

Implicit vs. Explicit Incentives: Theory and a Case Study*

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Abstract:

Empirical studies increasingly question whether standard principal-agent theory applies. We characterize the optimal implicit contract assuming a liquidity constrained agent. Bonus pay decreases while the salary promise and productivity increase with longer expected contract duration. We test our model using personnel data of an insurance company: accounting for the trade-off between salary and performance pay, we confirm that the former (latter) is positively (negatively) correlated with productivity. Longer expected contract duration impacts all three key variables – i. e. performance pay, salary promise, and productivity – as predicted by our theoretic model.

Keywords: implicit contract, explicit bonus pay, premature contract termination, compensation and productivity estimates.

JEL-Classifications: J3, M5.

1 Introduction

We derive the optimal contract between a principal and an agent in a stochastically repeated environment. Simplifying the established implicit contract model, we assume that both parties are risk-neutral. Also, the principal can observe the agent's effort supply. However, the agent is liquidity-constrained and verifiability requires the use of an undistorted, but risky monitoring signal. Generally, contracting therefore involves both a court-enforceable explicit bonus rule and an implicit salary promise that must be self-enforcing. Since the agent's rent increases with bonus pay, the principal implements the maximum credible salary promise. We focus on the case where credibility constrains the implementation of the first-best effort level. Then, bonus pay decreases, while the salary promise and productivity increase with longer expected contract duration.

Our analysis is motivated by doubts regarding the validity of the standard principal-agent model that arises in recent empirical work. Hence, we test our model using personnel data from a large German insurance company. The dataset contains detailed information on individual revenues, compensation, and other characteristics for more than 300 employees over the course of five years. First, we estimate the expected survival time of an employee within the firm. Second, we proxy expected contract duration by the median expected survival time when estimating a simultaneous equations model. As predicted by our theoretical model, longer expected contract duration increases the salary promise and productivity, while decreasing performance pay. Third, we show that the productivity effect of expected contract duration is confined to the induced trade-off between salary and performance pay.

The study proceeds as follows: the next section discusses the existing literature and motivates our approach. Section 3 develops the theoretical model. Section 4 introduces the dataset and contains the econometric investigation. Section 5 concludes.

2 Performance pay “puzzles:” theory and evidence

The standard, one-period principal-agent model constitutes the building block of incentive theory.¹ Empirically, Foster and Rosenzweig (1994), Booth and Frank (1999), Parent (1999), Lazear (2000), Oettinger (2001), Paarsch and Shearer (2000), and Shearer (2004) confirm that performance pay increases productivity. Questions regarding the underlying mechanism remain: focussing only on productivity effects, Lazear (2000) admits that incentives may be effective but not efficient. In fact, Freeman and Kleiner (2005) shows that a piece rate system

¹See Prendergast (1999) and, more recently, Lazear and Oyer (2007).

may increase labor productivity but not profits. And, actually contrasting with the standard model's prediction, Prendergast's (2000, 2002a, 2002b) finds that incentive intensities increase with more uncertainty. Explanations are that less uncertain environments support favoritism by superiors (Prendergast, 2002b), while more environmental uncertainty intensifies the moral hazard problem (Prendergast, 2002a).

Further, assuming private information regarding a worker's productivity, Balmaceda (2009) shows that performance pay increases with more environmental uncertainty. At the same time, however, the pay-for-performance sensitivity decreases. Empirically, Grund and Sliwka (2006) investigates worker heterogeneity regarding their risk-aversion; Franceschelli et al. (2009) focuses on heterogeneity with respect to productivities. Both studies demonstrate that performance pay induces a self-selection of workers over contracts. Only explicitly controlling for this sorting of workers, yields undistorted estimates of the risk-intensity trade-off.

Behavioral agency theory offers three explanations why performance pay may actually decrease productivity: first, extrinsic rewards crowd out intrinsic motivation. Thus, Bénabou and Tirole (2006) shows that, with stronger monetary incentives, the agent increasingly doubts that supplying effort constitutes a "good deed." Second, employees possess other-regarding preferences. For example, Falk and Kosfeld (2006) and Fehr et al. (2007) demonstrate that inequity-averse agents withhold effort, if performance pay induces wage inequality. Third, social norms are endogenous. For instance, in Sliwka (2007), Ellingsen and Johannesson (2008), and Fischer and Huddart (2008), the intensity of monetary incentives set by the principal signals his expectations regarding the acceptance of an effort norm. In equilibrium, workers self-select and/or adjust their behavior to meet these expectations.

The available evidence – reviewed e. g. by Ellingsen and Johannesson (2007) and Bowles (2008) – is mostly derived from experimental research. Econometric studies are rare and less supportive. McCausland et al. (2005), Heywood and Wei (2006), Green and Heywood (2008), and Pouliakas and Theodossiou (2009) all consistently find that performance pay increases job satisfaction. Further, Heywood et al. (2005) shows that monetary incentives reduce conflicts between firm management and employees. All of these studies use a large set of control variables and, in some cases, distinguish particular types of performance pay. However, Cornelissen et al. (2008) demonstrates that estimating the determinants of job satisfaction again requires controlling for self-selection on grounds of both risk-aversion and productivity.

Following MacLeod and Malcolmson (1989), implicit contract theory uses the repeated game approach to analyze the interplay between self-enforcing promises of future pay and contractual income claims. Baker et al. (1994), Pearce and Stacchetti (1998), and, in a

thoroughly simplified model focussing on performance management in a public firm, Baker (2002) assume risk-averse agents. In this case, the risk involved when implicitly contracting on non-verifiable signals is traded off against the distortion associated with verifiable signals used in explicit contracts. Generally, explicit and implicit incentives can be either complements or substitutes.² In a setting with only non-verifiable signals, Levin (2003) shows that optimal contracts are stationary – i. e., they, at least, contain some stopping rule for the implicit reward mechanism. Empirical evidence is very limited. Hayes and Schaefer (2000) finds that the unexplained variation in current CEO compensation is positively correlated with future firm performance. Gibbs et al. (2009) confirms that signal properties are used in the design of systems of performance measures triggering a mix of explicit and implicit incentive pay.

