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 that 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. 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.

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1 Introduction

Much of the recent literature on executive compensation (for recent surveys, see Frydman and Jenter (2010) or Murphy (2013)) is framed by the question whether executive compensation is excessive and driven by the powerful CEOs, who can extract large rents from their firms (see, e.g., Bebchuk and Fried (2004)); or whether compensation is determined by market forces, and some CEOs are highly paid because they have skills that few others have (see, e.g., Gabaix and Landier (2008), Terviö (2008), or Edmans et al. (2009). One of the problems with both views is that their predictions are based on models that are incomplete: the rent-extraction view is based on models that don't explain why a CEO has so much bargaining power, while the market-outcome view abstracts from informational asymmetries that make it hard to match the most talented CEOs with the firms where they can add most value.[1] (For a summary of empirical support for the two views, see Murphy (2013).)

In this paper, we study a model that closes this gap. Our model incorporates realistic problems of asymmetric information (CEOs have unknown talent; their actions are unobservable; and they can manipulate measures of performance) and describe the optimal contract that firms would offer, either when the firms have all bargaining power, or when the CEO candidates have all bargaining power because many firms compete to appoint a CEO from a limited pool of candidates. If there is competition for talent, the CEO candidates are in a powerful bargaining position, allowing them to extract rents from the firms. However, this does not simply increase their base pay, since the incentive problems require that performance is rewarded. So it is necessary to analyze the optimal contracts offered by the firms in both setups. Our model thus combines the idea that compensation is determined by market forces and the idea that CEOs can have strong bargaining positions.

As we discuss below (see Section 5), competition for talent has strengthened 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 disclo-

[1] Getting this match right is important: Hiring the wrong person as a CEO can destroy much more value than overpaying that CEO somewhat. For example, J.C. Penney's CEO Ron Johnson, appointed in late 2011, implemented pricing strategies that caused major drops in sales, leading to his dismissal in early 2013.

sure 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).[2]

Importantly, competition to hire a CEO does not merely transfer wealth from firms to CEOs: Competition for talent has real, allocative effects. When competing, the firms must offer 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 to offer 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 than in the absence of competition for talent. 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.[3] Finally, a large literature

[2] We discuss empirical support for our assumptions (in particular, the increase in competition for talent over the past few decades) and for our predictions below, in Section 5.

[3] CEO talent need not be equally valuable at different firms: A given CEO's talent may be valuable to one firm (say, a growing startup) and useless at another firm (say, a mature firm in need of cost control). The important assumption is that the firms cannot tell which CEO candidate has the skills needed by their firm.

on earnings management and fraud argues that measuring a CEO's performance is difficult because the measures that are observable can be manipulated by the CEO (see, e.g., Bergstresser and Philippon (2006), Burns and Kedia (2006), or Peng and Röell (2008*a*)).

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 a 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.[4] 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 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.[5] 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,

[4] 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.

[5] 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.

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. Other closely related papers are Benabou and Tirole (2012) and Bijlsma et al. (2012). Benabou and Tirole (2012) 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 observable and incentive compensation can only focus on the measurable task. Importantly, the agents have an "intrinsic" motivation for investing effort in the unobservable task, which depends on how much effort they invest in the observable task. Like in our paper, competition leads to excessively strong incentive provision (which they call "bonus culture"). There is no misreporting in their paper. Additionally, we do not require the incentive contracts to have an affine structure. That is important, because the equilibrium contracts in our model are piecewise linear but not affine; even the contract that maximizes the surplus generated is not affine. Bijlsma et al. (2012) study risk-taking incentives by traders, and how competition among banks to recruit traders affects the equilibrium contract offered to trades with heterogeneous but unobservable talent, and the traders' risk-taking. The equilibrium contract also generates excessively strong incentives (to take excessive risk).

Other papers that study competition through contracts include (among others) Rothschild and Stiglitz (1976), Stole (1995), and Armstrong and Vickers (2001). The role of competition *for 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. (Shareholders can even benefit from a CEO's manipulation, see Bolton et al. (2006).) 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). (Talent is observable in these papers, which is not the case in our model.)

A large accounting literature on earnings manipulation exists; see, e.g., Baiman et al. (1987), Dye (1988), Demski (1998). How the structure of incentive compensation affects performance manipulation is examined in Goldman and Slezak (2006), Peng and Röell (2008*b*), and Morse et al. (2011).

The rest of the paper is organized as follows. Section 2 presents the model and introduces two benchmark contracts, the "efficient" contract and the single-firm optimal contract. Section 3 studies competitive contracts and discusses their main properties. Section 4 compares the optimal contracts and the outcomes in the two setups. Section 5 discusses empirical implications. Section 6 discusses how regulation may change the outcome under competition. Section 7 discusses an alternative model, in which firms are uncertain about managers' costs of manipulation instead of their talent. Section 8 concludes. All proofs are in the Appendix.

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 adapt the model in Beyer et al. (2011) and extend it 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). The chosen action is not observable to outsiders, creating a moral hazard problem. Also, the manager's talent is not observable to outsiders, creating an adverse selection problem. Finally, the manager can misreport her performance, albeit at a cost.[6] The firms compete to hire the manager by offering compensation that is contingent on the reported performance.

The sequence of events is the following. First, the manager privately observes her talent (productivity), measured by $\tau \in \{\tau_\ell, \tau_h\}$, with $\tau_\ell < \tau_h$ and probabilities $p_h \in (0,1)$ and $p_\ell = 1 - p_h$. For convenience, we formalize talent inversely, as a cost-of-effort parameter $\theta = \frac{1}{\tau}$: A manager who realizes a higher value of θ has a higher cost of effort and is thus less talented or productive (notice that $\tau_\ell < \tau_h$ implies $\theta_\ell > \theta_h$).

Next, $N \geq 2$ firms simultaneously offer contracts to the manager, who can accept at most one of the contracts. A contract is a compensation rule $w(\cdot) : \mathbb{R} \to \mathbb{R}$ that depends on the performance r the manager will later report. After accepting a contract, the manager chooses an action (most easily interpreted as effort) $q \in \mathbb{R}_+$, 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 effort, the manager reports the future value of the firm, but may misreport it.

The manager must bear two nonpecuniary costs: choosing effort q causes disutility $\frac{\theta}{2}q^2$; and reporting a future value r different from the true value q causes disutility $\frac{c}{2}(r-q)^2$. Based on the chosen report r, and consistent with the contract, the manager receives a transfer $w(r)$. Finally, the future value of the firm q is realized.

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

The firms (and their shareholders) and the manager are risk neutral, so given a contract $w(\cdot)$ the manager's payoff is

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

and the profit of the firm hiring the manager is

$$q - w(r).$$

If the manager rejects all contracts, her expected payoff is normalized to zero.[7]

The firms must resolve several incentive problems using an imperfect tool: incentive compensation contingent on the manager's possibly misreported performance. The contract $w(\cdot)$ must induce the manager to choose a high value of q, while ensuring that the compensation for different levels of talent is not unnecessarily high. Choosing a high q is costly, but less so for a more productive or talented manager (with a lower θ), so it may be optimal to induce higher effort q from a more talented manager. 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 output. Since misreporting performance is costly for the manager, this makes it possible to link the compensation to the manager's reported performance. However, strong performance incentives also encourage misreporting of performance, without any benefits for the principal.

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

[7] If the manager's reservation payoff was type-dependent, the derivation of the optimal contract would be more complicated, potentially entailing some pooling (see Jullien (2000)). Of course, if the outside option was higher, the firms might prefer not to employ the low-talent manager.

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.

A key parameter that affects the cost of misreporting is c. We assume that c is common knowledge and identical across firms. The variable c captures the quality of the accounting and auditing rules, the usefulness of disclosure requirements and other regulations, the legal rights of directors and minority shareholders when dealing with 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; in the Appendix we discuss a model in which the manager's talent is observable but c varies across firms.

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 joint presence of hidden action and adverse selection makes the analysis potentially involved. However, by addressing the manager's effort choice in isolation, the model can be represented as an adverse selection model with a single observable action (i.e., reported performance) and then solved using standard techniques. While the manager chooses q and r simultaneously in the model, it is convenient to treat her decision problem as if she chose her report r first, and *then* her action q.

For a given report r, manager $\theta' s$ optimal effort is defined by

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

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

$$C(r,\theta) \equiv \min_{q} \left\{ \frac{\theta}{2}q^2 + \frac{c}{2}(r-q)^2 \right\} \tag{2}$$
$$= \frac{1}{2}\frac{\theta c}{\theta + c} r^2$$

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. Given the quadratic costs, it is never optimal for the manager to achieve a certain performance r exclusively through either effort or misreporting. That is, for any report the manager is planning to release she always finds it optimal to combine some effort with some misreporting, with the relative intensity of effort increasing in c. Naturally, the report r is always higher than its associated output $q(r,\theta)$ and the magnitude of misreporting

$$b(r,\theta) \equiv r - q(r,\theta) \tag{3}$$

decreases in c.

Having characterized the manager's optimal effort as a function of her report, the problem becomes more tractable, since we can focus on how competitive contracts affect the manager's reporting behavior. We represent the manager's preferences in terms of money t and reports r (with corresponding q, as given by (1)) by the indirect utility function

$$v(t,r,\theta) \equiv t - C(r,\theta).$$

In general, a contract $w(\cdot)$ will induce an allocation $\{r(\theta), t(\theta)\}$ consisting of a reporting schedule $r(\theta)$ and a monetary transfer $t(\theta)$. Alternatively, the allocation will be represented as consisting of reporting and payoff schedules $\{r(\theta), u(\theta)\}$ where

$$u(\theta) \equiv v(t(\theta), r(\theta), \theta).$$

In the following, we simplify notation by writing u_ℓ and u_h instead of $u(\theta_\ell)$ and $u(\theta_h)$.

We define the social surplus arising when a manager type θ reports r (and then chooses

$q(r, \theta)$ according to (1)) as

$$S(r, \theta) \equiv q(r, \theta) - C(r, \theta). \tag{4}$$

Before solving for the competitive equilibrium, we consider two benchmarks: an efficient contract $w_* (\cdot)$ and the single-firm contract $\hat{w} (\cdot)$.

The Efficient Contract

Definition 1 *A contract $w(\cdot)$ inducing a reporting schedule $r(\theta)$ is **efficient** if*

$$r(\theta) \equiv \arg\max_r S(r, \theta).$$

The social surplus measures how much value is created, net of all costs, including the manager's effort and manipulation costs. A contract is efficient if it maximizes this surplus, under the constraints that unobservable talent, effort and manipulation impose on the contractual relationship. It is not a "first-best" measure, which would require that these incentive problems can be controlled simultaneously.

The following lemma considers the existence of an efficient contract, which a benevolent planner, purely concerned with the maximization of social surplus but uninformed about θ, would choose.

Lemma 2 *There exist an efficient contract $w^*(\cdot)$ inducing the reporting schedule r_i^*,*

$$r_i^* = \theta_i^{-1} \textit{ for } i \in \{L, H\},$$

and the payoff schedule u_i^*,

$$\begin{aligned} u_h^* &= S(r_\ell^*, \theta_\ell) + C(r_h^*, \theta_\ell) - C(r_h^*, \theta_h), \\ u_\ell^* &= S(r_\ell^*, \theta_\ell) = \frac{c}{2\theta_\ell (c + \theta_\ell)}. \end{aligned}$$

In fact, there is a continuum of efficient contracts indexed by the size of the rents the low-talent manager θ_ℓ obtains, with u_ℓ^* ranging from $[0, S(r_\ell^*, \theta_\ell)]$. From all the allocations that implement efficient reporting, the allocation characterized in Lemma 2 is the allocation that maximizes the agents' payoffs subject to the firm getting non-negative profits on each manager type. The competitive setup we discuss below requires that these type-dependent break-even constraints are satisfied. At the opposite end of the continuum of efficient contracts, the payoff for the low-talent manger (type θ_ℓ) is zero. However, that is not the contract that a single firm would offer if the firm had all bargaining power, as we show next. That contract creates distortions to extract additional rents from the high-talent manager (type θ_h).

The Single-Firm Contract As a second benchmark, we analyze the single-firm case (similar results are derived in Beyer et al. (2011), in a model with a continuum of types). Recall that any contract can depend only on the manager's performance report r but not her effort q, since q is known to the manager, only.

Consider the firm's optimal contract. Note that the firm's choice set is the set of all possible functions that can be used to reward performance r. To characterize the optimal contract we solve for the optimal direct mechanism.[8] A direct mechanism can be represented by a menu of pairs $\{t_i, r_i\}$ where r_i is the report of type $i \in \{L, H\}$ and t_i is the monetary transfer associated with the report of that manager.

