta)^2(1-\nu)},$$

which is positive for $\alpha < \frac{2+\delta\nu}{2(1+\delta)}$.

In the FC region constraint (15) is always binding. Notice that

$$\frac{\partial}{\partial e} \left(\frac{1}{1+\delta} \Psi(e) - \psi(e) \right) = \Delta\theta \frac{1 - \alpha(2+\delta)}{(1-2\alpha)(1+\delta)},$$

which is positive for $\alpha < \frac{1}{2+\delta}$. It follows that the upper bound of the FC region, α_0 ,

satisfies $\alpha_0 < \frac{1}{2+\delta}$. Next, observe that

$$\frac{2 + \delta\nu}{2(1 + \delta)} - \frac{1}{2 + \delta} = \frac{\delta\nu}{2(1 + \delta)} \geq 0,$$

hence we have

$$\frac{\partial}{\partial \alpha} (W_C^{FC} - W_{NC}) > 0.$$

Next, we obtain

$$\begin{aligned} & \frac{\partial}{\partial \delta} (W_C^{FC} - W_{NC}) \\ &= (\Delta\theta)^2 \nu^2 \frac{2(1 - \alpha)(1 - 2\alpha - \alpha\delta) - \nu(1 - 2\alpha - \delta) - \delta\nu^2(1 - 2\alpha + 2\alpha^2)}{(1 - 2\alpha)^2(1 + \delta)^3(1 - \nu)^2}, \end{aligned}$$

which is positive for

$$\alpha_k < \frac{3 - \nu - (1 - \nu)\sqrt{(1 + \delta(1 + \nu))(1 + \delta(1 - \nu))} + \delta(1 - \nu^2)}{2(2 + \delta(1 - \nu^2))}.$$

It is straightforward to verify that $\alpha_k \geq \frac{1}{2+\delta}$, and thus

$$\frac{\partial}{\partial \delta} (W_C^{FC} - W_{NC}) > 0.$$

□

Proof of Proposition 2

The agents' expected rent can be found as $R_C = W_C - \Pi_C$. After simplification, we obtain:

$$\begin{aligned} R_{NC} - R_C^{FC}|_{\delta=0} &= \frac{2\nu(\Delta\theta)^2}{(1 - 2\alpha)^2(1 - \nu)^2} [\nu^2 + \alpha(1 - \alpha)(1 - 3\nu - \nu^2 - \nu^3)] \\ &> \frac{\nu(\Delta\theta)^2(1 - \nu)}{2(1 - 2\alpha)^2} > 0. \end{aligned}$$

Since R_C^{FC} is decreasing in δ , we have $R_{NC} - R_C^{FC} > 0$ for all $\delta \geq 0$.

We also have

$$\begin{aligned} R_{NC} - R_C^{PCI} \Big|_{\delta=0, \alpha \rightarrow 0} &= \frac{\nu \Delta \theta}{2(1-\nu)^2} [2(1-\nu)^3 - \Delta \theta (1-\nu - \nu^2 - 3\nu^3)] \\ &\geq \frac{\nu \Delta \theta}{2(1-\nu)^2} [1 - 5\nu + 7\nu^2 + \nu^3] > 0, \end{aligned}$$

where the first inequality follows because, by Assumption 2, $\Delta \theta \leq 1$. R_C^{PCI} is clearly decreasing in δ and α , hence the above inequality holds for all $\delta \geq 0$ and $\alpha \in [0, \frac{1}{2}]$.

In a similar fashion, we obtain

$$\begin{aligned} R_{NC} - R_C^{PCII} \Big|_{\delta=0} &= \frac{\nu \Delta \theta}{(1-\nu)^2} [2(1-\nu)^3 - \Delta \theta (1-\nu + \nu^2 - 3\nu^3)] \\ &\geq \frac{(1-\nu)^2 (1 - 5\nu + 7\nu^2 - \nu^3)}{1 - 2\nu(1-\nu)} > 0, \end{aligned}$$

where the first inequality holds because, by Assumption 2, we have

$$\Delta \theta \leq \frac{(1-\nu)^2}{1 - 2\nu(1-\nu)}.$$

Since R_C^{PCII} is decreasing in δ , $R_{NC} - R_C^{PCII} > 0$ holds for all $\delta \leq 0$.

