

Competitive Compensation Contracts*

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Abstract

We develop a model of equilibrium compensation contracts in a competitive market for heterogeneous workers. The eventual value of a match depends on the fortunes of the employer's industry, and turnover could be efficiency-enhancing. Applying the theory of contracts as reference points, we demonstrate that ex ante contracting entails better insurance than does ex post renegotiation and that predicted contract terms closely resemble observed terms. For example, salaries constitute lower bounds on pay, salaries are combined with non-indexed stock options when industry conditions are uncertain and employees possess much portable industry-specific human capital, severance pay is discretionary, and hedging of stock-options is permitted.

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1 Introduction

There is a widespread suspicion that top managers and other key personnel are overpaid. One reason for the suspicion is that such employees are often lavishly rewarded when the firm is lucky, yet not correspondingly penalized when the firm is unlucky (e.g., Hermalin and Weisbach, 1998, Bertrand and Mullainathan, 2001, Garvey and Milbourn, 2006, and Bell and van Reenen, 2016). Indeed, high salaries regularly constitute lower bounds on pay; even when these employees quit or are fired, they frequently receive discretionary severance pay that compensate for the anticipated pay reduction in subsequent employment (e.g., Yermack, 2006).¹ Here, we argue that asymmetric rewards and discretionary severance pay, as well as several other controversial features of common compensation contracts, are not necessarily evidence of corruption or inept compensation committees. Instead, these compensation practices may be natural outcomes of fierce competition for scarce talent, as previously suggested by, among others, Rosen (1992), Holmström and Kaplan (2003), Oyer (2004), and Hubbard (2005).

To articulate our argument, we construct a model of a competitive labor market comprising both specialists and non-specialists. A specialist is defined as a worker whose skills are specific to an industry and possibly even to a firm. Specialists may be craftsmen, traders, or managers – as long as their particular craft or managerial skill is sufficiently specific. In the model, industry-wide shocks do not affect the market value of non-specialists, who thus receive a fixed salary in equilibrium. However, the market value of specialists will be volatile. Therefore employers will design compensation contracts to shield their employed specialists against movements in the market value of their services, while facilitating efficient recruitment and turnover. When providing insurance for specialists, two factors are crucial. On the one hand, specialists' firm-specific skills constrain mobility. On the other hand, an employed specialist may be unable to commit to stay with the employer or to compensate the employer for leaving in the presence of attractive outside options. Firm-specific skills facilitate risk-sharing, whereas limited commitment in combination with economic fluctuations hinder it.

When specialists are sufficiently immobile and the industry is sufficiently stable, the equilibrium contract is a flat salary. This contract provides maximal income insurance. But if mobility is greater or industry conditions are less stable, retention of a specialist requires higher pay in good states. A crucial question is whether such flexibility could be efficiently provided through renegotiation. We argue that the answer is negative. Even if parties have complete information and are always able to find ex post acceptable arrange-

¹For an extensive critique of excessive pay based on these and related observations, see Bebchuk, Fried, and Walker (2002) and Bebchuk and Fried (2009).

ments, these arrangements are unlikely to be ex ante optimal. Specifically, we employ a version of the “contracts as reference points” theory pioneered by Hart and Moore (2008) and Hart (2009). The theory has two central components. First, a party that considers the contract to be unfair will react by under-performing (engage in shading). Second, the fairness of a contract is ascertained according to how it splits the surplus *as viewed from the date of agreement*. Thus, the terms of a mutually agreed contract might be considered fair ex post by a party that was well treated ex ante, even if the terms turn out to be relatively unfavorable in the realized state of the world. On the other hand, the same terms might be considered unfair if they are reached through renegotiation after the state has materialized. For experimental evidence that contracts serve as reference points in this way, see, e.g., Fehr, Hart, and Zehnder (2009, 2011, 2015) and Bartling and Schmidt (2015).²

Since adverse responses to an unfair renegotiation outcome are only relevant when the relationship continues, the model predicts that there will be rent-sharing when renegotiation produces retention, but not when it produces separation.³ Perhaps most importantly, even if optimal renegotiation outcomes are such that they never trigger any shading, a state-contingent contract is always preferable to a sequence of spot-contracts, because the state-contingent contract enables greater insurance.⁴

Overall, the model rationalizes the following commonly observed features of specialists’ compensation contracts and turnover:⁵

1. Contracts have a fixed salary component, and total pay is never below this salary.
2. If the specialist’s market value is reliably linked to a verifiable measure, for example to the firm’s stock market value, the contract offers linear variable pay above a performance threshold – for example a stock option.
3. The performance component is rarely indexed and thus does not filter out the impact on pay of macroeconomic or industry-wide shocks.
4. The performance component’s magnitude depends on the specialist’s expected mobility.

²This is not to say that more complete contracts are always beneficial. For experimental evidence of benefits from (increased) contractual incompleteness when contracts cannot be perfectly complete and need to rely on bounded punishment see, e.g., Fehr and List (2004) and Brandts, Charness, and Ellman (2016).

³This prediction is quite different from a model in which bargaining power is a personality trait.

⁴Fudenberg, Holmström, and Milgrom (1990) provide general conditions under which an optimal long-term contract can be mimicked by a sequence of short-term contracts. It is an interesting open question whether an analogous result holds under the “contracts as reference points” assumption.

⁵We provide extensive references to the relevant empirical literature below.

5. Employers offer discretionary severance pay.
6. Turnover of specialists is typically related to relatively poor performance of the whole industry rather than firm-specific performance.

To clarify the mechanisms behind our results, let us give a more detailed intuitive account of the main steps of the argument. The analysis is conducted within a simple competitive labor market model. There are several industries. Firms are homogeneous within an industry. Specialists differ in their industry-specific abilities, but are more similar *ex ante* than after acquiring industry-specific experience. Employees are recruited for two periods. A contract is signed at the beginning of the first period of employment and then potentially renegotiated at the beginning of the second period, upon the realization of industry-wide economic shocks. We assume that all information is symmetrically held.

Employees are more risk-averse than employers. Absent shirking problems or outside competition, the best compensation contract would thus be a fixed salary and no other payment. More generally, the ability of firms to commit to a long-term fixed salary – rather than being confined to offer short-term contracts – is a source of welfare gains in our model. However, fixed salary contracts imply that workers might be substantially overpaid in some states of the world, and firms would be tempted to renege on their promise. Institutions that prevent firms from reneging on their salary promises in bad states are thus crucial to the implementation of such socially valuable contracts.⁶

Another obstacle to income insurance through flat salary contracts is that laws against involuntary servitude prevent the use of penalties. Thus, the employer must reward employees for staying rather than penalizing them for leaving. At first sight, it would seem that the employer might then be best off by simply adjusting the salary upwards as attractive external offers arrive. This is the outcome of the classical model of Harris and Holmström (1982). In their environment of exogenous outside offers, the adjustable salary mechanism exposes the employee to the minimum income risk subject to free *ex post* mobility. However, our environment differs from that of Harris and Holmström (1982) in a crucial way. Due to the accumulation of firm-specific skills in the first period, the worker will be strictly better matched with the current employer than with any other employer in the same industry. While the employer will outbid same-industry competitors, contract renegotiations allow the worker to bargain for some of the firm-specific surplus. If the employee has any bargaining power at all, the renegotiated compensation will be strictly above the outside option. Hence, renegotiation imposes greater pay variability than an optimal contract with explicitly variable pay.

⁶It is noteworthy that the vast majority of CEO employment contracts are for a fixed term, thus circumventing the “at-will” legal default; see Schwab and Thomas (2006).

Optimal turnover requires that the worker is allowed to leave when the outside match is better than the original match, and – perhaps less obviously – that the worker is *paid to leave* when the current match is bad and worse than the outside match. While a complete contract would specify the amount of severance pay for each such state of the world, we argue that it is superfluous to contract on these states in advance. Since the employee neither has a credible threat to leave and reap a higher income than under the contract nor can express dissatisfaction by exerting less effort, the employer naturally has all the bargaining power in severance pay negotiations. Thus, discretionary severance pay emerges as an optimal device for attaining efficient separation in the case of poor industry performance. (Discretionary severance pay would not be optimal if we were to assume that workers have bargaining power under separation as well as under retention.)

In addition to explaining the basic features of employment contracts that we observe in practice, the model admits a variety of comparative static results, and these results too are broadly in line with available evidence. For example, the model predicts that the inter-firm portability of an employee’s skills is the main determinant of the magnitude of variable pay. The model is also consistent with the observation that the relative importance of variable pay is frequently greatest in industries with much uncertainty, another finding that is difficult to square with effort-inducement models.