In this paper, we further simplify by assuming that the principal can perfectly observe the agent’s effort. Yet, this observation is not verifiable. Further, there exists a verifiable, but risky monitoring signal. Principal and agent are risk-neutral; however, the latter is liquidity constrained. It suffices to assume that credibility constrains future income promises by the principal to derive a trade-off between implicit and explicit incentives. This trade-off is contingent on the probability that the agent terminates the contract. It reflects that the agent’s rent increases with more performance pay. Hence, if the expected duration of the contract increases, explicit performance pay decreases, while the promise of future salary and productivity increase. Empirically, we therefore proceed by estimating an employee’s median survival time within the firm to proxy expected contract duration. Using a simultaneous equations model, this variable impacts all three key variables – i. e. performance pay, salary, and productivity – as predicted by our theoretical model.

Note that, in addition to testing the implicit contract mechanism, our model is compatible with all of the approaches discussed above: first, while the standard one-period principal-agent model applies, the trade-off between implicit and explicit incentives yields a negative relationship between performance pay and productivity. Second, individual differences in the probability to terminate the contract should reflect the employees’ job satisfaction. Then, behavioral agency theory suggests a negative relationship between the probability of terminating the contract and performance pay and between performance pay and productivity. Third, the same effects are associated with increases in environmental risk that manifests in common shocks to expected contract duration.

²Specifically, only if there exists a verifiable signal that is sufficiently undistorted, implicit incentives become infeasible. Schmidt and Schnitzer (1995) add that efficiency does not depend on the number of available verifiable signals.

3 Theoretical analysis

3.1 The model structure

We analyze a contracting problem between a risk-neutral principal and a risk-neutral agent in a stochastically repeated environment. However, the agent is liquidity-constrained. Hence, payments to the agent must always be non-negative.³ After each production period, either the relationship ends with probability $(1-p)$ or the game is repeated in the next period with probability p . For parsimony, we assume that there is no discounting. Moreover, we restrict the analysis to simple contracts with no memory.

In any given production period the agent supplies productive effort $e \in [0, 1]$. This effort generates value $v(e)$ with $v'(e) > 0$ and $v''(e) < 0$. The agent's effort can be thought of as an internal service. Hence, effort itself, e , and its contribution to firm value, $v(e)$, are non-verifiable by a third party. The agent's private costs of effort are given by $c(e) = e^2$ and her outside option is set equal to zero. To guarantee an interior solution for the firm's overall optimization problem, we impose the additional requirement that $v'(1) < 2$.⁴

The principal is assumed to observe the agent's effort e .⁵ Moreover, there is a monitoring technology generating a verifiable binary signal s with $s \in \{0, 1\}$. For parsimony, we let $\Pr[s = 1|e] = e$ – said differently, effort is measured in terms of the probability to generate the favorable signal. Due to the repeated nature of the game, the principal can use both implicit and explicit incentives. Hence, a contract is a triplet, $\mathcal{C} = \{b, w, E\}$, where b denotes a bonus to be paid if $s = 1$ and w is a salary that the principal promises to pay if he observes effort $e \geq E$.

The bonus part of the contract constitutes an explicit agreement that is court-enforceable. In contrast, the salary is an implicit agreement which must be self-enforcing. In the case of renegeing the principal loses his credibility. In all future periods, he can then only offer pure explicit contracts.

The timing of the game is as follows: first, the principal designs a contract and makes a take-or-leave-it offer to the agent. Second, the agent either rejects or accepts the offer. If the agent rejects, the game ends. Third, if the agent accepts the contract, she supplies effort.

³If the agent were not liquidity constrained, he could simply buy the production possibility. It is well-known that a moral hazard problem does not arise in this case.

⁴The assumptions guarantee that the first-best effort is smaller than 1 which we need in order to obtain an interior solution. Alternatively, the model can be generalized by introducing an increasing convex cost of effort function satisfying $\lim_{e \rightarrow 1} c(e) = +\infty$.

⁵Equivalently he can infer e from $v(e)$.

Next, nature determines the realization of the monitoring signal s . Fourth, depending on the realization of this signal, the agent may receive a bonus. Also, contingent on his observation of the agent's effort, the principal either pays w or reneges.

3.2 The pure explicit contract

Investigating a pure explicit contract, backward induction starts at stage three. Given a bonus b and initially assuming that the agent participates, she maximizes her expected net income, $eb - c(e)$. Hence, she supplies the effort level e^b defined by

$$b = c'(e^b) = 2e^b . \quad (1)$$

Let $C^X(e)$ denote the principal's cost of inducing effort e using explicit contracting only. It follows that

$$C^X(e) = 2e^2 \geq e^2 = c(e) \quad (2)$$

The difference between the principal's cost of inducing effort and the agent's true effort costs is the agent's rent, $R(e)$. Since it is always non-negative, the agent's participation condition in stage two is always satisfied. Finally, in stage one the principal determines the optimal bonus by maximizing expected profit:

$$\pi^X = \max_e v(e) - 2e^2. \quad (3)$$

π^X constitutes the principal's per-period fallback profit if he were to lose his credibility.

3.3 The general contract

We apply backward induction taking π^X as given.

Stage 4. Suppose the agent has accepted a contract $\mathcal{C} = \{b, w, E\}$ and supplied effort e . The principal must decide whether to pay w or renege. In the former case, let π^I denote the principal's per-period expected profit when using the implicit contract. Thus, accounting for the probability that the game ends, the principal's credibility condition becomes

$$\sum_{t=1}^{\infty} p^{t-1} (\pi^I - \pi^X) = \phi(\pi^I - \pi^X) \geq w , \quad (4)$$

where $\phi = p/(1-p)$. In the remaining, $W = \phi(\pi^I - \pi^X)$ denotes the maximum credible salary promise.

