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INSTITUTT FOR SAMFUNNSØKONOMI

DEPARTMENT OF ECONOMICS

SAM 8 2012

ISSN: 0804-6824

March 2012

Discussion paper

Paying for Staying: Managerial Contracts and the Retention Motive

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Paying for Staying: Managerial Contracts and the Retention Motive*

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Abstract

Talented managers may leave the firm in order to work elsewhere. Focusing on the portability of managers' resources, we develop a model in which managerial compensation is designed to prevent inefficient departure. The model rationalizes the widespread use of flat salaries in combination with performance-vesting stock options and is consistent with observed differences in compensation contracts across individuals, firms, industries, and countries.

1 Introduction

Managerial compensation usually comprises two main components, namely, a fixed salary and a stock-option package (Murphy (1999) and Frydman and Saks (2010)).

For economists, these contracts pose a puzzle. The leading theory of compensation contracts emphasizes that variable pay encourages the manager to work harder, at the cost of providing less insurance (Holmström (1979)). But this effort inducement theory has several implications for which there is only limited empirical support. First, variable compensation

*Thanks to Carsten Bienz, Mike Burkart, Mariassunta Giannetti, Hans Hvide, Daniel Metzger, Trond Olsen, Patrick Rey, Per Strömberg, and Joel Watson for helpful discussions. Financial support from the Torsten and Ragnar Söderberg Foundation (Tore Ellingsen) and The Finance Market Fund (Eirik Gaard Kristiansen) is gratefully acknowledged .

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ought to be carefully indexed so as to filter out the effect of exogenous shocks on measured performance. But in reality many managerial contracts, especially those that involve large amounts of stock options, contain little or no explicit indexing (see Lazear and Oyer (2012) and references therein). Second, pay ought to depend on performance at all performance levels. In reality, most managers' pay is bounded below by a substantial salary. Third, there ought to be a negative relationship between the riskiness of the environment and the power of the incentives. In reality the relationship is as likely to be positive (Prendergast (2002)). Fourth, variable pay should only be linked to performance measures that the manager can substantially influence. In reality, options and stocks are frequently being used to reward broad layers of managers and other worker categories (Oyer and Schaefer (2005)).

Alternative theories of compensation focus on recruitment and retention rather than motivation.[1] While these theories have generated a smaller academic literature, they are popular among practitioners. For example, according to the survey data reported by Ittner et al. (2003), worker retention is the most important motive for equity grant programs in "new economy" firms.

Here, we explore theoretically the hypothesis that variable compensation primarily serves the purpose of retaining managers when their outside options are attractive.[2] Building on previous insights of Hashimoto (1979), Harris and Holmström (1982), Holmström and Ricart i Costa (1986), Blakemore et al. (1987), and Oyer (2004), we construct a simple model of retention-based compensation. We find that the optimal contract is composed of a salary and a non-indexed stock option package. Besides explaining contracts' shape, the model is consistent with observed variation in compensation practices across firms, industries, and countries.

The key assumption is that there is uncertainty concerning the future value of the manager's work, and that the inside and outside value are closely correlated. When the value becomes high enough, a manager who is only paid a fixed salary would leave the firm. Stock options are "in the money" precisely when times are good and the manager's value increases. Thus, if the

[1] In this paper, we shall neglect the potentially important role of incentive schemes in screening workers according to their privately observed characteristics; see, for example, Lazear (2005) and the references therein.

[2] While we lack formal measures of portability, many observations suggest that it is empirically relevant. Garvin (1983) finds that younger firms have more value in human than physical assets, and argues that this fact could explain why there are more spin-offs among younger firms. Likewise, Bhide (2000) finds that 71 percent of the firms included in the Inc 500, a list of young, fast-growing companies, were founded by people who replicated or modified an idea encountered in their previous employment. Detailed evidence on portability in the laser industry and from investment banks is offered by Klepper and Sleeper (2005) and Groysberg et al. (2008) respectively.

manager holds a sufficient quantity of options that are forfeited upon departure, she will stay with the firm even in good times. This model applies to all workers whose value to the firm co-moves with industry conditions, and therefore explains why pay is linked to the firm's stock price for categories of workers whose individual efforts cannot affect the stock price much.

Our argument is particularly closely related to the work of Holmström and Ricart i Costa (1986). There too, the optimal compensation is in the form of an option contract, with the fixed salary being due to the manager's risk aversion and the variable pay being due to the manager's inability to commit to staying when outside opportunities become attractive. Beyond recalling this result, which is often forgotten in current discussions about managerial pay, we make three contributions. First, we reformulate and streamline the model to emphasize that its logic does not depend on uncertainty about the manager's characteristics. Even industry-wide variation in market conditions can create the required variation in the manager's outside option. Second, we parametrize the model in such a way as to admit a broad range of comparative static results. Third, we demonstrate that the model's predictions are broadly in line with recently available evidence.

For example, the model entails the following predictions. (i) The relative importance of stock options in managerial compensation depends on the portability of the manager's human capital. If portability is high, the salary will be low and the option package large. (ii) The relative value of the option package is greater when the firm's value is more uncertain. (iii) The legal environment matters. When the manager's best outside option is to set up a new firm, start-up funding is easier to acquire when the legal system functions well, and we predict that there is more variable pay in good legal environments. (iv) Turnover is higher when the industry is performing poorly. (v) Severance pay compensates the manager for the difference between current compensation and the outside option, and need not be specified in the contract.

Apart from Holmström and Ricart i Costa (1986), we are not aware of any previous model that fully explains why managers are paid a combination of fixed salary and non-indexed stock options.[3] Among theoretical papers considering the retention motive, Hashimoto (1979) and Blakemore et al. (1987) merely assume that contracts are piece-wise linear. Oyer (2004) and Giannetti (2011) assume linear contracts, and thus by construction fails to account for the lower bound to compensation that options imply. Dutta (2003) derives a linear contract from first

[3]Models that attempt to explain how option packages vary with firm and market conditions, such as Johnson and Tian (2000) and Kuang and Suijs (2006), merely impose a combination of salary and options.

principles, but similarly fails to account for the lower bound to payments.[4] Papers emphasizing effort inducement usually impose a linear relationship between pay and performance, which in turn can be justified with reference to Holmström and Milgrom (1987). Hence, by construction, these models also fail to account for options.[5] Failing to account for the exact contractual shape is not necessarily a major drawback of a model, but here it is quite problematic because the empirically observed contracts appear to be so far from optimal, given standard assumptions about managers' preferences and the behavior of stock prices (Hall and Murphy (2002); Dittmann and Maug (2009)).[6]

The paper is organized as follows. Section 2 sets up the basic model. Section 3 derives the optimal compensation contract. Comparative static results are presented and discussed in Section 4. We then develop two extensions. Section 5 considers the possibility of efficient inter-industry turnover and provides an explanation for severance pay. Section 6 considers the case in which the manager must engage in costly search in order for attractive outside options to be available, admits efficient intra-industry turnover, and provides an explanation for pay caps. Section 7 concludes.