The optimal mechanism must maximize the firm's expected profits:

$$\hat{\mathcal{P}} : \max_{\{r_i, t_i\}} \sum_{i \in \{L,H\}} \left[q(r_i, \theta_i) - t_i \right] p_i \tag{5}$$

subject to the the incentive compatibility constraint for the report r,

$$u_h - u_\ell \geq C(r_\ell, \theta_\ell) - C(r_\ell, \theta_h), \tag{6}$$

$$u_\ell - u_h \geq C(r_h, \theta_h) - C(r_h, \theta_\ell), \tag{7}$$

and the manager's individual rationality constraint for both types (it is easy to show that

[8] By the Revelation Principle we can restrict attention to direct mechanisms, namely mechanisms that are both individually rational and incentive compatible.

the firm always wants to hire both types in equilibrium),

$$u_h \geq 0, \tag{8}$$

$$u_\ell \geq 0. \tag{9}$$

The above program implicitly incorporates the manager's effort incentive compatibility constraint, as captured by the definition of $q(r,\theta)$. Unlike standard screening problems, the value $q(r,\theta)$ received by the principal depends not only on the manager's observable action r but also on her hidden type θ. Some intermediate results help simplify the program. First, the two incentive compatibility constraints imply that the equilibrium reporting schedule $\hat{r}(\theta)$ must be decreasing in θ for it to be incentive compatible.[9] Second, the high-talent manager θ_h must earn strictly positive rents, since she can always take the contract of the low-talent manager θ_ℓ and derive a greater utility than θ_ℓ, which itself is non-negative. Hence, optimality requires that the participation constraint of θ_ℓ is binding. Third, observe that $\frac{\partial C(r,\theta)}{\partial r \partial \theta} > 0$. Taken together, these three results imply that only the incentive compatibility constraint of θ_h binds in equilibrium. We are thus left with the following simplified program:

$$\hat{\mathcal{P}} = \max_{\{r_h, r_\ell\}} p_h S(r_h, \theta_h) + p_\ell \left\{ S(r_\ell, \theta_\ell) - \pi \underbrace{[C(r_\ell, \theta_\ell) - C(r_\ell, \theta_h)]}_{u_h} \right\},$$

where $\pi \equiv \frac{p_h}{p_\ell}$. The firm maximizes the expected social surplus net of the high-talent manager's information rents. Solving this problem allows us to determine both the reporting schedule $\hat{r}\,(\theta)$ and the payoff schedule $\hat{u}(\theta)$ induced by the single-firm contract.

[9] Adding the incentive compatibility constraints yields

$$C(r_\ell, \theta_\ell) - C(r_h, \theta_\ell) + C(r_h, \theta_h) - C(r_\ell, \theta_h) \leq 0$$

The left hand side equals $\frac{1}{2}\,(\eta_\ell - \eta_h)\,(r_\ell^2 - r_h^2)$ where $\eta_i = \frac{c\theta_i}{c+\theta_i} \Rightarrow (\eta_\ell - \eta_h) > 0$. This in turn means that $r_\ell \leq r_h$, to satisfy the above inequality.

Lemma 3 *The single-firm contract $\hat{w}(\cdot)$ induces the reporting schedule $\hat{r}(\theta)$,*

$$\hat{r}_h = \theta_h^{-1}, \tag{10}$$

$$\hat{r}_\ell = \left[\theta_\ell + \pi \frac{c\Delta}{\theta_h + c}\right]^{-1}, \tag{11}$$

where $\Delta = \theta_\ell - \theta_h$, and the payoff schedule $\hat{u}(\theta)$,

$$\hat{u}_h = C(\hat{r}_\ell, \theta_\ell) - C(\hat{r}_\ell, \theta_h),$$
$$\hat{u}_\ell = 0.$$

As usual, the optimal contract entails *no distortion at the top* (θ_h) but a downward distortion of the report and effort exerted by the low-talent manager (θ_ℓ). The optimal contract depresses the manager's report, relative to the efficient level r_ℓ^*, thereby also depressing the manager's effort $q(r^*, \theta)$. The source of the distortion is the principal's market power along with his rent extraction concern: She benefits from lowering the equilibrium effort of the low-talent manager (θ_ℓ), such that it becomes more costly for the high-talent manager to claim to be a low-talent manager. That, in turn, makes it possible to reduce the high-talent manager's information rent. This comes at the cost of reducing the surplus generated by a low-talent manager, which limits the extent of the distortion applied in equilibrium.

Intuitively, the distortion is more severe if π is higher, i.e., the probability p_h of facing a high-talent manager is higher. It is also more severe if c is higher, i.e., misrepresentation is more costly, because it is then optimal to induce higher effort, which in turn creates a higher surplus that the firm wants to extract. For the same reason, the distortion is more severe if θ_h is lower, i.e., the high-talent manager is more productive and creates a larger surplus.

Note that the distortion introduced by the single-firm equilibrium contract is not driven by the manager's ability to misreport $r > q$. In the limit as c grows large, such that effort becomes *de facto* verifiable, but the report induced from the low-talent manager (and therefore also her effort) remains strictly below the efficient level,

$$\lim_{c\to\infty} \hat{r}_\ell = [\theta_\ell + \pi\Delta]^{-1} < \theta_\ell^{-1}.$$

This implies that the expected surplus generated by the single-firm contract is strictly lower than that induced by the efficient contract:

$$\lim_{c\to\infty} \mathbb{E}_\theta S\left(\hat{r}\left(\theta\right), \theta\right) < \mathbb{E}_\theta S(r^*\left(\theta\right), \theta).$$

So the distortion on the low-talent manager's behavior induced by the single-firm contract is present even as effort becomes contractible. This is because the source of the distortion is not the lack of verifiability of effort but instead the principal's market power.

3 Competition for Talent

Introducing competition for talent (multiple firms competing to hire one manager) dramatically changes the analysis. Intuitively, the firms will compete away all rents that are available in the single-firm setting. However, this does not happen merely as a transfer to the manager. When competing to attract the manager, the firms are limited in their ability to offer higher rents, because incentive compatibility constraints must remain satisfied. Rents can therefore be offered only by changing both the transfers that depend on reported performance *and* the effort levels induced by the equilibrium contracts. In equilibrium, this leads to a reversal of the distortion: The equilibrium competitive contracts distorts the effort induced from the high-talent manager, while the effort induced from the low-talent manager is not distorted.

Under competition, the manager's participation constraint becomes both endogenous and *type-dependent*: the firms must ensure that their contract is at least as attractive as what that manager, given her type, could earn at a competing firm. Thus, one firm's contract offer serves as the manager's outside option when considering a competing firm's offer. The payoff earned under a given contract will tend to increase in the manager's talent; so high-talent managers must be offered higher rents simply to keep up with competitors.

The analysis is complicated by equilibrium existence problems, since the firm value $q(r, \theta)$ depends not only on reported performance r but also on the manager's unknown talent. These problems are similar to those analyzed by Rothschild and Stiglitz (1976) in the context of competition between insurance firms facing households with unobservable loss risks. Separating equilibria invite deviations to pooling contracts if there are too many low-risk individuals; but pooling equilibria generally do not exist.[10] To ensure the existence of a competitive equilibrium we assume that the probability of facing a high-talent manager is not too large (formally, we assume that $p_h \leq p^o$, where p^o is described in the Appendix, after the proof of Proposition 4).

Formally, a competitive equilibrium can be characterized as the solution of the following program:

$$\tilde{\mathcal{P}} : \max_{\{\mathbf{r}, \mathbf{u}\}} u_h$$

subject to

$$u_\ell \geq S(r_\ell^*, \theta_\ell) \tag{12}$$

$$u_h - u_\ell \geq C(r_\ell, \theta_\ell) - C(r_\ell, \theta_h) \tag{13}$$

$$u_\ell - u_h \geq C(r_h, \theta_h) - C(r_h, \theta_\ell) \tag{14}$$

$$u_h \leq S(r_h, \theta_h) \tag{15}$$

$$u_\ell \leq S(r_\ell, \theta_\ell). \tag{16}$$

There are several ingredients to this program. First, the program ensures that the utility of the high-talent manager is maximized. If u_h was not maximized by the competitive contract, a firm could attract the high-talent manager by offering larger rents. Second, condition (12) implies that the utility of the low-talent manager is no lower than the utility she gets from her efficient contract (characterized in Lemma 2). Otherwise, a firm could offer the contract $\{r_\ell^*, t_\ell^* - \varepsilon\}$ for ε small enough, attract the low-talent manager with probability one, and make strictly positive profits from hiring that manager.

Conditions (13) and (14) are the classic incentive compatibility constraints. Together,

[10] The problems are more severe when the distribution of types is continuous: in that case, there are no pure strategy equilibria in the Rothschild and Stiglitz model (see Riley (1979)).

they imply that the reporting schedule must be increasing in talent.

Finally conditions (15) and (16) are participation constraints for the firms. Note that the firms must break even for every type, which is a stronger requirement than breaking even in terms of *expected* payoffs. This is necessary because if a firm makes a loss with one type, it must make a profit with the other type to break even on average; but then, the competing firm will try to lure away the type that lets the first firm make a profit, leaving only the type that causes a loss.

Proposition 4 *The competitive contract $\tilde{w}(\cdot)$ induces the reporting schedule $\tilde{r}(\theta)$*

$$\tilde{r}_h = \begin{cases} \frac{\theta_\ell + c + \sqrt{\theta_\ell^2 + 2c\Delta - \theta_h^2}}{c + \theta_h} \theta_\ell^{-1} & \text{if} \quad c < \bar{c} = \theta_h \frac{\theta_h + \theta_\ell}{\Delta} \\ r_h^* & \text{if} \quad c \geq \bar{c} \end{cases} \tag{17}$$

$$\tilde{r}_\ell = r_\ell^*, \tag{18}$$

and the payoff schedule $\tilde{u}(\theta)$:

$$\tilde{u}_h = S(\tilde{r}_h, \theta_h) \tag{19}$$

$$\tilde{u}_\ell = S(r_\ell^*, \theta_\ell) \tag{20}$$

The competitive reporting schedule $\tilde{r}(\theta)$ is the one that induces the least costly separation across types and that satisfies the firms' zero-profit conditions. Incentive compatibility requires that this schedule is decreasing in θ. Contrary to the single-firm case, the competitive solution induces no downward distortion of the low-talent manager's report (and effort), but instead an *upward* distortion in the report (and effort) exerted by *high-talent* managers, θ_h.[11] Also, unlike in the single-firm case, the report distortion is independent of the distribution of talent. (The reason is that the firms' rents are reduced to zero in equilibrium, for both types.)

Notice, however, that when $c \geq \bar{c}$, the competitive distortion disappears and the competitive equilibrium is efficient. The reason is that a higher misreporting cost amplifies

[11] As we show in the Appendix, 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.

the talent difference across types, thus relaxing the incentive compatibility constraint that generates the distortion. As c increases, mimicking high talent becomes harder for the low-talent manager, and when c goes above $\bar{c}$, the distortion in $\tilde{r}_h$ is no longer needed to ensure separation of types.

The competitive equilibrium is represented in Figure 1. The thin solid upward-sloping lines represent the firm value that the manager produces, given a report r, if she is more talented (θ_h; red) or less talented (θ_ℓ; blue). The curved red and blue lines are indifference curves of the two types. They represent the payoffs earned in equilibrium: the low-talent manager's effort is undistorted, so in equilibrium the induced report is r_ℓ, where the low-talent manager's indifference curve is tangent to the line describing possible firm values she can produce. In the case of the high-talent manager, the equilibrium contract induces excessive reports and effort.

The straight dashed line is the average output from pooling both types when the probability of the high-talent type is $p_h = p^o$. It is computed as $\overline{q}(r, p^o) = p^o \frac{c}{c+\theta_h} r + (1 - p^o) \frac{c}{c+\theta_\ell} r$. The existence of an equilibrium requires $p_h \leq p^o$. If instead $p_h > p^o$, then the average output can lie to the northwest of the high-talent manager's indifference curve, and it would be profitable for a firm to deviate from the separating equilibrium and instead offer a pooling contract inducing r in the vicinity of where the dashed line is tangent to the high-talent manager's indifference curve (red). That would improve both types' payoffs while leaving a positive profit for the firm. However, if p_h is sufficiently low, such a deviation from the equilibrium separating contract is not profitable.

Naturally, $\tilde{r}_h$ decreases in θ_h and c, and it converges to the efficient level r_h^* 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.