Although we primarily focus on the case in which outright bonding is illegal, in the sense that the employer cannot penalize an employee for leaving, we also observe that there are important segments of the labor market in which bonding can be legally attained with the help of outside markets – and we argue that some observed pay practices can be understood in this light. Specifically, the stock-option packages that are often offered to executives and other key personnel can have desirable bonding properties. Under the following special circumstances, we show that a stock-option package can even implement the perfect bonding outcome: (i) the employee will optimally remain matched with the original employer; (ii) the best outside offer will come from another firm whose match-value is closely correlated with that of the original employer; and (iii) the employee is allowed to trade the options in a frictionless financial market.⁷ The model thus offers an explanation for why firms permit managers to “undo the incentive effects” of their performance pay packages through options trading, a phenomenon that is often considered to constitute definite evidence of managerial rent extraction (Bebchuk, Fried, and Walker, 2002).

⁷This environment is special, but familiar. Conditions (i) and (ii) are fulfilled by the model of Harris and Holmström (1982).

2 Related Literature

The literature on optimal compensation contracts is huge. Yet, besides Harris and Holmström (1982) there are only a handful of closely related contributions. Most of the contracting literature focuses on effort incentives within a relationship, neglecting the issue of worker mobility. That is, it primarily studies the bilateral relationship between a single employer and a single employee, with market forces determining the average level of pay but otherwise playing a subordinate role.⁸ It is also typically concerned with explaining the strength of incentives rather than the contracting process and the precise contractual shape. For example, very few models attempt to explain why contracts comprise both pay floors and linear performance pay components.

A notable precursor to our work is Holmström and Ricart i Costa (1986). There too, optimal compensation takes the form of an option contract, with the fixed salary being due to the employee's risk aversion and the variable pay being due to the employee's inability to commit to staying with the current employer when outside opportunities become attractive. However, where Holmström and Ricart i Costa emphasize uncertainty about employee characteristics, we emphasize uncertainty about future market conditions. Therefore, we are able to address many empirical regularities regarding which their model is silent. For example, we can explain why plain stock options are used to reward employees whose talents are well known and whose effort does not greatly affect the value of the firm; in their model, the option is instead tied to what is revealed about the specific skills of individual employees, for which the stock price is typically a less precise indicator.⁹ Another difference is that Holmström and Ricart i Costa assume that mobility barriers are absent. Without any benefit from retention, the magnitude of their fixed wage component is bounded by the principal's ability to extract surplus from the employee through low pay in an initial period. In our model, the magnitude of the fixed wage is instead largely driven by the size of the mobility barrier, and can thus attain a more realistic size. Apart from Holmström and Ricart i Costa (1986), we are not aware of any previous model that explains why employees are paid a combination of fixed salary and non-indexed stock options.¹⁰

⁸See, for example, the surveys of Murphy (1999) and Lazear and Oyer (2012).

⁹In Holmström and Ricart i Costa (1986) the option value will be linear in the stock price when there is a strong impact of worker's ability on the firm's value, which is only true for exceptionally important employees.

¹⁰Models that attempt to explain how option packages vary with firm and market conditions, such as Johnson and Tian (2000), exogenously impose a combination of salary and options. Among previous theoretical models of compensation contracts that consider the retention motive, Hashimoto (1979) and Blakemore et al. (1987) assume that contracts are piece-wise linear. Oyer (2004) and Giannetti (2011) assume linear contracts. Dutta (2003) derives a linear contract from first principles. All three thus fail to account for the lower bound to payments. Finally, Pakes and Nitzan (1983) examine how contracts

In other respects, our work is most closely related to Oyer (2004), who also explains why performance pay is non-indexed and often extends to many employees rather than just the top management. Like us, Oyer argues that contracts may link pay to the firm's performance because both the firm's performance and the employees' outside options are likely to be correlated with industry performance (or more generally with macroeconomic conditions). If the main purpose of the contract is to ensure retention, the contract should not be indexed. Furthermore, Oyer argues that firms prefer to contractually commit to pay for performance rather than negotiating pay increases as outside offers arrive. However, the details of the latter argument are quite different from ours. Oyer emphasizes how a long-term contract avoids renegotiation costs *ex post*, whereas we instead focus on reduced pay variability. But there are two more important differences that make our model more general than Oyer's.¹¹ First, we do not restrict the shape of compensation. Oyer assumes that contracts are linear. Thus, by construction, he does not account for the lower bound to compensation that the combination of salary and options implies. Second, we model the whole labor market rather than just the problem facing a single firm that tries to retain workers. Among other things, we are thereby able to explain turnover and severance pay. Our two generalizations thus contribute substantive new results while at the same time confirming the robustness of Oyer's main insights.

The role of portable human capital has also recently been studied in the literature on relational contracting. For example, Kvaløy and Olsen (2012) argues that increased portability tends to favor individual incentives over group incentives, and will sometimes yield individual pay that is driven by outside options rather than inside contributions.

Finally, our work is complementary to the literature on matching and compensation of executives, such as Gabaix and Landier (2008), Terviö (2008), and Edmans, Gabaix, and Landier (2009). That literature also studies the compensation of employees with heterogeneous skills. However, the emphasis is on the equilibrium level of pay and on the matching of specialists within an industry composed of heterogeneous firms, whereas we instead focus on the shape of the compensation contract and neglect intra-industry firm heterogeneity.

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 new employers.

¹¹This is not to claim that our model nests Oyer's as a special case. There are additional differences. However, we believe that these are not crucial for the ensuing comparison.

3 The Model

There is a set F of risk-neutral firms and a set J of risk-averse workers. Workers are employable for two periods, but only produce in the second period; the first period can be thought of as training. Training is costless for both the employer and the employee.

There are n industries. Let I denote the set of industries. We assume that each firm can only operate projects in a single industry. We assume that a worker can switch employer (and even industry) between period 1 and period 2.

Tasks, technologies, and industries. There are two kinds of tasks. One kind is sensitive to employees' skills, the other kind is not. We refer to these tasks as specialized and general, respectively. As will become clear, performance-related compensation contracts will only be valuable in the case of workers that conduct specialized tasks. (Note that this distinction between specialized and non-specialized tasks is conceptually very different from the distinction between high-impact and low-impact employees.)

Firms have Leontief production functions.¹² Let J_f be the set of workers employed by firm f , of whom J_f^s are assigned to the specialized task and J_f^g to the general task. Firm f in industry i thus produces output

$$Q_{fi} = \min \left\{ \sum_{j \in J_f^g} e^j, \sum_{j \in J_f^s} e^j x_i^j \right\}, \quad (1)$$

where, x_i^j is the productivity of employee j in the firm's specialized task (all workers have the same productivity, normalized to 1, in the general task), and $e^j \in \mathbb{R}_+$ is employee j 's effort.

Uncertainty. Each firm takes the output market price p_i as given. Due to variation in demand, output prices are ex ante uncertain. Let realized prices be denoted $p = (p_1, p_2, \dots, p_n)$. We assume that p is observable and verifiable. Let $h(p)$ denote the distribution of p , with H denoting the cumulative distribution.

Worker abilities. Workers have different innate abilities regarding the specialized tasks. Worker j 's productivity in the specialized task of industry i , x_i^j , is determined by innate ability and by practice. The innate ability of worker j in industry i is denoted $a_i^j \in \mathbb{R}$. Note that we allow abilities to be negative; specialized tasks are difficult, and an unqualified employee could do harm. Worker j 's innate ability profile is denoted $a^j = (a_1^j, \dots, a_n^j)$. Think of $x_i^j = a_i^j$ as the productivity of worker j with only general job training in an industry $k \neq i$. When the worker remains in the original industry,

¹²We could allow more flexible functional forms, but this would make the analysis more complex without substantial new insights.

say in industry ι , and with the original employer, the productivity instead increases to $x_\iota^j = a_\iota^j(1 + \kappa)$, with $\kappa > 0$, as the worker has obtained specialized training.

While innate abilities are perfectly transferable across firms, we assume that acquired skills are only partially portable.¹³ Let $\theta\kappa$ denote the acquired skill that is portable to other firms in industry ι , with $\theta < 1$. The worker's firm-specific productivity is thus $a_\iota^j(1 - \theta)\kappa$. We assume that there is no portability across industries.

Refer to $\hat{a}^j = \max_i \{a_i^j\}$ as the worker's strongest ability.

Definition 1 *A worker j is said to be talented if and only if $\hat{a}^j > 0$.*

In other words, only those workers are labelled talented whose employment in a specialized task might contribute to raise output. Let \hat{J} denote the set of talented workers. We assume that this set is relatively small.

Assumption 1 $\sum_{j \in \hat{J}} (1 + \kappa)\hat{a}^j < |J| - |\hat{J}|$.

As will soon be evident, this assumption ensures that there is always a deficit of talented workers relative to specialized jobs. For simplicity, we assume that non-specialists do not need to be employed in period 1 in order to be productive in period 2; they simply need the first period to mature.¹⁴ Productivity and its components, talent and training, are commonly observable.

