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## Buried in Paperwork: Excessive Reporting in Organizations

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GOVERNANCE AND THE EFFICIENCY  
OF ECONOMIC SYSTEMS  
**GESY**

Discussion Paper No. 27

**Buried in Paperwork: Excessive  
Reporting in Organizations**

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October 2004

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# Buried in Paperwork: Excessive Reporting in Organizations

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October 19, 2004

## **Abstract**

This paper offers an explanation why a principal may demand too much paperwork from a subordinate: Due to limited liability and moral hazard a principal is unable to appropriate all rents. Internal paperwork allows a more accurate monitoring of the agent and enables the principal to appropriate a larger part of the agent's rent. In her decision the principal disregards the agent's cost increase of more internal paperwork. Consequently, the requested amount of internal paperwork may be too high from both the agent's personal point of view and the organization as a whole.

*JEL Classification No.: D23, D82*

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# 1 Introduction

Complaints about too much internal paperwork is a commonly heard criticism in many organizations.<sup>1</sup> Not only do members of organizations claim that the amount of bureaucracy is too high from their own personal point of view, but also for the organization as a whole. Such claims are clearly puzzling. In addition, also organizations dealing with governmental regulation often characterize the amount of paperwork as counter-productive.<sup>2</sup> Outsiders who are concerned with overall productivity share the criticism. For instance, a document of the white house on the H.R. 1646 - Foreign Relations Authorization Act, Fiscal Years 2002 and 2003 states "The Administration will work with the Congress to eliminate from the bill objectionable provisions, including unproductive reporting requirements and earmarks."<sup>3</sup>

This paper explains in a simple principal-agent relationship why a principal may, from an overall perspective, demand too much paperwork. The explanation is driven by the effect of self-reporting on rent sharing between agent and principal. More specifically we show in an agency model with limited liability that if internal paperwork leads to a better monitoring of the agent, it enables the principal to appropriate a larger part of the common surplus at the agent's expense. More importantly, the decrease in the agent's utility may more than offset the principal's increase. This we interpret as excessive reporting.

Effectively, we present the idea that reporting raises the informativeness of an audit. As a concrete illustration of what we have in mind, consider an employee who travels on companies business. Not being able to observe

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<sup>1</sup>For instance, the 1999 R&D Magazine/Kelly Scientific Resources Career Satisfaction Survey reports that almost half of the respondents (48.2%) consider "too much bureaucracy" as the least satisfying aspects of their job. (<http://www.kellyservices.com/ksr/whitepapers/paper6.html>)

<sup>2</sup>E.g., the Mercer County's "Agri-Culture:" Study Results reports that "68.2 percent of respondents felt that the programs have too much bureaucracy and 52.3 percent felt that the programs have too much paperwork." (<http://www.swampgoddess.com/the-sis4b.html>).

<sup>3</sup>See <http://www.whitehouse.gov/omb/legislative/sap/107-1/HR1646-r.html>.

the employee's behavior during his absence, the employer requires him to keep a diary. By specifying how often the employee must write an entry in his diary, the employer determines the reporting intensity. It is thereby natural that the employee incurs a cost for maintaining the diary and that this cost is increasing in the required reporting intensity. Once the employee returns from his travels, the diary contains information about his unobserved behavior. The amount of information is thereby increasing in the reporting intensity. However, in order for the employer to obtain this information, she must actually read and check the diary. This requires time and effort and is costly to the employer.

Apart from illustrating the setting, the example also demonstrates that a disclosure of information in practise is more complex than the standard literature assumes. Although the literature recognizes that disclosure may be costly (e.g. Townsend (1979)), it abstracts from the fact that it involves two distinct activities: the generation and the processing of information. Indeed, in real-life organizations these subactivities are often performed by different people and are associated with different costs. The current paper explicitly breaks down the activity of disclosure into these two subactivities. It thereby interprets the generation of information as the agent writing his report and the processing of information as the principal's decision to audit the agent.

