Competition for Talent under Performance Manipulation: CEOs on Steroids *

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Abstract

We study how competition for talent affects CEO compensation, taking into consideration that CEO decisions are not contractible, CEO skills or talent are not observable, and CEOs can manipulate performance as measured by outsiders. Firms compete to appoint a CEO by offering contracts generate large rents for the CEO. However, the incentive problems restrict how such rents can be created. We derive the equilibrium compensation contract offered by the firms, and we describe how the outcome is affected. Competition for talent leads to excessively high-powered performance compensation: as a function of measured performance, compensation is steeper and more convex. Competition for talent can thus explain the increase in pay-performance sensitivity over the last few decades, and the extremely high-powered compensation packages observed in some markets. Given the high-powered incentive compensation, CEOs exert inefficiently high levels of effort and also distort the performance measure excessively. If the cost of manipulating performance is low, competition for talent may reduce the overall surplus, compared with a setup in which one firm negotiates with one potential CEO (and the firm extracts the rents). We discuss possible remedies, including regulatory limits to incentive compensation.

Keywords: Competition in contracts, earnings management.

JEL Classification: D72, D82, D83, G20.

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1 Introduction

Incentive compensation for executives has long be regarded as the outcome of negotiations between a firm and the CEO it wants to appoint.[1] Aligning a CEO's incentives with those of shareholders can be difficult for many reasons: The CEO's talent (or her skills) may be unobservable; the decisions the CEO makes once in the job may be unobservable; and their effect on the performance or value of the firm may be hard to observe, possibly because a CEO can distort easily observable performance measures. A large theoretical literature studies these incentive problems, but the typical assumption is that the firm and the future CEO negotiate in isolation, ignoring possible competition from other firms who also want to recruit that CEO.[2] Competition for "talent" is important in practice: It has increased over the past few decades, fueled by the availability of information on compensation offered by other firms (provided either by compensation consultants, or available because of disclosure requirements), and by changes in the demand for executives ("talent" is increasingly regarded as transferable across firms; boards are increasingly willing to appoint outsiders as CEOs; and firms increasingly compete for the services of executives with "star" qualities, often poaching them from other firms). Importantly, competition to hire a CEO does not merely transfer wealth from firms to CEOs: Given contract incompleteness, such competition affects the structure of the equilibrium contract and thus the decisions the CEO makes.

In this paper, we study optimal incentive contracts if several firms compete to hire one CEO, and contracting is rendered difficult by the incentive problems described above: A CEOs must invest effort to improve the firm's performance, but the effort choice is unobservable; the cost of effort depends inversely on the CEO's "talent," which is unobservable to the firm; and the firm's performance as measured by outsiders can be distorted by the CEO, albeit at a cost. We first describe (as a benchmark) the optimal contract that would be negotiated by one firm and one CEO (of unknown talent) in isolation. Then we study the optimal contract if several firms offer contracts to one CEO.

Competition has real, allocative consequences. When competing, the firms must of-

[1] For recent surveys, see Murphy (2013), Frydman and Jenter (2010), and Edmans and Gabaix (2009).

[2] Models that allow for competition between firms (e.g., Gabaix and Landier (2008)) ignore problems of adverse selection or moral hazard.

fer higher rents to attract the CEO, but they must also protect themselves from offering too much compensation to a possibly less talented CEO, while also creating incentives to invest effort. The only way to offer higher rents to highly talented CEOs is then to offer extremely strong incentive compensation for high-performers, while offering weaker incentives for lesser performers, targeted at less talented CEOs. In equilibrium, a talented CEO is given excessively strong incentives, with compensation that is steep and convex in her reported performance. Given these strong incentives, a talented CEO exerts inefficiently high levels of effort but also distorts the reported performance more strongly. For a less talented CEO, the effects are weaker, compared with the one-firm setup. The effects of competition can be so strong that despite the higher effort induced by it, the overall surplus generated by the contract is lower than the surplus generated if only one firm offers a contract (a contract that induces inefficiently *low* effort levels in equilibrium).

The assumptions of our model are realistic, and they are standard in this literature. Its workhorse model is the effort-choice model, capturing the problem that the true effects of a CEO's decisions are not observable to other parties. Arguably, some CEOs seem to find it easier than others to make good decisions (decisions that create value), but identifying such a candidate for a CEO position is extremely hard. This supports our assumptions that investing more effort is costly, but the level of effort invested is not observable, and the cost of effort varies across CEOs but it is also unobservable. Finally, a large literature on earnings management and fraud argues that measuring a CEO's performance is difficult because the measures that are observable are not merely noisy, but they can be manipulated by the CEO.

Once hired, the CEO makes two decisions in our model: How much effort to exert and by how much to distort the measure of performance. Both activities increase the *measured* performance of the firm. Both are costly, and the costs are convex. If compensation is linked to measured performance, it is thus optimal for the CEO to exert some effort and to distort the performance measure somewhat. The incentive to distort the performance measure is relatively larger for less talented CEOs, whose cost of effort is by definition higher. The optimal contract must balance the incentive to exert effort and the incentive to distort the performance measure.

In the setup with one firm and one CEO, the firm *can* design a contract that induces an efficient effort choice, by choosing the slope and convexity of the compensation (as a function of measured performance) appropriately. However, the firm's preferred contract trades off efficiency against rent extraction, and it induces an inefficiently low level of effort particularly for less talented CEO's. By doing so, the contract reduces the rents earned by more talented CEO's.

The contract that induces an efficient effort level is not feasible if multiple firms compete to appoint a CEO. To attract the CEO under competition, each firm would offer higher levels of compensation for different performance achievements, but the increase would be particularly strong for high performer. That, however, would violate the incentive compatibility constraints for different types of CEO: A less-talented CEO would then exaggerate her level of talent, and make up for that by distorting the performance measure more strongly, leading the firm to overpay its newly hired CEO and make a loss.

In order to preserve incentive compatibility, a more talented CEO's rent can be increased only by linking compensation more strongly to reported performance. A less talented CEO's compensation should not offer stong incentives, since a less talented CEO would otherwise be tempted to distort the performance measure more strongly. In equilibrium, given stronger incentives, a talented CEO exerts higher effort, improving the firm's expected performance; but she also chooses to distort the performance measure more, since she benefits more from doing so (given the strengthened power of the incentive compensation). Her expected compensation is higher when firms compete to hire her, but this comes at the price of both inefficiently high effort and a more severe distortion of the performance measure.

In sum, competition to recruit talented CEOs leads to excessively high-powered incentive contracts, to more inequality in the rents that a CEO earns for different levels of talent, and to more strongly distorted performance measures. The question arises whether this is caused by a coordination problem that can be resolved through regulation.[3] We can study the scope for regulation in our model. Efficiency can be restored by requiring performance-specific caps on total compensation (that is, a limit to the CEO's total

[3] Legislators and regulators have in recent years introduced limits to executive compensation in several countries, limiting the size of bonuses and other performance-linked compensation.

compensation, given the measured performance): This makes it impossible for the firms to compete away all rents by offering excessively strong incentive compensation. One implementation of these caps would be as a progressive tax on incentive compensation. Implementing such a progressive cap may be hard, particularly since the tax schedule may have to be firm-specific in practice. Another drawback is that such regulation is effective only if it covers all firms that may potentially hire a CEO. If firms from some industries are not affected, or if firms from other countries (to which the CEO would be willing to move) are not affected, the main effect of a cap would be a brain drain from the regulated industries or countries.[4] However, firm-specific limits to compensation can be introduced through say-on-pay votes: Our model provides a rationale for giving shareholders the power to limit the CEO's compensation, even if CEOs and directors would prefer powerful incentive compensation.

A simpler regulatory tool is a fixed compensation cap, that limits the total compensation to a given maximum for *all* firms and CEOs. This fixed cap would have to be chosen carefully: If it is set too low, then it becomes hard for the firms to induce sufficient effort, and the regulation backfires. However, a carefully chosen fixed cap can mitigate the incentive to distort the performance measure upward, leading to more efficient outcomes, and it can make it harder for firms to poach the CEO of another firm by offering excessive performance compensation.

Our model is based on Beyer et al. (2011), which we extend by letting several firms compete to hire a manager. A closely related paper is Benabou and Tirole (2012): They also study how firms compete to hire a manager by structuring their contracts optimally, but the focus is on a two-task problem for the CEO, where one of two tasks is not measurable and incentive compensation must focus on the measurable task, instead. Like in our paper, competition leads to excessively strong incentive provision (which they call "bonus culture"). There is no misreporting in their paper (it is absolute for the non-measurable task); other differences include a focus on linear contracts and binary distribution of talent. Other papers that study competition through contracts include (among others) Roth-

[4]For example, limits to compensation at large banks may lead certain employees, whose pay would otherwise be strongly performance-linked, to move to unregulated financial institutions, so certain activities may shift from large banks to the shadow banking sector.

schild and Stiglitz (1976), Stole (1995), and Armstrong and Vickers (2001).