Worker preferences. Let r^j denote the total remuneration that worker j receives. Workers care about remuneration and effort according to the utility function

$$U^j = u(r^j) - c(e^j, \beta). \quad (2)$$

The function $u(\cdot)$ is increasing and strictly concave.¹⁵ As in Holmström and Milgrom (1991), we assume that the effort cost function $c(\cdot)$ is strictly convex in e , initially decreasing and eventually increasing. Thus, a worker prefers to exert some positive amount of effort when employed, even without any material incentive.

The “non-standard” element of the utility function is β , which indicates how well the worker likes the employer. Here, we assume that β is determined by how generously the

¹³Portability of human capital is affected both by technology and institutions; for empirical illustrations and relevant references see, for example, Groysberg, Lee, and Nanda (2009) and Marx, Strumsky, and Fleming (2009).

¹⁴This assumption saves us from keeping track of the period 1 employment of non-specialists. In a more dynamic model, the natural alternative assumption would be that non-specialists are productively employed in both periods.

¹⁵As usual, we imagine that all consumption takes place “at the end.” While it is feasible to model the interaction between compensation contracts and intertemporal consumption decisions, tractability tends to require strong assumptions. For example, Harris and Holmström (1982) assume that utility is time-separable and that workers cannot save or borrow.

employer treats the worker in negotiations. Specifically, let β denote the share of available (quasi-) rents that the employer offers to the employee.¹⁶ But rather than pursuing a general analysis of reciprocity, we follow the example of Hart and Moore (2008) and study negative reciprocity only. Specifically, we impose the simplification

$$U^j = u(r^j) - c(g(\beta)e^j), \quad (3)$$

where,

$$g = \begin{cases} g_N & \text{if } \beta \geq \underline{\beta}; \\ g_A & \text{if } \beta < \underline{\beta}; \end{cases} \quad (4)$$

and $0 < g_N < g_A$. The value g_A indicates that the worker is aggrieved. In the tradition of Hart and Moore (2008) and Fehr, Hart and Zehnder (2009, 2011), we assume that the worker feels aggrieved if and only if the employer, when negotiating compensation, offers the worker a fraction of the relevant gains from trade that is smaller than some level $\underline{\beta} > 0$.¹⁷

We choose the function c such that the minimizer of $c(g_N e)$ is $e_N = 1$. It follows that the minimizer of $c(g_A e)$, call it e_A , satisfies $e_A < 1$.¹⁸ The following assumption guarantees that the employer will want to avoid triggering grievance.

Assumption 2 $\underline{\beta} < 1 - e_A$.

Profits. From (1) it follows that a profit-maximizing firm will minimize costs by setting

$$\sum_{j \in J_f^g} e^j = \sum_{j \in J_f^s} e^j x_i^j.$$

Since there is never any quasi-rent to be shared with individual employees in the general task, there is no reason for grievance; hence we anticipate that $e^j = 1$ for employees in the general task. Let w_g denote the compensation of non-specialists and w^j denote the compensation of specialist j . The profit of a firm is then

$$\pi_{fi} = (p_i - w_g) \sum_{j \in J_f^s} e^j x_i^j - \sum_{j \in J_f^s} w^j. \quad (5)$$

Match surplus. From now on, we drop scripts j and f whenever it is clear that we talk about a single specialist. Let i_t denote the industry of a worker's employer in period

¹⁶A natural general assumption would be $c''_{e,\beta} < 0$.

¹⁷In the original Hart-Moore model, parties feel aggrieved if they do not obtain the *maximal* outcome that is feasible under the contract. Here, that would mean that workers are aggrieved if they do not receive all the gains from trade; i.e., $\beta = 1$.

¹⁸Consider for example $c = (1 - ge)^2$, with $g_N = 1$ and $g_A = 2$.

t. Throughout, when we refer generically to i_1 , we let $i_1 = \iota$.

Using (5), we define the (gross) surplus that is generated by a matched specialist, and how it depends on where the specialist spends period 2. If the specialist remains in the initial industry (industry ι), the surplus is

$$S_\iota(p_\iota) = (p_\iota - w_g)ea_\iota(1 + \kappa) \quad (6)$$

if the specialist remains with the original employer and

$$\tilde{S}_\iota(p_\iota) = (p_\iota - w_g)ea_\iota(1 + \theta\kappa) \quad (7)$$

if the specialist moves to another employer in the same industry. For industries $i \neq \iota$, the specialist generates a match surplus

$$S_i(p_i) = (p_i - w_g)ea_i. \quad (8)$$

Let

$$\bar{S}_\iota(p) = \max\{\max_{i \neq \iota}\{S_i\}, S_\iota, 0\}, \quad (9)$$

denote the surplus associated with the best possible matching of specialist j in state p , and let

$$\hat{S}_\iota(p) = \max\{\max_{i \neq \iota}\{S_i\}, \tilde{S}_\iota, 0\}, \quad (10)$$

denote the best outside option for specialist j in state p .¹⁹ Finally, let

$$T_\iota(p) = S_\iota - \hat{S}_\iota \quad (11)$$

denote the gain from trade that is reaped if the specialist remains with the original employer instead of leaving.

Define the surplus-maximizing task assignment in period 2 given assignment ι in period 1:

$$i_2^*(\iota) = \arg \max_i (p_i - w_g)(1 + 1_\iota k)a_i, \quad (12)$$

where 1_ι is an indicator function taking value 1 if the specialist is assigned to the same firm in both periods and 0 otherwise. The expected surplus, given that the worker is initially assigned to industry ι and subsequently assigned to $i_2^*(\iota)$, is $E[\bar{S}_\iota]$. (Only the prices p are stochastic, so we suppress the argument on E .) The optimal assignment in

¹⁹Here we assume that unemployment is the outcome in case a talented worker ends up with not having valued specialized skills; alternatively, we might have assumed that talented workers are preferred in general jobs, in which case the relevant pay would be w_g instead.

period 1 maximizes the expected surplus in the second period,

$$i_1^* = \arg \max_i E [\bar{S}_i]. \quad (13)$$

Let the expected surplus given optimal assignments in both periods be denoted

$$S^* = E [\bar{S}_{i_1^*}]. \quad (14)$$

Contracts. Throughout, we assume that effort is not explicitly contractible. However, assignment and pay is contractible to variable degrees. Let $j_t \in F$ denote the employer of worker j in period t . By definition, a contract accepted in period t implies employment in period t . For the period 1 contract, we consider the following five cases, in decreasing order of contracts' complexity and the parties' strength of commitment.

1. *Unconstrained contracts.* An unconstrained contract specifies a wage $w(a, p, j_2) \in \mathbb{R}$. Note that pay can be negative, and that it may be positive even in case the worker does not remain with the initial employer. We think of unconstrained contracts as a benchmark rather than a realistic description of actual contracts.
2. *Bounded contracts.* A bounded contract specifies a wage $w_b(a, p, j_2) \geq \lambda$. Thus, the difference between a bounded contract and an unconstrained contract is that the bounded contract has a lower bound λ on pay. When $\lambda = 0$ (as we will assume), this can be interpreted as a no-servitude law; in our context the lower bound matters because it precludes the employer from imposing fines (transfer fees) on workers who leave the firm.
3. *Simple performance contracts.* The simple performance contract is a bounded contract that specifies a state-contingent wage $w_c(a, p_f, j_2 = j_1)$ that is non-negative if the worker remains with the firm and zero otherwise. In addition to being bounded below, the wage depends only on the profitability of the firm and on whether the worker is assigned to the firm or not.
4. *Fixed-salary contracts.* In this case, the firm commits to make the same payment, w_a , in all states – as long as the worker remains with the firm in period 2; otherwise the pay is zero.
5. *Spot contracts.* In this case, the firm offers only a short-term contract at date 1. That is, it commits to pay w_s in all states, regardless of whether the worker stays in period 2 or not.

In addition to the contracts that are agreed before the resolution of uncertainty, we allow renegotiation and new contracts to be signed after p is realized. Since the state is known at this stage, the renegotiation offer only depends on where the employee works. In general, we allow the renegotiation offer to be any real-valued function $w_r(i_2)$. For the cases 3 and 4, this implies that renegotiation enables outcomes that could not be specified in the initial contract. For example, the renegotiation offer might pay out positive amounts even when the worker does not stay.

Timing and information. Our results are not very sensitive to the exact timing of offers, but the complexity of the analysis is. We choose the timing that admits the most straightforward analysis.

1. Contracting:

- (a) Firms propose contracts to as many talented workers they like.
- (b) Each talented worker receiving an offer decides one and only one offer to accept.

2. Competition and turnover:

- (a) The state p is realized.
- (b) Firms make new offers to their current specialists.
- (c) Firms make new offers to other talented workers.
- (d) Each talented worker decides which of the new offers to accept (thus becoming a specialized employee).
- (e) All unmatched workers supply non-specialized services; the wage for the general task, w_g , is determined in a competitive (Bertrand) fashion.

3. Workers exert effort and are paid:

- (a) Each specialist decides how much effort to exert.
- (b) All workers are paid according to the agreed contracts.

We assume that the history is common knowledge among all players. In particular, at Stage 2c firms know which offers were made at Stage 2b.

