Implicit vs. Explicit Incentives:
Theory and a Case Study

Dominique Demougin
Department of Law, Governance and Economics
European Business School*

Oliver Fabel
Department of Business Administration
University of Vienna†

Christian Thomann
Institute for Insurance Economics
University of Hannover‡

*Prof. Dominique Demougin, PhD, Chair for Law and Economics, Department of Law, Governance and Economics, European Business School (EBS), International University Schloß Reichartshausen, Rheingaustraße 1, 65375 Oestrich-Winkel, Germany; tel.: +49-611-360-18600, fax: +49-611-360-18602, e-mail: dominique.demougin@ebs.de.
†Prof. Dr. Oliver Fabel, Chair for International Personnel Management, Faculty of Business, Economics and Statistics, Department of Business Administration, University of Vienna, Brünner Straße 72, 1210 Vienna, Austria; tel.: +43-1-4277-38161 (-38162), fax: +43-1-4277-38164, e-mail: oliver.fabel@univie.ac.at.
‡Dr. Christian Thomann, Senior Researcher and Fellow, Institute for Insurance Economics, University of Hannover, Königsworther Platz 1, 30167 Hannover, Germany; tel.: +49-511-762-5083, e-mail: ct@ivbl.uni-hannover.de.
Implicit vs. Explicit Incentives: Theory and a Case Study

Abstract:

We derive the optimal contract between a principal and a liquidity-constrained agent in a stochastically repeated environment. The contract comprises 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. Thus, the bonus increases while the salary promise and the agent’s effort supply decrease with a higher probability of premature contract termination. We subject this mechanism to econometric testing using personnel data of an insurance company. The empirical results support our theoretical predictions.

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

**JEL-Classifications:** J3, M5.

Notice:

This version of the paper reports work-in-progress that still needs to be improved.

In particular, this qualification applies to the empirical part.

Thus, please, do not cite yet.
1 Introduction

We examine a contracting problem between a risk-neutral principal and an agent that is risk-neutral but liquidity constrained in a stochastically repeated environment. The incentive scheme comprises two parts: contingent on the realization of a verifiable - i.e. court-enforceable - monitoring signal, the principal can offer an explicit bonus. In addition, he can condition a salary promise on the observation that the agent’s effort supply satisfies an implicitly agreed threshold level. Since the agent’s effort supply cannot be verified by third parties, this promise must be self-enforceable.

The agent’s rent increases with the explicit bonus. Thus, the principal can extract more of this rent by substituting explicit by implicit incentives. However, the self-enforcement requirement may impose an upper limit on the credible salary promise. In this case, the exogenous probability that the agent terminates the contract prematurely determines the trade-off between implicit and explicit incentives. Specifically, the bonus increases and the salary promise decreases with a higher probability of premature contract termination. At the same time, the agent’s effort supply and, hence, productivity then decrease.

We test our model using personnel data released by a large insurance company. The dataset contains detailed information on individual revenues, compensation, and other characteristics of more than 300 employees over the course of five years. First, we estimate the mean survival time of an employee within the firm. As predicted by our theoretical model, longer expected contract duration increases the fixed salary and productivity and decreased variable pay. Finally, we show that the productivity effect of the mean survival time is confined to the induced trade-off between fixed and variable pay. Generally, the econometrics strongly support our theoretical approach.

The standard, one-period principal-agent model is often considered the
building block of incentive theory. Lazear (2000) successfully tests its implications within a work environment, the Safelite case, that rather perfectly fits the model assumptions. In general, however, empirical evidence may still be termed “tenuous.” According to Jensen and Murphy (1990) already, executive contracts lack strong performance-pay incentives. More recently, Freeman and Kleiner (2005) show that, due to monitoring and transaction costs, a piece rate system may increase labor productivity but not profits. Moreover, the announcement of future time rates increases productivity by twice the percentage realized when introducing piece-rates. Further, a series of very well-crafted studies by Prendergast (1999, 2000, 2002a, 2002b) demonstrates that incentive intensities do not decrease with more uncertainty as predicted by the standard model.