Finally, we want to highlight the difference of our framework to other work on disclosure and costly state-verification. First, we abstract from a strategic reporting by the agent. Consequently, the model differs from the literature on voluntary disclosure or accounting choice (e.g. Watts (1979) and Holthausen and Leftwich (1983)), where the agent has discretion regarding his accounting rules. In contrast, we assume that the agent's reporting activity is verifiable and contractible. This enables us to concentrate on effort as the agent's only source of moral hazard. Second, the principal cannot use the agent's report to help her decide whether to audit. In the words of Baiman and Demski (1980), we consider an *unconditional* investigation procedure; the principal cannot condition her auditing decision on the agent's report.<sup>4</sup> Indeed, from this

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<sup>4</sup>Strausz (2004) studies the question of whether a principal would want to use condi-

perspective the effect of the agent’s report is more mechanic; it directly affects the accuracy of a potential audit. Third, the model differs from the literature on window dressing (e.g. Lambert (1984) and Fischer and Verrecchia (2000)). As Cornelli and Yosha (2003) explain under window dressing the agent’s (costly) action typically shifts the distribution of an auditing signal to more favorable realizations rather than increases its precision.

The rest of the paper is organized as follows. The next section introduces a highly stylized, but tractable model with self-reporting and auditing. This model is analyzed in Sections 3 and 4. Section 5 addresses the robustness of results by illustrating similar effects of reporting in more standard frameworks with limited liability such as Kim (1997), Park (1994), and Demougins and Fluet (1998).

## 2 The Setup

Consider a risk neutral principal who employs a risk neutral agent. The agent has to decide whether to shirk or work. Shirking costs the agent zero effort, whereas the agent incurs a cost of  $e > 0$  if he decides to work. A working agent yields the principal an output  $y_w$ . From a shirking agent the principal receives a lower output  $y_s$ , where  $\Delta y \equiv y_w - y_s > e$ . We assume that both effort and output are non-verifiable and therefore non-contractible.<sup>5</sup> The principal may obtain verifiable evidence about the agent’s effort level if she decides to audit the agent.<sup>6</sup> The effectiveness of an audit depends on the principal’s effort in auditing. For simplicity, the principal chooses between two effort levels. If the principal audits with a low effort, the audit is inconclusive, i.e., a low auditing effort effectively means no audit. If, on the other hand, the principal chooses a high auditing effort, auditing is successful with probability  $\lambda < 1$ . In this case, it yields hard evidence about the agent’s true effort level. With probability  $1 - \lambda$  an audit is unsuccessful and no result

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tional or unconditional procedures.

<sup>5</sup>Section 5 addresses verifiable output.

<sup>6</sup>Since the agent’s effort determines the output deterministically, an alternative interpretation is that an audit makes the output verifiable. This interpretation also motivates our assumption that output is, initially, non-verifiable.

obtains. The high auditing effort costs the principal  $c > 0$ , while her costs associated with a low auditing effort are zero. Similar to the agent's action, the principal's auditing effort is unobservable.<sup>7</sup> Yet, the auditing outcome  $\{w, s, n\}$  is observable and verifiable.

The idea of this paper is that internal paperwork increases the precision of the principal's auditing technology. To capture this idea, we assume that at the beginning of their relationship the principal sets the amount of internal paperwork at some level  $r \in [0, 1]$ .<sup>8</sup> The success of the audit,  $\lambda$ , is positively related to the amount of internal paperwork. That is, the parameter  $\lambda$  is an increasing function of  $r$  with  $0 < \lambda(0) < 1 = \lambda(1)$ . Paperwork is costly to the agent. Hence, apart from the cost of effort  $e$ , the agent also incurs a cost of reporting  $k(r)$ , with  $k'(r), k''(r) > 0$  and  $k(1) = \infty$ . Interpreting  $r = 0$  as no paperwork, we assume  $k(0) = 0$ . For simplicity, the principal's cost of auditing  $c$  are independent of the amount of paperwork. Section 5 addresses extensions of this framework.

Apart from stipulating the amount of internal paperwork, the agent's employment contract specifies the conditional transfers from the principal to the agent. Since the only verifiable variable is the outcome of the audit, a general transfer schedule can only be conditioned on the outcome of the audit and is, consequently, a triple  $t = (t_w, t_s, t_n)$ . Agent and principal are risk neutral and the agent is protected by a limited liability level of zero. That is, a *feasible* contract  $t$  satisfies  $t \in \mathbf{R}_+^3$ . Outside options of the two players are zero.<sup>9</sup>

### 3 Optimal Transfers

This section derives, for a given level of internal paperwork  $r$ , the optimal transfers that induce the agent to work. Since this requires incentives, the

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<sup>7</sup>The model therefore falls in the class of auditing models without commitment. E.g. Melumad and Mookherjee (1989), Jost (1991), Khalil (1997), and Strausz (1997). Section 5 shows that the non-commitment is not crucial.