Stage 3. At this stage the agent decides among three alternatives:

1. If $w > W$, the agent supplies effort $e = e^b$.
2. If $w \leq W$ and $E \leq e^b$, the agent also chooses $e = e^b$.
3. If $w \leq W$ and $E > e^b$, the agent can gain the additional salary w only by supplying an effort level $e > e^b$. If

$$w + Eb - c(E) \geq e^b b - c(e^b), \quad (5)$$

the agent supplies effort $e = E$. Otherwise, the agent supplies $e = e^b$ and foregoes the promised salary.

Stage 2. The agent anticipates that she will either set $e = E$ or $e = e^b$. Recall that the RHS of (5) is equal to the agent's rent $R(e^b) \geq 0$. Hence, (5) implies that the agent always participates.

Stage 1. We proceed as in the previous section. First, we derive the principal's minimum cost function, $C^I(e, W)$, of inducing effort e given the maximum credible salary W . Second, we use $C^I(e, W)$ to solve for the optimal contract.

The minimum cost function $C^I(e, W)$

Suppose the principal wants to implement effort e . From above, we know that there are two relevant cases; either $e = e^b$ or $e = E$. When $e = e^b$, the principal sets $w = E = 0$. Thus, the pure explicit contract is optimal. Minimizing costs yields $C^I(e, W) = C^X(e) = 2e^2$.

In the case where $e = E$, the principal sets $E > e^b$. For ease of notation, we can eliminate E . The principal therefore solves the design problem

$$C^I(e, W) = \min_{e^b, w, b} w + be \quad (I)$$

$$\text{s.t.} \quad b = c'(e^b) \quad (\text{IC1})$$

$$w + c'(e^b)e - c(e) \geq c'(e^b)e^b - c(e^b) \quad (\text{IC2})$$

$$w \leq W \quad (\text{CC})$$

Equation (IC1) implicitly defines e^b as a function of the bonus b . Condition (IC2) states that the agent must be better off by supplying e rather than e^b . Finally, (CC) guarantees that the contract is credible.

First, consider situations where $W \geq c(e)$. The principal sets $w = c(e)$ and $b = 0$, thereby extracting all the rent, i.e. inducing costs $C^I(e, W) = c(e)$. The principal cannot do better without violating the agent's participation constraint.

Second, for the case $W < c(e)$, constraint (IC2) must be binding. Otherwise a reduction in b would be feasible and yield lower costs. This would contradict that $C^I(e, W)$ constitutes a minimum cost function. Accounting for the quadratic cost function, substituting from (IC1), and rearranging terms yields:

$$e^b = e - \sqrt{w} . \quad (6)$$

Since (IC2) is binding it also follows

$$w + be = c(e) + R(e^b) . \quad (7)$$

To minimize costs, the principal sets e^b , i.e. the bonus b , as low as possible, while raising the salary promise to satisfy (6). Consequently, $w = W$ in the optimal contract. Substituting W and $b = c'(e^b)$ on the left hand side of (7) and rearranging terms, yields:

$$C^I(e, W) = e^2 + \left(e - \sqrt{W}\right)^2 . \quad (8)$$

Intuitively, a higher maximum credible salary W allows the principal to increase his salary promise w and to lower the explicit bonus b . The latter reduces the agent's rent.

Expected profit maximization

Up to this point, we have assumed that W is exogenously given. However, it is endogenously determined by (4): a salary promise is only credible if the present value of the loss associated with breaching the contract exceeds the one-time saving in salary. Hence, the overall profit maximization problem becomes:

$$\pi^I = \max_{e, W} v(e) - C^I(e, W) \quad (\text{II})$$

$$\phi [v(e) - C^I(e, W) - \pi^X] \geq W \quad (\text{SC})$$

Let superscript “ I ” now also refer to optimal values. There are two possible cases: first, (SC) may not bind. In this case, the first-order condition with respect to W yields $C^I_W(e^I, W) = 0$. From above, this necessarily implies $W \geq c(e^I)$, i.e. the principal offers a pure implicit contract, setting $w^I = c(e^I)$ and $b^I = 0$. The first-order condition with respect to effort guarantees that e^I must be first-best.

Denote this first-best effort level by e^* .⁶ Then, second, the maximum credible salary promise W can be smaller than $c(e^*)$. Thus, the self-enforcement constraint (SC) becomes

⁶Hence, e^* satisfies $v'(e^*) = c'(e^*)$.

binding. In the remaining, we focus on this case; it implies that the minimum cost function $C^I(e, W)$ is given by (8). Since $w = W$, we can further simplify the notation to obtain the Lagrangian

$$L = v(e) - C^I(e, w) + \eta \{ \phi [v(e) - C^I(e, w) - \pi^X] - w \} . \quad (9)$$

The respective first-order conditions with respect to e and w yield:

$$[v'(e^I) - C_e^I(e^I, w^I)] [1 + \eta^I \phi] = 0 \quad (10)$$

$$-C_w^I(e^I, w^I) [1 + \eta^I \phi] - \eta^I = 0. \quad (11)$$

The multiplier η^I is non-negative such that $[1 + \eta^I \phi] > 0$. Given (8), condition (10) then immediately reveals that the optimal effort level is second-best.

Thus, applying the implicit function theorem, we can derive the impact of a variation in ϕ on the optimal contract:

Proposition 1 *Suppose that the principal is constrained in making credible promises concerning future salaries. Then, the optimal contract $\mathcal{C}^I = \{b^I, w^I, E^I\}$ is a function of $\phi = p/(1-p)$. Specifically:*

(a) *An increase in ϕ increases the salary promise w^I and the threshold effort level E^I that triggers the payment of this salary.*

(b) *Since this threshold level E^I is equal to the actual effort e^I of the agent, productivity $v(e^I)$ also increases with higher ϕ .*

(c) *However, the explicit bonus b^I that is paid out contingent on realizing a favorable monitoring signal as well as the expected bonus B^I decrease with higher ϕ .*

Proof: see appendix.