Explanations typically rely on additional assumptions regarding the contracting environment. Hence, Jensen and Murphy (1990) suggest that political forces both in the public sector and inside the organizations place limits on incentives for CEOs. According to Prendergast (2002a), private information becomes more valuable - and, thus, the moral hazard problem more acute - if the environment becomes more risky. Prendergast (2002b) adds that favoritism of supervisors can lead to lower incentive-intensities in less risky environments. More radical, experimental economics suggests that, rather than induced by monetary incentives, an agent’s effort supply is governed by a gift exchange motive that reflects reciprocal preferences.

Clearly, our approach is more traditional: Baker et al. (1994) and Pearce and Stacchetti (1998) already analyze the interplay between implicit and explicit incentives that arises with the availability of both objective and subjective performance signals. However, they primarily focus on the distributional effects of distorted or biased signals on the agent’s risk-premium. Drawing on MacLeod and Malcomson (1989), Levin’s (2003) repeated agency model then distinguishes common and private performance monitoring. With

---

1See Lazear and Oyer (2007), for instance.
3Prendergast (2002a).
4See Gächter et al. (1997) and, more recently, Hannan (2005), for instance.
risk-neutral principal and agent, court-enforceable performance pay and self-enforcing income promises constitute perfect substitutes.

In contrast, we show that implicit salary promises always dominate if the agent is liquidity-constrained. However, not all promises are credible. If credibility constrains the salary promise, the contract comprises additional explicit performance pay. In this case, the agent then captures a rent and her effort supply is only second-best. Our model is very tractable and yields testable implications concerning the trade-offs between the two incentive devices and the determinants of effort supply. To our knowledge, so far only Hayes and Schaefer (2000) investigate implicit contracts empirically. They show that the unexplained variation in current CEO-compensation is positively correlated with future firm performance.\textsuperscript{5}

The employees contained in our dataset coordinate the sales force of a large and long-established German insurance company. Using actual personnel data, we can observe individual productivities, salaries, commissions and bonuses, and many other characteristics of the employees’ tasks, career status, and job environment. We can track these employees from January 2003 until December 2007. Thus, the dataset comprises 1123 employee-year observations for 317 individuals. Since average employee tenure is longer than 10 years, this data appears particularly well-suited to study reputational contracting.

Eisner and Stotz (1961) already remark that insurance contracts are “sold rather than bought.” Insurance companies should therefore be very experienced in designing incentive contracts. In fact, performance pay constitutes a significant cost factor in this industry: in 2004, for instance, German life insurers paid out 16.3% of their gross premium revenue as commissions to their sales organizations.\textsuperscript{6} However, empirical research is mostly confined

\textsuperscript{5}Else, the existing evidence is rather circumstantial: for instance, Rayton (2003) reports that, although contracts lack explicit incentives based on firm performance, rank-and-file employees’ incomes exhibit considerable performance sensitivities.

\textsuperscript{6}For the American property and casualty market Cummins and Doherty (2006) report that commissions for personal lines (commercial lines) amount to 9.7% (11.4%) of gross
to analyses of distribution channels. Recently, only Cummins and Doherty (2006) focus on contract design when discussing the New York Attorney General’s 2005 investigation into the possible adverse effects of contingent commissions.

Our contribution is therefore threefold: first, we provide a novel theoretic approach to analyze the interplay of explicit and implicit incentives. Second, we can rather directly test this particular mechanism using personnel data. Third, focusing on rank-and-file employees of an insurance company, we also provide new insights into the “real-world” design of incentive contracts.

The study proceeds as follows. Section 2 develops the theoretic model. Section 3 introduces the dataset and contains the econometric investigation. Section 4 concludes.

2 Theoretical analysis

2.1 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. After each production period the agent leaves the firm for exogenous reasons and the game ends with probability \((1 - p)\). Thus, the game is repeated 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 \(e \in \) premium written.

\(^7\)See the survey by Regan and Tennyson (2000).