We have shown that $R_{NC} - R_C > 0$, hence the agents (as a group) will always be willing to pay the principal up to the amount given by $R_{NC} - R_C$ (notice that, by Proposition 1, the principal's threat to implement internal control is credible). If the principal accepts their offer, her payoff is given by

$$\Pi_{MNC} \equiv \Pi_{NC} + R_{NC} - R_C = W_{NC} - R_C.$$

If she rejects the offer, her payoff is $\Pi_C = W_C - R_C$. Hence $W_{NC} > W_C$ implies $\Pi_{MNC} > \Pi_C$. \square

Proof of Proposition 3

Suppose that $\underline{\alpha} > 0$ and the following conditions hold:

$$\begin{aligned} W_{NC} - W_C^{FC} - \underline{\alpha}(\Delta \theta)^2 (\underline{\alpha}(1-\nu) + 2\nu)(1-\nu) &> 0, & (A.11) \\ 1 - \Delta \theta \left(\frac{\nu}{1-\nu} + 1 + \underline{\alpha} \right) &\geq 0. \end{aligned}$$

To see that there exists a set with non-empty interior for which condition (A.11) holds, observe that, for $\delta = 0$, it is equivalent to $\underline{\alpha} < \tilde{\alpha}$, where

$$\tilde{\alpha} = \frac{\nu}{(1-\nu)^2} \left(\sqrt{(1-\nu)^2 + \nu} - \sqrt{(1-\nu)^2} \right) > 0.$$

Since W_C^{FC} is continuous in δ , condition (A.11) will also hold for sufficiently small $\delta > 0$.

Consider two reporting functions:

$$r_0(x) = x;$$

$$r_1(x) = \begin{cases} \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} & \text{if } x \in [\theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} - \underline{\alpha}\Delta\theta, \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} + \underline{\alpha}\Delta\theta], \\ x & \text{otherwise.} \end{cases}$$

We have $m(r_1) = \underline{\alpha}\Delta\theta > 0 = m(r_0)$. Since $W_{NC} - W_C^{FC} > 0$, the principal prefers to offer the MNC contract. Under the NC contract, the effort levels required of the efficient and inefficient agents, e_h and e_l , are given by (3) and (4):

$$e_h = 1, \quad e_l = 1 - \Delta\theta \frac{\nu}{1-\nu}.$$

Suppose that the principal sets $\alpha = \hat{\alpha}$. In the hl -case, when the efficient agent i claims to be inefficient and exerts the effort of $e_l - \Delta\theta$, the levels of output will be

$$x^i = \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} + \hat{\alpha}\Delta\theta,$$

$$x^j = \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu} - \hat{\alpha}\Delta\theta,$$

where $i, j = A, B$ and $i \neq j$. With reporting function r_1 , instead of x^i and x^j given above the principal observes, for both agents, $x = \theta_l + 1 - \Delta\theta \frac{\nu}{1-\nu}$, the levels of output required of inefficient agents. Furthermore, the agents cannot reduce their effort levels without being detected. In the ll -case, however, the agents can reduce their effort levels from e_l to $e_l - \hat{\alpha}\Delta\theta$ without being detected, and the principal compensates them only for these lower effort levels. For the same reason, information rents collected by the efficient agents in the hh -case are given by $\Phi(e_l - \hat{\alpha}\Delta\theta)$. Notice that reporting function r_1 does not distort output levels when the agents exert e_h .¹⁴

¹⁴Using a reporting function that is step-linear everywhere may lead to a distortion at $e = e_h$. The characterization of the solution changes but the qualitative nature of the result does not.

Agency welfare with reporting function r_1 is given by

$$\begin{aligned}
W(r_1) &= 2\nu^2 (\theta_l + \Delta\theta + e_h - c(e_h)) \\
&\quad + 2\nu(1 - \nu) (2\theta_l + \Delta\theta + e_l - c(e_l) + e_h - c(e_h)) \\
&\quad + 2(1 - \nu)^2 (\theta_l + (e_l - \hat{\alpha}\Delta\theta) - c(e_l - \hat{\alpha}\Delta\theta)) \\
&= 1 + 2\theta_l + 2\nu\Delta\theta - (\Delta\theta)^2 \frac{\nu^2}{1 - \nu} - \hat{\alpha}(\Delta\theta)^2 (\hat{\alpha}(1 - \nu) + 2\nu) (1 - \nu) \\
&= W_{NC} - \hat{\alpha}(\Delta\theta)^2 (\hat{\alpha}(1 - \nu) + 2\nu) (1 - \nu).
\end{aligned}$$

Notice that $\frac{\partial}{\partial \hat{\alpha}} W(r_1) = -(\Delta\theta)^2 (\hat{\alpha}(1 - \nu) + 2\nu) (1 - \nu) < 0$. That is, the principal implements $\hat{\alpha} = \underline{\alpha}$ but uses $\alpha = \bar{\alpha}$ in negotiating the agent's concession in exchange for not implementing internal control. By assumption, we have

$$W(r_1) - W_C^{FC} = W_{NC} - W_C^{FC} - \underline{\alpha}(\Delta\theta)^2 (\underline{\alpha}(1 - \nu) + 2\nu) (1 - \nu) > 0. \quad (\text{A.12})$$

Hence, by Proposition 2, $\Pi(r_1) - \Pi(r_0) > 0$. □