4 Empirical analysis

4.1 The data

To test the above Proposition, we can draw on personnel data covering the German satellite offices of a large, globally operating insurance company. In 2003 there are 83 satellite offices (2004: 84, 2005: 80, 2006: 79 and 2007: 76). We can track employees from January 2003 until December 2007. The dataset comprises 1123 employee-year observations for 317 individuals.

Employment is highest (lowest) in 2003 (2007) providing 237 (209) annual records. Table 1 exhibits the numbers of employees leaving the firm in each year as well as during the complete observation period. 223 of those 237 individuals who are employed in the initial year 2003 do not retire and are not promoted during the observation period. 79 of these 223 employees quit the firm for personal reasons over this five-year period.

Insert Table 1 about here

For our econometric analysis, we focus on this group of 223 individuals, since retirement and promotion issues do not fit our theoretical analysis. Table 2 reports separate descriptive statistics for all employees and for our focus group of 223 individuals. Employees are between 24 and 64 years old and mostly male (92%). The average *age* is 39 years. We construct a variable measuring the years of formal *education* ranging from 9 to 18 years.⁷ The mean of *education* is 11.8 years.

Further, mean (maximum) company *tenure* is 12.7 (39) years. Using postal code information, we further measure the distance between the employee’s home and her office. A substantial number of the employees works in the same town in which the satellite office is located (28.9%). The mean distance (*home_work*) is 25 km. Also, the mean distance between the company’s headquarters and the satellite offices (*dist_hq*) is 361.6 km.⁸

Insert Table 2 about here

We further use the German Statistical Office’s dataset⁹ on the regional income tax distribution in 2001 to proxy local labor market and insurance demand conditions. The lowest annual tax per taxpayer (*tax*) is recorded in the district of Chemnitz in Saxony (€2,847), while the highest value is found in the district of Darmstadt in Hesse (€8,770). Although German unification took place in 1990, unemployment rates are still significantly higher and wages significantly lower in former East Germany. Thus, we introduce a dummy variable to identify whether the employee lives in former West Germany or Berlin (*west_or_berlin*).

The company distinguishes three business lines: *life* insurance, property and casualty (*p_c*) insurance, and *health* insurance. The employees in our data set do not sell insurance

⁷Specifically, a university degree is taken to require 18 years of studying at all levels, a degree from a university of applied sciences (“Fachhochschule”) 16 years, the university-preparatory school degree (“Abitur”) 13 years, the subject-restricted university-preparatory school degree (“Fachhochschulreife”) 12 years, a degree of a commercial college (“Höhere Handelsschule”) 11 years, the secondary modern school degree (“Realschule”) 10 years, and the standard secondary school degree (“Volksschule” and “Hauptschule”) 9 years.

⁸To protect the company’s anonymity we do not report the maximum distance in this case.

⁹Federal Statistical Office (2008).

themselves. Rather, they support the regional office managers in coordinating the insurer’s exclusive agents in the regions and business lines. They communicate the insurer’s marketing strategies to these agents, assist in training the sales force, and screen the policies sold. At the same time, they constitute the sales agents’ primary contact with the insurer. Following our theoretical model, the firm’s management can observe the employees’ effort in carrying out these tasks. Yet, this observation is not verifiable.

In total, the insurer’s German sales agents collect commissions worth €654 million. Sales agents are always associated with particular regional office employees. The variable *productivity* sums all commissions that are paid out to such an employee’s subordinate sales personnel for new policies underwritten in a given year. It ranges from €50,184 to €1,994,893 with an average of €605,077. Our employees participate in their sales agents’ success by receiving additional commissions and bonuses that are triggered by reaching commission targets. In terms of our theoretical model, *productivity* therefore constitutes the verifiable performance signal. Recall that this signal is undistorted. Hence, *productivity* also provides an unbiased measure of the individual employee’s contribution to firm profit.

Average employee earnings (*total_income*) steadily increase during our observation period, though at varying rates.¹⁰ Over all years, it averages €45,069, with minimum and maximum incomes at €26,145 and €73,755. On average, roughly half of this income (43%) constitutes *performance_pay*. As explained above, this pay comprises the employee’s participation in her managed sales force’s commissions and additional bonuses that are contingent on satisfying, mostly seasonal, *productivity* targets. We cannot distinguish the determinants of the remaining half (57%) of the average employee’s income. The variable *salary* comprises contractual salaries, gratifications, and other wage benefits that are negotiated individually.

Although we focus on incentives for rank-and-file managers rather than sales personnel, insurance firms generally possess considerable experience with setting performance pay incentives. Eisner and Strotz (1961) already note that insurance contracts are “sold rather than bought.” Performance pay constitutes a significant cost factor in this industry: in 2004, German life insurers paid out 10.2% of their gross premium revenue as commissions to their sales organizations.¹¹

Nevertheless, calculating simple correlations reveals a different picture. The coefficients of correlations between *productivity* and both the ratios of *performance_pay* and *salary* to *total_income* are negative, with -0.58 in the first case and -0.67 in the second. Since, in our case, employees cannot self-select over a menu of pay schemes, there are only two possibilities: either the firm does not reward performance, or the incentive system is more complex than

¹⁰Throughout we adjust for inflation.

¹¹BaFin (2005).

suggested by simple correlation analysis.

4.2 The econometric strategy

The econometric approach must account for income-level effects when estimating the compensation structure: according to our theoretical model, this structure drives productivity which, in turn, determines the total rent that can be distributed between principal and agent. Our empirical analysis exploits individual differences in expected contract durations. Then, the theoretical model implies that maximum credible salary promises also vary over individuals. Consequently, the optimal compensation structure depends on the total rent.

Thus, we consider the following set of equations:

$$\begin{aligned}
 salary &= \alpha_1 + \beta_1^S(survival) + \beta_1^I(total_income) + X\gamma_1 + \varepsilon_1 \\
 performance_pay &= \alpha_2 + \beta_2^S(survival) + \beta_2^I(total_income) + X\gamma_2 + \varepsilon_2 \\
 productivity &= \alpha_3 + \beta_3^S(survival) + Z\gamma_3 + \varepsilon_3 \\
 total_income &= salary + performance_pay
 \end{aligned} \tag{12}$$

where *survival* reflects the expected duration of the contract as our proxy of the parameter ϕ from our theoretical model. Below, we provide a detailed description of how we obtain this proxy. Then, ε_i , $i = 1, 2, 3$, denote the respective error terms. Finally, X and Z are matrices of independent variables to control for other individual, job-specific, and market effects on income and productivity.