\(^8\)If 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.
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. Consequently, they are not explicitly contractible. 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 $v'(1) < 2$.9

The principal is assumed to observe the agent’s effort $e$.10 Moreover, there is a monitoring technology generating a verifiable binary signal $s$ with $s \in \{0, 1\}$. For parsimony, we let $\Pr[s = 1|e] = e$ – hence, we measure effort in terms of the probability to observe the favorable signal. Due to the repeated nature of the game, the principal can use both implicit and explicit incentives in order to align incentives. Specifically, a contract is a triplet, $C = \{b, w, E\}$, where $b$ denotes a bonus to be paid if the verifiable signal is favorable, $s = 1$. Further, $w$ denotes 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 other words, assuming the agent supplies effort $e \geq E$, it must be more advantageous for the principal to keep his promise and pay $w$ rather than to renege. In the case of reneging the principal looses 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. Next nature determines the realization of the monitoring signal $s$. Fourth, depending on the realization of

9The model can easily be generalized; for instance, by introducing any increasing convex cost of effort function. In that case requiring $\lim_{e \to 1} c(e) = +\infty$ would allow to eliminate the boundary condition on $v'$.

10Equivalently he can infer $e$ from $v(e)$. 5
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.

2.2 The pure explicit contract

In this section, we analyze the benchmark case where the principal solely relies on an explicit bonus to implement the agent’s effort supply. Hence, both the salary promise $w$ and the threshold $E$ that would trigger the salary payment are set equal to zero. We apply backward induction.

With such a pure explicit contract, there is no decision in stage four. In stage three, given a bonus $b$ and initially assuming that the agent participates, she supplies the effort level $e^b$ defined by

$$b = c'(e^b) = 2e^b.$$  \hspace{1cm} (1)

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

$$C^X(e) = 2e^2.$$  \hspace{1cm} (2)

The difference between the principal’s cost of inducing effort and the agent’s true effort costs measures the agent’s rent, $R(e)$. Accounting for the agent’s quadratic cost function, this rent can be obtained as

$$R(e) = C^X(e) - c(e) = e^2.$$  \hspace{1cm} (3)

Since the rent is always non-negative, the agent’s participation condition in stage two is necessarily satisfied.

Further, this result illustrates that requiring non-negative payments to the agent is essential for the analysis. Otherwise a principal wishing to implement effort $e$ could demand a fixed fee of $R(e)$ from the agent. The agent would only be allowed to participate in production upon paying this
fee. In that case the principal could extract the entire rent from the agent and implement the first-best effort level.\textsuperscript{11}

Finally, in stage one the principal determines the optimal contract: he solves for the optimal effort $e^X$ (and, thus, for $b^X = c'(e^X)$) by maximizing his expected profit

$$
\pi^X = \max_{e} v(e) - 2e^2.
$$

The value of $\pi^X$ then constitutes the principal’s future per-period profit if he would attempt to renge the implicit contract and lose his credibility.

### 2.3 The general contract

We proceed by analyzing the general contract that may include a salary promise to set additional implicit effort incentives. Again, we apply backward induction.

#### Stage four

Suppose the agent has accepted a contract $C = \{b, w, E\}$. In the final stage, the principal must determine whether to keep to his salary promise, $w$, or renge on his pledge. By reneging the principal saves on paying out $w$, but loses the agent’s trust for all future periods. Suppose that, with trust, the principal obtains per-period expected profits $\pi^I$. Then, the principal loses $(\pi^I - \pi^X)$ in every future period by reneging on his promise.\textsuperscript{12}

Thus, accounting for the probability $(1 - p)$ that the game ends for exogenous reasons, the principal’s promise to pay $w$ is credible only if

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

\textsuperscript{11}See Demougin and Fluet (2001).

\textsuperscript{12}Observe that we allow that the parties can always renegotiate the contract to $C^E = \{b^E, 0, 0\}$. 
where $\phi = p/(1 - p)$. In the remaining, $W = \phi(\pi^I - \pi^X)$ then denotes the maximum credible salary promise.