4 Analysis

We seek to characterize the subgame-perfect equilibrium outcome(s) of this game under various assumptions about the set of available contracts. However, before doing so, let us characterize the optimal outcomes.

4.1 Optimal outcomes

It is easily seen that a first-best outcome requires an assignment of each talented worker that maximizes that worker's expected surplus $E[S]$ while simultaneously providing complete insurance.

Proposition 1 (*First-best*) *An outcome is first-best only if: (i) the assignment of each talented worker satisfies (i_1^*, i_2^*) and (ii) each talented worker's remuneration is fixed, i.e., r is independent of p .*

Proof. See Appendix. ■

This result borders on the trivial. Since firms are risk-neutral, workers ought to be maximizing expected output, with firms carrying all the risk.

The harder question concerns the social arrangements that are needed to sustain such a high degree of insurance. In particular, under what conditions will a competitive market provide it? We now seek to answer this question.

4.2 Worker effort and contract renegotiation

In order to characterize subgame-perfect equilibria, the analysis starts at the last stage and moves backwards.

Stage 3. If the prevailing contract was determined by an offer that granted the employee at least a fraction $\underline{\beta}$ of the available surplus at the time the contract was signed, the employee exerts effort $e = 1$; otherwise, $e = \underline{e}$. (As we shall see, if the prevailing contract was signed at Stage 1, the employee will usually have been offered all the available surplus at that stage. Likewise, if an employee switched employer at Stage 2, the specialist will have obtained all the surplus. Thus, shading of effort will only be a potential concern if the current contract was proposed during renegotiation with the initial employer at Stage 2.)

Stage 2e. Due to Assumption 1, we know that there is an excess of non-specialist workers regardless of the contracting outcome involving talented workers. Hence, the unique competitive wage for the general task equals the workers' reservation value. That is, $w_g = 0$.

Stage 2d. Since workers only care about consumption, each talented worker accepts the offer (one of the offers) that yields the highest total pay.

Stage 2c. At this stage, there is Bertrand competition for talented workers. Consider any talented worker j who either does not hold an offer or who holds an offer that is below \hat{S}_t . Then, by the standard Bertrand logic, in any subgame-perfect pure-strategy equilibrium, at least two firms will make offers of exactly \hat{S}_t .

Stage 2b. Consider an incumbent specialist in firm f . Let $w_{inc} = w(p, f) - w(p, f')$ denote the net pay that is specified by the incumbent employer's contract if the employee stays rather than leaves. (If there is no long-term contract, we say that $w_{inc}(p) = 0$.) By the analysis of Stage 2c, we know that the worker will only be retained if $S_i \geq \hat{S}_i$. Two cases require some analysis, because they involve renegotiation.

Case (i) (Paying to retain): $S_i > \hat{S}_i > w_{inc}$. In this case, the employed specialist is worth more at the incumbent firm than outside, but will not stay in the firm under the current contract. In making a new offer, the employer has two main alternatives: Either pay just enough for the specialist to stay, but shade on effort, or pay enough for the specialist to stay and not shade. Recall that $T_i = S_i - \hat{S}_i$. If the incumbent employer offers a new level of pay $w' \geq \hat{S}_i + \underline{\beta}T_i$, the specialist will stay and exert effort $e_N = 1$. Since effort is constant for these offers, and they suffice to beat outside competition, the best such offer is $w^{js} = \hat{S}_i + \underline{\beta}T_i$, yielding a profit $(1 - \underline{\beta})T_i$. If the incumbent employer instead offers $w' \in [\hat{S}_i, \hat{S}_i + \underline{\beta}T_i)$, the specialist will stay and exert effort \underline{e} . Since the effort level is insensitive to the exact offer in this interval, we only need to consider the offer $w' = \hat{S}_i$. This offer yields a profit for the firm of $\underline{e}S_i - \hat{S}_i$. Comparing the two profits, it is a straightforward computation to see that

$$(1 - \underline{\beta})T_i > \underline{e}S_i - \hat{S}_i$$

if and only if

$$\underline{\beta} < \frac{S_i}{S_i - \hat{S}_i}(1 - \underline{e}).$$

This condition always holds because $S_i \geq 0$, $\hat{S}_i \geq 0$, $S_i - \hat{S}_i > 0$, (hence $S_i/(S_i - \hat{S}_i) > 1$), and $\underline{\beta} < 1 - \underline{e}$ (by Assumption 2). Hence we have established that in this case, the equilibrium (net wage) renegotiation offer by the incumbent employer is

$$w_r = \hat{S}_i + \underline{\beta}(S_i - \hat{S}_i), \tag{15}$$

where we let the subscript r indicate that this is the renegotiated wage.

Case (ii) (Paying to depart): $w_{inc} > \hat{S}_i > S_i$. In this case, the specialist is worth more on the outside, but agreed pay is higher than the best outside offer. There is a range of mutually profitable contracts, where the incumbent employer increases the pay in case of departure by at least $w_{inc} - \hat{S}_i$. Indeed, the equilibrium (increase in) severance pay is exactly this amount. Even if all the surplus from renegotiation goes to the employer, the specialist will not remain in the firm. Therefore, shading is not a concern in this case.

In the remaining cases, there is no renegotiation. Either, the incumbent's contract

is generous enough to retain the specialist or the outside option \hat{S}_i is so attractive that there is no profitable offer that can make the specialist stay.

We are now ready to characterize the equilibrium Stage 1 contracts, for each of the different contractual forms.

4.3 Unconstrained contracts

Suppose firms can make unconstrained contract proposals. Then, the unique equilibrium outcome gives each specialist a fixed salary corresponding to the specialist's expected value conditional on an optimal assignment.

Proposition 2 *When contracts are unconstrained, a fully optimal outcome is attained in an equilibrium where each firm in industry i_1^* offers talented workers contracts of the form*

$$w_u = \begin{cases} S^* & \text{if } i_2 = i_1^*; \\ S^* - \bar{S}_i & \text{if } i_2 \neq i_1^*. \end{cases} \quad (16)$$

There is no equilibrium in which any talented worker gets any other final pay.

Proof. See Appendix. ■

The idea is simple. The employee gets a fixed wage regardless of what task is conducted or where, but has to pay the original employer the full value of any surplus generated for another employer.

These ideal contracts are unrealistic. For example, they require that the firm is able to force the worker to pay potentially large penalties in case of departure. The contracts that we consider in the rest of the paper all share the realistic assumption that firms cannot penalize their employees for leaving. With this constraint, in period 2 an employed specialist must now be paid, in each state, at least the surplus that is attainable through re-matching with some other firm, \hat{S}_i .

4.4 Spot contracts

Under a spot contract, there is no commitment on either side. For this reason, expected gains from subsequent contracting must be distributed immediately. The spot contract thus specifies a fixed compensation w_s that is contingent merely on training with a firm. In the second period, the worker is offered a new contract in a competition between all firms. The equilibrium outcome for a worker can be described as follows.

Proposition 3 *Under spot contracting, the unique equilibrium outcome entails, for each talented worker, (i) an optimal second-period assignment $i_2^*(\iota)$ and (ii) the remuneration*

$$r_s = w_s + \hat{S}_\iota + \max\{0, \underline{\beta}T_\iota\},$$

where

$$w_s = E[\max\{0, (1 - \underline{\beta})T_\iota\}].$$

Moreover,

$$i_1 \in \arg \max_{\iota \in I} E[u(r_s)].$$

Proof. See Appendix. ■

The interpretation runs as follows. In period 2, the worker always obtains at least the best outside option \hat{S}_ι ; this is the second term in the expression for r_s . In addition, when it is optimal to stay with the incumbent employer, the worker obtains a fraction $\underline{\beta}$ of the net surplus; this is the third term. The expected value of the remaining fraction is paid out as a lump-sum, i.e., in all states; this is the first term. The expression for the wage also has a simple interpretation. It is the expected period 2 rent that accrues to the employer because the worker has acquired firm-specific capital.

Corollary 1 *Spot contracting always entails inefficient risk-sharing.*

Since the pay always varies with the best outside option – whether that alternative employment is in the same industry or in an other industry – the worker’s pay is always uncertain. As a result, the worker will care about industry volatility as well as about expected pay when choosing occupation.

4.5 Salary contracts

There are two important differences between a salary contract and a spot contract. First, unlike the spot contract which involves a sign-on payment irrespective of whether the worker subsequently stays or leaves, an optimal salary contract does not pay out anything in case the worker leaves for a better offer. Second, the salary pins down pay in all states where the worker’s outside option is not binding; the worker can only renegotiate when there is a credible threat of departing. For both reasons, there will typically be relatively attractive states p in which the salary compensation is lower than under spot contracts. In return, the worker is paid more in the relatively bad states.