<sup>8</sup>I.e., the amount of paperwork is verifiable and contractible

<sup>9</sup>For simplicity, we let the outside option and the limited liability coincide. This does not effect qualitative results.

principal must audit with a positive probability. Hence, the transfer schedule  $t$  should also induce the principal to audit. We first address the principal's incentives to audit.

If the principal does not audit, she obtains no evidence and pays the agent  $t_n$ . If the principal audits, she receives a successful audit with probability  $\lambda(r)$ . Consequently, when she expects the agent to work she expects to pay an amount  $\lambda(r)t_w + (1 - \lambda(r))t_n + c$ . Hence, the transfer schedule  $t$  induces the principal to audit if

$$t_w + c/\lambda(r) \leq t_n. \quad (1)$$

If the equation is satisfied in equality, the principal is indifferent concerning the audit, and any probability of auditing,  $p$ , is incentive compatible.<sup>10</sup> We may include this possibility by the additional constraint<sup>11</sup>

$$(1 - p)(t_w + c/\lambda(r) - t_n) = 0. \quad (2)$$

Given that the principal audits with probability  $p$ , the agent receives a utility  $p\lambda(r)t_w + (1 - p\lambda(r))t_n - e - k(r)$  if he works and  $p\lambda(r)t_s + (1 - p\lambda(r))t_n - k(r)$  from shirking. Consequently, the agent works if

$$p\lambda(r)(t_w - t_s) - e \geq 0. \quad (3)$$

Finally, the contract must be acceptable to the agent. That is, yield him more than his outside option of zero. Hence,

$$p\lambda(r)t_w + (1 - p\lambda(r))t_n - e - k(r) \geq 0. \quad (4)$$

The constraints (1), (2) and (3) ensure that a transfer schedule  $t$  is incentive compatible with the principal's decision to monitor with probability  $p$  and the agent's decision to work. Hence, a contract  $t = (t_w, t_s, t_n)$  is  $(e, p)$ -compatible if the combination  $(t, p)$  satisfies (1), (2) and (3). If  $(t, p)$  satisfies in addition the constraint (4), the transfer  $t$  is  $(e, p)$ -feasible.

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<sup>10</sup>As is well-known, optimal auditing strategies are often random (e.g. Mookherjee and Png 1989) and must therefore be considered explicitly.

<sup>11</sup>The condition ensures that when the principal audits with a probability less than one, the constraint (1) is satisfied in equality, while a strict inequality of (1) implies  $p = 1$ .



The optimal transfers associated with a reporting intensity  $r$  is a solution to the following maximization problem

$$\begin{aligned} \max_{t \in \mathbb{R}_+^3, p \in [0,1]} \quad & y_w - p\lambda(r)t_w - (1 - p\lambda(r))t_n - pc \\ \text{s.t.} \quad & (1), (2), (3), (4). \end{aligned}$$

The equilibrium outcome will depend on the efficiency of auditing  $\lambda(r)$ . We, therefore, define

$$\bar{\lambda}(r) \equiv (e + c)/(e + k(r) + c);$$

and define  $\bar{r}$  such that  $\lambda(\bar{r}) = \bar{\lambda}(\bar{r})$ .<sup>12</sup>

**Proposition 1** *Optimal transfers  $(t_w^*, t_s^*, t_n^*)$  exhibit  $t_s^* = 0$  and  $t_n^* = t_w^* + c/\lambda(r)$ . For  $r < \bar{r}$ , the optimal contract yields the agent  $U(r) = (1 - \lambda(r))(e + c)/\lambda(r) - k(r) > 0$  and the principal  $V(r) = y_w - (e + c)/\lambda(r)$ . The principal monitors with probability  $p^* = 1$ .*