Stage three

At stage three of the game, the agent must decide among three possibilities:

1. If $w$ is not credible, the agent will anticipate the principal’s behavior and his expected income is equal to his expected bonus. In this case, she supplies only the effort level $e = e^b$ that, by the arguments above, equates her marginal revenue to her marginal cost of effort.

2. If $w$ is credible and $E \leq e^b$, the agent’s expected revenue function entails an upward step of value $w$ upon reaching some effort level $e \leq e^b$. Thus, the agent again supplies effort $e^b$ and takes the additional salary, $w$, as a windfall gain.

3. If $w$ is credible and $E > e^b$, the agent can gain the additional salary $w$ only if supplying an effort level $e > e^b$. Thus, there are two possible cases:
   (a) if
   \[ w + Eb - c(E) \geq e^b - c(e^b) \]  
   the agent supplies effort $e = E$.
   (b) If (6) is not satisfied, the agent again chooses the effort level $e = e^b$ and foregoes the promised salary.

Stage two

A rational agent anticipates that she will always supply either $e = E$ or $e = e^b$ earning the rents $w + R(e^b)$ or $R(e^b)$. Moreover, if she supplies $e = E$, (6) guarantees that her rent is at least as high as $R(e^b)$. Consequently, in both cases the agent earns at least $R(e^b) \geq 0$. Thus, she always decides to participate in stage two.
Stage one

To solve the first stage of the game, we proceed as in the preceding section: first, we derive the principal’s minimum cost function of inducing some effort level $e$ given the maximum credible salary $W$, hereafter $C^I(e, W)$. Next, 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 $e$. First, consider the case $e = e^b$. Anticipating the agent’s response in stage three, the principal should obviously set $w = E = 0$. Consequently, his cost are $C^I(e, W) = C^X(e) = 2e^2$.

Alternatively, suppose the principal sets $e = E > e^b$. The principal must then solve the design problem

$$
C^I(e, W) = \min_{e^b, w, b} \left\{ w + be \right\} \quad \text{s.t. (1)}
$$

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

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

Equation (1) implicitly defines $e^b$. Condition (IC) states that the agent would be better off by supplying $e$ rather than $e^b$. Finally, (CC) guarantees that the contract is credible.

First, consider situations where $W \geq c(e)$. In that case, the principal can set $w = c(e)$, $b = 0$, and $E = e$. He would then induce costs $C^I(e, W) = c(e)$. Clearly, the principal cannot do better without violating the agent’s participation constraint. Since $b = 0$ implies $e^b = 0$, constraint (IC) is binding in the optimization problem (I) above.

Next, consider the case $W < c(e)$. Suppose that (IC) would not binding at the cost minimum. In this case, a marginal reduction in $b$ would reduce $e^b$, thereby decreasing the right hand side of (IC) without violating any of the
constraints. However a reduction in \( b \) then also lowers the principal’s cost. Hence, (IC) must again be binding given a cost-minimizing contract.

Accounting for the quadratic cost function, substituting from (IC) and solving therefore implies

\[
w + 2ee^b - e^2 = e^b
\]

\[
\Rightarrow w = (e - e^b)^2.
\]  

(7)

Recalling that \( e > e^b \), yields

\[
e^b = e - \sqrt{w}.
\]  

(8)

Consequently, to minimize costs the principal should set the bonus as low as possible while adjusting salary. For the case \( W < c(e) \), it must therefore be true that

\[
C_I(e, W) = W + 2e \left(e - \sqrt{W}\right).
\]  

(9)

Using the above, we can finally rewrite the principal’s minimum cost function as

\[
C_I(e, W) = e^2 + \left(e - \sqrt{W}\right)^2.
\]  

(10)

Expression (10) then helps to clarify the source of the cost saving potential associated with the salary promise as an additional implicit effort incentive. At one extreme with \( W = 0 \), observe that \( C_I(e, 0) = C_X(e) = 2e^2 \). At the other extreme where \( W \geq c(e) \), it follows that \( C_I(e, W) = c(e) = e^2 \). Then, consider intermediary values of \( W \) with \( 0 < W < c(e) \). Within this range, \( C^I_W(e, W) = 1 - e/\sqrt{W} < 0 \) since \( W < c(e) = e^2 \). 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 always reduces the agent’s rent associated with the implied value of \( e^b \). However, this potential to reduce costs is limited by the credibility constraint (CC). Consequently, \( w = W \) in the cost minimum.
**Expected profit maximization**