Proposition 4 *Under salary contracting, the unique equilibrium outcome entails, for each talented worker, (i) an optimal second-period assignment $i_2^*(\iota)$ and (ii) the remuner-*

ation

$$r_a = \max \left\{ w_a, \hat{S}_l, \hat{S}_l + \underline{\beta} T_l \right\},$$

where w_a is the largest solution to

$$E[r_a(w)] = E[\bar{S}_l].$$

Proof. See Appendix. ■

In this case, we refrain from writing out the explicit formula for the equilibrium wage w_a . Essentially, the wage equalizes the expected rents that the initial employer harvests under favorable realizations of p (because of the employees firm-specific human capital) and the expected losses that the initial employer incurs under unfavorable realizations, thereby ensuring that no employer earns any rent.

Comparing r_a to r_s , we can show that risk-averse workers are generally better off under salary contracts than under spot contracts.

Proposition 5 *Ex ante, for any talented worker and any chosen industry, the equilibrium remuneration under salary contract competition second-order stochastically dominates the equilibrium remuneration under spot contract competition.*

Proof. See Appendix. ■

A salary contract can even be first-best. That happens under the following condition.

Corollary 2 *A salary contract is optimal if and only if*

$$S^* \geq \max_{i \in I} (1 + 1_l \kappa \theta) (\bar{p}_i - w_g) a_i. \quad (17)$$

where 1_l is an indicator function taking value 1 if the specialist is assigned to the same firm in both periods and 0 otherwise.

The proof is straightforward from inspection of Proposition 4: If (17) holds, worker j will never get a wage offer exceeding the flat salary, that is $w_a = S^* > \hat{S}_l(p)$ for all feasible p . It is efficient to retain the worker if and only if

$$(p_l - w_g)(1 + \kappa) a_l \geq \max_{i \neq l} (p_i - w_g) a_i. \quad (18)$$

If inequality (18) does not hold, the current employer optimally offers severance pay $S^* - \max_{i \neq l} (p_i - w_g) a_i$ and the new firm offers the wage $\max_{i \neq l} (p_i - w_g) a_i$, which in combination yield the same fixed salary as if the worker stayed. The worker thus receives a remuneration that is independent of p and is efficiently matched. That is, there is no

need for variable pay if the worker's productivity in other firms or industries never veer above the expected productivity of the worker in the initial job.

4.6 Simple performance contracts

Simple performance contracts allow employers to tie pay to the performance of the own firm, but not explicitly to the performance of other firms.²⁰ We think of this as the contract environment that comes closest to the contracting environment that faces large firms in modern economies.

Observe that we do not impose any functional form on this contract. Nonetheless, equilibrium contracts turn out to be piece-wise linear.

4.6.1 Narrow specialization

As a starting point let us assume that each worker is talented in at most one industry, that is, a^j has at most one positive component. Call this narrow specialization. Under narrow specialization, the inability to condition contracts on subsequent offers from other industries obviously does not matter.

Proposition 6 *If workers are narrowly specialized, any competitive equilibrium outcome is attained through simple performance contracts of the form*

$$w_c(p_\iota) = \max\{\underline{w}_c, (p_\iota - w_g)a_\iota(1 + \theta\kappa)\}. \quad (19)$$

where the wage floor, \underline{w}_c , is the the highest solution to

$$E[w_c(p_\iota)] = E[\bar{S}_\iota].$$

Proof. Any alternative break-even contract to $w_c(p_\iota)$ will increase the risk exposure of the worker and keep the expected wage constant: Suppose the worker is paid less than $w_c(p_\iota)$ in cases where $w_c(p_\iota) = (p_\iota - w_g)a_\iota(1 + \theta\kappa)$, the worker will renegotiate the contract and thereby reduce the profit of the firm which will induce the firm to reduce the wage floor and thereby increase the risk exposure of the firm. Suppose $w_c(p_\iota) = \underline{w}_c$, reduced pay will increase the profit of the firm and not be a competitive outcome. Suppose the worker is paid more than $w_c(p_\iota)$ in cases where $w_c(p_\iota) = (p_\iota - w_g)a_\iota(1 + \theta\kappa)$. The worker will be paid strictly more his outside offer and the firm will need to reduce the wage floor

²⁰In the present setting, tying pay to performance of the own firm is equivalent to tying it to the performance of the own industry. Below, we comment on the case in which there are additional idiosyncratic shocks at the firm level.

in order to keep the break-even constraint. In both cases the worker will be exposed to more risk, receive the same expected wage, and prefer contract $w_c(p_i)$ instead. ■

The contract ensures that outside offers from within the industry are not attractive, and thus prevents renegotiation. This is valuable, because renegotiation would entail pay that is strictly above the outside offer, and thus increase the ex ante variance.

Figure 1 displays the simple performance contract (for simplicity, we have set $w_g = 0$). The slope b in the figure is $a_i(1 + \theta\kappa)$, illustrating that more talented workers and workers with more portable human capital have steeper performance pay schedules.

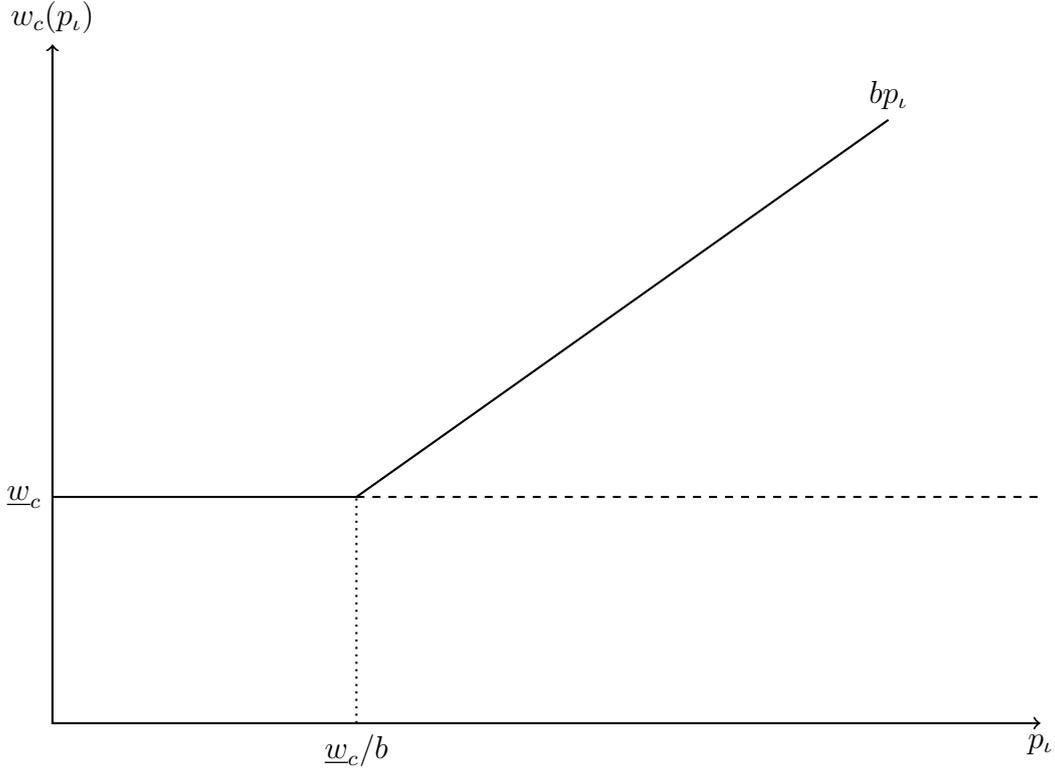


Figure 1: A simple performance contract

A fairly immediate corollary is that there is more performance pay when uncertainty is larger.

Corollary 3 *Assume narrow specialization. Let $\tilde{h}(p_i)$ be a mean-preserving spread of $h(p_i)$. The wage floor, w_c is weakly lower and the expected performance pay is weakly larger under $\tilde{h}(p_i)$ than under $h(p_i)$. The relationship is strict if*

$$\int_0^{\hat{p}} \tilde{H}(p_i) dp_i > \int_0^{\hat{p}} H(p_i) dp_i,$$

where $\hat{p} = w_c/(1 + \theta\kappa)a_i$.

Proof. To be added. ■

In this sense, the model makes the opposite prediction of the classical incentive contract model, according to which there should be less performance pay when uncertainty is greater. Our model thus provides a new reason for why the link between risk and incentives is tenuous in the data; see Prendergast (2002) for an overview of relevant evidence (as well as another explanation).

4.6.2 Multiple talents

If a worker has multiple talents, the worker should move across industries whenever some alternative industry offers higher productivity. Under the following additional assumption about the distribution of states p , the simple performance contract will take the same piece-wise linear shape as described in Proposition 6 .

Assumption 3 Define $z = (1 + \kappa)/(1 + \theta\kappa)$ and $m = \max\{S_i(p)\}_{i \neq \iota}$. The associated distribution, $g(m(p))$, satisfies (i) $G(m)/g(m)$ is increasing for $m \geq w_c(p_\iota)$ (a monotone hazard rate condition), and (ii)

$$\frac{G(w_c(p_\iota))}{w_c(p_\iota) g(w_c(p_\iota))} > z - 1. \quad (20)$$

This is a mild assumption.²¹

The role of Assumption 3 is to ensure that it is not optimal to pay above the intra-industry offer in order to implement an analogous reduction of the expected cost of fending off inter-industry offers.