*For  $r \geq \bar{r}$ , the optimal contract extracts all rents from the agent, i.e.,  $U(r) = 0$ , the principal monitors with a probability  $p^* < 1$  and receives a utility  $V(r)$ , where*

$$p^* = \left( \sqrt{4ec/\lambda(r) + (e + k(r) - c/\lambda(r))^2} + c/\lambda(r) - e - k(r) \right) / (2c)$$

and

$$V(r) = y_w - \frac{1}{2} \left( c/\lambda(r) + e + k(r) + \sqrt{(c/\lambda(r) - e - k(r))^2 + 4ec/\lambda(r)} \right).$$

The proposition shows that for low levels of internal paperwork, ( $r < \bar{r}$ ), the agent receives a positive rent. This result is due to limited liability and is best understood when considering the case  $r = 0$ . As  $k(0) = 0$  the agent incurs no costs if he shirks. Since limited liability implies that all transfers

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<sup>12</sup>Existence of  $\bar{r}$  follows from the continuity of  $\lambda(r)$  and  $\bar{\lambda}(r)$  and the fact that  $\lambda(0) < 1 = \bar{\lambda}(0)$  and  $\lambda(1) = 1 > \bar{\lambda}(r)$  for all  $r > 0$ . Uniqueness follows because  $\lambda(r)$  is increasing while  $\bar{\lambda}(r)$  is decreasing in  $r$ .

are non-negative, the agent can guarantee himself a utility of at least zero by shirking. Hence, since an  $(e, p)$ -compatible contract requires that working yields the agent weakly more than shirking, the contract automatically satisfies individual rationality. Therefore, the agent's individual rationality constraint does not bind at the optimum and the agent receives a rent.

On the other hand, if the required amount of internal paperwork is high,  $(r > \bar{r})$ , the principal appropriates the entire surplus and audits with a probability less than one. Indeed, for  $k(r) > 0$  a contract that is  $(e, p)$ -compatible is not automatically individual rational to the agent. This implies that the individual rationality constraint of the agent may bind at the optimum and this occurs exactly when the auditing technology is efficient.

The proposition moreover shows that the structure of optimal payments is such that  $t_n > t_w > t_s$ . Hence, the agent receives the largest payment, when there is neither evidence that the agent worked nor shirked. This feature is typical of costly verification models in which the principal cannot commit to verify.<sup>13</sup> In this case, the larger payment is needed to induce the principal to monitor. The fact that  $t_w > t_s$  is standard and represents the required incentives to induce the agent to work.

## 4 Optimal Reporting and Effort

The previous section derived the optimal transfers for a given level of internal paperwork  $r$ . Proposition 1 showed that for  $r < \bar{r}$  the principal's utility is  $V(r) = y_w - (e + c)/\lambda(r)$  and since  $\lambda$  is increasing  $r$ , we obtain the following result:

**Proposition 2** *If the principal induces the agent to work, she optimally chooses a standard  $r^* \geq \bar{r}$ . The principal's choice  $r^*$  exceeds the level  $r^{**} = 0$  which is optimal from the perspective of aggregate utility.*

The first result follows because for  $r < \bar{r}$  the principal's utility does, in equilibrium, not depend on the agent's personal cost of reporting  $k(r)$ .

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<sup>13</sup>See for example Khalil (1997) and Strausz (1997).

Indeed, when the principal considers a marginal increase of the agent's reporting requirement  $r$ , there are two effects. First, the increase makes the principal's monitoring technology more efficient. Second, the agent incurs an additional cost of  $k'(r)$ . Yet, since for  $r < \bar{r}$  the agent receives a rent, the principal does not have to compensate the agent for his increased cost  $k'(r)$ . Hence, from the principal's point of view a raise in  $r$  from a level below  $\bar{r}$  has only the beneficial effect of making monitoring more efficient and enables the principal to reduce the agent's rent. The rent extraction has the perverse effect that the agent's loss in utility outweighs the principal's gain so that aggregate utility declines.

To conclude this section we address whether the principal actually wants the agent to work. She does so, if her payoff from a working agent is higher than from a shirking one. Since a shirking agent yields the principal  $y_s$  and a working agent yields the principal at least  $y_w - (e + c)/\lambda(\bar{r})$ , we arrive at the following sufficient condition.