In (12), including *total_income* accounts for income-level effects on the compensation structure. The functional relationship between the income structure and productivity implies that *total_income* is correlated with the error terms of *salary* and *performance_pay*. In other words, the use of *total_income* in system (12) raises the issue of identification; it implies that we must use a simultaneous equations model (SEM) to estimate the system. Then, accounting for between-equation correlation of the error terms, we estimate (12) using Three Stage Least Squares (3SLS).

Given the nature of our data, we must further accept that variables may, on the one hand, affect productivity, while, on the other hand, they do not impact an employee's compensation, and vice versa. Regarding the former, we clearly expect that commissions and, hence, our productivity measure differs between the lines of business (*life*, *p_c*, *health*). However, job competition within the firm precludes such differences affecting income opportunities.

In contrast, distance from firm's headquarters (*dist_hq*) should exhibit only income effects. Specifically, a possible lack of promotion opportunities to other jobs at the firm's head-

quarters should be compensated. Also, gender effects on pay are well-documented. Thus, we include *male* only in the equations for salaries and performance pay. We can test whether these two sets of variables – i. e., *life*, *p_c*, and *health*, vis-à-vis *dist_hq* and *male* – are exogenous. Given the SEM-approach, it suffices that only one of the variables *life*, *p_c*, *dist_hq* or *male* is exogenous in at least one of the equations.

Finally, while the first three lines in (12) correspond to parts a), b), and c) of Proposition 1, the last line merely reflects the pay accounting identity. Note that we use the same set of explanatory variables in both income equations. So we could have eliminated this identity, thereby reducing both the number of equations and the number of endogenous variables. However, estimating the complete structure (12) yields more easily interpretable results.¹²

4.3 Expected contract duration

The parameter ϕ from our theoretical model determines the optimal balance between implicit and explicit incentives as well as productivity. We proxy ϕ by the expected duration of an individual’s contract. Clearly, our model assumes that the parties have rational expectations concerning this variable. Maintaining this assumption, we therefore use the information on quitting behavior to obtain an estimate of the expected contract duration.

Generally, we cannot integrate duration estimates into our simultaneous equations model (12) above. Instead, we must obtain an independent estimate for the group of 223 employees who are employed in 2003 and are neither retired nor promoted during the observation period.¹³ In a first step, Figure 1 displays non-parametric estimates of the hazard and survival functions. They are clearly non-monotonic. For this case, Kalbfleisch and Prentice (1980) suggest fitting either a log-normal or a log-logistic duration model.

Insert Figure 1 about here

We use only two individual-specific covariates: the distance between the employee’s home and her office (*home_work*) and the employee’s corporate *tenure* in 2003 as percent of her potential tenure years. The latter is calculated as *tenure* divided by *age* minus *education*. This transformation reflects the fact that – in contrast to productivity studies where “raw” *tenure* is often used to capture experience effects – our approach requires identifying a predictor for the individual’s future quitting behavior.¹⁴

¹²In this respect, note that, according to Zellner and Theil (1962, p. 68) and Greene (2003, p. 390), such identities do not affect the identification problem.

¹³See, for example, Theodossiou and White (1998) for a similar approach.

¹⁴Also, the inclusion of other individual characteristics as explanatory variables does not improve the overall

Goodness-of-fit can be assessed by calculating the Akaike Information Criterion (AIC). This measure selects the model that explains the data best with a minimum of estimated parameters. Given our application, the value of the AIC for the log-normal model estimate is 236.37 compared to 239.10 for the log-logistic model. Thus, we proceed by using the log-normal estimate.¹⁵ Table 3 reports the respective results in the “accelerated failure time form.” Hence, positive coefficients imply a deceleration of time.¹⁶ Note that the joint restrictions are significant at the 1%-level.

Insert Table 3 and Figure 2 about here

Figure 2 depicts the corresponding hazard function. The scaling parameter – denoted σ in Table 3 – determines the skewness of this function. It is highly significant; the respective z -statistic is equal to 3.53. For our subsequent analyses, we calculate the variable *survival* as the median predicted survival time for each individual. Since we exclude retirement cases, the survival time indicates the individual’s expected contract duration.

4.4 Productivity and income structure

Tables 4.a and b report the final and first stage estimations of system (12) above.¹⁷ Recall that our survival time estimate focuses on the year 2003. Thus, the first set of three equations in these tables uses only the income and productivity data for 2003. We also use the 2003 survival estimates to calculate the predicted median survival times for the four subsequent years 2004 - 2007.¹⁸ The second set of equations shown in Tables 4.a and b thus draws on the full set of 878 observations for the group of 223 individuals who do not retire and are not promoted during the observation period.¹⁹

Insert Tables 4.a and 4.b about here

The overall significance of the SEM is very solid for both estimates: lacking the possibility

quality of the estimate.

¹⁵However, we also fit a number of other duration models to the data. The AIC still supports the log-normal duation model: the AIC for the Weibull model is 240.34, 238.37 for the exponential and 237.97 for the Gompertz models. The log-normal duration model also has the highest log-likelihood. We further use the semi-parametric Cox Proportional Hazard model, which does not require specific distributional assumptions. The respective estimates are very similar to those reported in Table 3.

¹⁶See Martinussen and Scheike (2006).

¹⁷Note that the first-stage regressions constitute simple OLS-estimates.

¹⁸Using a probit model for the full sample of employees, we have checked that these expected survival times constitute very good predictors of the actual quitting behavior.