Note that the manager's rent equals the surplus that she generates, leaving a zero profit for the firm. That is a consequence of the assumptions that several firms compete to hire one manager and that the firms do not have any information the manager does not have. A more realistic model would have included an "inside option" for the firms: They could hire an internal candidate whom they know well, so they can form an estimate of that candidate's talent as a CEO. Say, all firms have inside candidates with a fixed talent

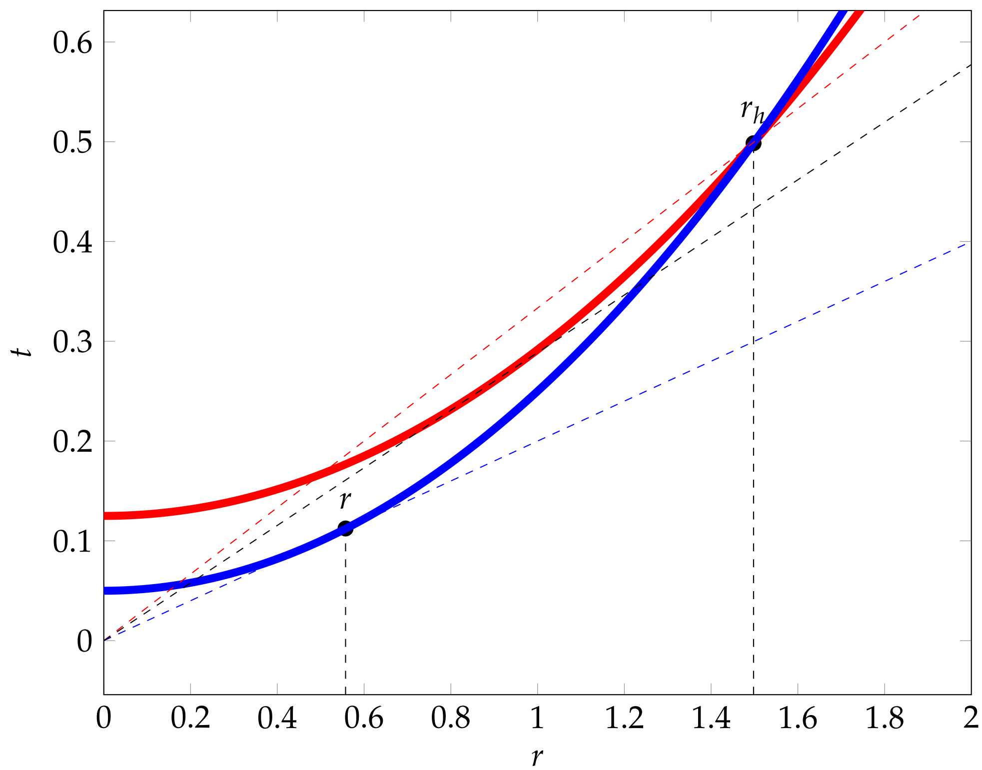

Figure 1: *The competitive equilibrium.*

τ_i. For small but positive values of τ_i, the firms will not compete away all rents, and the equilibrium contract will generate a profit for the firm equal to what the firm would earn if it hired the insider. Importantly, the structure of the contracts, i.e., the incentive power, does not change. As τ_i increases, the firms eventually prefer the insider to the low-talent manager, and they structure the contracts such that low-talent managers leave the market. As τ_i grows further, the same will happen to the high-talent manager. Hence, our assumption that the firms earn zero profits can easily be relaxed, without changing the results.

The manager's observed compensation in equilibrium can be written as

$$\tilde{w}(r) = E_\theta[q\left(\tilde{r}\left(\theta\right),\theta\right)|\tilde{r}\left(\theta\right) = r].$$

In other words, the manager's compensation equals the value of the firm, as assessed by investors who just received the manager's performance report. The equilibrium contract thus has the flavor of being linked to the firm's share price. Alternatively, if the report r represents earnings, then compensation can also be thought of as a bonus dependent on reported earnings. The two are equivalent since there is a monotonic relation between the performance report and the firm's value. This leads to the question of how the contract may be implemented in practice.

Given that the support of θ is discrete, there are multiple ways to implement the equilibrium allocation via a contract $\tilde{w}(\cdot){:}\mathbb{R} \to \mathbb{R}$. These contracts all share the feature that the manager reports either $\tilde{r}_h$ or $\tilde{r}_\ell$ and then receives total compensation of either $\tilde{t}_h$ or $\tilde{t}_\ell$. No other report-compensation pairs should be observed in equilibrium. Thus, we focus on these report-compensation pairs, which we call *observable compensation*, when analyzing the properties of equilibrium contracts under competition, and the outcomes they generate.

Definition 5 *Given a contract $w(\cdot)$ inducing an allocation $\{r(\theta), t(\theta)\}$, the* ***incentive power*** *of observable compensation is defined as*

$$\varphi(r) \equiv \begin{cases} \frac{t_\ell}{r_\ell} & \text{if} \quad r = r_\ell, \\ \frac{t_h - t_\ell}{r_h - r_\ell} & \text{if} \quad r = r_h. \end{cases}$$

Incentive power captures the equilibrium sensitivity of observable compensation with respect to reported performance. This definition allows us to compare the strength of incentives across regimes. Relying on this metric we can also consider the convexity of observable compensation by studying the relation between incentive power and reported performance. If incentive power increases in performance, then we say that observable compensation is convex.

Proposition 6 *(i) Observable compensation is convex in reported performance. (ii) Incentive power increases in the cost of misreporting c.*

The convexity of observable compensation means that in equilibrium, high-talent managers face greater incentive power than low-talent ones: The high-talent manager reports a higher performance, and the incremental observable compensation she receives for doing that has a higher slope (as a function of additionally reported performance) than that of a low-talent manager. Compensation must be less sensitive for lower reported performance levels, since the low-talent manager's incentive to misrepresent performance would otherwise be too strong (misreporting is relatively more attractive to her than to the high-talent manager, since her cost of effort θ_ℓ is higher; notice that the ratio $\frac{r(\theta)}{q(r(\theta),\theta)}$ increases in θ). On the other hand, compensation should be more sensitive to reported performance for the high-talent manager, who is more productive and thus more willing to use effort to generate performance. Given the convexity of the cost of misreporting, a sufficiently high performance level reported by the high-talent manager is unattractive to the low-talent manager, who will not mimick that report.

The above convexity result does not imply that the *specific* compensation schedule written into the contract is convex throughout. The actual contract may specify the compensation paid to a manager after performance reports that should not be observed in equilibrium, but as long as these promised payments do not violate the incentive constraints (for reporting $\tilde{r}_\ell$ or $\tilde{r}_h$ truthfully), they are inconsequential. While an econometrician may have access to some details of a CEO's theoretical compensation schedule, the important comparison is what compensation CEOs *realized*, given the performance they reported (performance that is reflected in the econometrician's data set).

That incentive power increases in c is intuitive: If the costs of misreporting increase, this makes reported performance a more useful measure to reward performance, so an optimal contract should make heavier use of it. A direct implication is that generally low incentive power (for both types) may be an optimal response to a low misreporting cost (Goldman and Slezak (2006) established a similar result in a single-firm setting).

We do not allow the cost of manipulation c to vary across firms. One could imagine that manipulation is easier at some firms and harder at others, maybe because some operations are opaque and others transparent, or because corporate governance is weaker in some firms than in others. If c varied (exogenously) across firms, then firms with higher values of c would be able to generate a larger surplus. That higher surplus would allow them to attract the more talented managers, leaving the less talented managers to the firms with lower values of c. Higher-c firms would exhibit higher incentive power and compensation levels, higher levels of manipulation, and (despite the compensation and manipulation) they would also be more valuable.[12] If the firms can increase the manipulation cost c at a cost, then competition for talent will drive up these investments in increasing c. As in Acharya and Volpin (2010), Dicks (2012), and Acharya et al. (2012), endogenizing c creates "governance externalities" between the firms, and a firm's equilibrium investment in increasing c creates a floor for other firms' choice of c (in those three papers, firms compete for talent by reducing corporate governance somewhat, trading off expected cash diversion against reduced monetary compensation).

4 The Effects of Competition

In this section, we analyze how competition for managerial talent affects the equilibrium contract and the outcome, compared with the single-firm setup. Both setups generate distortions in equilibrium, so neither of them generate efficient outcomes:

Proposition 7 *Competition induces excessive reports and output, while lack of competition induces inefficiently low reports and output. Formally,*

$$\tilde{r}\left(\theta\right) \geq r^{*}\left(\theta\right) \geq \hat{r}\left(\theta\right),$$
$$q\left(\tilde{r},\theta\right) \geq q\left(r^{*},\theta\right) \geq q\left(\hat{r},\theta\right).$$

Competition induces strictly higher effort from both types, compared with the single-firm setup. While the larger firm value that this generates may be attractive to the firm, the drawback is that the reports are increased, too. Increased reports are wasteful if there is more misreporting (i.e., if the reports increase by more than output does), and they affect the compensation that is realized. It is not immediately obvious whether there is more misreporting or less.

[12] This problem has a flavor similar to that in Laffont and Tirole (1987), suggesting that firms may first offer a menu of contracts to the managers, the managers then announce their preferences over those contracts, knowing that this influences how likely they are to be hired (note that there is only one firm in the Laffont and Tirole (1987) model).

Proposition 8 *Competition induces excessive misreporting. Formally,*

$$\tilde{b}(\theta) \geq b^{*}(\theta) \geq \hat{b}(\theta).$$

The misreporting escalation that occurs under competition is wasteful but unavoidable in equilibrium. A high-talent manager can credibly reveal her type only by reporting a sufficiently high performance, which low-talent managers prefer not to mimick because of the convex costs of both effort and misreporting. The report thus reveals information about the manager's type, and investors can then reverse-engineer the reported performance to infer the true value of the firm, $q(r, \theta)$. The investors are not deceived in equilibrium, but the misreporting is necessary to prevent investors from identifying a high-talent manager as low-talent, and treating her accordingly (as in a signal jamming model). The high-talent manager benefits from being able to separate from the low-talent manager, even at the cost of wasteful misreporting and inefficiently high effort.

In the single-firm setup, the firm focuses on *both* maximizing surplus and extracting rents from the manager. By reducing the effort and reporting levels, compared with the competitive outcome, it reduces surplus when dealing with a low-talent manager while it increases surplus when dealing with a high-talent manager. It can extract much of the high-talent manager's information rents by distorting the low-talent manager's outcome, and it can extract all rents from the low-talent manager.

Competition for talent changes the structure of the equilibrium contract:

Proposition 9 *Competition induces excessive incentive power. Formally, for all $i \in \{L, H\}$ we have*

$$\tilde{\varphi}(\tilde{r}_i) \geq \varphi^{*}(r_i^{*}) \geq \hat{\varphi}(r_i)$$

Competition boosts the incentive power of contracts beyond efficient levels. To understand this, suppose that under competition the firms offered the efficient contract. From Lemma 2, this contract must yield strictly positive profits to the firm hiring the high-talent manager. The rival firms would then have an incentive offer a contract that is more attractive to the high-talent manager, to poach her away and earn (most of) that profit. Raising the fixed part of the offered compensation would not be the best way to do that, since the low-talent manager would then also receive higher compensation, causing a loss to the firm if hired. As long as the firm makes a positive profit when hiring the high-talent manager, rival firms will try to poach her, leaving the firm to make a loss if she hires a low-talent manager. A better way to compete is to increase both the incentive power of the contract and the rents earned by a high-talent manager, such that incentive compatibility is preserved. This drives the incentive power beyond efficient levels, as much as necessary to ensure that the firm that hires a high-talent manager earns zero profits.

In essence, an inefficient outcome is unavoidable under competition: The firms compete to attract the high-talent manager, and in order to do that without incurring losses if they hire a low-talent manager, they must drive the incentive power beyond efficient levels (and beyond what they would offer in the single-firm setup).

The ability to misreport performance affects the structure of the equilibrium contract: if misreporting is more costly, the sensitivity of compensation to reported performance increases (intuitively, since reported performance is a better measure of true performance if misreporting is more costly). However, the effect on the *convexity* of observable compensation is not monotonic:

Proposition 10 *Under competition, the convexity of observable compensation is hill-shaped in c and vanishes as the cost of misreporting grows large ($c \to \infty$). In the single-firm setup, observable compensation remains convex in reported performance as c grows large.*

The convexity of observable compensation is thus driven by two features of the CEO labor market: The manager's ability to misreport her performance, and (if this is difficult or costly) a lack of competition for talent. Convexity makes it possible to incentivize effort from high-talent managers, without worrying about low-talent managers just claiming to have been successful (by severely misreporting performance). In the single-firm setup, convexity is a tool to extract rents from high-talent managers: The high-talent manager's effort level is efficient, while the low-talent manager's is distorted downward for incentive compatibility reasons. It is possible to implement the efficient outcome in the single-firm setup (see Lemma 2), but doing so would not maximize the firm's expected payoff, since the surplus gained from increasing the low-talent manager's effort does not make up for the high-talent manager's increased information rent. Thus, even if the costs of misreporting are unbounded, making effort contractible, the single-firm contract remains convex for rent-extraction reasons. In contrast, the competitive equilibrium contract loses its convexity and becomes linear when misreporting is prohibitevely costly:

What frictions are present in a model thus has a crucial effect on the equilibrium compensation contract. If the CEO has limited bargaining power, talent and effort are unobservable and misreporting is possible, we expect observable compensation to be convex; on the other hand, if misreporting is prohibitively costly and there is strong competition for talent, observable compensation should not be convex. Without any frictions, compensation should be convex in talent (see Rosen (1981)). This lack of robustness may explain the conflict between the calibration results and empirical findings in Dittmann and Maug (2007), whose calibrated principal-agent model (without misreporting) predicts less pay-performance convexity than they find in the data.

The two setups we analyzed lead to very different contracts and to different types of distortion: In the single-firm setup, the effort of a low-talent manager is distorted, while in the competitive setup, the effort of a high-talent manager is distorted; and the low-talent manager's effort is distorted *downward* in the single-firm setup, while the high-talent manager's effort is distorted *upward* in the competitive setup. So neither setup generates an efficient outcome. We now analyze to what degree "market forces" generate smaller efficiency losses than setups in which there is limited competition for talent.