Proposition 7 Under competition in simple performance contracts, the unique equilibrium outcome entails, for each talented worker, (i) an optimal second-period assignment $i_2^*(\iota)$ and (ii) the remuneration

$$r_c = \max \left\{ \underline{w}_c, \hat{S}_\iota + 1_\iota \underline{\beta} T_\iota \right\}, \quad (21)$$

where $1_\iota = 1$ if $S_\iota > \hat{S}_\iota > \tilde{S}_\iota$ and 0 otherwise, and \underline{w}_c is the unique solution to

$$E[r_c(\underline{w})] = E[\tilde{S}_\iota]. \quad (22)$$

²¹Note that (i) holds for any single-peaked distribution with a peak below $w_c(p_\iota)$. To interpret (ii), note that $G(w_c(p_\iota))$ is the probability that the employee is better paid in the original job than the most attractive potential offer from a different industry. To interpret $g(w_c(p_\iota))$, consider for reference a uniform distribution on the interval $[0, x]$. This distribution has constant density $g = 1/x$. For any $x > w_c(p_\iota)$, the left-hand side of (20) would then be above $G(w_c(p_\iota))$. Thus, for any function on the same interval that has less than average density at points $m \geq w_c(p_\iota)$, it is sufficient that $G(w_c(p_\iota)) > z - 1$.

(iii) Equilibrium wage contracts are given by $w_c(p_i)$ with a wage floor, \underline{w}_c , determined by equation (22).

Proof. The proof is analogous to the proof of Proposition 4. There are only two differences. First, the simple performance contract is not renegotiated in the case that the best outside offer comes from industry ι . Second, we need to prove that it is not optimal to have a performance-pay component exceeding the best intra-industry offer (see Appendix). ■

Observe that multiple talents and attractive offers from alternative industries can lead to renegotiations and higher pay in states where the original employer offer the best match. Frequent wage-renegotiations will drive down the wage floor and increase the risk exposure of the worker. On the other hand, if outside offers lead to efficient turnover, workers productivity will increase and wages will improve. The negative effects of inter-industry competition are important when workers are very risk averse and outside offers seldom implies efficient turnovers while the positive effects are more important when outside offers leads to efficient turnover and higher productivity of workers.

Figure 2 illustrates the various final outcomes for the special case of two industries, with $\iota = 1$.

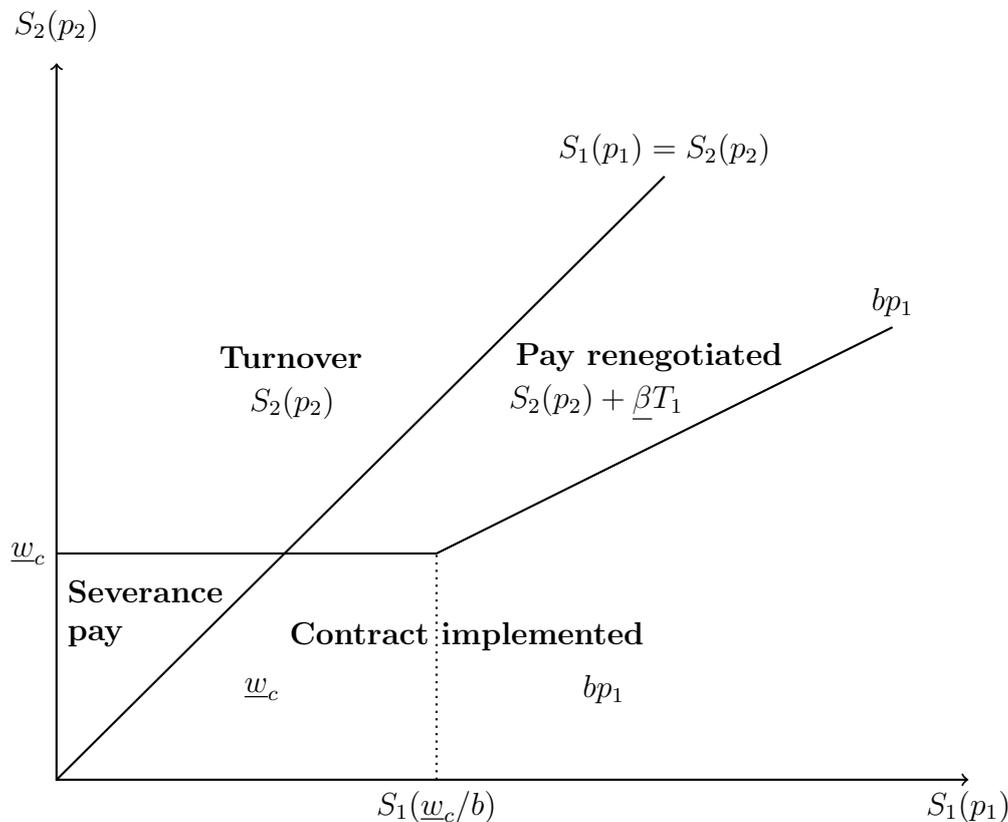


Figure 2: Pay and turnover as functions of $p = (p_1, p_2)$, with $\iota = 1$.

Recall that there are two differences between the contract w_c and the actual pay r_c . One is that the worker sometimes optimally moves to another industry which pays more. The other is that the worker's best outside option comes from such a different industry, yet is worth less than the worker's human capital in the initial firm. In the latter case, the wage is renegotiated upward to a level that is consistent with the worker staying and not shirking.

The typical case of turnover occurs when the own industry performs relatively poorly; p_i is low. This is consistent with the central regularity emphasized by Jenter and Kanaan (2015); 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.²²

As in the case of a pure salary contract, the fact that the worker is being promised a pay of at least \underline{w}_c by the original employer does not preclude the possibility that the worker leaves for an outside offer that is less than \underline{w}_c . Whenever $S_i < \hat{S}_i < \underline{w}_c$, it is desirable that the worker leaves. Since the worker cannot be commanded to leave, the employer will offer a severance pay of $\underline{w}_c - \hat{S}_i$ to make up for the lost wage; this transaction yields a gain of $\hat{S}_i - S_i$ to the employer; the worker gains nothing, as the severance pay and the pay from the new employer add up to \underline{w}_c . Since the wage floor is higher under competition in simple performance contracts than under competition in salary contracts, the severance pay will be higher under simple performance contracts.

To summarize, the model is consistent with the evidence that CEO severance pay is usually awarded on a discretionary basis by the board of directors and not according to terms of an employment agreement, was found by Yermack (2006).²³ Likewise, the feature that severance pay makes up for the loss in expected compensation rhymes well with Yermack's interpretation of the severance pay data: "boards use severance pay to assure CEOs of a minimum lifetime wage level."

Before interpreting this result further, we note that simple performance contracts dominate salary contracts whenever a salary contract is not strictly optimal.

Proposition 8 *Suppose (17) fails. Ex ante, for any talented worker, the remuneration under the equilibrium simple performance contract second-order stochastically dominates the remuneration under the equilibrium salary contract.*

Proof. See Appendix. ■

²²As 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, however, it makes perfect sense to keep talented workers when the industry is profitable and growing and release them to other more productive jobs elsewhere when the industry declines.

²³Discretionary 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, severance pay is only useful if contracted in advance.

The idea is simple. There is enough uncertainty that any equilibrium fixed salary contract would occasionally have to be renegotiated. The worker's pay is higher under such renegotiation than it would have been under the simple performance contract. Hence, the base wage is higher under a simple performance contract, which is therefore preferable.

4.7 Additional sources of variation

So far, we have assumed that all uncertainty is industry-specific. What if there is also firm-specific uncertainty? Suppose $p_i^f = \epsilon^f p_i$, where ϵ^f is a firm-specific shock with mean 1. The most attractive outside offer will now come from the firm with the most favorable realization of the firm-specific shock. We have assumed that it is impossible to make the contract dependent on the stock price of a particular other firm. However, suppose it is possible to let the contract depend on the industry stock-price index, which in turn would depend on the average state of industry ι , p_ι^{avg} . Suppose moreover that there are many firms in the industry.