2 The basic model

A firm needs a manager to run a two-period project. In order to recruit a manager with appropriate talent and retain this manager until the project completes, the firm proposes a contract which specifies pay as a function of the economy's state as well as the manager's characteristics.

To a first approximation, both the firm's owners and all potential managers are assumed to be risk neutral and care only about total expected consumption.[7] However, choosing between two contracts that yield the same expected pay but different risk, we assume that the manager strictly prefers the least risky compensation, whereas the owners remain indifferent. That is, the

[4] Pakes and Nitzan (1983) examine how contracts can be designed to retain research personnel. Their focus is similar to ours, but the contract derived is generally not linear in performance and it depends on the potential rivalry between old and a new firm given that the researcher leaves.

[5] Innes (1990) derives an option-like contract, but exogenously imposes monotonicity.

[6] However, Dittmann et al. (2010) show that observed contracts can be approximately justified if managers are sufficiently loss averse.

[7] We could dispense by the second assumption by explicitly modeling the possibilities of borrowing for consumption. However, like most of the managerial compensation literature we refrain from a realistic study of the intertemporal consumption decision.

difference in risk aversion between the firm and the manager is lexicographically small. While the assumption is quite unrealistic, as evidenced by the large premium required by managers to accept options instead of cash (Hall and Murphy (2002)), here it is an innocent simplification. In Appendix B we explain why all our main conclusions remain valid even if the manager is strictly risk averse.

The firm's owners have enough wealth to be financially unconstrained. The manager's wealth is denoted ω and is assumed to be non-negative and the same for all potential managers. For most of the results, the manager's wealth is irrelevant. Therefore, $\omega = 0$ except when otherwise noted.

The talent τ differs across potential managers. Both the firm's owners and the potential managers are completely informed about the environment.

In what follows, we simply refer to the agents as "the firm" and "the manager" respectively.

2.1 The project

If the manager stays through the second period, the project generates revenue

$$R_S = pq(\tau),$$

where q denotes the output, and p denotes the output's price.[8] We assume that the production function satisfies the conditions $q'(\tau) > 0$, $q''(\tau) \leq 0$, and that the manager's talent belongs to some interval $T = [0, \overline{\tau}]$. The price p is assumed to be uncertain when the project starts and to be realized at the end of the first period. The uncertainty is captured by the probability density function $f(p)$ with support $P \subseteq \mathbb{R}_+$. Let $\overline{p}$ denote the expected price.

If the manager leaves already after one period, the project generates revenue

$$R_L = \alpha R_S \leq (1-\theta) pq(\tau),$$

where $\theta \in [0, 1]$. Next, we interpret the parameter θ in more detail.

2.2 The outside opportunity

A manager who leaves the firm at the end of first period, can potentially generate a profit $\theta pq(\tau) - I$, where $I \geq 0$ denotes an investment cost. If $I = 0$, we can think of the manager

[8] Other interpretations of q and p are of course possible.

as working for an existing competitor. If I is large, we may think of the manager setting up a new firm. Except for the international comparisons that we consider in Section 4.4, our results do not depend on the size of I.

The "portability parameter" θ represents the resources that a departing manager can legally take away from the firm and utilize elsewhere.[9] The portability parameter is central to the model. In reality, portability depends on, among other things, the nature of the manager's expertise, the availability of intermediate goods, intellectual property rights protection, the ability to include credible no compete clauses in the managerial contract, and so on.

By making the assumptions $\theta \leq 1$ and $I \geq 0$, and by the definition of R_L, we focus on the case in which the departure of a manager in the midst of a project is inefficient. If the manager departs, the firm loses more than the manager gains. (Section 5 and 6 extend the basic model by examining efficient turnover.)

Consider now the case of $I > 0$. In order to take advantage of the outside opportunity and become an entrepreneur, a departing manager must be able to fund the investment I. Let the financial market's required rate of return be normalized to 0. To capture frictions in the financial market, we assume that financial contracts be imperfectly enforced, applying a simple version of the model of Ellingsen and Kristiansen (2011): An entrepreneur who diverts resources is apprehended with probability $\varphi < 1$. With probability $1 - \varphi$ the diversion attempt succeeds and the entrepreneur can enjoy the illegally diverted revenues. In case of a failed diversion attempt, the entrepreneur has to give up all financial resources. Additionally, the apprehended entrepreneur suffers a (nonmonetary) utility loss γ. These assumptions guarantee that optimal financial contracts are easy to characterize and deliver a simple expression for the manager's outside option. Moreover, as the parameters φ and γ can be seen as proxies for the quality of the legal environment, they are helpful when we make cross-country comparisons of managerial pay.

For most of the paper, we assume that the manager can leave the firm, but never leaves the industry. We relax this assumption in Section 5, where we assume that another outside option is to take a job in a different industry.

[9] It is straightforward to generalize the model so as to let the share θ be a function of the talent τ, but the generalization produces few additional insights.

2.3 Manager's participation condition

Let $\underline{w}(\tau)$ be the expected value of the best alternative offer to a manager with talent τ from the most attractive alternative employer. To ensure that the problem is nontrivial, we assume that $\overline{p}q(\tau) > \underline{w}(\tau)$ for some τ. Moreover, let

$$\tau^{fb} = \arg\max_{\tau} E_p\left[pq(\tau) - \underline{w}(\tau)\right] \tag{1}$$

be the set of optimal talent levels, i.e., those talent levels that maximize the net gain from employing the manager. Without significant loss of generality, we assume that this set is a singleton from now on and refer to τ^{fb} as the first-best talent level.

Finally, we assume that the best outside offer of the manager satisfies the inequality

$$\underline{w}(\tau) \geq \int_0^{\infty} \max\{\theta pq(\tau) - I, 0\} f(p)dp. \tag{2}$$

That is, the best outside offer is above what the manager would earn in expectation by immediately becoming an entrepreneur. Hence, $\underline{w}(\tau)$ is the manager's reservation utility.

2.4 Contracting and timing

At stage $t = 0$, the firm proposes a compensation contract $w(p, \tau)$, which the manager accepts or rejects. The compensation contract is costlessly enforced. Since both the manager and the firm are indifferent concerning the time profile of payouts, there is no reason to pay out anything before the end of the second period. If anything, delaying payment mitigates the manager's temptation to leave. As leaving is inefficient, we may restrict attention to contracts that only pay the manager upon having completed the project.

We impose no exogenous restriction on the shape of the contract, except that it is deterministic (and even this feature is without loss of generality) and non-negative. More precisely, compensation can be any mapping $w : P \times T \to \mathbb{R}_+$.

At stage 1, p realizes and the manager decides whether to stay or leave.

Finally, at stage 2, the project is completed, revenues realize, and the manager is paid. Figure 1 summarizes.