The principal now solves

\[
\pi^I = \max_{e, W} \quad v(e) - C_I^I(e, W) \\
\phi \left[ v(e) - C_I^I(e, W) - \pi^X \right] \geq W
\]  \hspace{1cm} \text{(II)}

\hspace{1cm} \text{(CC)}

First, consider the case where the self-enforcement constraint (CC) is not binding. Accordingly, taking the derivative with respect to \(W\) yields \(C_I^I(e, W) = 0\) which, from above, necessarily implies \(W \geq c(e^I)\). This is the only case such that increasing \(W\) further has no impact on the principal’s cost of implementing effort. Letting superscript “\(I\)” denote optimal values, we already know that, with \(W \geq c(e^I)\), the principal offers a pure implicit contract, i.e. a contract containing only a salary promise \(w^I = c(e^I)\) and no explicit bonus, \(b^I = 0\). The optimal effort supply \(e^I\) must then be first-best. Hence, \(e^I = e^*\) where \(e^*\) satisfies \(v'(e^*) = c'(e^*)\).

Yet, if the maximum credible salary promise \(W\) is smaller than \(c(e^*)\), the self-enforcement constraint (CC) must be binding. In the remaining, we focus on this second case. It then follows that \(C_I^I(e, W)\) is given by (10) above. Since \(w = W\) we can further simplify the notation to obtain the Lagrangian

\[
L = v(e) - C_I^I(e, w) + \eta \left\{ \phi \left[ v(e) - C^*^I(e, w) - \pi^X \right] - w \right\}.
\]  \hspace{1cm} \text{(11)}

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

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

\[
-C_w^I(e^I, w^I) \left[ 1 + \eta^I \phi \right] - \eta^I = 0.
\]  \hspace{1cm} \text{(12)} \hspace{1cm} \text{(13)}

The multiplier \(\eta^I\) is non-negative such that \([1 + \eta^I \phi] > 0\). Given (10), condition (12) then immediately reveals that the optimal effort level is second-best. Specifically, \(e^I < e^*\) in this case.
2.4 Properties of the optimal contract

Given the case where the self-enforcement constraint (CC) is binding and using (10) from above, the solution \((e^I, w^I)\) is implicitly defined by the system of equations

\[
v'(e^I) - 4e^I - 2\sqrt{w^I} = 0
\]
\[
\phi \left[ v(e^I) - w^I - 2e^I(e^I - \sqrt{w^I}) - \pi^I \right] - w^I = 0
\]  
(14)

Applying the implicit function theorem therefore yields:

\[
\left( \frac{\partial e^I}{\partial \phi} \right) = \left( \begin{array}{c} v''(e^I) - 4 \\ 0 \end{array} \right) - \phi \left[ 1 - e^I / \sqrt{w^I} \right] - 1 \left( \begin{array}{c} 0 \\ w^I \phi \end{array} \right)
\]  
(15)

On first sight, the sign of the expression \(-\phi \left[ 1 - e^I / \sqrt{w^I} \right] - 1\) appears unclear. However, it follows from (13) that

\[-\phi C_w^I(e^I, w^I) = \frac{\eta^I \phi}{1 + \eta^I \phi} \iff -\phi \left[ 1 - e^I / \sqrt{w^I} \right] - 1 = \frac{-1}{1 + \eta^I \phi} < 0 \]  
(16)

since \(\eta^I \geq 0\). Let \(\Delta^I\) denote the determinant of the matrix in (15). Clearly, \(\Delta^I\) must be positive. Thus, inverting this matrix and solving yields

\[
\frac{\partial e^I}{\partial \phi} = \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} \frac{1}{\sqrt{w^I}} > 0 
\]  
(17)

\[
\frac{\partial w^I}{\partial \phi} = \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} \left( 4 - v''(e^I) \right) > 0 
\]  
(18)