Proposition 11 *(i) When the cost of misreporting c is relatively low, the competitive equilibrium is less efficient than the single-firm equilibrium:*

$$\mathbb{E}_{\theta} S(\tilde{r}(\theta), \theta) < \mathbb{E}_{\theta} S(\hat{r}(\theta), \theta).$$

ii) When $c \geq \overline{c}$, the competitive equilibrium is efficient:

$$\mathbb{E}_{\theta} S(\tilde{r}(\theta), \theta) - \mathbb{E}_{\theta} S(r^{*}(\theta), \theta) = 0.$$

If the cost of misreporting is sufficiently high, it is easy to separate the two types of manager in the competitive setup: there is no need to distort the induced effort levels for incentive compatibility reasons. Competition for talent then leads to an efficient outcome. That is not true for the single-firm setup: There, it remains optimal to distort the low-talent manager's effort even if misreporting becomes very costly. The difference is that the competitive setup creates distortions out of necessity, while in the single-firm setup the inefficiency serves to extract rents from the manager. Recall that the efficient outcome is feasible in the single-firm setup (see Lemma 2), but it would not maximize the firm's expected payoff, since the surplus gained from increasing the low-talent manager's effort does not make up for the high-talent manager's increased information rent. Thus, even if the costs of misreporting are unbounded, making effort contractible, the single-firm contract remains convex for rent-extraction reasons. In contrast, the competitive equilibrium contract loses its convexity and becomes linear when misreporting is prohibitevely costly: A simple linear contract ensures that both types exert the efficient effort levels, i.e., it maximizes the surplus for both types and allocates it to the manager.

With lower costs of misreporting, however, both setups create inefficiencies. As Proposition 11 shows, the distortion needed to preserve incentive compatibility in the competitive setup can be so significant that the efficiency loss exceeds that of the single-firm setup. Competition can thus be beneficial or value-destroying, depending on the circumstances.

The relative inefficiency of competition is particularly acute when the misreporting cost is low. The reason is that, as just explained, a lower cost of misrepresentation requires a stronger distortion of the more productive manager's effort in the competitive setup, while the distortion in the single-firm setup focuses on the less productive low-talent manager, who produces a smaller surplus, so distortions are relatively less important (which also explains why a distortion is optimal for any level of c). The single-firm distortion is driven by the firm's market power and its ability to write contracts that extract all of the manager's information rents.

The relative inefficiency of competition also depends on the distribution of talent. If $c < \bar{c}$ and the probability of high-talent managers is high, then an increase in that probability makes competition more inefficient, relative to the single-firm setting. The reason is that competition strongly distorts the behavior of high-talent managers, who are able to produce larger surpluses, whereas the single-firm setting merely distorts the behavior of low-talent managers.

In Proposition 9, we show that the incentive power of the equilibrium contract is increased by competition. Managers exert more effort and require compensation for that. Given the convexity of observed compensation, this can change the relative size of the compensation the managers receive. Specifically, if high-talent managers face much stronger incentives under competition, their observable compensation may increase by more than that of low-talent managers. In other words, inequality in pay may increase. The idea that competitive labor markets can lead to inequalities among workers of different talent can be found in, e.g., Lucas (1978), Rosen (1981). "Superstars" earn incomes that are much larger than those of their mere-mortal peers, whether it refers to scientists, sportsmen, or CEOs. 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 managerial rents, and then examine the dispersion of compensation.

Proposition 12 *(i) Competition increases the dispersion of CEO rents. Formally,*

$$\tilde{u}_h - \tilde{u}_\ell > u_h^* - u_\ell^* > \hat{u}_h - \hat{u}_\ell.$$

(ii) Competition may decrease the dispersion of CEO's total compensation.
(iii) Competition increases CEO compensation.

The increase in rent dispersion caused by competition does not per se imply that competition increases the dispersion of compensation because compensation can be decomposed as the sum of the manager's rent $\tilde{u}\left(\theta\right)$ and her personal costs $C(r\left(\theta\right),\theta)$, or:

$$\tilde{t}(\theta) = \tilde{u}(\theta) + C(\tilde{r}\left(\theta\right),\theta),$$

In fact, while competition increases the dispersion of rents it might reduce the dispersion of the managers' cost making the overall effect ambiguous. Figure 2 illustrate this possibility by comparing the dispersion of compensation under competition and single-firm setting.

This example reveals that when the cost of misreporting is high, competition reduces the dispersion of compensation because it actually reduces the gap between the reports

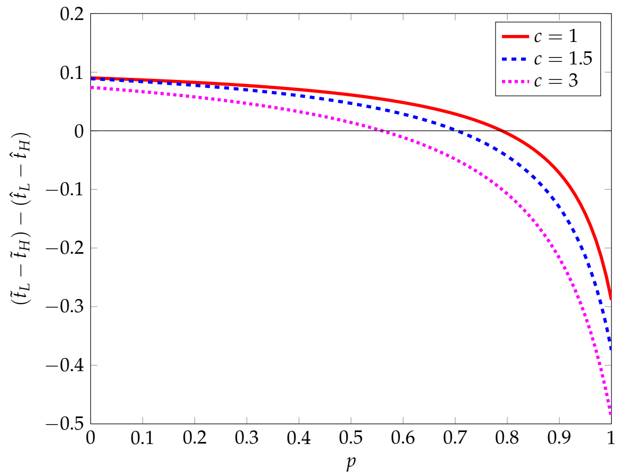

Figure 2: *Competition and the dispersion of compensation. Competition may decrease the dispersion of compensation, particularly when the cost of misreporting c is large.*

of low and high-talent managers relative to the single-firm setting.

5 Empirical Implications

There have been major changes in the area of executive compensation in the past few decades (see Hall and Liebman (1998); Frydman and Saks (2010); Frydman and Jenter (2010); Murphy (2013)). Since the mid to late 1970s, executive compensation has increased dramatically; it has become more strongly linked to firm value, with an increasing use of stock options; and income dispersion among executives has increased. However, since the early 2000s, these changes seem to have come to a halt.

The contracting environment in which firms and CEOs negotiate also changed. First, the competition for talent strengthened (see Murphy (2013); Murphy and Zabojnik (2004); Murphy and Zabojnik (2007); Faulkender and Yang (2013); Frydman and Jenter (2010)), with more firms trying to appoint a CEO from a limited pool of promising candidates. Consistent with this, firms increasingly appointed outsiders as CEOs, while until the late 1980s it was uncommon (insiders were normally promoted into the position; see Murphy and Zabojnik (2004); Murphy and Zabojnik (2007); Frydman and Jenter (2005); Murphy (2013)). One factor in this increase in competition was that "general" managerial skills that are transferable across firms gained in appreciation, while firm-specific or even industry-specific knowledge became relatively less important (see Frydman and Jenter (2005); Murphy and Zabojnik (2007); Fee and Hadlock (2003); Kaplan et al. (2012); Custódio et al. (2013); Falato et al. (2012)). CEOs increasingly had experience in a variety of industries and increasingly had MBAs, giving them general managerial skills. The pool of acceptable candidates was also limited because firms increasingly looked to appoint executives that had experience running other firms as CEOs (Frydman and Jenter (2005); Murphy and Zabojnik (2007)). And some candidates were regarded as "stars," particularly sought after by firms looking to appoint a "charismatic leader" as their CEO (see Khurana (2002)).

Adding to the increased competition for talent, it became easier to poach other firms' CEOs. Compensation consultants were increasingly used by boards of directors, making it easier and more acceptable to obtain information about compensation at other firms (in particular after disclosure requirements were enacted in 2006; see Bizjak et al. (2011); Faulkender and Yang (2013); Albuquerque et al. (2013)) and to contact a firm's CEO about a possible switch to another firm. At the same time, CEOs could form more precise forecasts about their possible compensation packages at other firms and use that information when negotiating a compensation package with their board.

Other important changes to the contracting environment happened around the turn of the century. A long stock market bull run ended, making stock and stock option compensation less rewarding; and it became harder to manipulate performance measures, in part due to the passing of the Sarbanes-Oxley Act (SOX) in 2002 (see Bergstresser and Philippon (2006), Cohen et al. (2008)).

This evidence is consistent with our results. Proposition 9 predicts that competition for talent generates excessive incentive power, stronger than in the absence of such competition. In other words, the model predicts that an increase in competition for talent strengthens the link between reported performance and compensation. Further, Proposition 12.(iii) predicts that compensation will generally be higher under competition for talent. Proposition 12 also predicts that competition increases the dispersion of CEO rents, and similarly for compensation, unless the proportion of high-talent managers is high and the cost of manipulation c is high. (Given how hard the problem of finding the "right"

CEO seems to be, it seems reasonable to assume that the proportion of "high talent" types is low for most firms.)

An explanation for the flattening of compensation since 2000 and the decreased use of options (and increased use of restricted stock) may be a general backlash after abuses of option compensation became known, coupled with many executives finding themselves with under-water options and decreasing or stagnating share prices. Given the soft economic conditions, it also became harder for executives to produce great performance.

Improved disclosure regulation has important effects, according to our model's predictions. As discussed in, say, Cohen et al. (2008), the Sarbanes-Oxley Act (SOX) passed in 2002 improved the quality of disclosure, even if executives adapted other decisions, for example by changing the real investments or pricing decisions made by their firms. In our model, the manager chooses both the effort level and the extent of manipulation, and if manipulation becomes more costly, the optimal response is to adapt both the report and the effort decision. But changes in c also affect the structure of the optimal contract. Importantly, Proposition 10 predicts that the convexity of the competitive contract is hill-shaped in c. Thus, if SOX (and general improvements in investor control) made manipulation *significantly* more costly after 2001, the model predicts that observable compensation should become less convex in reported performance (in the limit, compensation becomes linear). If, simultaneously, performance decreased generally since 2001, then we should expect less convex contracts producing lower levels of observable compensation.

The years leading up to 2000 also saw a surge in the intensity of earnings manipulation (see Bergstresser and Philippon (2006), Burns and Kedia (2006), or Peng and Röell (2008*a*)), particularly at firms whose CEOs had significant stock option holdings, and some of the largest accounting frauds ever witnessed in the U.S. (e.g., Enron, Tyco International, Adelphia, Peregrine Systems and WorldCom). That is consistent with a significant increase in competition for talent: Proposition 8 predicts excessive performance manipulation, and Proposition 9 predicts excessive incentive power for that setup. The two effects go hand in hand, and both are caused by competition for talent, even if the incentives that the optimal contract generates in that setting seem to "cause" the manipulation.

Our model also makes predictions that have not been tested. For example, Proposition 7 predicts that as competition for talent becomes significant, CEOs switch from exerting (on average) low effort to exerting (on average) excessively high effort. On average, managers thus become more effective or productive, both in terms of reported performance (r) and true performance (q). In particular, low-talent managers increase effort from an inefficiently low level to a higher, efficient level; and high-talent managers increase effort from their efficient level to an excessively high level. Effort provision increases across the board, but the *efficiency* of effort provision is asymmetric: low-talent managers improve their efficiency, while high-talent managers reduce theirs, by investing too much effort.

A more general model could include a manager's decision whether to participate in this market. We assumed that a manager's outside option yields a payoff of zero, so a nonnegative rent makes a manager participate. However, if the outside option has a positive value, then less talented managers may choose not to accept any contracts (if their productivity is sufficiently low, such that the extracted surplus is low). Under these assumptions, the competitive and the single-firm regime lead to very different outcomes. The single-firm regime distorts the low-talent manager's effort downwards, and thus also the surplus generated. Consequently, a low-talent manager may choose not to accept any contracts, even if she would be able to generate a positive surplus. In contrast, the competitive setup does not distort the low-talent manager's effort or surplus. The high-talent manager's effort is distorted upwards, and the surplus she produces is thereby reduced (see Proposition 11), but the surplus is larger in equilibrium than that produced by a low-talent manager.[13] So in the competitive setup, the participation decision is efficient. Importantly, if competition for talent becomes significant, the pool of managers who gets hired can worsen: Some firms hire low-talent managers that would have stayed out of the market if there was no competition for talent. Thus, even though managers face stronger incentives and work harder, the average manager is less talented, and the realized productivity may be reduced.

[13] That follows from the incentive constraint (13), recalling that $C(r, \theta)$ is increasing in θ and that $\theta_\ell > \theta_h$.

6 Regulation

Given the inefficiency of competitive contracts, it is natural to study the scope for regulation in this model. An immediate implication is that regulators should make misreporting as costly as possible:

Proposition 13 *The surplus generated by the managers increases in c, both in the single-firm setup and in the competitive setup.*

That making manipulation of reported performance more costly is beneficial is hardly surprising, and both legislators and regulators have long focused on making it as difficult and costly as possible (for example, with disclosure requirements, the standardization of accounting rules, required auditing, etc.).