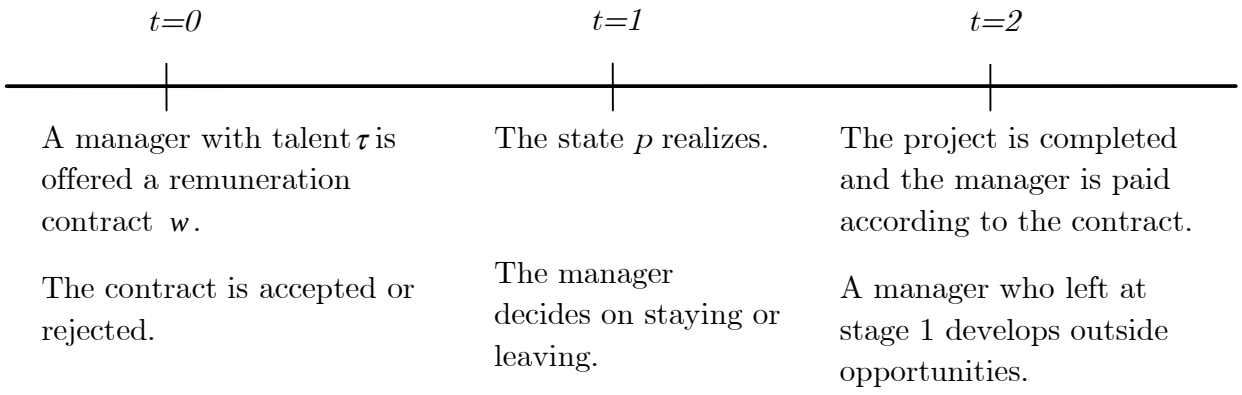

Figure 1: Timing

3 Analyzing the basic model

The firm's problem is to decide which type of manager to approach and to offer the contract that maximizes the firm's expected surplus from the project. That is, the firm determines τ and the compensation contract $w(p,\tau)$ so as to maximize expected payoff,

$$U = E_p\left[pq(\tau) - w(p,\tau)\right], \tag{3}$$

subject to the manager's participation constraint at date 0,

$$E_p\left[w(p,\tau)\right] \geq \underline{w}(\tau), \tag{4}$$

the manager's retention constraint at date 1,

$$w(p,\tau) \geq \theta pq(\tau) - I \qquad \text{for } p \in \Im, \tag{5}$$

where $\Im \subseteq P$ is the set of states p that makes it potentially profitable and feasible for the manager to fund an outside project.[10]

[10] A standard argument, similar to the proof of Lemma 1 in Ellingsen and Kristiansen (2011), implies that any contract that violates the retention constraint in some relevant state is suboptimal; there is another contract that yields higher expected profit for the firm.

Before solving the firm's problem, we must characterize opportunities for the manager to become an entrepreneur, i.e., the set $\Im$. Applying the arguments of Ellingsen and Kristiansen (2011), the set $\Im$ and the repayment to external investors $r(p)$ are given by the profitability condition,

$$\theta pq(\tau) - I \geq 0, \tag{6}$$

the entrepreneur's no-diversion constraint,

$$\theta pq(\tau) - r(p) \geq (1-\varphi)\theta pq(\tau) - \varphi\gamma, \tag{7}$$

and the investors' participation constraint,[11]

$$r(p) \geq I. \tag{8}$$

We solve the game backwards by first examining the manager's departure decision at date 1 (Step 1), then the contract that minimizes the cost of recruiting a manager of given talent (Step 2), and finally we examine the firm's optimal choice of talent (Step 3).

Step 1: If the outside project is unprofitable, it will not be funded. If the project is profitable, the entrepreneur is able to repay I, but may be unwilling. Willingness to repay is greater when the repayment is smaller, and is thus greatest when $r(p) = I$. Consequently, (7) can be written

$$\theta pq(\tau) - I \geq (1-\varphi)\theta pq(\tau) - \varphi\gamma. \tag{9}$$

Since an increase in p increases the left-hand side of inequality (9) more than the right-hand side, a unique minimum,

$$\hat{p} = \min\left[\frac{I-\varphi\gamma}{\varphi\theta q(\tau)}, \frac{I}{\theta q(\tau)}\right],$$

satisfies inequalities (9) and (6). Consequently, we have identified the set of states in which retention is a potential problem, $\Im = [\hat{p}, \infty\rangle$.

The firm's maximization problem is to choose τ and $w(p, \tau, \theta)$ in order to maximize (3)

[11] By Lemma 1 in Ellingsen and Kristiansen (2011) it is never optimal to offer a contract to outside investors that implies that the entrepreneur makes a diversion attempt.

subject to (4) and the retention constraint

$$w(p,\tau,\theta) \geq \theta pq(\tau) - I \qquad \text{if } p \geq \hat{p}. \tag{10}$$

Step 2: Keep τ fixed. Observe that the firm can minimize expected wage costs and satisfy (4) and (10) by offering a fixed wage w^f in combination with an additional state-contingent wage $w^v(p)$ equal to the difference between the outside opportunity and the fixed wage (whenever this difference is positive). In the range where $w^v(p)$ is positive, the total payment is the smallest that ensures retention. Hence, in all states in which more than w^f is paid out, the pay cannot be reduced without violating any constraint. Thus, it is impossible to rearrange the remuneration without reducing the pay below w^f in some states and thereby imposing more risk on the agent. Let us now formally compute the optimal contract.

Because inequality (10) is linear in p, variable pay $w^v(p)$ is linear as well. Let

$$p^h = \max\left[\frac{I-\varphi\gamma}{\varphi\theta q(\tau)}, \frac{w^f+I}{\theta q(\tau)}\right] \tag{11}$$

denote the lowest value of p that (i) makes the outside project financially feasible (so (9) holds with equality), and (ii) more attractive than the fixed wage w^f (i.e., $\theta pq(\tau) - I \geq w^f$). To ensure that the inside wage exactly matches the outside opportunity, the variable wage must then satisfy

$$w^v(p) = \theta pq(\tau) - I - w^f \qquad \text{for } p \geq p^h.$$

Finally, to ensure the participation of a manager with talent τ at date 0, the fixed wage cannot be smaller than

$$w^f = \underline{w}(\tau) - \int_{p^h}^{\infty} w^v(p) f(p) dp. \tag{12}$$

Since $\int_{p^h}^{\infty} w^v(p) f(p) dp$ is decreasing in p^h, w^f is uniquely defined by equation (12). In Step 3 below, we show that $w^f(\tau) > 0$ for the optimal choice of talent, τ. This completes the proof that the the optimal contract satisfies equation (15) and equation (14).

Step 3: The firm chooses the manager's talent, τ, to maximize

$$E_p\left[pq(\tau) - w^f(\tau) - w^v(p,\tau)\right]. \tag{13}$$

Since $\underline{w}(\tau) = w^f(\tau) + E_p\left[w^v(p,\tau)\right]$ (by Step 2), the firm's maximization problem with respect to τ is equivalent to maximizing surplus, see (1). Hence, $\tau^* = \tau^{fb}$. Finally, note that Assumption

(2), implies $w^f(\tau^{fb}) > 0$.