Suppose that firm-specific uncertainty is small, say, with $\epsilon^f \in [1 - \delta/2, 1 + \delta/2]$. Then, the worker ought not to leave the original employer. If a firm uses own performance to construct the simple performance contract, it has to offer the following contract to surely fend off any offers from firms in the same industry:

$$(1 + \delta) p_\iota (1 + \theta\kappa).$$

Note that firm-specific uncertainty in addition to industry-specific uncertainty implies more use of variable pay. If the firm instead offers a contract based on average performance (and the number of firms is very large), it suffices to offer

$$(1 + \frac{1}{2} \delta) p^{avg} (1 + \theta\kappa),$$

which involves less performance wage and a higher wage floor and will retain workers in the same cases as above. However, such index options are only preferable as long as the industry index is a better indicator of the outside option than is the firm's own stock price.²⁴ For example, suppose that the portability θ varies across firms within the same industry and is higher between firms that have more correlated stock prices. Then, the ideal contract would have been to condition pay on the stock price of the closest competitors. But since that is not possible, it could be better to base performance-related pay on the own firm's stock price than on a broad index of all the firms in the

²⁴Observe that pay depends positively on the industry index rather than negatively; negative dependence is the recommendation when the purpose is to reward high effort.

industry.²⁵ At any rate, when firms' stock prices are closely correlated with the industry average, any loss from conditioning on the own firm's stock price rather than the index will be small.

Another natural extension of the model is to allow match-specific shocks. Suppose the employee suddenly gets to dislike the current firm or fancy another. If these shocks are large enough, turnover is motivated in equilibrium. The notable additional insight is that a given level of match-specific shock is more likely to produce turnover if human capital is more portable. Therefore, we should expect to see high turnover to go hand-in-hand with high levels of "pay for luck."

5 Interpretation and Implications

Why is the simple performance contract piece-wise linear in equilibrium? Formally, the reason is plain. The fraction θ of the industry-specific skill that is portable is a constant. Therefore the value of portable human capital is $p_1\kappa\theta a_1$. If instead θ had been dependent on the state p , the optimal contract would have been non-linear.²⁶ In our view, it is difficult to argue that there is a direct technological impact of p on θ .

5.1 Stock options

In reality, a typical piece-wise compensation contract involves stock options. As is easily seen, a standard call option admits implementation of the equilibrium contract.

Corollary 4 *Simple performance contracts can be implemented through a combination of a salary and an option to purchase the own firm's stock.*

Specifically, if we interpret p_i as the stock price, the strike price of worker j 's stock option, p_i^s solves the equation $\underline{w}_c = p_i(1 + \kappa\theta)a_i$. That is, the stock option becomes valuable exactly at the point where outside offers exceed the worker's salary, \underline{w}_c . In order to prevent (inefficient) turnover, the size of the option package must be proportional to the worker's portable human capital, $\kappa\theta a_i$.

5.2 The role of portability

Preventing people from leaving with valuable human capital is a central element of good corporate governance; for detailed arguments, see for example Rajan and Zingales (2001)

²⁵In reality, a related problem with using industry indexes is that they do not capture the competition from new entrants.

²⁶Ellingsen and Kristiansen (2011) advance a similar argument for the optimality of simple securities.

and references therein. Which are the factors affecting portability, and how do they show up in empirical work?

Portability is affected by two main factors. Portability is higher (i) when the initial employer has weak property rights over the employee's human capital (and it is difficult to transfer such rights from the employee to the employer), and (ii) when there exist other firms that can make good use of the human capital. With these two factors in mind, we see that the positive association between portability and variable pay resonates well with many empirical observations:

1. "Knowledge" firms utilize stocks and especially stock options to a larger degree than do "brick and mortar" firms; see Anderson et al. (2000); Ittner et al. (2003); Murphy (2003); Oyer and Schaefer (2005)). The knowledge firms themselves report that performance-based pay is primarily used for retention purposes; see Ittner et al. (2003)). We think of knowledge firms as having high $\theta\kappa$ relative to brick-and-mortar firms.
2. Option-based compensation is particularly common 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)). We think of growth firms as being more recent and having less well protected technologies, hence a higher portability θ .
3. 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 Cremers and Grinstein (2014); also Murphy and Zabochnik (2004, 2006). For reasons provided above, we think of high observed mobility as indicating high θ .
4. Managers have weaker performance incentives in regulated sectors; see Murphy(1999); Frydman and Saks (2010)). Regulated sectors are often operated by a monopoly, and generally have fewer potential alternative employers. Hence, θ is low.
5. There is less performance-based pay in family firms (e.g., Kole (1997); Anderson and Reeb (2003); Bandiera et al (2010)), especially when the manager is a family member (Gomez-Mejia et al. (2003)). We think that family members are more reluctant to move, hence θ is low.
6. There is less mobility of managers, and managers have weaker performance incentives in jurisdictions with stronger enforcement of noncompete employment clauses

(Garmaise, 2011). This is perhaps the most direct interpretation of our theory – θ is smaller when noncompete clauses are stronger.²⁷

7. There is a weaker link between pay and industry-wide shocks (“luck”) in companies with large owners, especially when these large owners sit on the company’s board of directors (Bertrand and Mullainathan (2001); see also Fahlenbrach (2009)). We think of large owners as exercising better control and hence reducing θ .²⁸
8. Performance hurdles for option contracts are increasing in the quality of corporate governance; see Bettis et al. (2010). This point is similar to the previous one. If good corporate governance entails better safeguards against workers departing with valuable assets, good corporate governance will be associated with a higher hurdle price p_t^s (see section 5.1).

In addition to this cross-section evidence, Murphy and Zabojnik (2004, 2006) 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 this view is accepted, our model can account for the increase in variable pay over the last few decades that is documented by Frydman and Saks (2010).

5.3 Hedging

With a simple performance contract, the employee carries all the risk associated with the call option package. Suppose now that the worker tries to hedge this risk by selling an identical set of call options for a fixed price in a perfect financial market. As we shall now see, such a contract combines desirable insurance with optimal bonding.

Consider a state p in which the options are “in the money”; they are worth $m(p_t) = bp_t - \underline{w}_c > 0$. Then, in case the worker stays, she may simply exercise her own options in order to satisfy the call of the buyer of the options. On the other hand, if the worker departs, she forfeits the call options promised by the employer. Thus, to satisfy the buyer’s call, she has to pay $m(p_t)$ from her own pocket. Thus, she will depart if and only if $\hat{S}_t - bp_t > 0$. In other words, there is departure if and only if it is optimal that the worker is employed in another industry. The hedging does not entail any allocation loss, and it eliminates all the remuneration risk for states p such that the worker is optimally

²⁷A related finding is that mobility is smaller when firms defend their patents more aggressively, see Ganco, Ziedonis, and Agarwal (2015).

²⁸A problem with this argument is that the presence of large owners could be endogenous; they are there because θ is high to begin with; a challenge for empirical work would be to tease out exogenous variation in ownership.

allocated to the initial industry. In case retention is sure to be ex post optimal, the first-best is thus attained.

Proposition 9 *Suppose the financial market is perfect and that workers are narrowly specialized. Then a simple performance contract $w_c(p_t)$ that can be freely hedged implements the first-best outcome.*

The model thus offers both a straightforward normative argument for allowing hedging and a positive argument for why hedging occurs.²⁹

6 Final remarks

Critics of executive compensation practices often argue that non-indexed performance pay, high pay-floors, and discretionary severance pay cannot be efficient, and are thus *prima facie* evidence of managerial rent-extraction. To the contrary, we find that optimal contracts have all three features; in fact, these features could be socially desirable even as instruments to reduce pay inequality. In our model, a commitment to non-indexed performance pay serves primarily to reduce the very highest realizations of pay that would be observed under fixed-salary contracting.

Our model highlights the importance of the retention motive for the shape of compensation contracts: When the worker’s outside option never binds, a fixed salary is the equilibrium outcome, but when market conditions are sufficiently variable, compensation contracts will be designed to match the worker’s most attractive outside employment opportunity. While it is possible to adapt to outside offers after the fact, such renegotiation does not mimic an optimal ex ante contract. Pay variability is lower when variable pay components are contracted ex ante than when they are negotiated ex post.

Deviations from plain salary contracting will be especially large in volatile industries where industry-specific human capital is portable across firms. If our model is right, such industries are likely to continue their “controversial compensation practices,” such as granting stock options that pay lavishly when the industry booms and provide discretionary severance pay when it busts. To the extent that new public or corporate policies – such as higher taxation of stock options or more indexation of contracts – are put in place in order to curb such pay practices, the total cost of compensating the most talented employees could be going up rather than down.

²⁹Among the CEO contracts studied by Schwab and Thomas (2006), only five out of 271 restricted hedging. For other studies of the prevalence of hedging, see Bettis, Bizjak, and Lemmon (2001) and Kallunki, Nilsson, and Hellström (2009).

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Appendix: Proofs

Proof of Proposition 1

The proof is by contradiction. If (ii) is violated, then there is some constant remuneration $r_c < E[r]$ such that the risk-averse worker would be better off with r_c than with r . And any one of the risk-neutral firms are willing to trade the fixed payment r_c in return for the stochastic r . Consider a violation of the assignment rule (i). Then, given (ii), a reassignment of the worker to the payoff-maximizing industry (in periods 1 and 2 respectively) would generate an increase in output, which could be shared among the original employer and the new employer.