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 \(\phi\) as

\[
\frac{\partial B^I}{\partial \phi} = 4e^I \frac{\partial e^I}{\partial \phi} - 2\sqrt{w^I} \frac{\partial e^I}{\partial \phi} - 2e^I \frac{1}{0.5\sqrt{w^I}} \frac{\partial w^I}{\partial \phi}
\]
\[
= \frac{1}{\Delta^I} \cdot \frac{w^I}{\phi} \frac{1}{\sqrt{w^I}} \left[ -2\sqrt{w^I} + e^I v''(e^I) \right] < 0 
\]  
(19)

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 $\phi$.

Concluding, we can therefore characterize the optimal contract as follows:

**Proposition 1** Suppose that the principal is constrained in making credible promises concerning future salaries. Then, the optimal contract $C^I = \{b^I, w^I, E^I\}$ is a function of the probability $p$ that the principal-agent relationship does not terminate prematurely. Specifically:

(a) An increase in $p$ 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 supply $e^I$ of the agent, productivity $v(e^I)$ also increases with higher probability $p$.

(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 $p$.

Thus, the proposition yields a number of testable hypotheses with regard to the productivity effects of implicit salary promises and explicit bonus incentives as well as the trade-off between these two incentive devices.

3 **Empirical analysis**

3.1 **The data**

To test the model 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 during the complete observation period. These individuals actually quit for reasons other than retirement. Also, we exclude employees who exit the satellite offices due to career moves within the firm.

Insert Table 1 about here

Table 2 reports that the employees are between 26 and 68 years old and mostly male (91.8%). The average age in a given year is 42 years. We construct a variable measuring the years of formal education ranging from 9 to 18 years.\textsuperscript{13} The mean of education is 11.7 years. Further, mean (maximum) company tenure is 10.3 (39) years. Using zip-code information, we further measure the distance between the employee’s home to her office. A substantial part of the employees works in the same town in which the satellite office is located (28.9%). The mean distance (home\_work) is 35 km.

Insert Table 2 about here

The company distinguishes three business lines: life insurance, property and casualty insurance (p\_c), and health insurance. Further, we identify whether an employee is promoted during a year. The average number of employees working in a particular satellite office (office\_size) is 2.8. We proxy the area served by each office by measuring the driving distance to the next satellite office (dist\_next\_office). On average, this distance is 54.8 km. The mean distance between the insurer’s head quarter and the satellite offices (dist\_hq) is 244.69 km.

\textsuperscript{13}Specifically, a university degree is taken to require 18 years of studying, 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 (“Fachschulreife”) 12 years, the 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.
Since wages are set competitively, we use the German Statistical Office’s dataset on the regional income tax distribution to proxy the state of the local labor market. The lowest tax per taxpayer ($tax_{2001}$) is recorded in the district of Chemnitz in Saxony (€2,847), the highest value stems from the district of Darmstadt in Hessia (€8,770). The average employee in our dataset works in a district with €5,431 per-capita tax burden. Although, German unification already took place in 1990, unemployment ratios are still significantly higher in former East Germany. Thus, we create a dummy variable to identify whether the employee lives in former West Germany or Berlin ($west\_or\_berlin$).

The employees in our data set coordinate the insurer’s exclusive agents in their regional areas. They do not sell insurance themselves. However, our employees’ sales personnel collects commissions worth €654 millions in total. The variable $production$ then sums all commissions that are paid out to an employee’s subordinate sales personnel for new policies underwritten in a particular year. Since this commission accounting is carried out by the headquarter, there exists an observable and verifiable effort signal. Per-employee $production$ ranges from €48,533 to €2,002,686. It is €582,000 on average. Mean $production$ decreased from 2003 to 2004 and 2004 to 2005 and increased in the two remaining years.