**Corollary 1** *It is optimal for the principal to induce the agent to work if*

$$\Delta y \geq (e + c)/\lambda(\bar{r}).$$

Due to the presence of rents, the principal does not make decisions that maximize aggregate utility. Proposition 2 shows that this leads to excessive reporting. Yet, the presence of rents may also affect the principal's decision concerning the agent's effort level. In particular, if the minimum rent that is needed to induce the agent to work is too high, the principal prefers the agent to shirk even though aggregate payoffs may be larger under working. But since excess reporting leads to a reduction in rents, it may make it actually worthwhile for the principal to induce the agent to work. This argument indicates that excess reporting may have the beneficial effect that it reduces effort distortion. Indeed, let the function

$$\Delta y(r) \equiv (e + c)/\lambda(r),$$

represent, for a given intensity  $r$ , the difference  $y_w - y_s$  for which the principal is indifferent between inducing the agent to work or shirk. Since

$\lambda(r)$  is increasing in  $r$ , it holds that  $\Delta y(0) > \Delta y(\bar{r})$ . Hence, whenever  $\Delta y \in (\Delta y(\bar{r}), \Delta y(0))$  it is optimal for the principal to induce the agent to work under her optimal reporting standard  $r^*$ , but making the agent work would not be optimal under the aggregate utility maximizing paperwork level  $r = 0$ .

Consequently, if the principal's reporting requirement affects her decision which effort level to induce, the question what to consider excessive reporting becomes more subtle. The source of this subtlety is that the principal effectively takes two decisions: the reporting standard  $r$  and the induced effort level  $e$ . Due to the moral hazard problem, both these decisions may be distorted and the corollary shows that the two distortions may affect each other. If  $\Delta y > \Delta y(0)$  this complication does not arise and the principal's reporting requirement is unambiguously excessive. However, for  $\Delta y < \Delta y(0)$ , a higher reporting requirement may have the beneficial effect that it reduces the principal's effort distortion. This positive effect offsets the principal's high reporting requirement.

## 5 A More Standard Model

In the previous sections we used an extremely stylized model to demonstrate our argument that, when reporting facilitates verification, concerns about the distribution of rents may lead to excessive reporting. The simple structure kept the model tractable so that we were able to solve it explicitly. In this section we want to argue that the main insight is general and robust. For this we introduce reporting and auditing in the risk-neutral agency framework with limited liability as analyzed in, for example, Park (1994), Demougin and Fluet (1998), and Kim (1997).

Hence, consider an agency setting in which a risk neutral agent is protected by a liability of zero. The agent has to choose some unobservable effort  $e$  from a continuous interval  $[e_l, e_h]$  with costs  $c(e)$ . As is standard, the agent's effort  $e$  thereby determines the output  $x \in X$  according to the distribution function  $q(e)$ . The output accrues to a risk neutral principal. In addition to choosing an effort level, the agent reports to the principal with

some intensity  $r$ . The agent thereby incurs a personal cost of  $k_a(r)$ . We assume that the function  $k_a(\cdot)$  is increasing and convex. To induce the agent to work, the principal must audit the agent with some intensity  $a \in [a_l, a_h]$ . She thereby incurs a cost  $k_p(a, r) > 0$ .

In order to induce the agent to work, the principal may write an incentive contract  $t$  which conditions on all available, verifiable information. This verifiable information consists of the output  $x$  and a signal  $s \in S$  from the principal's auditing process. The signal  $s$  is stochastic and its distribution depends on the agent's effort level  $e$ , the agent's reporting intensity  $r$ , and the principal's auditing intensity  $a$ . Consequently, our model falls, for a fixed pair  $(r, a)$ , in the class of problems analyzed by Demougin and Fluet (1998). These authors demonstrate that, in this type of models, the agency cost is equivalent to the agent's rent and that if the information system is relatively inaccurate or the level of limited liability is relative high then this rent is strictly positive.<sup>14</sup> Consequently, a superior information system is one which reduces the agent's minimum rent that is required to implement some effort level  $e > e_l$ .