Proof of Proposition 2

We first show that this contracting outcome is part of a subgame-perfect equilibrium. Note that the worker pays a penalty equal to the maximum surplus \bar{S}_i if the worker departs. From the analysis of Stage 2c, we know that workers will earn \hat{S}_i if in period 2 they move to another employer than the incumbent. If $S_i \geq \hat{S}_i$, so the incumbent employer is the optimal employer, it thus does not pay to depart. If instead $S_i < \hat{S}_i$, i.e., the original employer is not the optimal employer in period 2, then the final net pay is S^*

regardless of whether the worker stays or leaves. Let the worker resolve the indifference according to the surplus maximizing assignment. Finally, note that no firm can gain by making another offer. If the offer is more generous, it creates a loss. If it is less generous, worker j signs another contract.

We finally show that no subgame-perfect equilibria support any other final pay. (i) Contracts that yield an expected pay is above S^* are clearly loss-making for a risk-neutral employer. (ii) Suppose there were an equilibrium in which a talented worker is employed at some contract \hat{w} yielding an expected total pay strictly below S^* . Suppose first that a departing worker is underpaid by a new employer. This cannot be consistent with equilibrium, because the new employer then earns a positive rent; it would be profitable for another employer in the same industry to bid higher. Underpayment must thus be associated with states in which the worker is retained. But if so, the worker is underpaid on average by the initial employer. But this cannot be consistent with equilibrium either. Now, the incumbent employer earns a rent, and it would have been profitable for another employer in this industry to bid higher.

Proof of Proposition 3

Start in period 2, after realization of the state p . If $S_i < \hat{S}_i$, we know from the analysis of Stages 2c-d that any SPE has the feature that the worker leaves and is paid \hat{S}_i by the new employer.

If $S_i > \hat{S}_i$, we know from the analysis of Stage 2b, that the renegotiated wage is given by equation (15).

Next, since there is Bertrand competition between risk-neutral employers, the fixed pay w_s must be such that the worker's expected pay equals the expected value of the worker's services, $E[r_s(w)] = E[\bar{S}_i]$. This means that the salary must equal the expected benefit that the employer will reap in period 2, which is $E[\max\{0, (1 - \beta)T_i\}] \geq 0$.

Finally, the characterization of the initial industry choice, i_1 is self-evident: A worker j at Stage 1 who faces schedules $r_s(p, i)$ chooses an industry in which the expected utility is maximized, and that expected utility hinges only on $r_s(p, i)$.

Proof of Proposition 4

Begin at period 2. There are four distinct cases to consider. (i) If $w_a \leq S_i < \hat{S}_i$ or $S_i < w_a < \hat{S}_i$, any equilibrium has the feature that the worker leaves and is paid \hat{S}_i by the new employer. (ii) If $S_i < \hat{S}_i < w_a$, it is still desirable that the worker leaves, but now that requires a severance pay of at least $w_a - \hat{S}_i$ to make up for the lost wage. Any equilibrium has the feature that the incumbent offers exactly this severance pay and the

worker departs. (iii) If $\hat{S}_l < S_l \leq w_a$ or $\hat{S}_l \leq w_a \leq S_l$, the worker stays and exerts effort $e = 1$. (iv) If $w_a < \hat{S}_l < S_l$, the worker ought to stay, but has an attractive outside option. We know from the analysis of Stage 2b that the equilibrium renegotiation offer is given by equation (15) Note that all the ensuing payments are consistent with r_a and that the second-period assignments are optimal.

It remains to prove that there exists at least one solution to $E[r_a(w)] = E[\bar{S}_l]$ and that the largest solution to this equation will be the equilibrium outcome. Note that $w = 0$ implies positive expected profit to the firm, and competitive bidding at stage 1 raises the wage above this level. Since $r(w)$ is continuous and unbounded above, there exists at least one solution in which firm profit is 0 and the equation is satisfied. Define the highest solution w_a (there might exist several solutions if an increase in w reduces the probability of renegotiation at date 2). It only remains to prove that w_a is also the salary that will be offered in equilibrium. For this, observe that w_a is the salary that gives the initial employer zero expected profit and the worker the highest fixed wage (no other employer obtains a profit given this contract and the worker's behavior); thus there is no other competitive outcome.

Proof of Proposition 5

Keep the outcome in period 1 fixed and arrange the remunerations r_a and r_s in an increasing order. Denote the resulting probability densities $h_a(r)$ and $h_s(r)$ respectively, and let H_a and H_s denote the corresponding cumulative distribution functions. We have that (i) $E[r_s] = E[r_a]$, (ii) $r_s \leq r_a$ for $\max \left\{ \hat{S}_l, \hat{S}_l + \underline{\beta}T_l \right\} < w_a$, and (iii) $r_s > r_a$ for all other values of p (indeed, in these states $r_s(p) = r_a(p) + w_s$). Hence, there exists a value, \hat{w} such that $H_a(\hat{w}) = H_s(\hat{w})$, $H_a(w) \leq H_s(w)$ for $w < \hat{w}$ and $H_a(w) \geq H_s(w)$ for $w > \hat{w}$.³⁰ It follows that

$$\int_0^{\bar{w}} H_s(r) - H_a(r) dr \geq 0,$$

where \bar{w} is the maximum wage (highest feasible p and a). Because $w_a > w_s$, the inequality is strict at least for the lowest possible spot contract remuneration, $r = w_s$. By the definition of second-order stochastic dominance we have that the distribution of $H_a(r)$ dominates $H_s(r)$.

Proof of Proposition 7

The proof follows that of Proposition 4, with two exceptions.

³⁰The single-crossing property of the cumulative distribution functions is not necessary for showing second-order stochastic dominance, but it is sufficient.

First, the contract no longer needs to be renegotiated when the best offer comes from industry ι ; this modification is immediate.

Second, we need to check that it is never profitable to pay above the best intra-industry outside option, that is, to set $r(p) > \tilde{S}_\iota(p)$. The potential benefit from doing so is to prevent renegotiation (and thus constrain rent-sharing) when $p_\iota a_\iota > m(p) > r_c(p)$. This benefit is increasing in the employee's bargaining power, so it is sufficient to show that it is unprofitable to raise contracted pay in case $\underline{\beta} = 1$. A contracted pay raise is unprofitable if realized pay goes up in "good" states (due to worse insurance); we now show that it does so.

Suppose the wage offer at date 0 for a given p_ι is increased from $x = p_\iota a_\iota(1 + \theta\kappa)$ to $x + \epsilon$. In case $m > x + \epsilon$, the wage will be renegotiated in the same way as before, and the adjustment does not matter. Otherwise, the realized wage increases in case $m < x$ and decreases in case $m \in (x, x + \epsilon)$. To be precise, with $\underline{\beta} = 1$, the change in expected wage payments is

$$\begin{aligned} & G(x)\epsilon + [G(x + \epsilon) - G(x)] [p_\iota a_\iota(1 + \theta\kappa) + \epsilon - p_\iota a_\iota(1 + \kappa)] \\ = & G(x)\epsilon + [G(x + \epsilon) - G(x)] [x + \epsilon - z x] \end{aligned} \quad (23)$$

$$= G(x + \epsilon) [(1 - z)x + \epsilon] - G(x)(1 - z)x. \quad (24)$$

Differentiation with respect to ϵ yields

$$g(x + \epsilon) [(1 - z)x + \epsilon] + G(x + \epsilon).$$

Thus, the expected wage increases if

$$\frac{G(x + \epsilon)}{g(x + \epsilon)} > (z - 1)x - \epsilon,$$

which is implied by Assumption 3.

Proof of Proposition 8

The proof is similar to the proof of Proposition 5. Keep the outcome in period 1 fixed. Arrange the remunerations r_a and r_c in an increasing order. Denote the resulting probability densities $h_a(r)$ and $h_c(r)$ respectively, and let H_a and H_c denote the corresponding cumulative distribution functions. We have that (i) $E[r_c] = E[r_a]$, (ii) $r_a \leq r_c$ for $\max \left\{ \hat{S}_\iota, \hat{S}_\iota + \underline{\beta}T(p) \right\} < \underline{w}_c$, and (iii) $r_a \geq r_c$ for all other values of p . Note that $r_a > r_c$ whenever the contract is renegotiated under salary contract and not under simple performance contract (i.e., when $I = 1$ in (21)). This happens with positive probability because

(17) fails. Hence, there exists a value, w^0 such that $H_a(w^0) = H_c(w^0)$, $H_c(w) \leq H_a(w)$ for $w < w^0$ and $H_c(w) \geq H_a(w)$ for $w > w^0$. It follows that

$$\int_0^{\bar{w}} H_a(r) - H_c(r) dr \geq 0,$$

where \bar{w} is the maximum wage (highest feasible p and a). Because $\underline{w}_c > w_a$, the inequality is strict for at least the lowest possible spot contract remuneration, $r = w_a$. By the definition of second-order stochastic dominance we have that the distribution of $H_c(r)$ dominates $H_a(r)$.