¹⁹Thus, there are 223 individuals in 2003 of which 190 (167, 154, 144) remain employed in the same function in 2004 (2005, 2006, 2007).

to report R^2 values for the final stage, the corresponding χ^2 tests reject the hypothesis that all coefficients are equal zero. Also, F tests do not indicate a weak instrument problem. We follow Wooldridge (2002, p. 201-202) in using a version of the Hausman test to investigate whether the overidentification restrictions are valid. For one additional instrument, the critical value of the over-identification test is 2.70. Hence, we cannot reject the null-hypothesis that the excluded variables are exogenous for any of our equations.

Focussing on the key variable *survival*, the symmetry of the coefficients for salaries and performance pay in the final stage directly follows from explicitly including the *total_income* identity. However, note that, even given this constraint, the final stage regression could still yield three different scenarios: *survival* could, in principle, either increase *performance_pay* at the expense of *salary*, decrease *performance_pay* while increasing *salary*, or show no effect on the income structure at all. Only the second of these scenarios is consistent with our theory.

The results reported in Table 4.a strongly support all three parts of the Proposition 1. Moreover, it does not matter whether we limit the estimation to the year 2003 or consider the full observation period 2003 - 2007. Although the results are somewhat stronger using the larger sample,²⁰ both approaches confirm that longer expected durations of contracts increase fixed salaries at the expense of performance pay. At the same time, individual productivity increases with longer expected contract duration.

Insert Table 5 about here

Using a SEM-approach further allows for an interesting experiment: with the same first-stage regression reported in Table 4.b, Table 5 contains the final stage estimates of an alternative system of equations obtained by replacing *survival* with *performance_pay* and *salary* as determinants of productivity. Specifically, we now estimate the system

$$\begin{aligned}
 salary &= \alpha_1 + \beta_1^S(survival) + \beta_1^I(total_income) + X\gamma_1 + \varepsilon_1 \\
 performance_pay &= \alpha_2 + \beta_2^S(survival) + \beta_2^I(total_income) + X\gamma_2 + \varepsilon_2 \\
 productivity &= \alpha_3 + \beta_3^F(salary) + \beta_3^V(performance_pay) + Z\gamma_3 + \varepsilon_3 \\
 total_income &= salary + performance_pay.
 \end{aligned} \tag{13}$$

Recall that the system (12) yields a coefficient-value of 906.48 for *survival* (in the sixth column of Table 4.a). The respective standard error is 329.73. According to system (13), the

²⁰ Apart from the statistical effects of increasing the number of observations, an income promise, which, in theory, would be realized “in the next period”, can, in practise, be delivered over a number of subsequent years.

marginal effect of *survival* on *productivity* can be calculated as:

$$\begin{aligned}\beta_3^F \beta_1^S + \beta_3^V \beta_2^S &= -15.43 \times 20.55 + 25.77 \times 47.24 \\ &= 904.93.\end{aligned}\tag{14}$$

Hence, using a standard t test, the hypothesis that β_3^S as derived from (12) is significantly different from $\beta_3^F \beta_1^S + \beta_3^V \beta_2^S$ obtained when estimating (13) must be rejected. In other words, the importance of *survival* to explain *productivity* appears to be entirely absorbed by the effect of *survival* on the compensation scheme.

Finally, we regress *survival* on the residuals of the *productivity*-equation obtained when estimating system (13). The coefficient value is -1.33 with standard error 294. The respective t statistic is equal to zero. Hence, the income structure appears to reflect expectations of future contractual compliance rather than effects that stem from current productivity.

4.5 Robustness of results

Cross-sectional labor market studies using longitudinal data show that an individual's *tenure* may also directly affect productivity and income. Our estimates of the *survival*-effects may therefore be judged to capture such effects rather than supporting our implicit contract model. In addressing this issue, we face two constraints: first, the short time-span covered by our data does not allow for causality tests. Second, recalling Table 3, the very fact that *pure tenure* constitutes a very good predictor of *survival* prevents us from adding *tenure* as an explanatory variable to the system (12). Hence, we choose the following procedure: in a first step, we regress *tenure* on our *survival*-estimate. By construction, the vector of these residuals is perfectly orthogonal to the vector of *tenure* realizations. In a second step, using these residuals to replace *survival* in (12), we obtain statistically significant coefficient values which are virtually identically to the ones reported in Tables 4a and b above.

The final stage estimates in Tables 4.a and 5 are derived using the Three Stage Least Squares (3SLS) method. This model uses the information contained in the covariance matrix via Generalized Least Squares (GLS) estimation. Thus, 3SLS incorporates all information contained in the system of equations to estimate all parameters in each individual equation. In contrast, Two Stage Least Squares (2SLS) only draws on the information in the specific individual equation to estimate the parameters from the corresponding equation. While this means that 3SLS is more efficient, it bears the risk that a specification error in one equation will be transmitted to all other equations. Consequently, we also use 2SLS to estimate the models above. Compared with the results in Tables 4.a. and 5, the differences are minimal.

Since we know the number of sales agents controlled by each of the managers in our data

set, we can also calculate management performance as *productivity* per managed agent. When using this variable to replace *productivity* as a productivity measure in (12), the coefficient values for *survival* change. But there is no difference in their signs and significance levels. We also estimate model versions in which *survival* in year t is taken to affect *salary* in year $t + 1$. The respective coefficients in the two income equations cease to be mirror-images of each other. However, signs and significance levels are again not affected.

Finally, we can improve the overall explanatory power of our model by distinguishing different sets of explanatory variables for *salary* and *performance_pay*. In this case, the equality of coefficients on survival between our two model versions (12) and (13) above cannot be checked as easily. To save space, we have decided not to report any of the above extensions and variations of our basic model; they are available upon request.

5 Conclusions

We derive the optimal contract between a principal and a liquidity-constrained agent in a stochastically repeated environment characterized by moral hazard. The contract comprises two parts; a court-enforceable explicit bonus rule based on a verifiable signal and an implicit salary promise conditioned on the observable, but not verifiable agent's effort. Hence, the latter promise must be self-enforcing. We find that the agent's rent increases with bonus pay. Thus, the principal implements the maximum credible salary promise. We show that the bonus decreases while the salary promise and the agent's effort increase with longer expected contract duration.