The role of competition for diverse talent has been analyzed (for the case of frictionless markets) in Lucas (1978), Rosen (1981), and Terviö (2008). The distribution of talent determines the managers' compensation in equilibrium, such that more skilled managers earn larger rents if lower-skill managers are less productive, because competition focuses on the higher-skill managers. Gabaix and Landier (2008) extend this work by assuming that talent is more productive in "larger" firms, such that in equilibrium the most talented managers are employed by the largest firms and earn the highest rents. In all of these papers, talent is observable and performance is contractable, while we study a setup in which both talent and performance are unobservable, and firms structure their contracts to be attractive to more talented managers who then have an incentive to perform well (and not misreport performance too much).

Technically, our paper is related to the literature on optimal contracting in the presence of adverse selection (see, e.g., Mussa and Rosen (1978), Laffont and Tirole (1986), and Melumad and Reichelstein (1989)), since a manager's talent is unobservable to the firms. We add moral hazard to this: effort choice, and the decision how much to manipulate the observable performance measure.

The role of costly performance manipulation has been emphasized in many papers. Maggi and Rodriguez-Clare (1995), Dutta and Gigler (2002), Liang (2004), and Crocker and Slemrod (2007) show how allowing for some misreporting helps reduce a manager's rents and can therefore be part of an optimal contract. The idea that weaker governance can be traded off against higher compensation (and the externalities this creates) is studied in Acharya and Volpin (2010), Dicks (2012), and Acharya et al. (2012). How the structure of incentive compensation affects performance manipulation is examined in Goldman and Slezak (2006), Bergstresser and Philippon (2006), and Morse et al. (2011). A large accounting literature on earnings manipulation extsts; see, e.g., Baiman et al. (1987), Dye (1988), Demski (1998).

The rest of the paper is organized as follows. Section 2 presents the model and introduces two benchmark contracts. Section 3 studies competitive contracts and discusses its main properties: misreporting, efficiency, and inequality. Section 4 concludes. The

Appendix contains proofs of the main results.

2 Model

This paper studies how competition for managerial talent affects incentive compensation offered to attract managers, and the decisions a manager makes in equilibrium, after being hired. We extend the model in Beyer et al. (2011) to a setup with many firms competing to hire one manager. Once hired, the manager must choose a costly action that affects the future value of the firm and then report performance information relevant for the valuation of the firm by outside investors (for example, current earnings or earnings forecasts). To make the problem both realistic and interesting the chosen action is not observable to outsiders, creating moral hazard problems. Also, the manager's talent or productivity is not observable to outsiders, creating an adverse selection problem. Finally, the manager can misreport her performance, albeit at a cost.[5] This cost makes it possible to use the manager's reported performance to provide incentives to perform. The firms compete to hire the manager by offering compensation that is contingent on the reported performance. By choosing the right structure for this compensation, they hope to identify how talented the manager is, and to induce the manager to choose an action that maximizes the firm's future value to shareholders.

The sequence of events is the following. First, the manager privately observes her talent (productivity), measured inversely as a cost-of-effort parameter θ. (A manager who realizes a higher value of θ has a higher cost of effort and is thus less talented or productive.) We assume that $\theta \in \Theta \equiv \left[\underline{\theta}, \overline{\theta}\right] \in \mathbb{R}_+$, with a distribution $F(\theta)$ and a density $f(\theta)$. We assume that $f(\theta) > 0$ for all $\theta \in \Theta$, and that the inverse hazard rate $H(\theta) = \frac{F(\theta)}{f(\theta)}$ is convex.

Next, $N \geq 2$ firms (indexed by $i \in \{1, 2, .., N\}$) simultaneously offer contracts $w_i(\cdot)$ to the manager, who can accept at most one of the contracts. A contract $w_i(\cdot)$ offers a compensation $w_i(r)$ that depends on the performance r that the manager will later report. After accepting a contract, the manager chooses an action (most easily interpreted as ef-

[5] The cost of misreporting can be interpreted as the effort required to falsify information, or the expected cost of being caught and punished.

fort) $q \in \mathbb{R}$, which affects the future value of the firm. For simplicity, the future value of the firm equals the manager's effort q. Simultaneously with the choice of q, the manager reports the future value. The manager must bear two nonpecuniary costs: Choosing action q causes disutility $\frac{\theta}{2}q^2$; and reporting a future value r causes disutility $\frac{c}{2}(r-q)^2$. To ensure the existence of a pure strategy equilibrium we assume that the cost of misreporting is sufficiently high, $c \geq \overline{c}$. Based on the chosen report r, the manager receives a transfer $w_i(r)$. Finally, the future value of the firm is realized (but it is not verifiable).

The firms (and their shareholders) and the manager are risk neutral, so if hired by firm 1, the manager's payoff is (given q and r)

$$w_1(r) - \frac{c}{2}(r-q)^2 - \frac{\theta}{2}q^2,$$

and the profit of firm 1 is

$$q - w_1(r).$$

If the manager rejects all contracts, her expected payoff is $u > 0$.[6]

The model is stylized, but it captures the key trade-offs and it can easily be extended to more complex and more realistic setups. For example, the future value of the firm could be assessed by investors as a function of the manager's earnings announcement, and other information revealed along with it. The manager's compensation could then be based on this assessed value using stock and stock option awards. As long as the manager's compensation cannot be made fully contingent on the firm's realized value in the distant future, such a more complicated setup merely adds notation without offering any additional insights. Similarly, with risk neutral agents, the model can easily be extended to allow for uncertainty about the future value, given a chosen action q and report r.[7]

The firms must resolve several incentive problems using an imperfect tool: incentive compensation contingent on the manager's possibly misreported performance. The

[6] If the manager's reservation payoff was type-dependent, the derivation of the optimal contract would be more complicated, entailing pooling over some regions (see Jullien (2000)). If the reservation payoff was strictly positive, the firm may prefer not to employ a high-cost manager.

[7] As shown below, the equilibrium competitive contract $w_i(\cdot)$ is convex, and it can be replaced by an equivalent menu of linear contracts. Adding noise to the payoffs would then be inconsequential, given risk neutrality.

contract w_i must induce the manager to choose a high value of q, while ensuring that the compensation for different levels of talent or productivity is not unnecessarily high. Choosing a high q is costly, but less so for a more productive or talented manager (with a lower realized θ). In addition to these adverse selection and moral hazard problems, the firm's future value is not contractible, and the firm can only use the manager's *report* about her performance to link compensation to the chosen action. However, misreporting performance is costly for the manager, which makes it possible to link the compensation to the manager's true performance.

A key variable that affects the cost of misreporting is c. We assume that c is common knowledge and identical for all firms. c measures countrywide policies like the quality of the accounting and auditing rules, the usefulness of disclosure requirements and other regulations, the ability of directors and minority shareholders to influence or replace managers, the absence of frictions in the market for corporate control, and the effectiveness of the legal system. An extension to the case in which c varies across firms is beyond the scope of this paper, since the analysis would be considerably more complicated: firms with higher values of c would be more productive, given a manager's type, improving their ability to attract productive managers. (An extension to the case in which c varies across *managers*, however, would be very similar to our model.)

Finally, the assumptions that the costs of effort and misreporting are quadratic are obviously not essential, but they simplify the exposition and analysis.

2.1 Preliminary Results

The above can be described as a multi-task setting with a hidden task. The joint presence of hidden action and adverse selection makes the analysis potentially intractable. As we next show, by solving the manager's effort choice in isolation, the model can be represented as a single task problem and solved using standard techniques.

For a given report r the manager's optimal effort, denoted $q(r, \theta)$, is defined as

$$
\begin{aligned}
q(r,\theta) &\equiv \arg\min_{q} \left\{ \frac{\theta}{2} q + \frac{c}{2} (r-q)^2 \right\} \\
&= \frac{c}{c+\theta} r.
\end{aligned}
$$

So the manager chooses effort to minimize the total cost she bears from issuing the report r. This combines the cost of effort and the cost of misreporting information. In equilibrium, it is never optimal for the manager to achieve a performance r exclusively through effort or exclusively through misreporting. That is, for any report the manager plans to release, she always finds it optimal to combine effort with misreporting, with the relative intensity of effort increasing in c. Naturally, the report r is always higher than output q and the magnitude of misreporting $r - q$ decreases in c.

The indirect cost function associated with the manager's cost minimization problem is given by

$$
\begin{aligned}
C(r,\theta) &\equiv \min_{q} \left\{ \frac{\theta}{2} q + \frac{c}{2} (r-q)^2 \right\} \\
&= \frac{1}{2} \frac{c\theta}{c+\theta} r^2.
\end{aligned}
$$

Having found the manager's effort strategy, we can think of the original problem as a single task problem and focus on how the optimal contract affects the manager's reporting behavior.

Before considering the optimal contract under competition, we solve for two benchmarks: the efficient contract, and the single firm contract.