Average employee earnings ($total\_income$) are steadily increasing during our observation period, though at varying rates. Over all years it is equal to €42,616 with minimum and maximum incomes at €25,084 and €69,563. Roughly half (56.5%) of the employees’ income is fixed ($fixed\_salary$). One-time bonuses account for 12.1% of the income while 31.3% are derived from monthly commissions. However, both types of performance pay are triggered by reaching $production$ targets. Hence, we combine bonuses and commissions to calculate total variable pay per year ($variable\_pay$).
3.2 The econometric strategy

Generally, the data appears appropriate to test our theoretical model. Nevertheless, the econometric approach has to cope with a number of difficulties arising both from the quality of the data and the endogeneity of variables. Hence, the results summarized in Proposition 1 above are obtained from comparative static analysis. Estimating the three functional relationships in Proposition 1 a) - c) - theoretically obtained using the Jacobi-matrix and further insertions - therefore warrants the use of a simultaneous equations model (SEM).

We choose the following basic SEM-structure:

\[ \begin{align*}
\text{fixed\_salary} &= \alpha_1 + \beta_1^S(\text{survival}) + \beta_1^I(\text{total\_income}) + X_1\gamma_1 + \varepsilon_1 \\
\text{variable\_pay} &= \alpha_2 + \beta_2^S(\text{survival}) + \beta_2^I(\text{total\_income}) + X_2\gamma_2 + \varepsilon_2 \\
\text{production} &= \alpha_3 + \beta_3^S(\text{survival}) + X_3\gamma_3 + \varepsilon_3 \\
\text{total\_income} &= \alpha_4 + \beta_4^F(\text{fixed\_salary}) + \beta_4^V(\text{variable\_pay}) + \varepsilon_4
\end{align*} \]  

(20)

where \text{survival} constitutes our proxy of the expected duration \( \phi \) of the contract and \( X_i, i = 1, 2, 3 \), are matrices of independent variables to control for individual, job-specific, and product market effects. Finally, \( \varepsilon_i, i = 1, 2, 3, 4 \), denotes the measurement error.

While the first three lines in (20) correspond to parts a) - c) of Proposition 1, the last line in merely reflects a pay accounting identity. However, recall that our observation period covers only 5 years beginning in 2003. Hence, including \( \text{total\_income} \) in the equations for \( \text{fixed\_salary} \) and \( \text{variable\_pay} \) serves to set initial income levels such that the respective estimates identify the determinants of differences in the compensation structure.

From our theoretic model the expected contract duration \( \phi \) (that is computed from the exogenous probability \( p \) of premature contract termination) determines the optimal structure of implicit and explicit incentives mechanism. The model further assumes that the principal has rational expectations concerning this variable. Maintaining this assumption, we therefore use the information on quits to obtain a proxy.
Clearly, the vast majority of the employees remains within the firm during our observation period. To deal with this problem of censored data, we use a duration model to estimate expected survival. Moreover, we obtain these estimates only for the group of 223 employees who were employed in 2003 already. In a first step, figures 1.a and b then display non-parametric estimates of the hazard and survival functions for these individuals.

Insert Figures 1.a and b about here

Since the hazard function appears to depend (positively) on duration, we follow Kalbfleisch and Prentice (1980) in choosing a log-logistic duration model. However, this choice implies that - and, thus, explains why - we cannot integrate the survival time estimate into our simultaneous equations model (20) above. Instead, we must obtain an independent estimate of the hazard function given the log-logistic distributional assumption.

Table 3 reports the respective regression results. The hazard rate is taken to constitute a function of time and only two individual-specific covariates: the employee’s corporate tenure in 2003 and the distance between her home and her office (home_work) to account for a potentially inconvenient office location that may warrant quits. We then exclude these two explanatory variables when subsequently estimating the system (20).

Insert Table 3 about here

Note that the joint restrictions on the hazard rate model are significant at the 1%-level. Having obtained this estimate we calculate median predicted survival times as $\text{survival}_i(t) = \frac{\ln(0.5)}{\ln(\lambda_i(t))}$ where $\lambda_i(t)$ denotes the estimated hazard rate for individual $i$ in year $t$ of our observation period.