We subject the mechanism of our model to an econometric investigation that draws on personnel data for the rank-and-file managers of the German satellite offices of a large globally operating insurance company. Using a hazard rate model, we first obtain estimates of the employees' expected survival time within the firm based on individual characteristics. These estimates enter into a simultaneous equations system that, under the assumptions of our model, identifies the determinants of salary promises, performance pay, and productivity. The results strongly support our theoretical predictions: the interplay between salary and performance pay is governed by the expected duration of the contract. Moreover, this incentive mechanism drives productivity.

Thus, the employer captures efficiency gains by replacing bonuses with salary promises for employees who are characterized by higher probabilities of staying with the firm. Our analysis can be interpreted in light of the ongoing discussion of environmental risk, job satisfaction, and contract design. Intuitively, a higher probability of premature contract termination

reflects more uncertainty in the employment relationship. According to our findings, we should observe a reduction in salaries and effort together with an increase in bonus pay; yet without contradiction to standard incentive theory.

References

- BaFin (2005). *Statistik der BaFin - Erstversicherungsunternehmen '04 (Lebensversicherung)*, Table 140, Sections 10 a and b. Bonn, Germany: Bundesanstalt für Finanzdienstleistungsaufsicht - BaFin. Accessible via: www.bafin.de.
- Baker, George P., Robert Gibbons and Kevin J. Murphy (1994). Subjective Performance Measures in Optimal Incentive Contracts. *Quarterly Journal of Economics*, vol. 109, 1125-1156.
- Baker, George P. (2002). Distortion and Risk in Optimal Incentive Contracts. *Journal of Human Resources*, vol. 37, 728-751.
- Balmaceda, Felipe (2009). Uncertainty, Pay for Performance, and Asymmetric Information. *Journal of Law, Economics, and Organization*, vol. 25, 400-441.
- Bénabou, Roland and Jean Tirole (2006). Incentives and Prosocial Behavior. *American Economic Review*, vol. 96, 1652-1678.
- Booth, Alison L. and Jeff Frank (1999). Earnings, Productivity, and Performance-Related Pay. *Journal of Labor Economics*, vol. 17, 447 – 63.
- Bowles, Samuel (2008). Policies Designed for Self-Interested Citizens May Undermine "The Moral Sentiments": Evidence from Economic Experiments. *Science*, vol. 320, 1605 - 1609.
- Cornelissen, Thomas, John S. Heywood and Uwe Jirjahn (2008). *Performance Pay, Risk Attitudes and Job Satisfaction*. Berlin, Germany: German Institute for Economic Research – DIW, Socio-Economic Panel Study, SOEP paper series, no 136.
- Ellingsen, Tore and Magnus Johannesson (2007). Paying Respect. *Journal of Economic Perspectives*, vol. 21, 135-149.
- Ellingsen, Tore and Magnus Johannesson (2008). Pride and Prejudice: The Human Side of Incentive Theory. *American Economic Review*, vol. 98, 990-1008.

- Eisner, Robert and Robert H. Strotz (1961). Flight Insurance and the Theory of Choice. *Journal of Political Economy*, vol. 69, 355-368.
- Falk, Armin, and Michael Kosfeld (2006). The Hidden Costs of Control. *American Economic Review*, vol. 96, 1611-1630.
- Federal Statistical Office (2008). *Regional Database Germany*, Statistics 73111, Table 368-01-3, Year 2001, Düsseldorf, Germany: Federal Statistical Office and the Statistical Offices of the Länder. Accessible via www.regionalstatistik.de.
- Fehr, Ernst, Alexander Klein and Klaus M. Schmidt (2007). Fairness and Contract Design. *Econometrica*, vol. 75, 121-154.
- Fischer, Paul and Steven Huddart (2008). Optimal Contracting with Endogenous Social Norms. *American Economic Review*, vol. 98, 1459-1475.
- Foster, Andrew D. and Mark R. Rosenzweig (1994). A Test for Moral Hazard in the Labor Market: Contractual Arrangements, Effort, and Health. *Review of Economics and Statistics*, vol. 76, 213-27.
- Franceschelli, Ignacio, Sebastian Galianib and Eduardo Gulmez (2009). Performance Pay and Productivity of Low- and High-Ability Workers. *Labour Economics*, forthcoming.
- Freeman, Richard B. and Morris M. Kleiner (2005). The Last American Shoe Manufacturers: Changing the Method of Pay to Survive Foreign Competition. *Industrial Relations*, vol. 44, 307-330.
- Gibbs, Michael J., Kenneth A. Merchant, Wim Van der Stede and Mark E. Vargus (2009). Performance Measure Properties and Incentive System Design. *Industrial Relations*, vol. 48, 237-264.
- Green, Colin and John S. Heywood (2008). Does Performance Pay Increase Job Satisfaction? *Economica*, vol. 75, 710-728.
- Greene, William H. (2003). *Econometric Analysis*, 5th Edition, Upper Saddle River, N. J.: Prentice Hall.
- Grund, Christian and Dirk Sliwka (2006). *Performance Pay and Risk Aversion*. Bonn, Germany: Institute for the Study of Labor – IZA, Discussion Paper no. 2012.

Hayes, Rachel M. and Scott Schaefer (2000). Implicit Contracts and the Explanatory Power of Top Executive Compensation for Future Performance. *RAND Journal of Economics*, vol. 31, 273-293.

Heywood John S., Uwe Jirjahn and Georgi Tsertvadze (2005). Does Profit Sharing Reduce Conflict With the Boss? Evidence from Germany. *International Economic Journal*, vol. 19, 235-250.

Heywood, John .S. and Xiangdong Wei (2006). Performance Pay and Job Satisfaction. *Journal of Industrial Relations*, vol. 48, 523-540.

Kalbfleisch, John D. and Ross L. Prentice (1980). *The Statistical Analysis of Failure Time Data*, New York: Wiley & Sons.