Definition 1 *The social surplus arising when a manager type θ reports r is defined as*

$$
S(r,\theta) \equiv q(r,\theta) - C(r,\theta) - u
$$

1. *A contract $w(\cdot)$ inducing a reporting schedule $r(\cdot)$ is ex-ante efficient if it maximizes $\int_{\underline{\theta}}^{\theta_o} S(r(\theta), \theta) dF(\theta)$, where θ_0 solves $S(r(\theta_o), \theta_o) = 0$.*

2. *A contract $w(\cdot)$ inducing a reporting schedule $r(\cdot)$ is interim efficient if*

$$r(\theta) \equiv \arg\max_{r} S(r, \theta).$$

The social surplus measures the creation of value of the contractual relationship. A contract that creates more value is thus more efficient. The following result considers the existence of an interim efficient contract.

Lemma 2 *There exists an interim efficient contract given by*

$$w_{\dagger}(r) = C(r, \frac{1}{r}) + \int_{1/r}^{\theta_{\dagger}} C_{\theta}(\frac{1}{\theta}, \theta) d\theta + u. \quad (1)$$

This contract induces the reporting schedule

$$r_{\dagger}(\theta) = \frac{1}{\theta}.$$

Under this contract, only managers with $\theta \leq \theta_{\dagger}$ participate (i.e., are hired), where $\theta_{\dagger}$ is defined by

$$\begin{aligned} &S(r_{\dagger}(\theta), \theta_{\dagger}) = 0 \\ &\qquad \Rightarrow \theta_{\dagger} = \frac{\sqrt{u^2c^2 + 2uc} - uc}{2u} \end{aligned}$$

The interim efficient contract is the one chosen by a firm that is exclusively concerned with the maximization of social surplus. The extent of participation induced by the efficient contract depends both on the manager's outside option u and the cost of misreporting c in an intuitive manner: a lower outside option and a higher cost of misreporting result in a higher probability the manager is hired.

As a second benchmark, we analyze the one-firm case (based on Beyer et al. (2011)). Recall that the contract can depend only on the manager's disclosure about the future firm value not her effort. As before, it is convenient to treat the manager's problem as if she chose the disclosure about the future value r first, and then chose her effort q. The firm's optimization program can thus be written as

$$\max_{\{w_1(\cdot),\theta_1\}} \int_{\underline{\theta}}^{\theta_1} \left[q(r_1(\theta),\theta) - w_1(r_1(\theta))\right] dF(\theta) \tag{2}$$

where θ_1 is the threshold representing the least talented manager who is hired under this contract. Now, for any type $\theta \leq \theta_1$, the contract must satisfy three constraints: the effort-choice incentive compatibility constraint or

$$q(r,\theta) = \frac{c}{c+\theta} r, \tag{3}$$

the incentive compatibility constraint for reporting the firm's future value,

$$r_1(\theta) = \arg\max_r \{w_1(r) - C(r,\theta)\}, \tag{4}$$

and the manager's participation constraint,

$$U_1(\theta) \equiv \max_r \{w_1(r) - C(r,\theta)\} \geq u. \tag{5}$$

Solving this problem is potentially involved because the firm's choice set is the set of all possible functions that can be used to reward performance. The analysis is however greatly simplified using the Revelation Principle according to which it is sufficient to restrict attention to direct mechanisms. We set up a direct mechanism in which the manager is asked to reveal her type θ, and based on the manager's announcement $\widehat{\theta}$, the direct mechanism specifies a monetary transfer $t_1(\widehat{\theta})$ and a future-value announcement $r_1(\widehat{\theta})$ the manager must disclose. (If the manager claims her type is θ, she must announce that the firm's future value will be $r_1(\theta)$.) Given her true cost of effort and the cost of misrepresentation, and the required announcement $r_1(\widehat{\theta})$, the manager then optimally chooses $q(r_1(\widehat{\theta})) = \frac{c}{c+\theta} r_1(\widehat{\theta})$, according to (3).

An outcome $(r_1(\theta), t_1(\theta))$ that cannot be implemented using a direct mechanism cannot be implemented by any mechanism. Define the equilibrium rent of the type θ manager as

$$U_1(\theta) = t_1(\theta) - C(r_1(\theta), \theta). \tag{6}$$

The direct mechanism is incentive compatible only if for any (θ, θ') in Θ^2,

$$t_1(\theta) - C(r_1(\theta), \theta) \geq t_1(\theta') - C(r_1(\theta'), \theta). \tag{7}$$

Using standard methods (see e.g., Laffont and Martimort (2001), pp. 134-138), the firm's optimization problem can be expressed as an optimal control problem:

$$\max_{\{U_1(\cdot), r_1(\cdot), \theta_1\}} \int_{\underline{\theta}}^{\theta_1} [q(r_1(\theta), \theta) - C(r_1(\theta), \theta) - U_1(\theta)] f(\theta) d\theta \tag{8}$$

subject to, for all $\theta \leq \theta_1$ the following three constraints are satisfied:

$$\frac{\partial U_1(\theta)}{\partial \theta} \equiv \frac{\partial}{\partial \theta} \max_{\widehat{\theta}} \left\{ t(\widehat{\theta}) - C(r_1(\widehat{\theta}), \theta) \right\} = -C_\theta(r_1(\theta), \theta) \tag{9}$$

$$\frac{\partial r_1(\theta)}{\partial \theta} < 0 \tag{10}$$

$$U_1(\theta) \geq u. \tag{11}$$

In this optimal control problem, the control variable is $r_1(\cdot)$ and the state variable is the manager's equilibrium rent $U_1(\cdot)$. The law of motion of the state variable $U_1(\cdot)$ across types is determined by the local incentive compatibility constraint (9). Equation (10) is often referred to as the global incentive compatibility constraint, being the constraint that ensures the manager does not have an incentive to lie globally about her type. The standard approach is to solve the optimization problem ignoring (10) and then verify that the reporting schedule indeed satisfies the constraint (10).

The individual rationality constraint (11) is binding only for the marginal type θ_1 defined by the indifference condition

$$U_1(\theta_1) = u. \tag{12}$$

Similarly, (9) implies that

$$U_1(\theta_1) - U_1(\theta) = -\int_{\theta}^{\theta_1} C_\theta(r_1(\tau), \tau) d\tau.$$

From (12), we have $U_1(\theta_1) = u$, so

$$U_1(\theta) = \int_{\theta}^{\theta_1} C_\theta(r_1(\tau), \tau) d\tau + u. \tag{13}$$

Using integration by parts, and (12),

$$\begin{aligned}\int_{\underline{\theta}}^{\theta_1} U_1(\theta) f(\theta) d\theta &= U(\theta_1) - \int_{\underline{\theta}}^{\theta_1} \frac{\partial U_1(\theta)}{\partial \theta} F(\theta) d\theta \\ &= u - \int_{\underline{\theta}}^{\theta_1} \frac{\partial U_1(\theta)}{\partial \theta} F(\theta) d\theta.\end{aligned}$$

Substituting this into (8), and replacing $\frac{\partial U_1(\theta)}{\partial \theta}$ the program can be further simplified,

$$\max_{\{r_1(\cdot), \theta_1\}} \int_{\underline{\theta}}^{\theta_1} \left[q(r_1(\theta), \theta) - C(r_1(\theta), \theta) - u - C_\theta(r_1(\theta), \theta) H(\theta) \right] f(\theta) d\theta.$$

Substituting $C(r, \theta) = \frac{1}{2} \frac{c\theta}{c+\theta} r^2$ and $q(r, \theta) = \frac{c}{c+\theta} r$, this objective function can be maximized pointwise (i.e., for each θ),

$$\begin{aligned}&\max_r q(r, \theta) - C(r, \theta) - C_\theta(r, \theta) H(\theta) \\ &\max_r \frac{c}{c+\theta} r - \frac{1}{2} \frac{c\theta}{c+\theta} r^2 - \frac{1}{2} c^2 \frac{r^2}{(c+\theta)^2} H(\theta)\end{aligned}$$

which gives the equilibrium reporting schedule induced by the optimal single firm contract:

$$r_1(\theta) = \frac{1}{\theta + \frac{c}{c+\theta} H(\theta)}. \tag{14}$$

When $H(\theta)$ is convex, $r(\theta)$ is decreasing, hence the neglected global incentive compatibility constraint (10) is satisfied. Importantly, the shareholders are not misled by the manager about the future value of the firm, even though the equilibrium entails misreporting ($r \neq q$).

So far, we have characterized the optimal reporting schedule $r_1(\theta)$ and the agent's equilibrium payoffs $U_1(\theta)$. We will now consider the original problem: namely how to implement this reporting schedule through a contract that rewards reported performance

$w_1(\cdot)$. Recall that under the direct mechanism the agent receives a monetary transfer $t_1(\widehat{\theta})$ if the agent claims being type $\widehat{\theta}$. In equilibrium, a type θ reports her type truthfully hence,

$$t_1(\theta) \equiv U_1(\theta) + C(r_1(\theta), \theta).$$

Since $r_1(\theta)$ decreases in θ, then we can invert this function and define $\gamma_1(r)$. The optimal contract $w_1(\cdot)$ can thus be recovered from the equilibrium transfer as

$$\begin{aligned} w_1(r) &\equiv t_1(\gamma_1(r)) \\ &= U_1(\gamma_1(r)) + C(r, \gamma_1(r)). \end{aligned}$$

It is not difficult to check that a manager confronted with this nonlinear transfer $w_1(\cdot)$ chooses the same report as when faced with the optimal revelation mechanism, namely the one characterized by (14) (see Laffont and Martimort (2001) p. 139).