To summarize, the optimal contract can be described as follows.

Proposition 1 *(i) The optimal contract, $w^*(p)$, is given by the sum of a linearly increasing state-contingent wage*

$$w^v(p) = \theta pq(\tau) - I - w^f \tag{14}$$

that is paid out only in good enough states $p \geq p^h$, and a fixed wage

$$w^f = \underline{w}(\tau) - \int_{p^h(w^f)}^{\infty} w^v(p) f(p) dp, \tag{15}$$

that is paid out in all states p.
(ii) The firm optimally hires a manager with first-best talent, τ^{fb}.

The optimal contract is illustrated in Figure 2.

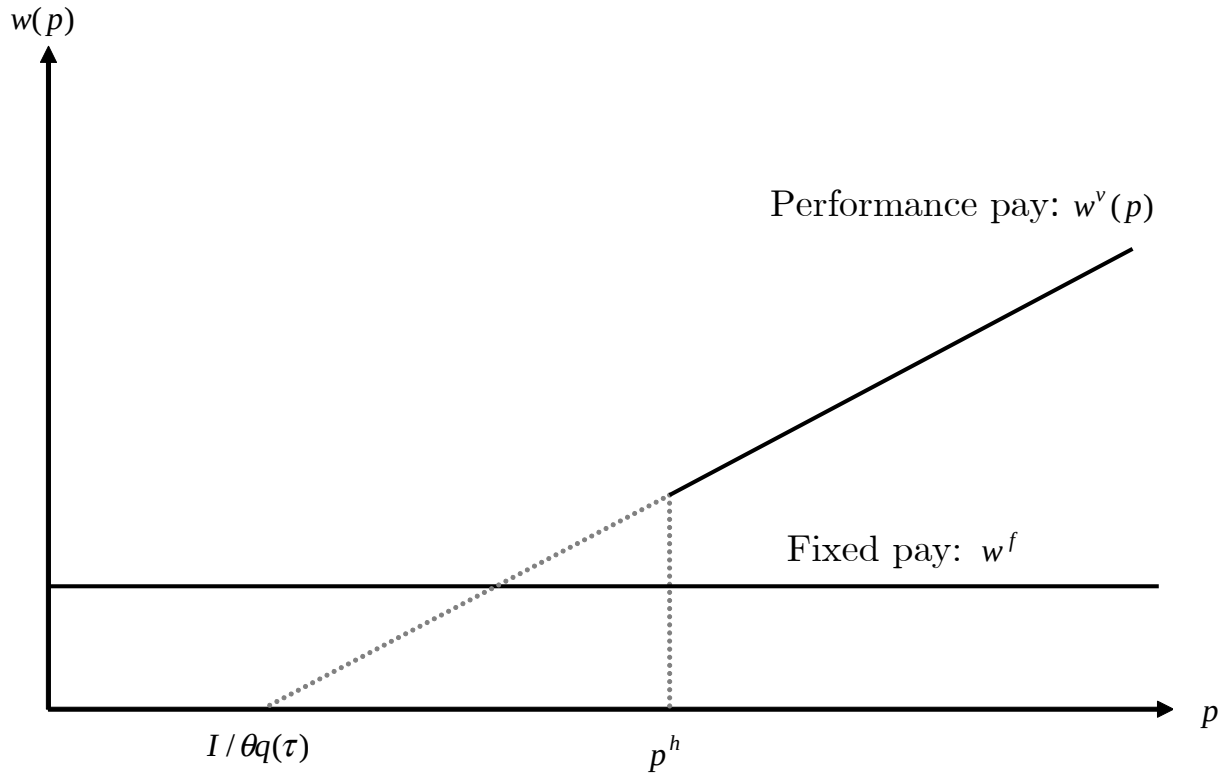

Figure 2: The figure describes the manager's compensation, composed of fixed pay and variable pay, as a function of the state p.

When p takes a value in the range between $I/\theta q(\tau)$ and p^h, the outside project is profitable, but not financially implementable.

The general shape of the optimal contract fits well with stylized facts. Managerial compensation is more strongly related to performance when performance is high than when it is low; see e.g., Hermalin and Weisbach (1998), Bertrand and Mullainathan (2001), and Garvey and Milbourn (2006). Indeed, the compensation contract matches exactly a rather common form of managerial contract: the flat salary in combination with either conventional or perfomance-vesting stock options. The idea is that the manager holds a fraction θ of the firm's stock, where the exercise price is set so as to correspond to the output price p^h. To demonstrate the point, and prepare for subsequent comparative static analysis, let us construct the options explicitly.

We have assumed that the firm's owners have full liability. If the manager stays, the total value of the firm, including the manager's equity claim but not the fixed wage, is $V = pq(\tau) - w^f$. The value can be decomposed into a common stock (limited liability) claim worth $\max\{V, 0\}$, which is divided between owners and the manager, and a debt worth $\min\{V, 0\}$, which is borne by the owners.[12] Note that this does not preclude that the manager is given options to buy common stock given that some conditions are satisfied. The corresponding share price (normalizing the number of shares to 1) is also $\max\{V, 0\}$.[13]

Consider first the case in which the manager's outside project is not financially constrained. According to the contract, the manager gets variable pay once the output price reaches the threshold $(w^f + I)/\theta q(\tau)$. Correspondingly, when the share price reaches the hurdle

$$\begin{aligned} h &= \left(\frac{w^f + I}{\theta q(\tau)}\right) q(\tau) - w^f \\ &= \frac{I + (1-\theta)w^f}{\theta}, \end{aligned}$$

the manager can exercise the call options at exactly the hurdle price h. Clearly, this option package implements the desired compensation.

If the manager's outside project is subject to a financial constraint, a similar argument applies, except the exercise price will now be below the hurdle price; that is, the option is

[12] If the lowest possible price, p, had a lower bound such that the firm always could pay the fixed wage, i.e. $p \in \left[w^f/q(\tau), \infty\right\rangle$, then there would be no need for owners to hold a debt claim worth $\min\{V, 0\}$ or to assume that owners have full liability.

[13] We abstract from the firm's choice of capital structure and examine a firm without debt financing.

"performance-vesting". More precisely, the exercise price remains at h, whereas the hurdle price corresponding to the output price threshold $(I - \varphi\gamma)/\varphi\theta q(\tau)$ is

$$\begin{aligned} \widehat{h} &= \left(\frac{I - \varphi\gamma}{\varphi\theta q(\tau)}\right) q(\tau) - w^f \\ &= \frac{I - \varphi\gamma - \varphi\theta w^f}{\varphi\theta}. \end{aligned}$$

As noted in the Introduction, ours seems to be the first model in which stock options with performance-based vesting is shown to be an optimal form of compensation.