Lazear, Edward P. (2000). Performance Pay and Productivity. *American Economic Review*, vol. 90, 1346-1361.

Lazear, Edward P. and Paul Oyer (2007). *Personnel Economics*. NBER Working Papers, no. 13480.

Levin, Jonathan (2003). Relational Incentive Contracts. *American Economic Review*, vol. 93, 835–857.

McCausland, David, Konstantinos Pouliakas and Ioannis Theodossiou (2005). Some are Punished and Some are Rewarded: A Study of the Impact of Performance Pay on Job Satisfaction. *International Journal of Manpower*, vol. 26, 636-659.

MacLeod, Bentley and James Malcomson (1989). Implicit Contracts, Incentive Compatibility, and Involuntary Unemployment. *Econometrica*, vol. 57, 447-480.

Martinussen, Torben and Thomas H. Scheike (2006). *Dynamic Regression Models for Survival Data*, New York: Springer.

Oettinger, Gerald S. (2001). Do Piece Rates Influence Effort Choices? Evidence from Stadium Vendors. *Economics Letters*, vol. 73, 117-123.

Paarsch, Harry J. and Bruce Shearer (2000). Piece Rates, Fixed Wages, and Incentive Effects: Statistical Evidence from Payroll Records. *International Economic Review*, vol. 41, 59-92.

- Parent, Daniel (1999). Methods of Pay and Earnings: A Longitudinal Analysis. *Industrial and Labor Relations Review*, vol. 53, 71-86.
- Pearce, David G. and Ennio Stacchetti (1998). The Interaction of Implicit and Explicit Contracts in Repeated Agency. *Games and Economic Behavior*, vol. 23, 75-96.
- Pouliakas, Konstantinos and Ioannis Theodossiou (2009). Confronting Objections to Performance Pay: A Study of the Impact of Individual and Gain-sharing Incentives on the Job Satisfaction of British Employees. *Scottish Journal of Political Economy*, vol. 56, forthcoming.
- Prendergast, Canice (1999). The Provision of Incentives in Firms. *Journal of Economic Literature*, vol. 37, 7-63.
- Prendergast, Canice (2000). What Trade-Off of Risk and Incentives? *American Economic Review*, vol. 90, 421-425.
- Prendergast, Canice (2002a). The Tenuous Trade-Off between Risk and Incentives. *Journal of Political Economy*, vol. 110, 1071-1102.
- Prendergast, Canice (2002b). Uncertainty and Incentives. *Journal of Labor Economics*, vol. 20, 115-137.
- Schmidt, Klaus M. and Monika Schnitzer (1995). The Interaction of Explicit and Implicit Contracts. *Economics Letters*, vol. 48, 193-199.
- Shearer, Bruce (2004). Piece Rates, Fixed Wages and Incentives: Evidence from a Field Experiment. *Review of Economic Studies*, vol. 71, 513-534.
- Sliwka, Dirk (2007). Trust as a Signal of a Social Norm and the Hidden Costs of Incentive Schemes. *American Economic Review*, vol. 97, 999-1012.
- Theodossiou, Ioannis and Mark J. White (1998). Does Tenure Affect Earnings? *Journal of Economic Studies*, vol. 25, 328-343.
- Wooldridge, Jeffrey M. (2002). *Econometric Analysis of Cross Section and Panel Data*, Cambridge: MIT Press.

Zellner, Arnold and Henri Theil (1962). Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations. *Econometrica*, vol. 30, 54-78.

Appendix: Proof of Proposition 1

The solution (e^I, w^I) is implicitly defined by the system of equations

$$\begin{aligned} v'(e^I) - 4e^I - 2\sqrt{w^I} &= 0 \\ \phi \left[v(e^I) - w^I - 2e^I(e^I - \sqrt{w^I}) - \pi^X \right] - w^I &= 0 \end{aligned} \quad (15)$$

Applying the implicit function theorem therefore yields:

$$\begin{pmatrix} \frac{\partial e^I}{\partial \phi} \\ \frac{\partial w^I}{\partial \phi} \end{pmatrix} = - \begin{pmatrix} v''(e^I) - 4 & -1/\sqrt{w^I} \\ 0 & -\phi \left[1 - e^I/\sqrt{w^I} \right] - 1 \end{pmatrix}^{-1} \begin{pmatrix} 0 \\ \frac{w^I}{\phi} \end{pmatrix} \quad (16)$$

From (11), we have

$$-\phi C_w^I(e^I, w^I) = \frac{\eta^I \phi}{1 + \eta^I \phi} \implies -\phi \left[1 - e^I/\sqrt{w^I} \right] - 1 = \frac{-1}{1 + \eta^I \phi} < 0 \quad (17)$$

since $1 + \eta^I \phi > 0$. Thus, the determinant of the matrix in (16), Δ^I , is positive. Inverting this matrix and solving yields:

$$\frac{\partial e^I}{\partial \phi} = \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} \frac{1}{\sqrt{w^I}} > 0 \quad (18)$$

$$\frac{\partial w^I}{\partial \phi} = \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} (4 - v''(e^I)) > 0 \quad (19)$$

Denoting the expected bonus with $B^I = e^I b^I = 2e^I(e^I - \sqrt{w^I})$, we can further determine the effect of a variation in ϕ as

$$\begin{aligned} \frac{\partial B^I}{\partial \phi} &= 4e^I \frac{\partial e^I}{\partial \phi} - 2\sqrt{w^I} \frac{\partial e^I}{\partial \phi} - 2e^I \frac{1}{0.5\sqrt{w^I}} \frac{\partial w^I}{\partial \phi} \\ &= \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} \frac{1}{\sqrt{w^I}} \left[-2\sqrt{w^I} + e^I v''(e^I) \right] < 0 \end{aligned} \quad (20)$$

upon substituting the respective partials, rearranging terms, and some simplification. Finally, since the expected bonus decreases while the probability of receiving the bonus increases, we can easily infer that b^I must also be decreasing in ϕ . ■