Lemma 3 *1. The optimal single firm contract is given by*

$$w_1(r) = C(r, \gamma_1(r)) + \int_{\gamma_1(r)}^{\theta_1} C_\theta(r_1(\theta), \theta) d\theta + u$$

2. This contract induces a reporting schedule

$$r_1(\theta) = \frac{1}{\theta + \frac{c}{c+\theta} H(\theta)}. \tag{15}$$

3. The participation threshold θ_1 is defined by

$$S(r_1(\theta_1), \theta_1) = 0.$$

As usual, the optimal contract entails *no distortion at the top* ($\underline{\theta}$) but a downward distortion of the reports and efforts exerted by lesser talented managers ($\theta > \underline{\theta}$). The optimal contract depresses the manager's report, relative to the efficient level $r_\dagger$, thereby also depressing the manager's effort. The source of this distortion is the principal's rent extraction concern: the principal does not internalize the manager's information rent being thus willing to tolerate some inefficiencies if they reduce the manager's rents.

The effect of the cost of misreporting c over the equilibrium outcome is intuitive. A higher misreporting cost reduces the magnitude of misreporting, increases effort, and improves both the manager's welfare and the firm's expected profits. Observe that even when output q is contractible, the single firm solution generates significant inefficiencies. In fact, even in the limit as c grows large (namely when effort is contractible) the social surplus generated by the single firm contract is strictly lower than that induced by the efficient contract. Formally:

$$\lim_{c \to \infty} \int_{\underline{\theta}}^{\theta_1} S\left(r_1\left(\theta\right), \theta\right) dF\left(\theta\right) < \int_{\underline{\theta}}^{\theta_\dagger} S(\theta^{-1}, \theta) dF\left(\theta\right).$$

The next section studies the competitive contract.

3 Competition

Competition dramatically modifies the analysis. First, the presence of multiple firms competing in contracts poses equilibrium existence problems in settings where firm value $q(r, \theta)$ depends not only on performance r but also on the manager's unknown talent θ^{-1}. This is similar to the problem encountered by Rothschild and Stiglitz (1976) in their famous analysis of competition among insurance companies, where a pure strategy equilibrium does not exist if the probability of low risk individuals is too high.[8][9] Second under competition, the manager's participation constraint is endogenous and type dependent: to hire a manager, the firm must consider that the manager's outside option is given by the offer of competing firms, and depends on the manager's talent.

Consider the firm's optimization program under competition. Using the Revelation

[8] In order to overcome this issue, the extant literature has adopted several approaches. Perhaps the simplest one is to work with two types and assume the probability of the *bad type* is high enough. This is the approach followed by Benabou and Tirole (2012). Since here we work with a continuum of types we need a different approach. In order to ensure existence of a pure strategy equilibrium, we assume that the cost of misreporting is high enough, $c \geq \overline{c}$.

[9] Later on, Riley (1979) demonstrated that this equilibrium existence issue is more severe when the distribution of types is continuous: in that case there simply isn't a pure strategy equilibrium in the Rothschild and Stiglitz problem..

Principle, the firm's optimization program can be formulated as follows. For any $i \in \{1,..,N\}$ the mechanism offered by firm i must solve

$$\max_{\{U_i(\cdot),r_i(\cdot),\theta_i\}} \int_{\underline{\theta}}^{\theta_i} [q\left(r_i\left(\theta\right),\theta\right) - C(r_i\left(\theta\right),\theta) - U_i(\theta)]dF\left(\theta\right)$$

subject to

$$\frac{\partial U_i\left(\theta\right)}{\partial \theta} = -C_\theta\left(r_i\left(\theta\right),\theta\right) \tag{16}$$

$$U_i\left(\theta\right) \geq U_N\left(\theta\right) \text{ for all } \theta \leq \theta_i \tag{17}$$

$$\frac{\partial r_i\left(\theta\right)}{\partial \theta} < 0 \tag{18}$$

where $U_N\left(\cdot\right)$ is the manager's equilibrium rents. The firms' problem is significantly altered by competition. Unlike in the single firm case, the manager's participation constraint (17) is now endogenous and type dependent. To hire the manager, firm i must offer no less than the manager gets from a rival firm offering the equilibrium contract. Because firms are homogenous, they compete à la Bertrand; they break even not only in expectation but type by type.

Proposition 1 *A competitive equilibrium consists of a reporting schedule, a contract, and a participation threshold $\{r_N\left(\cdot\right), w_N\left(\cdot\right), \theta_N\}$ such that when $c \geq \overline{c}$ the unique symmetric Nash equilibrium is characterized as follows:*

1. *The competitive contract is given by*

$$w_N(r) = r + \frac{\theta_N \exp[-c\left(r - \frac{1}{\theta_N}\right)]}{c\left(c+\theta_N\right)} - \frac{1}{c},$$

2. *The reporting schedule $r_N\left(\theta\right)$ satisfies*

$$r_N\left(\theta\right)[\theta + \frac{\left(\frac{\partial r_N(\theta)}{\partial\theta}\right)^{-1}}{c+\theta}] = 1,\ r_N\left(\theta_N\right) = \frac{1}{\theta_N} \tag{19}$$

3. *The participation threshold is*

$$\theta_N = \theta_{\dagger} = \frac{\sqrt{u^2c^2 + 2uc} - uc}{2u},$$

The reporting schedule $r_N(\theta)$ arising under competition is the one that induces the least costly separation across types and, at the same time, satisfies the firms' zero-profit condition. Using the results in Mailath (1987), one can show that this reporting schedule must be decreasing, continuous and satisfy the ordinary differential equation (19). Contrary to the single firm case, the competitive solution induces no distortion at the bottom (i.e., for the least productive type that is hired, θ_N) but an upward distortion in the report and effort exerted by higher productivity types ($\theta < \theta_N$).[10] Also, unlike in the single firm case, the distortion in the manager's actions is independent of the distribution of talent $f(\cdot)$.

The reporting schedule can be solved in closed form from (19), which gives

$$r_N(\theta) = \frac{1}{\theta} + \frac{1 + \mathcal{L}\Big(-2(c+\theta)\,\theta^{-1}\exp\left(\frac{\left(c + \theta_N \ln\left(\frac{1}{2}\frac{\theta_N}{c+\theta_N}\right)\right)\theta - (\theta + c)\theta_N}{\theta_N \theta}\right)\Big)}{c}. \tag{20}$$

where $\mathcal{L}(\cdot)$ is the LambertW function.[11] Naturally, $r_N(\theta)$ decreases in θ and c, and converges to the efficient level $r_{\dagger}(\theta)$ as c grows large. In the limit, as $c \to \infty$, the gap between report and effort vanishes so contracts based on reported performance and effort become equivalent.

Consider the competitive contract. This contract is computed as

$$w_N(r) \equiv E[q\left(r_N\left(\tilde{\theta}\right), \tilde{\theta}\right) | r_N(\theta) = r], \tag{21}$$

[10] If the unknown parameter was c rather than θ, the competitive solution would induce a downward distortion on reports. Private information about c corresponds to a situation where the manager's misreporting costs are unknown to the firm. In that context, managers experience incentives to prove their honesty by reporting less than they would have reported when c is known.

[11] The Lambert W function, $\mathcal{L}(\cdot)$, is implicitly defined by the equation

$$z = \mathcal{L}(z)e^{\mathcal{L}(z)},$$

for any complex number z.

which given (3) boils down to

$$w_N(r) = \frac{c}{c+\gamma_N(r)}r. \tag{22}$$

where $\gamma_N(\cdot)$ is the inverse of $r_N(\cdot)$, given by

$$\gamma_N(r) = c\frac{e^{rc}(c+\theta_N) - e^{\frac{c}{\theta_N}}\theta_N}{e^{rc}(rc-1)(c+\theta_N) + e^{\frac{c}{\theta_N}}\theta_N}.$$

Note that $E[q(r_N(\tilde{\theta}), \tilde{\theta})|r]$ can be interpreted as the market assessment of the firm's future value, which could represent the stock price in a competitive market. Hence, the contract can be reinterpreted as one that rewards the manager based on the evolution of the stock price, as opposed to reported performance.

The competitive contract $w_N(\cdot)$ has the following properties.