To what extent are our results affected if we assume that the manager has positive wealth? When $I = 0$, the only way in which wealth may matter here is as a bonding device. The firm can ask the manager to invest ω in the firm and only return the money in case the manager stays. Such bonding will have the beneficial effect of making the manager more reluctant to leave, which in turn allows a reduction in variable pay and a corresponding increase in fixed pay, thereby reducing the risk that the manager has to bear. At first sight, such bonding schemes may seem exotic or unrealistic. However, many firms ask managers to pay for their option packages and have vesting clauses that require the manager to stay with the firm for several years after the purchase. As far as we know, our risk reduction explanation for selling options to the manager, rather than merely giving the options for free, is new in the literature.

4 Managerial pay across firms and industries

Let us now investigate how the compensation depends on the parameters of the model and relate these comparative static results to empirical regularities. For simplicity, we initially focus only on the case in which the manager's outside option is never subject to a financial constraint.[14] Most results are independent of whether the financial constraint binds or not, except the results that directly concern the impact of investor protection. Differences in investor protection becomes relevant only when we turn to cross-country comparisons in the next section.

A sufficient condition for the financial constraint to be slack is that

[14] Hurst and Lusardi (2004), in an emprical study of US entrepreneurs argue that liquidity constraints are not important causal determinants of entry into self-employment. However, in countries with less developed financial markets, funding constraints are likely to be tighter.

$$\frac{I-\varphi\gamma}{\theta\varphi q(\tau)} < \frac{I}{\theta q(\tau)},$$

or equivalently

$$I < \frac{\varphi\gamma}{1-\varphi}. \tag{16}$$

Recall that, under this assumption, the options' exercise price equals the hurdle price h.

To simplify the comparative static analysis, from now on we make additional assumptions concerning functional forms. The production function $q(\tau)$ is strictly concave, the reservation wage function $\underline{w}(\tau)$ is strictly convex, and both functions are twice differentiable. Then, it follows from Proposition 1 (ii) that the firm optimally employs a manager with the talent level solving the first-order condition

$$\overline{p}q_\tau(\tau) - \underline{w}_\tau(\tau) = 0, \tag{17}$$

with the second-order condition

$$\overline{p}q_{\tau\tau}(\tau) - \underline{w}_{\tau\tau}(\tau) < 0, \tag{18}$$

clearly being fulfilled due to our functional form assumptions.

4.1 Asset exposure and corporate governance

The portability of assets vary across firms and industries. First, portability is related to technological properties of the assets. Assets that are highly portable include knowledge of possible business projects, customer relationships and knowledge of key technologies to the firm. Other assets, such as buildings and equipment, are not legally portable at all. Second, portability is related to organizational properties of the firm and its environment. For example, presence of a knowledgeable owner or of family ties between owners and the manager, as well as absence of alternative social connections, are all likely to reduce portability.

Proposition 2 *Higher asset portability θ entails (i) an increase in the quantity of granted options, and (ii) a decrease in the hurdle price h.*

Proof: See Appendix A.

In other words, more portable assets implies that the manager's performance threshold is lowered and that the manager owns a larger fraction of the firm if the threshold is exceeded.

Available evidence indeed suggests a positive relationship between the importance of intangible assets an variable pay. The link is most direct in the sizeable literature documenting that "knowledge" firms utilize stocks and especially stock options to a larger degree than do "brick and mortar" firms (Anderson et al. (2000); Ittner et al. (2003); Murphy (2003); Oyer and Schaefer (2005)), and the firms themselves report that such performance-based pay is primarily used for retention purposes (Ittner et al. (2003)). The model is likewise compatible with the prominence of option-based compensation in "growth firms", both for executives (e.g., Smith and Watts (1992); Gaver and Gaver (1993); Mehran (1995); Himmelberg et al. (1999); Palia (2001)) and non-executives (e.g., Core and Guay (2001)).

According to Cremers and Grinstein (2010), industries with a higher fraction of outside executives have both a larger fraction of performance related pay and a smaller degree of indexing, i.e., more pay for luck; see also Murphy and Zabojnik (2006) and Murphy and Zabojnik (2004). To the extent that the prevalence of recruitment of outside managers is a proxy for human resource portability, this is what the model predicts.

The role of the legal and social environment is perhaps clearest in regulated industries, where the manager is typically prevented from starting up a new business. It is well established that managers have weaker performance incentives in regulated sectors (Murphy (1999); Frydman and Saks (2010)). A similar mechanism might explain why there is less performance-based pay in family firms (e.g., Kole (1997); Andersson and Reeb (2000); Bandiera et al. (2010)), especially when the manager is a family member (Gomez-Mejia et al. (2003)).

More generally, we would expect stricter corporate governance to manifest itself as a reduction of portability, and thus entail less "pay for luck." Therefore, the model is consistent with the finding that pay for luck is smaller in firms with large owners, especially when these large owners sit on the Board (Bertrand and Mullainathan (2001); see also Fahlenbrach (2009)). Likewise, it is consistent with the more specific finding that the performance hurdles for option contracts are increasing in the quality of corporate governance (Bettis et al. (2010)).

Strictly speaking the model cannot explain variation in indexation, since it predicts that options should always be non-indexed. However, if we were to introduce a force favoring indexation, the model would say that portability should reduce indexation. This is in line with the empirical finding of Rajgopal et al. (2006), who find that there is less indexation in industries where there is stronger competition for managers.

In addition to this cross-section evidence, Murphy and Zabojnik (2006) and Murphy and Zabojnik (2004) argue that the relative importance of transferable talent has increased over

time, as evidenced by the executives' education as well as the increasing frequency of externally hired executives. If so, our model can account for the increase in variable pay over the last few decades (Frydman and Saks (2010)).

4.2 Firm risk

Some firms have more volatile performance (p) than others. According to the model, what is the relationship between the riskiness of the environment and the shape of executive compensaton?

Let more risk be depicted as a mean-preserving spread in the probability density function.

Proposition 3 *Let $f_H(p)$ be a mean-preserving spread of $f(p)$. Then, ceteris paribus, the hurdle price and fixed wage is weakly lower and the expected value of the manager's options is weakly higher under $f_H(p)$ than under $f(p)$. The relationships are strict if*

$$\int_0^{p^h} F_H(p)dp > \int_0^{p^h} F(p)dp.$$

Proof: See Appendix A.

The intuition is simple. Greater uncertainty means that it is relatively more likely that extreme prices are observed. Very low prices do not affect pay, since only a fixed wage is paid out in low states anyway. Very high prices, on the other hand, are associated with large payments to the manager. In order for the total compensation to remain constant, it is thus necessary to reduce the fixed wage.

The result is the opposite of the prediction of classical linear incentive model, which predicts that higher risk entails less variable wage, although the difference narrows if we consider marginal pay. In our model, the marginal pay is constant once the realization of the state exceeds the critical level p^h. Overall, our result is well in line with the empirical absence of a negative relationship between risk and incentives (Prendergast (2002)).

4.3 Firm and manager productivity

To examine the role of changes in productivity, we introduce the new parameter λ and let output be $\lambda q(\tau)$. The productivity parameter λ may reflect technology, organization, or market conditons.