More recently, attention has shifted to executive compensation: Besides the claim that many CEOs earn too much, legislators and regulators are looking at the incentive power created by contracts that reward performance (as perceived by investors), using bonuses, stock awards, options, etc. For example, in early 2009, certain financial institutions that required financial assistance from the U.S. Treasury had their CEOs' compensation (excluding restricted stock) capped at $500,000.[14] Soon afterwards, a "pay czar" was appointed to oversee executive compensation at those firms.[15] In March 2013, Swiss voters approved a law restricting executive compensation, limiting golden handshakes and golden parachutes and requiring binding shareholder "say on pay" votes.[16] A few weeks earlier, European regulators passed laws restricting bonuses paid to executives at certain financial firms, limiting them to no more than the executive's base salary (or twice that amount, with shareholder consent).[17]

Given the current interest in this type of regulation, we now ask whether regulation can restore efficiency, and if so, how. Regulation can indeed reduce or even eliminate the

[14] See "Obama Lays Out Limits on Executive Pay," *Wall Street Journal*, Feb. 5, 2009.

[15] See "Treasury to Set Executives' Pay at 7 Ailing Firms," *New York Times*, June 11, 2009.

[16] See "Swiss Voters Approve a Plan to Severely Limit Executive Compensation," *New York Times*, March 4, 2013.

[17] See "Cap and Flayed," *The Economist*, February 23, 2013; "Europe Caps Bank Bonuses," *New York Times*, March 24, 2013; and "Europe's Bonus Clampdown Hits Two-Thirds of Fund Managers," *Bloomberg Businessweek*, March 22, 2013. Banks seem to be busy raising base salaries, already: see "Salaries Lifted to Beat Bonus Cap," *Financial Times*, August 20, 2013.

inefficiencies created in the competitive setup.

Proposition 14 *Under competition, if* $c \in \left[\frac{\theta_h(2p_h\theta_\ell-\Delta)}{\Delta}, \overline{c}\right)$*, then efficiency can be restored by setting a compensation cap*

$$\overline{w} = \frac{1}{2}\frac{\theta_h^2+\theta_\ell^2}{\theta_\ell\left(c+\theta_\ell\right)\theta_h^2}c.$$

If $c < \frac{\theta_h(2p_h\theta_\ell-\Delta)}{\Delta}$*, then efficiency can be partly restored with a restriction on total compensation.*

A regulator can induce efficiency in the competitive setup, by restricting total compensation to be no greater than the compensation that the efficient contract would award to a high-talent manager. The compensation cap must limit total compensation, not just its variable component. One obvious problem with restrictions on the variable component is that a firm could bypass regulatory limits on variable compensation by changing the fixed component.[18] Additionally, if the regulation was defined as a cap on variable compensation (thus restricting the magnitude of $t_h - t_\ell$), then the existence of a competitive equilibrium would be compromised. To see this, suppose that the cap prevents firms from paying the high-talent manager her competitive compensation. Then the firms would earn profits on the high-talent manager and would thus face competitive pressure to increase the levels of compensation (t_ℓ), to compete away those profits. Raising the level of compensation would in fact allow a firm to significantly increase its chances of hiring the manager. But such an increase would not be sustainable, because low-talent managers would be overpaid, so that an alternative contract, attracting only the high-talent manager, would become available to competing firms.

In our model, the optimal cap is independent of performance. However, with more than two types, the optimal cap would be contingent on reported performance r. In particular, the compensation cap would increase in performance. This means that in general one size does not fit all, when efficiency is the regulator's main concern.

Notice that the cap entails a wealth transfer between the manager and the firms. In fact, when the cap is imposed, the firms earn abnormal profits. To avoid this wealth transfer, the regulation could be implemented as a progressive (payroll) tax, whose goal

[18] This is one important criticism of the European Union's recent legislation; see the articles cited in footnote 17. Variable compensation can be relabeled as fixed compensation by adding "clawback" provisions.

is to curb misreporting. The low performer would pay no tax, but the high performer would pay an amount equal to

$$\text{tax} = q(r_h^*, \theta_h) - \overline{w}.$$

Proposition 14 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 tools a regulator could consider in the real world, given the lack of information that regulators typically face. The regulation results may be hard to implement, and the specific results are not robust to changes in assumptions. For example, in the absence of competition for talent (in the single-firm setup), a beneficial dictator should induce higher effort from the low-talent manager, by *subsidizing* performance at low performance levels. Furthermore, our analysis ignores general equilibrium effects. If a cap is applied to a single industry (e.g., banking) 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. 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 talented managers of the regulated country would migrate to the unregulated country, simply because compensation levels would be higher in the unregulated country. The regulated country would thus suffer a talent drain.[19]

7 Extension: When c Is Unknown

In this section, we sketch the outcome of a model in which the unobservable characteristic of a CEO is her cost of manipulation instead of her talent. Assume that the manager's talent θ is known but the misreporting cost c is the manager's private information, where $c \in \{c_h, c_\ell\}$ with probability p_h and p_ℓ. In this context, c represents the manager's hidden

[19] See "Salaries Lifted to Beat Bonus Cap," *Financial Times*, August 20, 2013.

type as opposed to a characteristic of the firm. We refer c as the manager's integrity and we say that a manager with cost c_h has low integrity, and a manager with cost c_ℓ has high integrity.

The significance of this extension is that it reverses the implications of the previous analysis. In particular, the incentive power of competitive contracts is excessively low. As before we define functions

$$q(r,c) \equiv \frac{c}{c+\theta}r$$
$$C(r,c) \equiv \frac{1}{2}\frac{\theta c}{c+\theta}r^2$$

and

$$\Delta \equiv c_\ell - c_h.$$

Consider now the competitive equilibrium. The competitive equilibrium solves

$$\tilde{\mathcal{P}} : \max_{\mathbf{r},\mathbf{u}} u_\ell$$

subject to

$$u_h \geq S(\theta^{-1}, c_h) = \frac{c_h}{2\theta\left(c_h+\theta\right)} \tag{21}$$
$$u_\ell - u_h \geq C(r_h, c_h) - C(r_h, c_\ell) \tag{22}$$
$$u_h - u_\ell \geq C(r_\ell, c_\ell) - C(r_\ell, c_h) \tag{23}$$
$$u_h \leq S(r_h, c_h) \tag{24}$$
$$u_\ell \leq S(r_\ell, c_\ell). \tag{25}$$

Proposition 15 *The competitive reporting schedule $\tilde{r}(c)$ is given by*

$$\tilde{r}_h = \theta^{-1}$$
$$\tilde{r}_\ell = \frac{c_\ell\left(c_h+\theta\right) - \sqrt{\theta\Delta\left(2c_hc_\ell + \theta c_h + \theta c_\ell\right)}}{c_h\left(c_\ell+\theta\right)}\theta^{-1}.$$

So unlike the case were θ is unknown, here the competitive solution leads to under reporting as opposed to over reporting. The high integrity manager issues a report that is lower than the efficient report θ^{-1} but also ends up exerting less effort.[20] This suggests that competitive contracts suffer from too little power, particularly at low levels of reported performance. Unlike the case when θ is unknown, here the competitive contract is always inefficient regardless of the gap between managers' integrities Δ. The manager with low integrity get the most rents.

We now consider the single-firm setting.

Proposition 16 *The reporting schedule with a single firm $\hat{r}(\theta)$ is given by*

$$\hat{r}_h = \theta^{-1} \tag{26}$$

$$\hat{r}_\ell = \frac{c_\ell}{c_\ell + \frac{\pi\Delta}{c_h+\theta}}\theta^{-1} \tag{27}$$

Unlike the competitive solution, the single-firm solution distorts the report of the high-integrity manager c_ℓ. But much like competition, it distorts the report of the high-integrity manager c_ℓ downwards. In other words, the single-firm solution generates weak incentives, particularly for managers with high integrity. Unlike competition, the sign of the distortion in the provision of incentives is independent of the nature of the asymmetry of information, and whether it refers to talent or integrity.

8 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

[20] This is the outcome one would intuitively expect if the manager had to signal credibility to the market by means of his report.

(taken by Edmans et al. (2009), among others) is that these compensation contracts are determined in competitive labor markets, and that larger observable 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 that is higher and more strongly linked to reported 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 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 Proofs

A.1 Proof of Proposition 4

First note that (12) and (16) together imply that

$$\tilde{u}_\ell = S(r_\ell^*, \theta_\ell),$$

which in turn means that $\tilde{r}_H = r_\ell^*$, otherwise either the firms would make a loss on type θ_ℓ or a strictly profitable contract, targeting θ_ℓ, would be available. We now establish that only the incentive compatibility constraint of θ_ℓ, as given by equation (14), binds in equilibrium. Suppose, on the contrary, that (13) is the binding IC constraint. Then

$$u_h - S(r_\ell^*, \theta_\ell) = C(r_\ell^*, \theta_\ell) - C(r_\ell^*, \theta_h).$$

This implies that

$$u_h = q(r_\ell^*, \theta_\ell) - C(r_\ell^*, \theta_h).$$

But since

$$q(r_\ell^*, \theta_\ell) - C(r_\ell^*, \theta_h) < S(r_\ell^*, \theta_h),$$

this means that the firms are making strictly positive profits on θ_h, which violates the zero profit condition. Also, by adding the two IC constraints, one can see that both constraints cannot bind simultaenously, hence only (14) may bind in equilibrium. It is not difficult to verify that (13) evaluated at $\{r_h^*, r_\ell^*\}$ binds if and only if $c \leq \bar{c}$. Naturally, when (14) binds the value of $\tilde{r}_h$ must be given by

$$S(r_\ell^*, \theta_\ell) - u_h = C(r_h, \theta_h) - C(r_h, \theta_\ell),$$

which, by the zero profit condition, implies

$$S(r_\ell^*, \theta_\ell) - [q(r_h, \theta_h) - C(r_h, \theta_h)] = C(r_h, \theta_h) - C(r_h, \theta_\ell).$$

The solution to this equation is

$$\tilde{r}_h = \frac{\theta_\ell + c + \sqrt{\theta_\ell^2 + 2c\Delta - \theta_h^2}}{c + \theta_h}\theta_\ell^{-1}.$$

By contrast, when (13) evaluated at $\{r_h^*, r_\ell^*\}$ does not bind, the optimal $\tilde{r}_h$ is the efficient one, namely $\tilde{r}_h = r_h^*$. Finally, it is not difficult to verify that

$$S\left(r_\ell^*, \theta_\ell\right) - S\left(r_h^*, \theta_h\right) - \left[C(r_h^*, \theta_h) - C(r_h^*, \theta_\ell)\right] \geq 0$$

if and only if $c \geq \bar{c}$. This establishes that the constraint (14) will bind iff $c < \bar{c}$. ■

A.2 Existence of Equilibrium

To prove the existence of the competitive equilibrium we need to rule out the existence of a pooling contract $\left\{t^d, r^d\right\}$ generating positive profits to the principal who deviates from the equilibrium separating contract. First, note that a pooling contract inducing a report r generates expected output

$$\overline{q}\left(r, p_h\right) = \left[\frac{p_h}{c + \theta_h} + \frac{p_\ell}{c + \theta_\ell}\right] cr.$$

A deviation to this contract is profitable if $t^d \leq \overline{q}\left(r^d, p_h\right)$. Below we look for the value of p_h such that the indifference curve of θ_h in equilibrium is exactly tangent to $\overline{q}\left(r, p_h\right)$. If p_h is below that value, then no contract can attract θ_h.

Figure 1 in the text shows how this cut-off value for p_h is derived. The solid red and blue lines represent the outcome produced by high and low-talent managers. The dashed line, in between, is the average output from pooling both types when the probability of $p_h = p^o$. It is computed as $\overline{q}(r, p^o) = [p^o \frac{c}{c+\theta_h} + (1 - p^o)\frac{c}{c+\theta_\ell}]r$. The existence of an equilibrium requires $p_h < p^o$, since in that case $\overline{q}(r, p_h)$ would lie strictly below the indifference curve of θ_h, hence a pooling contract could never be profitable, given the equilibrium contract.

Consider the indifference curve of θ_h (in the t, r space) evaluated at the equilibrium payoff $\tilde{u}_h$ (see equation (19)):

$$t = \tilde{u}_h + C(r, \theta_h).$$

This indifference curve is tangent to $\overline{q}\,(r, p_h)$ at $r = r^o$ defined by

$$\frac{\theta_h r^o}{c + \theta_h} = \frac{p_h}{c + \theta_h} + \frac{p_\ell}{c + \theta_\ell}$$

or

$$r^o = \frac{p_h \Delta + c + \theta_h}{(\theta_\ell + c)\,\theta_h}$$

At that point, the average outcome is

$$\overline{q}(r^o, p_h) = \frac{c\,(p_h \Delta + c + \theta_h)^2}{(c + \theta_h)\,(\theta_\ell + c)^2\,\theta_h}$$

Hence for any $p < p^o$ there is no profitable pooling equilibrium, where p^o is defined by

$$\overline{q}(r^o, p^o) = \tilde{u}_h + C(r^o, \theta_h).$$

or

$$p^o = \frac{(\theta_\ell + c)\sqrt{\frac{2\tilde{u}_h}{c}\,(c + \theta_h)\,\theta_h} - (c + \theta_h)}{\Delta}, \tag{28}$$

where $\tilde{u}_h = S(\tilde{r}_h, \theta_h)$, and

$$\tilde{r}_h = \begin{cases} \frac{\theta_\ell + c + \sqrt{\theta_\ell^2 + 2c\Delta - \theta_h^2}}{c + \theta_h}\theta_\ell^{-1} & \text{if} \quad c < \overline{c} = \theta_h \frac{\theta_h + \theta_\ell}{\Delta} \\ r_h^* & \text{if} \quad c \geq \overline{c} \end{cases}$$

(see Proposition 4).