Proposition 2 *(i) The competitive contract $w_N(\cdot)$ is increasing and convex in performance, namely $w'_N(r) > 0$ and $w''_N(r) > 0$. (ii) The slope of the contract, $w'_N(r)$, increases in corporate governance. (iii) The convexity of the competitive contract vanishes as the quality of governance grows large, or $\lim_{c\to\infty} w''(r) = 0$.*

These results may explain some empirical puzzles. The first puzzle is the seemingly low pay for performance sensitivity documented by Jensen and Murphy (1990). In this model a low pay-for-performance sensitivity may be an optimal response to low levels of governance quality. Goldman and Slezak (2006) established a similar result in a single firm setting.

Second, the paper may explain the seemingly excessive convexity of CEO contracts documented by Dittmann and Maug (2007), who calibrate the standard principal agent model where the CEO has exponential utility and makes only an effort decision, finding that the optimal contract should only involve stock but not options. The fact that their empirical estimation strongly contradicts this prediction gives rise to a puzzle, as Edmans and Gabaix (2009) point out.

Unlike in the screening literature where the shape of the contract is ambiguous and depends on the distribution of types, in this model the convexity of the contract does not depend on the distribution of talent F because the convexity of the contract is not driven by the firm's rent extraction concerns. As in Beyer et al. (2011) convexity arises here to attenuate the adverse effect of misreporting. The convexity of the contract allows firms to reduce the power of incentives for lower productivity types while maintaining the power of incentives for higher types, since the former engage in more aggressive misreporting (notice that the ratio $\frac{q(r(\theta),\theta)}{r(\theta)}$ decreases in in θ).

The analysis of Rosen (1981) also explains the convexity of compensation. He shows that in a frictionless market, compensation must be convex in talent because a lower talent is only imperfect substitution for higher talent. The worse is this substitution, the greater the rents earned by the higher talent managers because the demand for the better managers increases more than proportionately in talent.

The next sections study the properties of competitive contracts along the following dimensions: misreporting, efficiency, and inequality.

3.1 Competition and Misreporting

In the 1980 and 1990's the US CEO market witnessed a dramatic increase in the level and differentials of compensation. Interestingly, this rapid increase in compensation levels was followed by a surge in the intensity of earnings manipulation, as we see in Figures 1 and 2.[12] and some of the largest frauds ever witnessed in the U.S. (e.g., Enron, Tyco International, Adelphia, Peregrine Systems and WorldCom).

In this section, we try to reconcile these facts and study whether stronger competition for CEO's can explain both facts.[13] The following intermediate result is needed.

Proposition 3 *Competition induces excessive incentive power. Formally for all r we have that*

$$w_N'(r) > w_\dagger'(r) > w_1'(r).$$

[12]For example, Bergstresser and Philippon (2006) provide evidence that accruals, normalized by firm's assets, significantly increased in the period 1980-2000, especially since 1995.

[13]Frydman and Jenter (2005) and Murphy and Zabojnik (2007) provide theory and evidence documenting a relative increase in the demand for general managerial skills, as opposed to firm-specific skills, in recent decades. They argue that this greater emphasis on general skills would have intensified competition for CEOs, by raising manager's outside options.

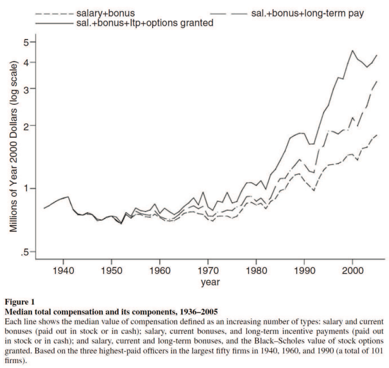

Figure 1: *(Frydman and Saks, 2010)*

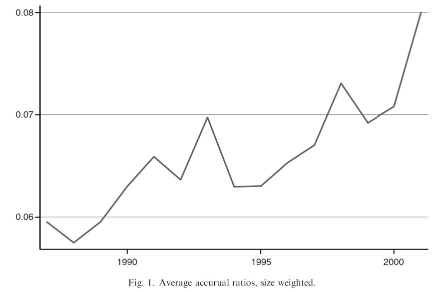

Figure 2: *(Bergstresser and Philippon, 2006)*

Competition boosts the incentive power of contracts beyond efficient levels. Under competition, the firms do not internalize the effect of increasing the power of contracts on the capacity of rival firms to retain their talent. If in the absence of competition say firm 1 offered the efficient contract while giving the entire surplus to the CEO, then lesser talented managers would be implicitly subsidized by more talented ones. Firm 1 would then face a serious adverse selection problem whereby competing firms would choose a contract entailing a lower salary but higher pay for performance sensitivity. As a result, more talented managers would decline firm 1's offer in favor of the steeper contract of competing firms, and firm 1 would keep only the less talented managers. Of course, firm 1 would then make a loss, since talented managers would no longer be present to finance the subsidy of lesser talented ones.

The excessive power of competitive contracts leads to the following results.

Proposition 4 *Competition induces excessive reports, excessive output, but efficient participation. Formally for all $\theta < \theta_1$:*

$$r_N(\theta) > r_\dagger(\theta) > r_1(\theta),$$

$$q_N(\theta) > q_\dagger(\theta) > q_1(\theta),$$

and

$$\theta_1 < \theta_N = \theta_\dagger$$

The fact that competition boosts output beyond the level prescribed by the efficient contract $w_{\dagger}$ could be considered as a desirable property of competitive contracts. However, notice that this output is sustained by excessive reporting. A priori it is unclear whether competition generates more or less misreporting, defined as

$$b(\theta) \equiv r(\theta) - q(r(\theta), \theta).$$

The following proposition answers this question.

Proposition 5 *Competition induces excessive misreporting. Formally, for all $\theta < \theta_1$ we have*

$$b_N(\theta) > b_{\dagger}(\theta) > b_1(\theta)$$

Notice that in this model some misreporting is always efficient when c is finite: in fact the single firm setting induces too little misreporting compared with the efficient contract, which explains why it generates too little output.

3.2 Competition and Efficiency

The 2007-2008 financial crisis has triggered an intense public debate about CEO compensation. On one end of the spectrum some argue that CEO compensation is too exuberant. In their view, compensation not only is excessive but also too weakly correlated with performance. On the other end of the spectrum, some argue that the structure of compensation simply obeys to market forces: for them, the current levels of compensation would be necessary to retain talent in competitive markets.

To understand how efficient are competitive contracts the next proposition compares the surplus arising under competition with that arising when there is a single firm. Efficiency is measured in a utilitarian way as *the expected size of the pie*.

Proposition 6 *If the mass of the distribution of θ is sufficiently concentrated around $\underline{\theta}$ then the competitive contract is less efficient than the single firm contract. Formally,*

$$\int_{\underline{\theta}}^{\theta_N} S(r_N(\theta), \theta) \, dF(\theta) < \int_{\underline{\theta}}^{\theta_1} S(r_1(\theta), \theta) \, dF(\theta).$$

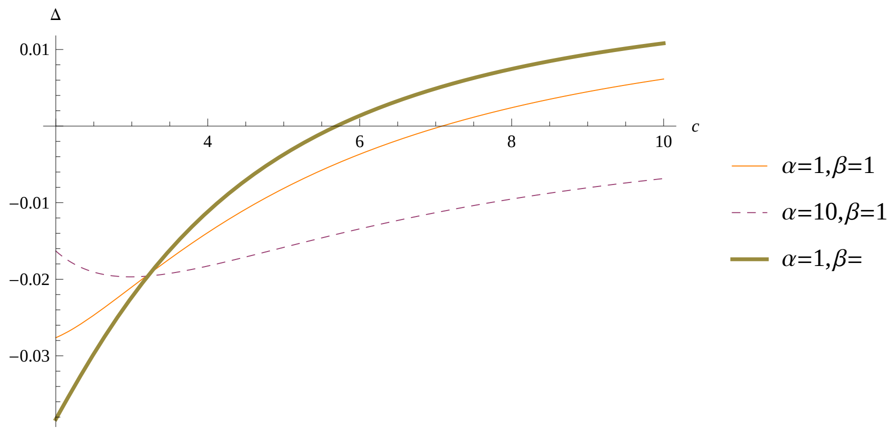

Figure 3: *Competition and Efficiency.* $\Delta \equiv \int_{\underline{\theta}}^{\theta_N} S\left(r_N\left(\theta\right), \theta\right) dF\left(\theta\right) - \int_{\underline{\theta}}^{\theta_1} S\left(r_1\left(\theta\right), \theta\right) dF\left(\theta\right)$. $(\theta - 1 \sim Beta(\alpha, \beta))$

Competition would lead to (interim) efficiency if either effort were contractible or talent was observable. However, in our setting the efficient contract $w_{\dagger}\left(\cdot\right)$ cannot be sustained under competition because this contract entails an irreconcilable tension between zero profits and incentive compatibility. Under the zero profit condition, efficiency requires that the manager's rents decrease very fast across types, at the speed the social surplus does, i.e, $\frac{\partial S(r_{\dagger}(\theta),\theta)}{\partial \theta}$. Otherwise the zero profit condition would be violated and the firms would have an incentive to increase pay, since by slightly outbidding their opponents they would significantly increase the chances of hiring the manager. On the other hand, incentive compatibility requires that the manager's rents evolve according to $U_{\dagger}'\left(\theta\right) = -C_{\theta}\left(r_{\dagger}\left(\theta\right), \theta\right)$, but this is greater than $\frac{\partial S(r_{\dagger}(\theta),\theta)}{\partial \theta}$. In other words, if the contract is to satisfy the zero profit condition and implement efficient reporting, then this will induce a violation of incentive compatibility in that lesser talented managers would have an incentive to mimic more talented ones by aggressively misreporting the value of the firm. Of course, this would render the contract unprofitable because the firms would end up overpaying the manager, on average.