Proposition 4 *Suppose the productivity of managerial talent increases, that is, λ goes up. Then (i) the firm hires a more talented manager and (ii) the manager's options become more sensitive to market demand, that is, $dw^v(p)/dp$ increases.*

Proof: See Appendix A.

The hiring of a more talented manager follows from the previous result that the hired manager's talent is optimal (Proposition 1 (ii)) together with the curvature assumptions on q and $\underline{w}$, which ensure that the optimal solution moves smoothly with parameters. The value of the manager's stock options becomes more sensitive to market demand because the manager's outside option improves when the productivity increases. The effect of increased productivity on the fixed wage is ambiguous, however. On one hand, the increased variable pay reduces the need for fixed pay. On the other hand, the recruitment of a better manager requires an increase in overall pay.

Proposition 4 offers an explanation for why, empirically, the pay-performance sensitivity is greater for managers with better reputation (Milbourn (2003)).

Could the proposition be used to address the relationship between the pay-performance sensitivity and market-to-book value, which has been found to be positive by some authors (Core and Guay (1999); Smith and Watts (1992); Core and Larcker (2002); Frydman and Saks (2010)) and negative by others (Bettis et al. (2010); Yermack (1995))? A theoretical problem here is that the relationship between productivity and the market-to-book value (Tobin's Q) is ambiguous in general, provided that the firm has invested optimally. Specifically, given optimal investment I^*, Tobin's Q in our framework is simply $T = \overline{p}\lambda q(I^*)/I^*$. The optimal investment level is the solution to $\overline{p}\lambda q'(I^*) - 1 = 0$. For example, suppose the production function is $q(I) = I^k$, with $k \in (0,1)$. Then $I^* = (1/\overline{p}\lambda k)^{1/(k-1)}$, and it follows that $T(I^*) = 1/k$. In other words, there is no connection at all between productivity λ and Tobin's Q for this rather general class of production functions.[15]

4.4 CEO pay across countries

The "law and finance" literature has found that access to financing vary across countries due to differences in legal protection of investors. A manager considering leaving a firm to become

[15]For a related criticism of the interpretation of Tobin's Q as a measure of productivity, see Dybvig and Warachka (2010).

an entrepreneur will take into account the financing opportunities of new ventures. Knowing the manager's outside options, the firm's owners in turn adjust the compensation package.

We now analyze the impact of financial constraints on optimal compensation. That is, we violate Assumption (16) and instead assume that I is so large as to produce the inequality[16]

$$\frac{(1-\varphi)I-\gamma}{\varphi} > \underline{w}(\tau^{fb}). \tag{19}$$

Assumption (19) is satisfied when the legal protection of investors is weak (low φ and γ) or a large investment (high I) is needed to start the outside project.

Proposition 5 *If condition (19) holds, then improved investor protection (higher φ or γ) implies that the manager receives less fixed pay w^f, faces a lower hurdle price $\widehat{h}$, and receives more valuable stock options, $E_p[w^v(p)]$.*

Proof: See Appendix A.

The result is consistent with the fact that, compared to managers in other countries, US CEOs receive a larger fraction of their pay as performance pay (Abowd and Kaplan (1999); Conyon et al. (2011); Fernandes et al. (2010)). Note that Kumar et al. (2001) find emprical evidence for a negative correlation between firm size and legal development. Where it is easy for managers to set up their own business, variable pay should be more prominent.

5 Severance pay

Hitherto, we have assumed that the manager will only leave the job for another job in the same industry. Realistically, managers sometimes change industry, especially when the own industry is declining. Such changes are often efficient, as talented managers should be matched with profitable projects. How should the contract be designed to accommodate efficient transitions?

Let $\beta\underline{w}(\tau)$ be the wage offer from a firm in an unrelated industry to a manager with talent τ at date 1, with $0 < \beta < 1$. The manager should leave to another industry if the remuneration in the other industry exceeds the current firm's loss from the manager's departure;

$$\beta\underline{w}(\tau) \geqslant (1-\alpha)pq(\tau)$$

[16]Inequality (19) follows from $\underline{w}(\tau) \geq w^f(\tau)$ (total wage exceeds fixed wage) and $(I+\varphi\gamma)/\varphi q(\tau) > (I + w^f(\tau))/q(\tau)$ (financially constrained manager).

or, equivalently, if

$$p \leqslant p^s = \frac{\beta \underline{w}(\tau)}{(1-\alpha)q(\tau)}.$$

To make the problem non-trivial, assume that $p^s \leq p^h$. In order to induce the manager to leave in the states $p \leqslant p^s$, the contract can give the firm the right to replace the manager, who in exchange is entitled to a severance pay $s = w^f - \beta \underline{w}(\tau)$. Under this contract, separation is efficient and the worker's utility is independent of whether there is separation or not.

Proposition 6 *Suppose an unrelated industry is offering wage $\beta \underline{w}(\tau)$ at date 1 ($0 < \beta < 1$). (i) Then the optimal contract is the same as in Proposition 1, except that in states $p \in [0, p^s]$ the manager leaves the firm and receives a severance pay $s = w^f - \beta \underline{w}(\tau)$. (ii) The likelihood of turnover is higher when the firm's industry is performing badly relative to other industries (p is low) and when the inter-industry portability of human capital, β, is high.*

If the owner has all the bargaining power, the optimal contract's outcome can alternatively be implemented by renegotiating the original contract in states $p < p^s$. In this sense, the model is consistent with the evidence that severance pay is usually awarded on a discretionary basis by the board of directors and not according to terms of an employment agreement (Yermack (2006)).[17] Since it may be difficult to contract explicitly on β, as the manager's best alternative is not always known in advance, discretion may even be strictly preferred.

The feature that severance pay makes up for the loss in expected compensation, $w^f - \beta \underline{w}(\tau)$, rhymes well with Yermack's (2006) interpretation of severance pay data: "boards use severance pay to assure CEOs of a minimum lifetime wage level."

The predicted role of industry performance p on turnover is consistent with the central regularity emphasized by Jenter and Kanaan (forthcoming): They find that CEOs are mostly fired after bad firm performance caused by factors beyond the manager's control, especially when the firm's industry is performing poorly. As Jenter and Kanaan note, this behavior by corporate boards is inexplicable, or suggestive of irrationality, in the incentive provision framework. Once we consider the retention motive, it makes a lot more sense to keep talented managers when the industry performs well and release them (and reduce the level of compensation for the incoming manager) when the industry declines.

[17] Discretionary severance pay is difficult to reconcile with models that emphasize ex ante incentive issues, such as those of Almazan and Suarez (2003), Inderst and Mueller (2010), and Manso (2011). In these models, it is necessary to commit to severance pay in advance.

Likewise, the predicted role of inter-industry portability of the manager's human capital, β, is consistent with the view that increased managerial turnover is related to the increased importance of general, as opposed to firm-specific or industry-specific, managerial skills (Murphy and Zabojnik (2004), Murphy and Zabojnik (2006), Frydman (2005)).