To make this more concrete, let  $R(e|a, r)$  represent the minimum rent which the principal must leave to the agent if she wants to induce an effort level  $e > e_l$ . Then our idea that reporting and auditing improves the principal's information is equivalent to saying that  $R$  is decreasing in  $a$  and  $r$ . In particular,  $\partial R / \partial r < 0$ .

From the principal's perspective the cost of implementing an effort level  $e > e_l$  depends on her personal auditing costs and the total transfer to the agent. Per definition, the total transfer to the agent is his total costs plus the rent, i.e.,  $k_a(r) + c(e) + R(e|a, r)$ . That is, the cost to the principal of implementing an effort level  $e$  is

$$C_p(r|e, a) = k_p(a, r) + k_a(r) + c(e) + R(e|a, r).$$

Thus, for a given effort level  $e$  and auditing level  $a$ , the principal chooses a reporting intensity  $r_p^*(e, a)$  that minimizes her costs  $C_p(r|e, a)$ . Yet, from a

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<sup>14</sup>This is a general feature of agency models with risk neutrality and limited liability. See also Kim (1997) and Park (1994).

perspective of the organization as a whole costs are

$$C_o(r|e, a) = k_p(a, r) + k_a(r) + c(e).$$

Due to  $\partial R/\partial r < 0$  it follows  $C'_p(r|e, a) < C'_o(r|e, a)$ . That is, a marginal increase in the reporting intensity  $r$  raises the principal's costs less than the costs of the organization as a whole. This indicates that the principal's incentives regarding reporting are excessive. In particular, if we let

$$r_o^*(e, a) \equiv \min_r C_o(r|e, a)$$

denote the optimal reporting intensity from an overall perspective and assume internal solutions, then from comparing first order conditions, it follows  $r_p^*(e, a) > r_o^*(e, a) > 0$ .<sup>15</sup> Thus, the principal's demands a higher reporting intensity than would be optimal from the perspective of the organization as a whole. This constitutes excessive reporting.

Until now we examined the role of reporting in a framework where the agent is risk neutral. We want to conclude this section by arguing that, also in an environment where the agent is risk averse, the principal's concern about rents lead to excessive reporting.

Holmström (1979) and Shavell (1979) show that when the agent is risk averse, the agent can only be given incentives when he incurs risk. Hence, if the risk-averse agent is protected by limited liability, the agency cost consists of two components: the agent's rent and a compensation for the imposed risk. Kim (1995) and Jewitt (1997) show that a superior information system enables the principal to provide stronger incentives while imposing less risk on the agent. This implies that when reporting increases the precision of the auditing signal, it lowers both types of agency costs. As before, the principal will be concerned with appropriating the agent's rent, whereas the division of rents is immaterial from a perspective of the organization as a whole. Since reporting reduces the rent, the principal's incentives are therefore too

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<sup>15</sup>Internal solutions arise when the cost function  $k_p(a, r)$  is U-shaped in  $r$ , where a U-shaped  $k_p(a, r)$  captures the idea that some initial level of reporting facilitates but more intense reporting complicates auditing.

strong. Thus, in a risk-averse framework we may expect excessive reporting for similar reasons. A new aspect is that reporting has an additional value; it reduces the amount of risk that is needed to provide incentives. As a result, a strictly positive level of reporting may also be desirable for the organization as a whole. Yet, the principal will incorporate this effect as well. On top of this, however, she also considers the effect of reporting on the rent. This induces her to require more reporting than is desirable from the perspective of the organization as a whole.

## 6 Conclusion

This paper explains why a superior (the principal) may demand too much reporting from its subordinates (the agent). Effectively, the explanation depends on the dual role of reporting. On the one hand, it affects costs and therefore the size of the surplus between the agent and principal. On the other hand, reporting allows the principal to appropriate a larger part of the surplus. The paper showed that the second effect may outweigh the first. This we interpret as excessive reporting.

Our explanation of excessive reporting requires that, in the absence of reporting, a principal leaves rents to the agent. In our model this characteristic obtains due to a limited liability on the agent's side. Yet, similar results may be expected in a model in which principal and agent share the surplus according to some bargaining rule and the level of reporting affects the parties' threat-points or outside options. Also in this case reporting plays the aforementioned dual role: it determines the size of the surplus and its division. We have chosen to illustrate our results in a simple model with limited liability in which the agent's rent is obtained endogenously rather than imposed by an ad-hoc bargaining rule.