To overcome this problem and ensure that $\frac{\partial S(r_N(\theta),\theta)}{\partial \theta} = U_N'\left(\theta\right)$ competition must lead to a misreporting escalation whereby managers prove their actual talent by out-reporting lower productivity managers by a greater extent than that prescribed by the efficient contract. This misreporting escalation ensures both that incentive compatibility is preserved (because it becomes too costly for lower talented managers to mimic higher talented ones) and that firms break-even.

The relative inefficiency of competition depends on the distribution of talent, as we see in Figure 3. The higher the likelihood of high talented managers the more inefficient competition becomes, relative to the single firm setting. This is explained by the fact that competition strongly distorts the behavior of top-talented managers, whereas the single firm setting strongly distorts the behavior of bottom-talented managers.

The relative inefficiency of competition is also particularly acute when the misreporting cost is low (see Figure 3). In this case, the intensity of misreporting strongly depends on the manager's talent θ^{-1}. By contrast, the fact that competition is relatively more efficient when misreporting costs are high is intuitive: when c grows large, misreporting ceases to be a concern and output becomes contractible. In this context, competition results in the manager getting the entire output (he becomes the residual claimant) and since output does not depend on the manager's type this immediately leads to efficiency: the manager fully internalizes the effect of his effort on output and chooses efficient effort. Put differently, when the cost of misreporting grows large, competition leads to efficiency because conditional on a report r, output does not depend on the manager's hidden type, so competition takes place among identical firms in a nearly independent value environment.

By contrast, in the absence of competition the contract is inefficient even when c grows large. This is because the presence of private information about talent still induces the principal to use very low pay for performance sensitivity as a means of reducing the manager's information rents.

Before proceeding, it is important to underline the strength of the distortions induced by competition: though one should not expect competition to automatically lead to efficient outcomes at least one might expect competition to lead to a more efficient outcome than a monopsony. However, as shown above, this may be false when misreporting is not too expensive.

Regulation Given the inefficiency of competitive contracts described above, it is interesting to study the scope of regulation. There are two classes of policies a regulator may consider in this model. Policies seeking to increase governance quality (e.g., those resulting in higher c), and taxation-like policies seeking to restrict the transfers between a firm and its managers. Here, we focus on the latter type of policies.

Naturally, the existence of an efficient contract $w_{\dagger}(\cdot)$, as characterized by Proposition 2 , suggests that a regulator should use this contract as model for regulation. Indeed, the next result demonstrates that a regulator can induce interim efficiency by restricting total compensation to be no greater than $w_{\dagger}(\cdot)$. Essentially this regulation amounts to limiting the variable part of total compensation (i.e., the bonus) as a percentage of the manager's salary.

Proposition 7 *There exists a regulation that induces interim efficiency. This regulation can be implemented as a cap $\overline{w(r)}$ such that total compensation must be bounded above by $\overline{w(r)}$. The cap is given by*

$$\overline{w(r)} = w_{\dagger}(r)$$

Some comments are in order. The efficient cap is contingent on performance r, in particular the cap must increase in performance. This means that one size does not fit all, when efficiency is the regulator's main concern.

Also note that the level of compensation is not relevant for efficiency but only the slope. In that sense the regulation can be implemented as an upper bound on variable compensation, with the bound being defined as a percentage of the manager's salary. [14]

Notice that the cap entails a wealth transfer between the manager and the firms. In fact, when the cap is imposed, the principal earns abnormal profits.

The cap plays the role of a tax-schedule whose goal is to curb misreporting, specially at high levels of performance. This implicit tax schedule can be computed as:

$$tax(r) = q(r, 1/r) - w_{\dagger}(r)$$

Proposition 7 should not be interpreted, literally , as a policy recommendation. Given its complexity, a compensation cap that is contingent on performance is beyond the set of

[14] The deal agreed in Brussels late on February 27th on European bankers bonuses is one of those occasions. The agreement, which still needs to be signed off by EU finance ministers, endorsed long-standing demands by the European Parliament for a limit on bankers pay. Bonuses can be no higher than their salaries (or double their salaries, if a bank's shareholders explicitly agree). The Economist, Feb 28th 2013.

tools a regulator would consider in the real world, given the lack of information regulators typically face. Perhaps a more realistic regulation is setting a uniform cap independent of performance. If set optimally, this uniform cap also improves efficiency relative to the unregulated case.

Table 1 provides a simulation of the implicit tax rate for each percentile of the distribution of θ. The first column shows that the intensity of manipulation decreases in performance. We chose the parameters in the simulation to reflect realistic levels of manipulation. For top performers, those in the percentile 10, the variable part of compensation is close 7 times the salary (which equals $u = 0.1$). The regulation however restricts the variable compensation to be only 6 times the salary. In this case the implicit tax, would be close to 6% of reported performance. Interestingly, the implicit tax is non-monotonic, and relatively flat across deciles of performance, relative to manipulation.

Table 1: *Implicit Tax Rate of Optimal Regulation* $(c = 20, u = 0.1, \theta - 1 \sim Beta(4,4))$

Pctl.	$\frac{b_N(\theta)}{q(r_N,\theta)}$	r_N	$r_\dagger$	w_N	$w_\dagger$	$\frac{tax}{r_\dagger}$
10	6.4%	0.83	0.78	0.78	0.69	5.99%
20	6.8%	0.79	0.74	0.74	0.65	6.01%
30	7.0%	0.76	0.71	0.71	0.62	6.01%
40	7.3%	0.74	0.69	0.69	0.60	6.00%
50	7.5%	0.72	0.67	0.67	0.58	5.99%
60	7.7%	0.70	0.65	0.65	0.56	5.97%
70	8.0%	0.68	0.63	0.63	0.54	5.94%
80	8.2%	0.66	0.61	0.61	0.52	5.91%
90	8.6%	0.63	0.58	0.58	0.50	5.85%
100	10.0%	0.55	0.50	0.50	0.43	5.54%

Our analysis ignores several aspects of real world markets. A regulator should consider general equilibrium effects. If a cap is applied to a single industry (e.g., Banks) then this might lead to a talent drain in the banking industry, because the most talented managers would obtain higher compensation in the unregulated sectors of the economy.

Some market pundits (see e.g, The Economist, Feb 28, 2103) argue that restricting the variable part of compensation (i.e, bonus) will force firms in the regulated sector of the economy to increase salaries as a means to retain their talent. This substitution between the variable and fixed compensation is unlikely to arise in our setting, at least under competition, since that would actually exacerbate adverse selection problems.

Regulation must also consider the interrelation of labor markets across countries. If a country sets the cap unilaterally then the effectiveness of the cap may depend on whether talent is mobile across countries (see e.g., Borjas (1987)). If in this model there were two countries, say the regulated country and the unregulated one, and if managers could freely move across countries at no cost, then the managers of the regulated country would emigrate to the unregulated country, simply because compensation would be higher in the unregulated country. Now, if the inhabitants of the regulated country had to pay a fixed cost to leave their country, then the compensation cap would induce a talent drain: only the most talented managers would move to the unregulated country.

3.3 Competition and Inequality

The distribution of compensation has long been a concern to economists and practitioners. The idea that competitive labor markets engender large inequalities among workers of different talents pervades the literature (see e.g., Lucas (1978), Rosen (1981)) and seems to have strong empirical support, whether it refers to scientists, sportsmen, or CEO's. The conventional view is that when talent is heterogenous, the winner takes all in competitive markets.

But is this true when performance can be manipulated? To address this question we first consider how competition affects the dispersion of rents across talent, and then examine the dispersion of compensation.