6 Search for uncertain outside opportunities

We have assumed that the manager always knows the value of the outside opportunity, and that the value of the outside opportunity is perfectly correlated with the inside value. In this section, we show that our main insights hold true also if we simultaneously relax both these assumptions. Moreover, our modified set-up allows us to study efficient intra-industry departure and to rationalize caps on total pay.

The model is as before, except for the following changes. In order to identify an outside opportunity, the manager has to pay a positive search cost s at stage 1, after the state p is realized. For example, we might think of searching as a preliminary development effort or contacts with other prospective business partners. Search is observable and verifiable, so contracts can depend on whether it takes place. (The results do not depend on perfect observability; what we need is that it is possible to inflict large enough expected penalties on the seach activity.)

At stage 1, if and when the manager searches, the value of the outside opportunity is uncertain. Its value is $\widetilde{\theta}pq(\tau) - I$, where $\widetilde{\theta} = \theta + \epsilon$, and the stochastic term ϵ satisfies $E[\epsilon] = 0$; we impose no specific distributional assumptions.

6.1 Analysis

For a given outside alternative (realization of $\widetilde{\theta}$), it is efficient that the manager departs if and only if the value of the outside option exceeds the firm's loss from turnover,

$$\widetilde{\theta}pq(\tau) - I \geq (1-\alpha)pq(\tau).$$

The expected gain from search, given that the manager returns in case of bad outcomes is

$$G(p) = E_\theta \left[\max \left((\widetilde{\theta} - (1-\alpha))pq(\tau) - I, 0 \right) \right].$$

Note that $G'(p) > 0$. Searching is efficient if and only if the expected gain exceeds the costs,

$$G(p) \geq s.$$

Define p^{cap} as the threshold $G(p^{cap}) = s$.

Since the manager's compensation equals the ex ante reservation wage, the cost of any inefficiencies will be borne by the owners. Hence, if possible, a wage contract should encourage efficient search and separation. In other words, there should be search if and only if $p \geq p^{cap}$ and separation upon search if and only if $\widetilde{\theta} pq(\tau) - I \geq (1-\alpha) pq(\tau)$. (This condition should also hold off the equilibrium path; the firm cannot commit to behave inefficiently.)

We now describe a contract that implements the optimal outcomes and leaves the manager with an expected remuneration equal to her reservation wage. As before, the contract specifies a fixed wage for all sufficiently low p. The reason is that the expected outside option is so small that it is inefficient for the manager to search, and also so small that the manager is not tempted to search. In the next interval, p is such that this fixed wage is not large enough to discourage search. However, search is still inefficient and should thus be discouraged through the use of variable pay Finally, for sufficiently large p, the outside option is quite likely to be more valuable than the inside option, and the worker should search. Once the state enters this interval, the variable pay remains capped at some maximum value. Specifically, there is an optimal search-contingent contract with the following properties.

Proposition 7 *(i) If the manager does not search, there is an optimal contract $w^{**}(p)$ that pays a linearly increasing state-contingent wage*

$$\hat{w}^v(p) = \min\left[p, p^{cap}\right] \theta q(\tau) - I - \hat{w}^f - s$$

in all states p above threshold state p^s (defined by equation (11)) together with a fixed wage

$$\hat{w}^f = \underline{w}(\tau) - \int_{p^s(\hat{w}^f)}^{p^{cap}} \hat{w}^v(p) f(p) dp - \int_{p^{cap}}^{\infty} \left[p\theta q(\tau) - I - s\right] f(p) dp,$$

in all states.
(ii) If the manager searches, the contract pays the outside option

$$w^r = p\widetilde{\theta} q(\tau) - I$$

if $(\widetilde{\theta} - (1-\alpha)) pq(\tau) - I < 0$, and anything up to $w^{**}(p^{cap})$ otherwise.

(iii) The firm optimally hires a manager with first-best talent, τ^{fb}.

The only important difference compared to the model without search is that there can now be efficient separation. In order to induce the worker to leave when this is efficient, there must be a cap on variable pay. Otherwise, everything is essentially as before. (Hence, we omit the formal proof.) Note that the contractual payments when there is search are the same as the payments that would be negotiated if there were no contract in this case. Thus, a natural interpretation of the model is that it specifies a payment for all states in which the manager does not search, while negotiating new payments in case the manager searches. We might thus think of this case as contract renegotiation.

The model has a number of immediate implications: An increase in the search cost s entails higher fixed pay, lower variable pay, and less turnover; an increase in portability θ increases both variable pay and turnover; and, obviously, an increase in the cost of replacing the manager α reduces turnover. A mean-preserving spread in the uncertain component of the outside option reduces the pay cap, while entailing more turnover as well as more contract renegotiation.

Finally, observe that, for the firm, the prospect of turnover is not at all problematic. To the contrary, the fact that the manager may end up with an attractive outside job simply means that the firm may reduce the fixed wage and thereby appropriate the value of the turnover option. Hence, the model is consistent with the observation that some firms actively encourage key personnel to become entrepreneurs. A recent article in New York Times provides several examples from Silicon Valley where firms attract and keep talent by promising to help workers in setting up their own businesses at a later stage (e.g., by offering advise, to develop business plans, to establish contact with venture capital firms)."At Square, the co-founder and chief executive, Jack Dorsey, who also co-founded Twitter, gives employees 20-minute lessons on topics like how to raise venture capital. Every employee can view Square's product plans and financials to learn about building a business. "It helps people stay but also helps them to go," said Glenn Kelman, Redfin's chief executive." by Clare Cain Miller and Jenna Wortham, New York Times, March 25, 2011.

7 Final remarks

We have argued that many features of managerial compensation can be understood in light of the retention motive: When the manager's outside option does not bind, a fixed salary is

optimal, but when the state is sufficiently favorable, pay must adapt to match the manager's most attractive outside option.

Besides rationalizing the cross-sectional evidence described above, we think that the model offers a plausible explanation for the vast increase in executive stock options over the last few decades (Frydman and Saks (2010)). This movement has gone hand in hand with greater managerial turnover, more exernal recruitment, managers with more general education, and better access to outside financing. In short, stock options has become more important precisely when the managers' outside options are more likely to be binding.

8 Appendix A: Proofs

Proof of Proposition 2: Part (i) follows directly from the fact that the option grant is proportional to θ. To prove (ii), recall that (as long as the manager's participation constraint binds), θ does not affect τ^*.Thus, differentiation of the hurdle price equation

$$h = \frac{I + (1-\theta)w^f}{\theta},$$

yields

$$\frac{dh}{d\theta} = \frac{1}{\theta^2}\left[(1-\theta)\frac{dw^f}{d\theta} - w^f - I\right].$$

We only lack the sign of $dw^f/d\theta$. To find it, differentiate (14) and (15) to get

$$\frac{dw^v(p)}{d\theta} = pq(\tau) - \frac{dw^f}{d\theta}$$

and

$$\frac{dw^f}{d\theta} = -\int_h^\infty \frac{dw^v(p)}{d\theta} f(p)dp,$$

where the second computation uses the fact that $w^v(h) = 0$. Substitute to get

$$\frac{dw^v(p)}{d\theta} = pq(\tau) + \int_h^\infty \frac{dw^v(p)}{d\theta} f(p)dp.$$

To see that this expression is positive, suppose the contrary that it is negative. Since the right-hand side is increasing in p, and p is nonnegative, this would mean that the integral is

negative. But since $f(p)$ is a probability density function, the integral cannot be smaller than $dw^v(h)/d\theta$, and hence the equation is violated at $p = h$. Having shown that $dw^v(p)/d\theta > 0$ for all p, it follows that $dw^f/d\theta < 0$, and hence that $dh/d\theta < 0$.