A.3 Proof of Proposition 6

Consider first incentive power under competition. When $c \geq \bar{c}$, the incentive power of competitive contracts is given by

$$\tilde{\varphi}(r) \equiv \begin{cases} \frac{c}{c+\theta_\ell} & \text{if} \quad r = \tilde{r}_\ell \\ \frac{c}{c+\theta_h}\left[\frac{\theta_h}{c+\theta_\ell}+1\right] & \text{if} \quad r = \tilde{r}_h \end{cases} \tag{29}$$

which is clearly increasing in r and convex, so we focus on the case $c < \bar{c}$.

When $c < \bar{c}$, the incentive power of competitive contracts is given by

$$\tilde{\varphi}(r) \equiv \begin{cases} \frac{c}{c+\theta_\ell} & \text{if} \quad r = \tilde{r}_\ell \\ \frac{c}{c+\theta_h}\left(1+\frac{\frac{c+\theta_h}{c+\theta_\ell}\Delta}{\Delta+\sqrt{\theta_\ell^2+2c\Delta-\theta_h^2}}\right) & \text{if} \quad r = \tilde{r}_h \end{cases} \tag{30}$$

It is easy to verify that $\tilde{\varphi}(\tilde{r}_h) > \tilde{\varphi}(\tilde{r}_\ell)$. We next show that incentive power increases in c. This is immediate for $\tilde{\varphi}(r_\ell)$. Consider $\tilde{\varphi}(\tilde{r}_h)$. First note that

$$\tilde{\varphi}(\tilde{r}_h)\big|_{c=0} = 0$$

and

$$\tilde{\varphi}(\tilde{r}_h)\big|_{c=\bar{c}} = \frac{1}{2}\frac{(\theta_h+\theta_\ell)^2}{\theta_h^2+\theta_\ell^2}$$

Also note that

$$\left.\frac{\partial}{\partial c}\tilde{\varphi}(r_h)\right|_{c=\bar{c}} = \frac{1}{4\theta_h}\frac{\left(\theta_\ell^2+2\theta_\ell\theta_h-\theta_h^2\right)(\theta_\ell-\theta_h)^2}{\left(\theta_h^2+\theta_\ell^2\right)^2} > 0$$

$$\left.\frac{\partial}{\partial c}\tilde{\varphi}(r_h)\right|_{c=0} > 0.$$

We now show that $\frac{\partial}{\partial c}\tilde{\varphi}(\tilde{r}_h) > 0 \; \forall c \in [0,\bar{c}]$. The proof is by contradiction. Suppose there exists a a subset of $[0,\bar{c}]$ such that $\tilde{\varphi}(\tilde{r}_h)$ is decreasing in c over that subset. Then the equation

$$\frac{\partial}{\partial c}\tilde{\varphi}(\tilde{r}_h) = 0 \tag{31}$$

must have an even number of roots in $(0, \bar{c})$ (because $\tilde{\varphi}(\tilde{r}_h)$ increases in c at both ends of the interval $[0, \bar{c}]$. We will show that (31) can have at most one solution for c in $[0, \bar{c}]$.

The solution to (31) is given by

$$c = \frac{1}{2}\frac{y^2 - \theta_\ell^2 + \theta_h^2}{\Delta},$$

where y solves the equation $\Gamma(y) = 0$ and

$$\Gamma(y) \equiv y^4 - 4\theta_\ell y^3 + 2(2\theta_\ell - \theta_h)\Delta y^2 - (\theta_\ell + \theta_h)\Delta^3. \tag{32}$$

This follows from

$$\begin{aligned}\left.\frac{\partial}{\partial c}\tilde{\varphi}(\tilde{r}_h)\right|_{c=\frac{1}{2}\frac{y^2-\theta_\ell^2+\theta_h^2}{\Delta}} &= \left.\frac{\partial}{\partial c}\left(\frac{c}{c+\theta_h}\left(1+\frac{\frac{c+\theta_h}{c+\theta_\ell}\Delta}{\Delta+\sqrt{\theta_\ell^2+2c\Delta-\theta_h^2}}\right)\right)\right|_{c=\frac{1}{2}\frac{y^2-\theta_\ell^2+\theta_h^2}{\Delta}} \\ &= \frac{-\Delta^2\Gamma(y)}{y\left(y^2+\Delta^2\right)^2(\Delta-y)^2},\end{aligned}$$

which equals zero (as required for (31)) if $\Gamma(y) = 0$.

We now show that the equation $\Gamma(y) = 0$ has only one admissible solution in y, namely a y such that $c = \frac{1}{2}\frac{y^2-\theta_\ell^2+\theta_h^2}{\Delta}$ belongs to $[0, \bar{c}]$. If so, then we must have $\frac{\partial}{\partial c}\tilde{\varphi}(\tilde{r}_h) > 0$ $\forall c \in [0, \bar{c}]$.

By Descartes' rule of signs, the equation $\Gamma(y) = 0$ has only one negative solution, which we denote by y_1. Evaluate $\Gamma(y)$ at $y = -\sqrt{\theta_\ell^2 - \theta_h^2}$ (such that $c = \frac{1}{2}\frac{y^2-\theta_\ell^2+\theta_h^2}{\Delta} = 0$):

$$\left.\Gamma(y)\right|_{y=-\sqrt{\theta_\ell^2-\theta_h^2}} \propto \Delta^2(\theta_\ell + \theta_h) + \Delta^{\frac{3}{2}}(\theta_\ell + \theta_h)^{\frac{3}{2}},$$

which is positive. Thus,

$$-\sqrt{\theta_\ell^2 - \theta_h^2} < y_1 < 0,$$

and y_1 is not admissible, since $c = \frac{1}{2}\frac{y_1^2-\theta_\ell^2+\theta_h^2}{\Delta} < 0$.

Now we show that the equation $\Gamma(y) = 0$ has only one positive solution for y. Consider the critical points of $\Gamma(y)$. The equation

$$\frac{\partial \Gamma(y)}{\partial y} = 0$$

has three solutions in y, all of which are non-negative and can be ordered as follows:

$$\begin{aligned} y &= 0 \\ y &= \frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2} \\ y &= \frac{3}{2}\theta_\ell + \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2} \end{aligned}$$

(Note that $\frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2} > \frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 8\theta_h^2} > \frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2} > \theta_\ell > 0$.)

Furthermore,

$$\begin{aligned} \Gamma''(y)\big|_{y=0} &= 8\theta_\ell^2 + 4\theta_h^2 - 12\theta_\ell\theta_h \\ &> 12\theta_\ell^2 - 12\theta_\ell\theta_h \\ &> 0 \end{aligned}$$

Hence, at $y = 0$ we have a local minimum, therefore at

$$y = \frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}$$

we must either have a local maximum, or an inflexion point. But it cannot be an inflexion point, or else at

$$y = \frac{3}{2}\theta_\ell + \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}$$

we should have a maximum, but we know that $\Gamma(y)$ explodes as $y \to \infty$.

Next, we show that

$$\Gamma(y)\big|_{y=\frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}} < 0.$$

To see this, notice that

$$\Gamma(y)\big|_{y=\frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}} = \frac{8\theta_h^3 - \theta_\ell^3 - 26\theta_\ell^2\theta_h - 8\theta_\ell\theta_h^2 - \sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}\left(4\theta_h^2 - \theta_\ell^2 - 12\theta_\ell\theta_h\right)}{2\theta_\ell^{-1}}.$$

We want to show that the right-hand side of the above equation is negative. So consider the equation

$$8\theta_h^3 - \theta_\ell^3 - 26\theta_\ell^2\theta_h - 8\theta_\ell\theta_h^2 - \sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}\left(4\theta_h^2 - \theta_\ell^2 - 12\theta_\ell\theta_h\right) = 0$$

This equation has the following solutions in θ_h:

$$\begin{aligned}
\theta_h &= \frac{1}{2}\left(\frac{5}{2} - \frac{3}{2}\sqrt{3}\right)\theta_\ell \\
\theta_h &= 0 \\
\theta_h &= \theta_\ell \\
\theta_h &= \frac{1}{2}\left(\frac{5}{2} + \frac{3}{2}\sqrt{3}\right)\theta_\ell
\end{aligned}$$

We are interested in the sign of

$$8\theta_h^3 - \theta_\ell^3 - 26\theta_\ell^2\theta_h - 8\theta_\ell\theta_h^2 - \sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}\left(4\theta_h^2 - \theta_\ell^2 - 12\theta_\ell\theta_h\right)$$

when $\theta_h \in [0, \theta_\ell]$.

So consider

$$\left.\frac{\partial\left[8\theta_h^3 - \theta_\ell^3 - 26\theta_\ell^2\theta_h - 8\theta_\ell\theta_h^2 - \sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}\left(4\theta_h^2 - \theta_\ell^2 - 12\theta_\ell\theta_h\right)\right]}{\partial\theta_h}\right|_{\theta_h = 0} = -8\theta_\ell^2 < 0$$

This demostrates that

$$\left.\Gamma\left(y\right)\right|_{y = \frac{3}{2}\theta_\ell - \frac{1}{2}\sqrt{\theta_\ell^2 + 12\theta_\ell\theta_h - 4\theta_h^2}} < 0$$

for $\theta_h \in [0, \theta_\ell]$. In turn, this implies that equation $\Gamma\left(y\right) = 0$ has only one positive solution for y. ■

A.4 Proof of Proposition 7

It is easy to verify that $\hat{r}_\ell < r^*_\ell = \tilde{r}_\ell$, and that if $c < \bar{c}$, then $\hat{r}_h = r^*_h < \tilde{r}_h$, while if $c \geq \bar{c}$, then $\hat{r}_h = r^*_h = \tilde{r}_h$. Using the definition of $q(r,\theta)$ in (1), these inequalities readily imply that $q(\tilde{r},\theta) \geq q(r^*,\theta) \geq q(\hat{r},\theta)$ for all $\theta \in \{\theta_h, \theta_\ell\}$. ■

A.5 Proof of Proposition 8

From the definition of $b(r,\theta)$ (see (3)),

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

So the ranking of misreporting across regimes is determined by the ranking of reports $r(\theta)$. From Prop. (7), this implies that $\tilde{b}(\theta) \geq b^*(\theta) \geq \hat{b}(\theta)$. ■

A.6 Proof of Proposition 9

Incentive power at $r = r_h$ can be written as

$$\frac{t_h - t_\ell}{r_h - r_\ell} = \frac{u_h - u_\ell + C(r_h,\theta_h) - C(r_\ell,\theta_\ell)}{r_h - r_\ell}$$

When the incentive compatibility constraint of θ_ℓ is binding (as under competition and efficiency) incentive power boils down to

$$\begin{aligned}\frac{t_h - t_\ell}{r_h - r_\ell} &= \frac{C(r_h,\theta_\ell) - C(r_h,\theta_h) + C(r_h,\theta_h) - C(r_\ell,\theta_\ell)}{r_h - r_\ell} \\ &= \frac{C(r_h,\theta_\ell) - C(r_\ell,\theta_\ell)}{r_h - r_\ell} \\ &= \frac{1}{2}(r_\ell + r_h)\frac{\theta_\ell c}{\theta_\ell + c}\end{aligned}$$

This is increasing in r_h and r_ℓ. Since $\tilde{r}_h \geq r^*_h$ we get that $\tilde{\varphi}(\tilde{r}_h) \geq \varphi^*(r^*_h)$.

In the single-firm setting, the incentive compatibility constraint of θ_h binds, hence

$$\begin{aligned}\hat{\varphi}\left(\hat{r}_h\right) &= \frac{C(\hat{r}_\ell,\theta_\ell) - C(\hat{r}_\ell,\theta_h) + C(\hat{r}_h,\theta_h) - C(\hat{r}_\ell,\theta_\ell)}{\hat{r}_h - \hat{r}_\ell} \\ &= \frac{C(\hat{r}_h,\theta_h) - C(\hat{r}_\ell,\theta_h)}{\hat{r}_h - \hat{r}_\ell} \\ &= \frac{1}{2}\left(\hat{r}_\ell + \hat{r}_h\right)\frac{\theta_h c}{c+\theta_h} \\ &< \frac{1}{2}\left(\tilde{r}_\ell + \tilde{r}_h\right)\frac{\theta_\ell c}{c+\theta_\ell}\end{aligned}$$

(the inequality follows because $\tilde{r}_\ell > \hat{r}_\ell$, $\tilde{r}_h > \hat{r}_h$, and $\frac{\theta c}{c+\theta}$ is increasing in θ). ■

A.7 Proof of Proposition 10

Using (29) and (30), $\lim_{c\to 0}\tilde{\varphi}\left(\tilde{r}_\ell\right) = \lim_{c\to 0}\tilde{\varphi}\left(\tilde{r}_h\right) = 0$ and $\lim_{c\to\infty}\tilde{\varphi}\left(\tilde{r}_\ell\right) = \lim_{c\to\infty}\tilde{\varphi}\left(\tilde{r}_h\right) = 1$. For intermediate values of c, $\tilde{\varphi}\left(\tilde{r}_\ell\right) < \tilde{\varphi}\left(\tilde{r}_h\right)$.