Proposition 8 *Competition increases the dispersion of CEO rents. Formally,*

$$U_N'(\theta) < U_\dagger'(\theta) < U_1'(\theta)$$

The increase in rent dispersion caused by competition does not imply that competition increases the dispersion of compensation because compensation consists both of the

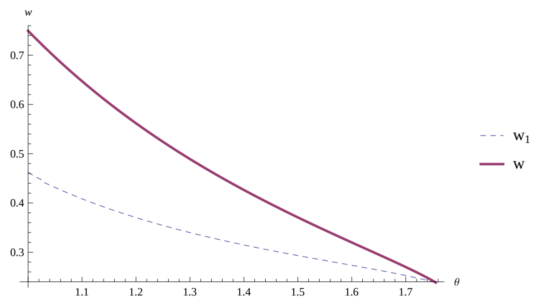

Figure 4: *Compensation dispersion when c=1.*

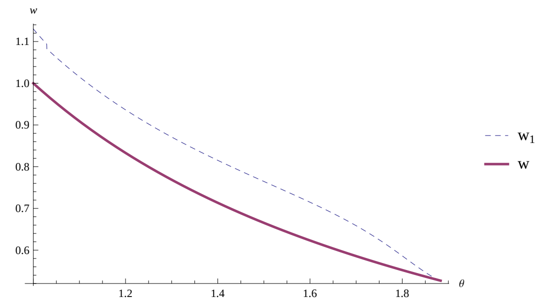

Figure 5: *Compensation dispersion when c=10.*

manager's payoff and her overall cost:

$$w_N(r_N(\theta)) = U_N(\theta) + C(r_N(\theta), \theta),$$

In fact while competition increases the dispersion of rent it might reduce the dispersion of cost, making the overall effect of competition on the dispersion of compensation ambiguous. Figure 4 and 5 illustrate this possibility by comparing the dispersion of compensation under competition and monopsony when the distribution of $\theta - 1 \sim Beta(4, 4)$. This example reveals that when the cost of misreporting is high, competition does not increase the dispersion of compensation. By contrast, the compensation gap between the most talented manager and the least talented one would be greater under monopsony (in Figures 4 and 5 the monopsony wage has been re-scaled upwards to make it comparable with the competitive wage).

4 Concluding Remarks

The high-powered compensation packages observed in the U.S. and other countries over the past few decades have sparked debates about their costs and benefits. Shareholders and outsiders have argued that in some cases, the compensation packages were merely devices used by CEOs to extract wealth from firms whose bargaining position was weak, compared with the CEO's. In the academic literature, this rent-extraction position has been defended by Bebchuk and Fried (2004), among others. A completely different view (taken by Edmans et al. (2009), among others) is that these compensation contracts are determined in competitive labor markets, and that larger realized compensation reflects the increased productivity of highly talented CEOs whose decisions are crucial for the performance of their firms.

We combine the two views by analyzing a model in which firms compete to appoint a CEO, by offering compensation contracts that the CEO may find attractive, and the equilibrium contract must give the CEO an incentive to make decisions that maximize the value of the firm. The CEO in our model is thus in a position to extract rents from firms, because firms compete to appoint one CEO candidate, but compensation also reflects the productivity of the CEO, once appointed. We analyze the equilibrium contract if there are realistic obstacles to writing "complete" contracts: The CEO's decisions are not observable, creating a moral hazard problem; the CEO's cost of making value-increasing decisions is unobservable, creating an adverse selection problem; and the CEO can manipulate (at a cost) the firm's performance as measured by the shareholders or directors (creating another moral hazard problem). In sum, our model captures features of the market for CEO labor that the literature regards as important.

Competition for CEO talent has a significant effect on the equilibrium contract. It is excessively high-powered, with compensation steeper and more convex in performance. Competition for CEOs has increased strongly in the U.S. during the second half of the 20th century: CEO talent has become transferable across industries, directors have moved towards appointing outsiders instead of insiders, and information about compensation packages offered by competing firms has become more readily available. The increasing slope and convexity of equilibrium compensation can thus explain changes in compensation contracts and CEO decisions over the past few decades: the model predicts large rent extraction by the most talented CEOs, but also extreme productivity paired with excessive manipulation of performance measures. Importantly, rent extraction must come through high-powered incentives, because any other form of wealth transfer creates or exacerbates incentive problems. In particular, rent extraction cannot happen through a simple increase in a CEO's base salary.

Politicians and shareholder rights advocates have proposed limits on CEO compensation. We therefore analyze how regulation can improve efficiency in the market for CEO labor. We show that efficiency can be restored, using limits to pay-performance sensitivity. The model shows that simple limits to this sensitivity may be beneficial, even if they seem sub-optimal from a firm's perspective.

A possible extension of our model would be to consider competition among firms which differ in their governance quality. Such an extension would allow us to endogenize governance quality and consider whether the most talented managers are attracted by firms with lower misreporting costs.

A Appendix. Omitted Proofs

Proof of Proposition 1. The unique reactive equilibrium is the Pareto dominating equilibrium. From the manager's optimization problem, the reporting schedule $r^*(\theta)$ in a separating equilibrium must solve the following problem

$$\max_r \{q(r, \gamma^*(r)) - C(r, \theta)\} \tag{23}$$

where $\gamma^*(r)$ is the inverse of $r^*(\theta)$, namely the market conjecture about the manager's talent given a report r, and $q(\cdot, \cdot)$ and $C(\cdot, \cdot)$ are defined by the manager's effort optimization problem, as in (**??**) and (**??**). Taking the first order conditions from (23) yields

$$q_r(r^*, \gamma^*(r)) + q_\theta(r^*, \gamma^*(r)) \cdot \frac{\partial \gamma^*(r)}{\partial r} - C_r(r^*, \theta) = 0. \tag{24}$$

In a Pareto dominating separating equilibrium (least costly separating) the reporting schedule $r^*(\theta)$ must solve (24) along with the boundary condition

$$r^*(\bar{\theta}) = r^{fb}(\bar{\theta}) = \frac{1}{\bar{\bar{\theta}}}.$$

■

Proof of Proposition 2. The convexity of the contract can be immediately verified by twice differentiating (22) which gives

$$\frac{\partial^2 w^*(r)}{\partial r \partial r} = \bar{\theta} c e^{\frac{c}{\bar{\bar{\theta}}}} \frac{e^{-cr}}{\bar{\bar{\theta}} + c}.$$

The effect of c on the contract slope can be obtained by taking the cross partial derivative of $w^*(\cdot)$

$$\begin{aligned}
\frac{\partial^2 w^*(r)}{\partial r \partial c} &= e^{-c\frac{r\bar{\theta}-1}{\bar{\theta}}} \frac{r\bar{\theta}^2 + rc\bar{\theta} - c}{\left(c + \bar{\theta}\right)^2} \\
&\geq e^{-c\frac{r\bar{\theta}-1}{\bar{\theta}}} \frac{r\bar{\theta}^2}{\left(c + \bar{\theta}\right)^2} > 0.
\end{aligned}$$

■

Proof of Proposition 5. Given (**??**), expected misreporting boils down to

$$b(r) = \frac{c}{c+\theta} r.$$

so whether competition exacerbates misreporting or not depends on whether competition induces higher reports than the monopsony solution. It is however easy to establish that:

$$r^m \leq r^{fb} \leq r^c.$$

■

Proof of Proposition ??. To implement the first best the contract must induce $r^{fb}(\frac{1}{\theta}) = \frac{1}{\theta}$. Since it must also be incentive compatible, by the Envope Theorem

$$\dot{U}(\theta) = -C_\theta(r^{fb}(\theta), \theta).$$

Solving this differential equation and assuming without loss of generality that $U(\overline{\theta}) = 0$, one gets

$$U(\theta) = \int_\theta^{\overline{\theta}} C_\theta(r^{fb}(\tau), \tau) d\tau.$$

Implementing the first best simply requires to invert the first best reporting schedule $r^{fb}(\frac{1}{\theta}) = \frac{1}{\theta}$ and then substitute it into

$$U(\theta) = \max_r \{w(r) - C(r, \theta)\}$$

to get:

$$w(r) = U(1/r) + C(r, 1/r).$$

To prove that the slope of the contract is greater under competition one needs to note that, given any contract $w(\cdot)$ in equilibrium

$$U(\theta) = \max_r (w(r) - C(r, \theta))$$

hence:

$$w_r(r(\theta)) = C_r(r(\theta), \theta).$$

by Proposition (5) we know that $r^*(\theta) \geq r^{fb}(\theta)$. Furthermore, by the convexity of $C(\cdot, \theta)$ we must have

$$w_r(r^*(\theta)) \geq w_r(r^{fb}(\theta)).$$

Now, this only proves that the competitive contract is steeper when evaluated at the equilibrium reporting schedule. To show that $w_r^*(r) \geq w^{fb}(r)$ for all r. However

$$\frac{\partial w^{fb}(r)}{\partial r} = \frac{cr}{cr+1}$$

whereas

$$\frac{\partial w^*(r)}{\partial r} = 1 - \frac{\overline{\theta} e^{c\frac{1-r\overline{\theta}}{\overline{\theta}}}}{c + \overline{\theta}}$$

Cleary for large r the slope of the competitive contract is greater than that of the monopsony contract. Furthermore the two slopes intereset only once and at

$$r = \frac{1}{\overline{\overline{\theta}}},$$

which by the mean value theorem implies that

$$\frac{\partial w^*(r)}{\partial r} \geq \frac{\partial w^{fb}(r)}{\partial r}.$$