Proof of Proposition 3: First consider the effect on expected performance pay. To show that expected performance pay is increasing in an MPS we need to show that

$$\int_{p^h}^{\infty} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f_H(p)dp > \int_{p^h}^{\infty} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f(p)dp. \tag{20}$$

By assumption (16), we have

$$p^h = \frac{I + w^f(\tau)}{q(\tau,\theta)}.$$

Observe that

$$\begin{aligned}
\int_{p^h}^{\infty} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f(p)dp &= \int_0^{\infty} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f(p)dp \\
&\quad - \int_0^{p^h} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f(p)dp \\
&= \overline{p}q(\tau,\theta) - I - w^f(\tau) \\
&\quad - \int_0^{p^h} \left(pq(\tau,\theta) - I - w^f(\tau)\right) f(p)dp \\
&= \overline{p}q(\tau,\theta) - I - w^f(\tau) + q(\tau,\theta)\int_0^{p^h} F(p)dp.
\end{aligned} \tag{21}$$

The last equality follows from integration by parts. By deriving the analogous expression for f_H, it follows that inequality (20) holds if $\int_0^{p^h} F(p)dp \leq \int_0^{p^h} F_H(p)dp$, which is a consequence of the definition of F_H. The inequality (20) is strict if $\int_0^{p^h} F(p)dp < \int_0^{p^h} F_H(p)dp$. Recall that Assumption (2) implies that the participation constraint is binding. Because the expected performance pay is increasing in an MPS (for a fixed $w^f(\tau)$), $w^f(\tau)$ decreases until the manager's participation constraint (15) is again binding. Hence the expected performance pay is increasing, and $w^f(\tau)$ and the corresponding hurdle price $(I + (1-\theta)\, w^f(\tau))/\theta$ are decreasing in an MPS.

Proof of Proposition 4: For part (ii) to hold, we require $d^2w^v/dpd\lambda > 0$ for $p \geq p^h$. From equation (14) we have

$$\frac{dw^v}{dp} = \lambda q(\tau),$$

and it follows that

$$\frac{d^2w^v}{dpd\lambda} = q(\tau) + q_\tau(\tau)\frac{d\tau^*}{d\lambda}.$$

Since both $q(\tau)$ and $q_\tau(\tau)$ are positive, part (ii) follows if part (i) holds. Differentiating (17) with respect to τ^*, we have

$$\frac{d\tau^*}{d\lambda} = -\frac{\overline{p}q_\tau(\tau)}{\overline{p}\lambda q_{\tau\tau}(\tau) - \underline{w}_{\tau\tau}(\tau)} > 0.$$

And since the denominator is negative by (18), part (i) holds.

Proof of Proposition 5. Recall that the hurdle price is

$$\widehat{h} = \frac{I - \varphi\gamma - \varphi\theta w^f}{\varphi\theta},$$

which is decreasing in φ and γ for a fixed w^f. Hence, the expected performance pay, $\int_{p^h}^{\infty} w^v(p,\tau)f(p)dp$, is increasing in φ and γ for a fixed $w^f(\tau)$. Since the manager's participation constraint is binding, $w^f(\tau)$ must decrease as expected performance pay increases (equation (15)). Hence improved legal protection (increased φ and γ) reduces the hurdle price, $\widehat{h}$, and fixed pay, $w^f(\tau)$, while raising the expected performance pay, $\int_{p^h}^{\infty} w^v(p,\tau)f(p)dp$.

9 Appendix B: Risk-averse manager

The manager is risk averse with utility function $u(w)$, $u'(w) \geq 0$, $u''(w) \leq 0$. Owners are risk neutral and offer a wage, $w^r(\tau, p)$ to attract the manager at date 0 (ex ante participation constraint) and to retain the manager after p is realized (ex post participation constraint).

The manager has a profitable outside project if and only $p \geq \frac{I}{\theta q(\tau)}$ and the manager will have incentives to repay investors if

$$u\left(\theta pq(\tau) - I\right) \geq u((1-\varphi)\theta pq(\tau)) - \varphi u(\gamma). \tag{22}$$

This is the risk-averse version of inequality (7). Let p^r be the lowest value satisfying (22). The manager has a profitable and fundable project if $p \geq \hat{p} = \min\left[p^r, \frac{I}{\theta q(\tau)}\right]$.

Consider $p \geq \hat{p}$. Observe that the managers will not depart as long as she receives a wage $w^r(\tau, p)$ satisfying

$$u(w^r(\tau,p)) \geq u\left(\theta pq(\tau) - I\right),$$

or simpler

$$w^r(\tau, p) \geq \theta pq(\tau) - I, \tag{23}$$

for all $p \geq \hat{p}$. Observe that linear inequality (23) is the same as (5) (with a risk-neutral manager).

The owners cost minimization problem given manager talent τ is

$$\min_{w^r(p,\tau)} E_p \left[w^r(p, \tau) \right]$$

subject to the retention constraint (23) and the ex ante participation constraint

$$u(\underline{w}(\tau)) \leq \int_0^\infty u(w^r(p, \tau)) f(p) dp.$$

It follows that unless the linear inequality (23) is binding, the manager receives a fixed wage. If the linear inequality is binding, the wage is linearly increasing in p such that the variable pay is minimized and the manager stays.

Since the manager receives an expected wage equal to her reservation wage and the owners capture the net surplus, the owners recuite first-best talent, τ^{fb}. To summarize;

Proposition 8 *(i) The optimal contract to a risk-averse manager, $w^{r*}(p)$, is given by the sum of a linearly increasing state-contingent wage*

$$w^{vr}(p) = \theta pq(\tau) - I - w^{fr} \tag{24}$$

that is paid out only in good enough states $p \geq p^{hr}$, and a fixed wage,$w^{fr}(\tau)$, such that

$$u(\underline{w}(\tau)) = \int_0^\infty u(w^{vr}(p) + w^{fr}(\tau)) f(p) dp, \tag{25}$$

that is paid out in all states p.
(ii) The hurdle price is set such that the outside opportunity in fundable and better than only receiving the fixed wage only

$$p^{hr} = \max \left[p^r, \frac{I + w^{fr}}{\theta q(\tau)} \right].$$

(iii) The firm optimally hires a manager with first-best talent, τ^{fb}.

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