Incentive power in the single-firm case is given by

$$\widehat{\varphi}\left(r\right) \equiv \begin{cases} \frac{1}{2}\frac{\theta_\ell c}{\theta_\ell + c}\frac{1}{\theta_\ell + \frac{c\pi(\theta_\ell-\theta_h)}{c+\theta_h}} & \text{if} \quad r = \widehat{r}_\ell \\ \frac{1}{2}\frac{\theta_h c}{\theta_h + c}\left(\frac{1}{\theta_h} + \frac{1}{\theta_\ell + \frac{c\pi(\theta_\ell-\theta_h)}{c+\theta_h}}\right) & \text{if} \quad r = \widehat{r}_h, \end{cases} \tag{33}$$

and it is easily verified that $\lim_{c\to 0}\widehat{\varphi}\left(\widehat{r}_\ell\right) = \lim_{c\to 0}\widehat{\varphi}\left(\widehat{r}_h\right) = 0$ and that $\widehat{\varphi}\left(r\right)$ is increasing and convex, for any $c > 0$. ■

A.8 Proof of Proposition 11

We show that competition is less efficient than the single-firm setup if $c \in [0, c^\dagger)$ for some $c^\dagger < \bar{c}$. Compare the efficiency loss in the two setups, as a function of c:

$$\Phi(c) \triangleq \underbrace{p_\ell\left(S(\theta_\ell^{-1},\theta_\ell) - S(\hat{r}_\ell,\theta_\ell)\right)}_{\text{efficiency loss, single-firm setup}} - \underbrace{p_h\left(S(\theta_h^{-1},\theta_h) - S(\tilde{r}_h,\theta_h)\right)}_{\text{efficiency loss, competition}}$$

One can easily verify that

$$\left.\frac{\partial\Phi(c)}{\partial c}\right|_{c=0} < 0.$$

Also, since $\Phi(0) = 0$, we know that $\Phi(c)$ is negative when c is in the vicinity of 0. Furthermore since $\Phi(\bar{c}) > 0$, then there must be a $c^{\dagger}$, with $c^{\dagger} < \bar{c}$, such that for all $c \in [0, c^{\dagger}]$ competition is less efficient than the single-firm setup. Similarly, assume that $c < \bar{c}$. Define the relative efficiency of competition by

$$\Psi(p) \triangleq (1-p)\left(S(\theta_\ell^{-1}, \theta_\ell) - S(\hat{r}_\ell, \theta_\ell)\right) - p\left(S(\theta_h^{-1}, \theta_h) - S(\tilde{r}_h, \theta_h)\right).$$

One can easily verify that $\Psi\left(p\right)$ is negative when p is close to 1 and that $\Psi\left(0\right) = 0$. Also $\lim_{p\to 0} \Psi'\left(p\right) < 0$. In fact,

$$\lim_{p\to 0} \Psi'\left(p\right) \propto -\left[\theta_h^2\theta_\ell + \theta_\ell c^2 + 2\theta_h^2 c - c^2\theta_h + \theta_h^3 - 2\theta_h\sqrt{\Delta\left(\theta_\ell + 2c + \theta_h\right)c}\right]$$

which is negative for $c \in \left(-\theta_H, \bar{c}\right)$. Hence $\Psi\left(p\right)$ must be negative when p is close to zero. Also, notice that $\Psi''\left(p\right) = 0$ only at

$$p = \frac{\theta_\ell}{2\frac{c(\theta_\ell - \theta_h)}{c+\theta_h} + \theta_\ell} \in (0,1)$$

This means that the function $\Psi\left(p\right)$ can cross zero at most twice in $(0,1)$. This in turn implies that $\Psi\left(p\right)$ can be positive only in an interval in the interior of $[0,1]$. One could also show that $\Psi\left(p\right)$ is negative all over $[0,1]$ when c is sufficiently low. Naturally, when $c \geq 0$, it must be the case $\Psi\left(p\right) \geq 0$. ■

A.9 Proof of Proposition 12

For part (i) it suffices to note that

$$\tilde{u}_h - \tilde{u}_\ell = C(\tilde{r}_h, \theta_\ell) - C(\tilde{r}_h, \theta_h)$$
$$u_h^* - u_\ell^* = C(r_h^*, \theta_\ell) - C(r_h^*, \theta_h),$$

hence, since $\tilde{r}_h > r_h^*$ and since $C(r,\theta_\ell) - C(r,\theta_h)$ increases in r, it follows that $\tilde{u}_h - \tilde{u}_\ell > u_h^* - u_\ell^*$. Similarly, from the solution to the single-firm problem we know that

$$\hat{u}_h - \hat{u}_\ell = C(r_\ell^*, \theta_\ell) - C(r_\ell^*, \theta_h).$$

Since $r_H^* < r_h^*$, this implies that

$$u_h^* - u_\ell^* > \hat{u}_h - \hat{u}_\ell.$$

Part (ii) can be illustrated with two examples. Assume $c = 1$, and $\theta_h = 1$ and $\theta_\ell = 1.5$. Then $(\tilde{t}_h - \tilde{t}_l) - (\hat{t}_h - \hat{t}_l)$ is equal to 0.0193 when $p_h = .25$ and -0.00413 when $p_h = 0.7$ (for these parameters $p_h^o = 0.714$).

For part (iii), recall that the low-talent manager earns a positive rent under competition, higher than the zero rent in the single-firm case; and under competition, she reports a higher performance r_ℓ (see Proposition 7), so her disutility $C(r,\theta)$ from choosing r and q is higher. This implies that the compensation $t_\ell = U_\ell + C_\ell$ is higher under competition. Next, from part (i) of this Proposition, the rent dispersion is higher under competition, i.e., $U_h - U_\ell$ is higher; since U_ℓ is higher, so must be U_h. And since r_h is higher under competition, it follows that $t_h = U_h + C_h$ is higher under competition. ■

A.10 Proof of Proposition 13

In the single-firm setup, the result follows from analyzing how changes in c affect $S(\hat{r}_h, \theta_h)$ and $S(\hat{r}_\ell, \theta_\ell)$,

$$\begin{aligned} S(\hat{r}_h, \theta_h) &= \frac{c}{2\theta_h(\theta_h + c)} \\ S(\hat{r}_\ell, \theta_\ell) &= \frac{c}{(c+\theta_\ell)\left(\theta_\ell + \frac{ch(\theta_\ell - \theta_h)}{c+\theta_h}\right)} - \frac{\theta_\ell c}{2\left(\theta_\ell + c\left(\theta_\ell + \frac{ch(\theta_\ell-\theta_h)}{c+\theta_h}\right)^2\right)}. \end{aligned}$$

In the competitive setup, a similar analysis of $S(\tilde{r}_\ell, \theta_\ell)$ and $S(\tilde{r}_h, \theta_h)$ (for the case $c \geq \bar{c}$) quickly yields the result; when $c < \bar{c}$, the result for $S(\tilde{r}_h, \theta_h)$ follows from analyzing the channels through which changes in c affect the surplus,

$$S(q(r(c)), r(c), c) = q(r(c), c) - C(r(c), c).$$

The total derivative with respect to c is

$$\frac{dS}{dc} = \left(\frac{\partial q(r(c), c)}{\partial r(c)} - \frac{\partial C(r(c), c)}{\partial r(c)}\right)\frac{\partial r(c)}{\partial c} + \frac{\partial q(r(c), c)}{\partial c} - \frac{\partial C(r(c), c)}{\partial c} \tag{34}$$

Using (1) and (2), the first term in parentheses can be rewritten as

$$\frac{\partial q(r(c), c)}{\partial r(c)} - \frac{\partial C(r(c), c)}{\partial r(c)} = \frac{\partial}{\partial r}\left(\frac{c}{c+\theta_h} r - \frac{1}{2}\frac{\theta_h c}{\theta_h + c} r^2\right) = \frac{c\,(1 - r\theta_h)}{c + \theta_h}.$$

Since $\tilde{r}_h > \frac{1}{\theta_h}$, that term is negative. Using (17),

$$\begin{aligned}\frac{\partial r(c)}{\partial c} &= \frac{\partial}{\partial c}\frac{\theta_\ell + c + \sqrt{\theta_\ell^2 + 2c\,(\theta_\ell - \theta_h) - \theta_h^2}}{\theta_h + c}\frac{1}{\theta_\ell} \\ &= -\frac{(\theta_\ell - \theta_h)\left((\theta_\ell + c) + \sqrt{\theta_\ell^2 + 2c\,(\theta_\ell - \theta_h) - \theta_h^2}\right)}{(c+\theta_h)^2\sqrt{\theta_\ell^2 + 2c\,(\theta_\ell - \theta_h) - \theta_h^2}}\frac{1}{\theta_\ell},\end{aligned}$$

which is also negative. So the first summand in (34) is positive.

The second and third summands in (34) can be rewritten (again using (1) and (2)) as

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

That term has the same sign as $2 - r\theta_h$, which is positive if, replacing $r = \tilde{r}_h$ using (17),

$$\begin{aligned}\frac{\theta_\ell + c + \sqrt{\theta_\ell^2 + 2c\Delta - \theta_h^2}}{c + \theta_h}\frac{1}{\theta_\ell}\theta_h &< 2 \\ \frac{\sqrt{\theta_\ell^2 + 2c\Delta - \theta_h^2}}{c + \theta_h} - \frac{\theta_\ell}{\theta_h} &< c\frac{\theta_\ell - \theta_h}{\theta_h\,(c + \theta_h)}.\end{aligned}$$

The right-hand side is positive, so it is sufficient to show that the left-hand side is negative, or

$$\frac{\sqrt{\theta_\ell^2 + 2c\left(\theta_\ell - \theta_h\right) - \theta_h^2}}{\theta_h + c} < \frac{\theta_\ell}{\theta_h}.$$

The left-hand side is decreasing in c, so the condition is satisfied if it is satisfied for the smallest value of c in $[0, \bar{c}]$, i.e., $c = 0$. That is the case, so we have $2 - r\theta_h > 0$, and thus the sum of the second and third summands in (34) is positive. Consequently, (34) is positive, i.e., $S(\tilde{r}_h, \theta_h)$ is increasing in c if $c < \bar{c}$. ■

A.11 Proof of Proposition 14

Given the compensation cap $\overline{w}$, a competitive contract must satisfy

$$\max_{\{r_h, r_\ell\}} u_h$$

subject to:

$$u_\ell = S(r_\ell^*, \theta_\ell) = \frac{1}{2\theta_\ell(c + \theta_\ell)}. \tag{35}$$

$$u_\ell - u_h \geq C(r_h, \theta_h) - C(r_h, \theta_\ell) \tag{36}$$

$$u_\ell \leq q(r_\ell, \theta_h) - C(r_\ell, \theta_\ell) \tag{37}$$

$$u_h \leq \overline{w} - C(r_h, \theta_h) \tag{38}$$

The restricted contract maximizes the utility of the high-talent manager subject to four constraints. Equation (35) requires that the low-talent manager must obtain the whole surplus produced by her symmetric information contract, otherwise a firm could make strictly positive profits from offering such a contract. Equation (36) requires that the contract be incentive compatible for the low-talent manager. Obviously, the incentive compatibility constraint of θ_h will not bind when the cap is set appropriately, so we have removed it for simplicity. Equation (37) requires that the firm does not make a loss on θ_ℓ.

As before, if the firm made a loss when hiring type θ_ℓ, it could profitably deviate by dropping the (portion of the) contract aimed at θ_ℓ. Finally, equation (38) requires that the compensation of θ_h be no higher than the cap $\overline{w}$. First note that (35) and (37) taken together imply that $\tilde{r}_\ell = \theta_\ell^{-1}$. Second, the compensation constraint (38) must bind for the high-talent manager. Now, the incentive compatibility constraint (36) must also bind. Since $\tilde{r}_h < r_h^*$ violates the incentive compatibility constraint, we must therefore only consider whether $\tilde{r}_h > r_h^*$ can be optimal. But if $\tilde{r}_h > r_h^*$, then a firm could increase u_h by reducing r_h without violating incentive compatibility, hence $\tilde{r}_h > r_h^*$ cannot be optimal. The value of $\tilde{r}_h$ must thus be determined by the constraints (35), (36) and (38). Solving this system leads to $\tilde{r}_h = \theta_h^{-1}$.

The equilibrium induced by this cap is both incentive compatibly for θ_ℓ at $\tilde{r}_h = r_h^*$ if

$$\begin{aligned}\tilde{u}_\ell &= \frac{c}{2\theta_\ell(c+\theta_\ell)}\\ &= \overline{w} - C(r_h^*, \theta_\ell),\end{aligned}$$

which implies that

$$\overline{w} = \frac{1}{2}\frac{\theta_h^2 + \theta_\ell^2}{\theta_\ell\,(c+\theta_\ell)\,\theta_h^2}c$$

To verify the existence of such an equilibrium, we must rule out deviations. Under this compensation cap, the firms earn strictly positive profits on θ_h, so they might have an incentive to offer a pooling contract, $\{\overline{w}, r^d\}$, where $r^d < r_h^*$. Note that r^d must be lower than r_h^*, otherwise neither type would accept the contract, given the compensation is capped at $\overline{w}$.