■

Proof of Proposition 6. It is clear that for high levels of governance quality the competitive case induces a greater social surplus than the monopsony one, given that the competitive solution converges to first best as the value of c grows large, or

$$\lim_{c \to \infty} r^*(\theta) = r^{fb}(\theta).$$

On the other hand, we shall prove that

$$\lim_{c\to 0}\frac{\partial S^m(c)}{\partial c} = \lim_{c\to 0}\frac{\partial S^{fb}(c)}{\partial c}$$
$$= \frac{1}{2}E[\frac{1}{\theta^2}]$$
$$> \lim_{c\to 0}\frac{\partial S^*(c)}{\partial c},$$

which given that

$$S^m(0) = S^*(0)$$

implies that for small c the social surplus under monopsony is greater than under competition. To establish this note that

$$\lim_{c\downarrow 0}\frac{\partial S^m(c)}{\partial c} = \lim_{c\downarrow 0} E\left(\frac{1}{2}\frac{\theta^2}{(cH+c\theta+\theta^2)^2}\right)$$
$$= E\left(\lim_{c\downarrow 0}\frac{1}{2}\frac{\theta^2}{(cH+c\theta+\theta^2)^2}\right)$$
$$= E\left(\frac{1}{2\theta^2}\right) = \lim_{c\downarrow 0}\frac{\partial S^{fb}(c)}{\partial c}$$

Next we show that $\lim_{c\downarrow 0}\frac{\partial S^*(c)}{\partial c} < E\left(\frac{1}{2\theta^2}\right)$. Defining

$$S^*(c) = E[S(\tilde{\theta}, c, r^*(\tilde{\theta}))]$$

where

$$S(\theta, c, r^*(\theta)) \equiv \frac{c}{c+\theta}r^* - \frac{1}{2}\frac{c\theta}{c+\theta}r^{*2},$$

and r^* is given by (20). Hence,

$$\frac{\partial S^*(c)}{\partial c} = E\left[\frac{dS(\theta, c, r^*(\theta))}{dc}\right]$$
$$= E\left[S_c(\theta, c, r^*) + S_r(\theta, c, r^*)\frac{\partial r^*}{\partial c}\right]$$

It is easy to verify that $\lim_{c\downarrow 0} S_r(\theta, c, r^*)\frac{\partial r^*}{\partial c} = 0$. This follows from the fact that $\lim_{c\downarrow 0} S_r(\theta, c, r^*) =$

0 and $\lim_{c\downarrow 0}\frac{\partial r^*}{\partial c}$ is bounded. In fact the latter is implied by

$$\lim_{c\downarrow 0} r^* = \frac{1}{\theta}+\sqrt{\frac{1}{\theta^2}-\frac{1}{b^2}} > \frac{1}{\theta}$$

Also, note that $S_c(\theta,c,r^*) = \frac{1}{2}\frac{r^*\theta}{(c+\theta)^2}(2-r^*\theta)$. Using this and (20) one can verify that

$$\lim_{c\downarrow 0} S_c(\theta,c,r^*) = \frac{1}{2b^2}$$

which means that

$$\lim_{c\downarrow 0}\frac{\partial S^*(c)}{\partial c} = \frac{1}{2b^2} < \lim_{c\to 0}\frac{\partial S^m(c)}{\partial c} = E\left(\frac{1}{2\theta^2}\right).$$

■

Proof of Proposition ??. One needs to establish that the compensation cap must be binding everywhere, so that indeed the first best is implemented. Let $w^{**}(\cdot)$ be the competitive contract prevailing in the presence of the cap $w^{fb}(\cdot)$. Assume that in equilibrium there is an open set (r_1,r_2) of reports in $\left[\overline{\theta}^{-1}, r^{fb}(\underline{\theta})\right]$ where the compensation cap is not binding, so that $w^{**}(r) < w^{fb}(r)$ for $r\in(r_1,r_2)$. There are two possibilities: either there is a set of types of positive measure choosing a report in (r_1,r_2) or the set of types issuing a report on (r_1,r_2) is empty so there is a hole in the support of $w^{**}(\cdot)$. In the first case, any deviation like $w^{**}(r)+\varepsilon$ for $r\in(r_1,r_2)$ and ε arbitrarily small must be profitable as it attracts the entire mass of types who were issuing a report in $r\in(r_1,r_2)$, inducing a first order gain to the deviating firm. In fact, the value of ε can be chosen small enough so that the potentially adverse effects of this deviation, arising from its effect on the choices of other managers is only of second order magnitude. In the second case, if the set of reports in (r_1,r_2) is empty, then there must be a pool of heterogenous managers who are realeasing the same reports at either boundary of this set. By the standard arguments, a firm could cream skim its competitors by offering a contract that is only appealing to the most productive types in this pool. ■

Proof of Proposition ??. On the surface one might think that when compensation cannot exceed a fixed amount $\overline{w} < w^*(\underline{\theta})$ then the equilibrium contract $w(\cdot)$ should take the form

$$w\,(r) = \min(w^*\,(r)\,, \overline{w}).$$

but note that this cannot be an equilibrium contract, because paying $\overline{w}$ to those who report slightly less than $r(\overline{w})$, defined by $w^*(r(\overline{w})) = \overline{w}$, would be a dominant strategy given that the the firms would be making positive profits on each type of the pool of that choosing the contract $\{\overline{w}, r(\overline{w})\}$. Bertrand competition would then create a pressure to reduce the report of these managers down to the level where the zero profit condition holds. So we will show that the contract must in fact be discontinuous and defined as:

$$w(r) = \begin{cases} w^*\,(r) & r < \overline{r}(\overline{w}) \\ \overline{w} & \text{if } r \geq \overline{r}(\overline{w}) \end{cases} \tag{25}$$

where $\overline{r}(\overline{w})$ denotes the report that satisfies the firm's zero profit condition when the cap is $\overline{w}$. $\overline{r}$ is defined as

$$E[q(\overline{r}, \theta) | \theta \leq \widehat{\theta}] = \overline{w},$$

where $\widehat{\theta}$ is the type that is indifferent between his unrestricted competitive contract $\left\{w^*(r^*(\widehat{\theta})), r^*(\widehat{\theta})\right\}$ and $\{\overline{r}(\overline{w}), \overline{w}\}$. The value of $\widehat{\theta}$ is defined as

$$\overline{w} - C(\overline{r}, \widehat{\theta}) = w(r^*(\widehat{\theta})) - C(r^*(\widehat{\theta}), \widehat{\theta}).$$

Note that $r^*(\widehat{\theta}) < \overline{r}(\overline{w})$ by incentive compatibility. Now, by continuity it is clear that when $\overline{w} \to w^*(r^*(\underline{\theta}))$, then $\overline{r}(\overline{w}) \to r^*(\underline{\theta}) > r^{fb}(\underline{\theta})$. Since $\overline{r}(\overline{w})$ must be a decreasing function of $\overline{w}$ (by incentive compatibility), the mean value theorem ensures that by setting the cap low enough it will be possible to induce

$$\overline{r}(\overline{w}) = r^{fb}(\underline{\theta}).$$

Hence, after the cap has been set at that level, all types in $[\underline{\theta}, \widehat{\theta}]$ where $\widehat{\theta} < \overline{\theta}$, will report $r^{fb}(\underline{\theta})$, where

$$r^{fb}(\theta) \leq r^{fb}(\underline{\theta}) < r^*(\theta) \text{ for all } \theta \in [\underline{\theta}, \widehat{\theta}].$$

Hence, the social surplus must increase when $\overline{w}$ is set so that $\overline{r}(\overline{w}) = r^{fb}(\underline{\theta})$. In fact, for all $\theta \in [\underline{\theta}, \widehat{\theta}]$ the misreporting excess will be lower, so that the reports of these types will be closer to their first best report $r^{fb}(\theta)$. Note that the contract defined by (25) entails pooling over $[\underline{\theta}, \widehat{\theta}]$, so one has to show that no cream skimming-like deviation is possible, given the compensation cap $\overline{w}$. This becomes apparent if one notices that any deviation contract of the form $\{\tilde{r}, \tilde{w}\}$ where $\tilde{w} < \overline{w}$ and $\tilde{r} \leq \overline{r}(\overline{w})$ must either attract no one or an interval $[\theta_1, \theta_2]$ with $\theta_2 > \widehat{\theta}$, such that $\tilde{r} > r^*(\theta_2) \geq r^{fb}(\theta_2)$. This in turn means that the deviation attracts a positive measure of types $\theta \in [\theta_1, \theta_2]$ which are unprofitable in the sense that $\tilde{w} > q(\tilde{r}, \theta)$ for all $\theta \in [\theta_1, \theta_2]$. Hence, the possibility of cream skimming this deviation renders the deviation infeasible under the definition of a reactive equilibrium.

■

Proof of Proposition 8. This is demonstrated by noting that incentive compatibility requires that

$$U_\theta = -C_\theta(r, \theta).$$

On the other hand, by assumption, $-C_{\theta r}(r, \theta) < 0$. We have established that competition induces a reporting schedule

$$r^*(\theta) \geq r^m(\theta).$$

Hence

$$U^*_\theta \leq U^m_\theta.$$

■

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