## Appendix

### Proof of Proposition 1:

The transfer  $t_s$  influences only the incentive constraint of the agent, (3). Since a lower  $t_s$  relaxes this constraint, it is optimal to set  $t_s$  as low as possible, i.e.,  $t_s = 0$ . Next note that one may assume without loss of generality that (1) is binding at the optimal such that  $t_n^* = t_w^* + c/\lambda(r)$ . For suppose not, then necessarily  $p^* = 1$  and  $\delta \equiv t_n - t_w - c/\lambda(r) > 0$ . Increasing  $t_w$  by  $\delta$  and reducing  $t_n$  by  $\delta p\lambda(r)/(1 - p\lambda(r))$  yields a contract for which (1) is binding. This contract yields the principal the same utility and remains to satisfy (3), (4) and the limited liability constraints. Hence, it must also be optimal.

By substitution we may therefore reduce the problem to

$$\begin{aligned} \max_{t_w, p} \quad & y_w - t_w - c/\lambda(r) \\ & t_w \geq \frac{e}{p\lambda(r)} \end{aligned} \quad (5)$$

$$t_w \geq e + k(r) - (1 - p\lambda(r))c/\lambda(r). \quad (6)$$

The objective function is decreasing in  $t_w$  and independent of  $p$ . Therefore, (5) or (6) is binding at the optimum. The right hand side of (5) is decreasing, while the right hand side of (6) is increasing in  $p$ . Hence, if for  $p = 1$  the r.h.s. of (5) is larger than the r.h.s. of (6), then at the optimum (5) binds and  $p^* = 1$ . That is, if  $\lambda(r)(e + k(r) + c) < (e + c)$ , then the optimal contract exhibits  $p^* = 1$  and  $t_w^* = e/\lambda(r)$ . The principal's utility is  $V_r = y_w - (e + c)/\lambda(r)$ , while the agent receives the utility  $U_r = (1 - \lambda(r))(e + c)/\lambda(r) - k(r) > 0$ .

For  $\lambda(r)(e + k(r) + c) > (e + c)$ , the optimal  $p$  is less than one and chosen such that  $t_w$  can be set as small as possible. Therefore,  $p^* = \arg \min_p \max\{e/(p\lambda(r)), e + k(r) - (1 - p\lambda(r))c/\lambda(r)\}$  and the optimal  $p$  is such that the r.h.s of (5) equals the r.h.s. of (6). It follows

$$p^* = \left( \sqrt{4ec/\lambda(r) + (e + k(r) - c/\lambda(r))^2} + c/\lambda(r) - e - k(r) \right) / (2c)$$

and  $t_w^* = e/(p^*\lambda(r))$ . With substitution and a rearrangement of terms the principal's utility is

$$V_r = y_w - \frac{1}{2} \left( c/\lambda(r) + e + k(r) + \sqrt{(c/\lambda(r) - e - k(r))^2 + 4ec/\lambda(r)} \right).$$

and the agent's utility is zero. Q.E.D.



**Proof of Proposition 2:**

First part of the statement follows directly from the observation that for  $r < \bar{r}$  the principal's utility is  $V(r) = y_w - (e + c)/\lambda(r)$  is increasing  $r$ .

For the second statement first note that for  $r < \bar{r}$  aggregate utility  $V(r) + U(r) = y_w - e - c - k(r)$ . According to Proposition 1 optimal transfers satisfy  $t_s^* = 0$  and  $t_n^* = t_w^* + c/\lambda(r)$  and substitution yields  $V(r) = y_w - t_w^*(r) - c/\lambda(r)$ . For  $r > \bar{r}$  it holds  $U(r) = 0$  such that aggregate utility coincides with the principal utility  $V(r) = y_w - t_w^*(r) - c/\lambda(r)$ . The agent's incentive constraint (3) implies that  $t_w \geq e/(p\lambda(r))$ .  $V(r) = y_w - t_w^*(r) - c/\lambda(r) < y_w - e/(p\lambda(r)) - c/\lambda(r) < y_w - e - c$ . It follows that overall utility is maximized for  $r = 0$ . Q.E.D.

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