This pooling deviation is not profitable, however, if the average (pooling) output of $\overline{q}(r) = \left[p_h \frac{c}{c+\theta_h} + p_\ell \frac{c}{c+\theta_\ell}\right] r$ is lower than the compensation cap for any $r \leq r_h^*$. Hence, to prevent the pooling deviation, the following condition must be met:

$$\overline{w} - \overline{q}(r_h^*) \geq 0 \qquad \Rightarrow c \geq \theta_h\left(\frac{2p_h\theta_\ell}{\Delta} - 1\right).$$

If this condition is met, efficiency can be attained through the compensation cap $\overline{w}$ (it is straightforward to check that $\frac{\theta_h(2p_h\theta_\ell - \Delta)}{\Delta} < \overline{c}$). If the condition is not met, an efficiency gain could be attained by setting a less restrictive compensation cap. ■

A.12 Proof of Proposition 15

First note that (21) and (24) imply that

$$\tilde{u}_h = \frac{c_h}{2\theta\left(c_h + \theta\right)}$$

and that

$$\tilde{r}_h = \theta^{-1}.$$

Second, we show that (22) cannot bind. Suppose it binds. Then

$$u_\ell = q(r_h, c_h) - C(\theta^{-1}, c_\ell) > u_h,$$

but this would violate (23).

Next, (23) must bind or else u_ℓ could be increased without violating the incentive compatibility of c_h. Naturally, (25) must bind. Hence $\tilde{r}_\ell$ is determined by

$$\frac{c_h}{2\theta\left(c_h + \theta\right)} = q(r_\ell, c_\ell) - C(r_\ell, c_h),$$

which yields

$$\tilde{r}_\ell = \left(\frac{c_\ell\left(c_h + \theta\right) - \sqrt{\theta \Delta_c\left(2c_h c_\ell + \theta c_h + \theta c_\ell\right)}}{c_h\left(c_\ell + \theta\right)}\right)\theta^{-1}$$

The term in parentheses is smaller than one. ■

A.13 Proof of Proposition 16

Consider the single-firm program

$$\mathcal{P} : \max_{r_L, r_\ell} p_h\left(S(r_h, c_h) - u_h\right) + p_\ell\left(S(r_\ell, c_\ell) - u_\ell\right)$$

$$
\begin{aligned}
u_\ell &\geq 0 \\
u_h &\geq 0 \\
u_\ell - u_h &\geq C(r_h, c_h) - C(r_h, c_H\ ) && (39) \\
u_h - u_\ell &\geq C(r_\ell, c_\ell) - C(r_\ell, c_h) && (40)
\end{aligned}
$$

First note that c_h must get the information rents, so $u_\ell = 0$. Suppose (39) is binding, then

$$u_h = -(C(r_h, c_h) - C(r_h, c_H\ ))$$

Then the program becomes

$$\mathcal{P} : \max_{r_L, r_\ell} p_h \left(S(r_h, c_h) + C(r_h, c_h) - C(r_h, c_H\ ) \right) + p_\ell \left(S(r_\ell, c_\ell) \right)$$

This leads to $r_h = \frac{c_h(c_\ell+\theta)}{(c_h+\theta)c_\ell}\theta^{-1} < \theta^{-1}$ and $r_\ell = \theta^{-1}$. Since $r_h < r_\ell$ this would not be not incentive compatible. Hence, (40) must be the binding incentive compatibility constraint:

$$
\begin{aligned}
u_h - u_\ell &= C(r_\ell, c_\ell) - C(r_\ell, c_h) \\
u_h &= C(r_\ell, c_\ell) - C(r_\ell, c_h).
\end{aligned}
$$

Then the program becomes

$$
\begin{aligned}
\mathcal{P} : &\max_{r_L, r_\ell} p_h \left(S(r_h, c_h) - [C(r_\ell, c_\ell) - C(r_\ell, c_h)] \right) + p_\ell \left(S(r_\ell, c_\ell) \right) \\
&= \max_{r_L, r_\ell} p_h \left(S(r_h, c_h) \right) + p_\ell \left(S(r_\ell, c_\ell) - \pi \left(C(r_\ell, c_\ell) - C(r_\ell, c_h) \right) \right)
\end{aligned}
$$

This leads to $\hat{r}_h$ and $\hat{r}_\ell$ as described in (26) and (27). ■

References

Acharya, Viral, Marc Gabarro and Paolo Volpin (2012), Competition for managers, corporate governance and incentive compensation, Working paper, SSRN.

Acharya, Viral and Paolo Volpin (2010), 'Corporate governance externalities', *Review of Finance* **14**(1), 1–33.

Albuquerque, Ana, Gus De Franco and Rodrigo Verdi (2013), 'Peer choice in CEO compensation', *Journal of Financial Economics (forthcoming)* .

Armstrong, Mark and John Vickers (2001), 'Competitive price discrimination', *The RAND Journal of Economics* **32**(4), 579–605.

Baiman, Stanley, John H. Evans III and James Noel (1987), 'Optimal contracts with a utility-maximizing auditor', *Journal of Accounting Research* **25**(2), 217–244.

Bebchuk, Lucian A. and Jesse M. Fried (2004), *Pay Without Performance: The Unfulfilled Promise of Executive Compensation*, Cambridge, MA: Harvard University Press.

Benabou, Roland and Jean Tirole (2012), Bonus culture: Competitive pay, screening, and multitasking, Working paper, Princeton University and Toulouse School of Economics.

Bergstresser, Daniel and Thomas Philippon (2006), 'CEO incentives and earnings management', *Journal of Financial Economics* **80**(3), 511 – 529.

Beyer, Anne, Ilan Guttman and Ivan Marinovic (2011), Optimal contracts with performance manipulation, Working paper, SSRN.

Bijlsma, Michiel, Jan Boone and Gijsbert Zwart (2012), Competition for traders and risk, Working paper, Tilburg University.

Bizjak, John, Michael Lemmon and Thanh Nguyen (2011), 'Are all CEOs above average: An empirical examination of compensation peer groups and pay design', *Journal of Financial Economics* **100**(3), 538–555.

Bolton, Patrick, José Scheinkman and Wei Xiong (2006), 'Executive compensation and short-termist behaviour in speculative markets', *Review of Economic Studies* **73**(3), 577–610.

Borjas, George J. (1987), 'Self-selection and the earnings of immigrants', *The American Economic Review* **77**(4), 531–553.

Burns, Natasha and Simi Kedia (2006), 'The impact of performance-based compensation on misreporting', *Journal of Financial Economics* **79**(1), 35 – 67.

Cohen, Daniel, Aiyesha Dey and Thomas Lys (2008), 'Real and accrual-based earnings management in the pre- and post-Sarbanes-Oxley periods', *The Accounting Review* **83**(3), 757–787.

Crocker, Keith J. and Joel Slemrod (2007), 'The economics of earnings manipulation and managerial compensation', *The RAND Journal of Economics* **38**(3), 698–713.

Custódio, Cláudia, Miguel Ferreira and Pedro Matos (2013), 'Generalists versus specialists: Lifetime work experience and chief executive offer pay', *Journal of Financial Economics* **108**, 471–492.

Demski, Joel S. (1998), 'Performance measure manipulation*', *Contemporary Accounting Research* **15**(3), 261–285.

Dicks, David L. (2012), 'Executive compensation and the role for corporate governance regulation', *Review of Financial Studies* **25**(6), 1971–2004.

Dittmann, Ingolf and Ernst Maug (2007), 'Lower salaries and no options? On the optimal structure of executive pay', *The Journal of Finance* **62**(1), 303–343.

Dutta, Sunil and Frank Gigler (2002), 'The effect of earnings forecasts on earnings management', *Journal of Accounting Research* **40**(3), 631–655.

Dye, Ronald A. (1988), 'Earnings management in an overlapping generations model', *Journal of Accounting Research* **26**(2), 195–235.

Edmans, Alex, Xavier Gabaix and Augustin Landier (2009), 'A multiplicative model of optimal CEO incentives in market equilibrium', *Review of Financial Studies* **22**(12), 4881–4917.

Falato, Antonio, Dan Li and Todd Milbourn (2012), Which skills matter in the market for CEOs? Evidence from pay for CEO credentials, Working paper, Washington University in St. Louis.

Faulkender, Michael and Jun Yang (2013), 'Is disclosure an effective cleansing mechanism? The dynamics of compensation peer benchmarking', *Review of Financial Studies* **26**(3), 806–839.

Fee, Edward and Charles Hadlock (2003), 'Raids, rewards, and reputations in the market for managerial talent', *Review of Financial Studies* **16**(4), 1315–1357.

Frydman, Carola and Dirk Jenter (2005), Rising through the ranks: The evolution of the market for corporate executives, 1936-2003, Working paper, MIT.

Frydman, Carola and Dirk Jenter (2010), 'CEO compensation', *Annual Review of Financial Economics* **2**(1), 75–102.

Frydman, Carola and Raven E. Saks (2010), 'Executive compensation: A new view from a long-term perspective, 1936-2005', *Review of Financial Studies* **23**(5), 2099–2138.

Gabaix, Xavier and Augustin Landier (2008), 'Why has CEO pay increased so much?', *The Quarterly Journal of Economics* **123**(1), 49–100.

Goldman, Eitan and Steve L. Slezak (2006), 'An equilibrium model of incentive contracts in the presence of information manipulation', *Journal of Financial Economics* **80**(3), 603 – 626.

Hall, Brian and Jeffrey Liebman (1998), 'Are CEOs really paid like bureaucrats?', *Quarterly Journal of Economics* **113**(3), 653–691.

Jullien, Bruno (2000), 'Participation constraints in adverse selection models', *Journal of Economic Theory* **93**(1), 1 – 47.

Kaplan, Steven, Mark Klebanov and Morten Sorensen (2012), 'Which CEO characteristics and abilities matter?', *Journal of Finance* **67**(3), 973–1007.

Khurana, Rakesh (2002), *Searching for a Corporate Savior: The Irrational Quest for Charismatic CEOs*, Princeton, NJ: Princeton University Press.

Laffont, Jean-Jacques and Jean Tirole (1986), 'Using cost observation to regulate firms', *Journal of Political Economy* **94**(3), 614–641.

Laffont, Jean-Jacques and Jean Tirole (1987), 'Auctioning incentive contracts', *Journal of Political Economy* **95**(5), 921–937.

Liang, Pierre Jinghong (2004), 'Equilibrium earnings management, incentive contracts, and accounting standards*', *Contemporary Accounting Research* **21**(3), 685–718.

Lucas, Robert E. (1978), 'On the size distribution of business firms', *The Bell Journal of Economics* **9**(2), 508–523.

Maggi, Giovanni and Andrés Rodriguez-Clare (1995), 'Costly distortion of information in agency problems', *The RAND Journal of Economics* **26**(4), 675–689.

Melumad, Nahum D. and Stefan Reichelstein (1989), 'Value of communication in agencies', *Journal of Economic Theory* **47**(2), 334 – 368.

Morse, Adair, Vikram Nanda and Amit Seru (2011), 'Are incentive contracts rigged by powerful CEOs?', *Journal of Finance* **66**(5), 1779–1821.

Murphy, Kevin (2013), Executive compensation: Where we are, and how we got there, *in* G.Constantinides, M.Harris and R.Stulz, eds, 'Handbook of the Economics of Finance', Vol. 2, Part A, Elsevier Science North Holland, pp. 211–356.

Murphy, Kevin J. and Jan Zabojnik (2007), Managerial capital and the market for CEOs, Working Paper 984376, SSRN.

Murphy, Kevin and Jan Zabojnik (2004), 'CEO pay and appointments: A market-based explanation for recent trends', *American Economic Review* **94**(2), 192–196.

Mussa, Michael and Sherwin Rosen (1978), 'Monopoly and product quality', *Journal of Economic Theory* **18**(2), 301–317.

Peng, Lin and Ailsa Röell (2008*a*), 'Executive pay and shareholder litigation', *Review of Finance* **12**, 141–184.

Peng, Lin and Ailsa Röell (2008*b*), 'Manipulation and equity-based compensation', *American Economic Review* **98**(2), 285–290.

Riley, John G. (1979), 'Informational equilibrium', *Econometrica* **47**(2).

Rosen, Sherwin (1981), 'The economics of superstars', *The American Economic Review* **71**(5), 845–858.

Rothschild, Michael and Joseph Stiglitz (1976), 'Equilibrium in competitive insurance markets: An essay on the economics of imperfect information', *The Quarterly Journal of Economics* **90**(4), 629–649.

Stole, Lars A. (1995), 'Nonlinear pricing and oligopoly', *Journal of Economics and Management Strategy* **4**(4), 529–562.

Terviö, Marko (2008), 'The difference that CEOs make: An assignment model approach', *The American Economic Review* **98**(3), 642–668.