However, we have also used a log-normal model and the semi-parametric Cox Proportional Hazard model that does not require specific distributional assumptions. The respective estimates are very similar to those reported in table 3.

The inclusion of other individual characteristics as explanatory variables does not improve the overall quality of the estimate.
3.3 The incentive structure and productivity: some (very) preliminary results

Estimating the system (20) above, we can in principle draw on 883 observations over the period 2003 to 2007 for the group of 223 individuals who are employed in 2003 already. However, since we only observe these individuals at five subsequent points in time, there our control variables may not show sufficient variation over time. For comparisons, we therefore also include an estimate using only the income and productivity data for the 2003. Furthermore, to isolate the effects of our key variables we currently do not include the full set of potential control variables.

Thus, our econometric results reported in tables 4 and 5 are still rather preliminary and descriptive. Specifically, we cannot claim to “test” our theoretic model yet. Very clearly, though, the coefficients associated with survival are statistically significant and possess the expected signs. Recall that survival is obtained from a forward-looking estimate and does not pick up actual individual quit-behavior over time. Hence, the coefficients on fixed and variable compensation should indicate a trade-off between implicit and explicit incentives.

Moreover, comparing the respective results in tables 4 and 5 and acknowledging the productivity differences between business lines and over time, this trade-off appears rather stable. Hence, in 2004 the German government announced a drastic and adverse change in taxing newly written life-insurances. Nevertheless, this change - i. e. the fact that many consumers brought forward their life-insurance purchases to evade the future tax treatment - does not affect compensation structure.

4 Conclusions

We derive the optimal contract between a principal and a liquidity-constrained agent in a stochastically repeated environment. The contract com-
prises 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. Thus, the bonus increases while the salary promise and the agent’s effort supply decrease with a higher probability of premature contract termination.

We subject this mechanism to a preliminary econometric investigation using personnel data of an insurance company. The results generally support our theoretical predictions. However, at this stage, our empirical findings are still rather descriptive. Thus, our research agenda is directed at improving the econometric modelling towards approaching an actual test of our theory.

References


Fig. 1.a: Smoothed hazard estimate

Fig. 1.b: Kaplan-Meier survival estimate
Table 1: Employees leaving the company

<table>
<thead>
<tr>
<th>Year</th>
<th>Employees in this year</th>
<th>Employees leaving in this year</th>
<th>Employees leaving until 2007 (excluding retirees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>237</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>2004</td>
<td>234</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>2005</td>
<td>229</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>2006</td>
<td>214</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>2007</td>
<td>209</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 2: Descriptive statistics of Dataset (pooled cross sections)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>log(total income)</td>
<td>1123</td>
<td>10.66</td>
<td>0.17</td>
<td>10.13</td>
<td>11.15</td>
</tr>
<tr>
<td>log(turnover)</td>
<td>1123</td>
<td>13.18</td>
<td>0.44</td>
<td>10.79</td>
<td>14.51</td>
</tr>
<tr>
<td>log(tax2001)</td>
<td>1123</td>
<td>8.60</td>
<td>0.31</td>
<td>7.95</td>
<td>9.08</td>
</tr>
<tr>
<td>log(distance)</td>
<td>1123</td>
<td>5.57</td>
<td>1.10</td>
<td>0.00</td>
<td>not to be reported</td>
</tr>
<tr>
<td>log(age)</td>
<td>1118</td>
<td>3.73</td>
<td>0.19</td>
<td>3.26</td>
<td>4.23</td>
</tr>
<tr>
<td>log(education)</td>
<td>1089</td>
<td>2.46</td>
<td>0.15</td>
<td>2.20</td>
<td>2.89</td>
</tr>
<tr>
<td>log(tenure)</td>
<td>1117</td>
<td>2.33</td>
<td>0.73</td>
<td>0.00</td>
<td>3.66</td>
</tr>
<tr>
<td>promotion</td>
<td>1123</td>
<td>0.03</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>male</td>
<td>1123</td>
<td>0.92</td>
<td>0.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>health &amp; accid.</td>
<td>1123</td>
<td>0.32</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>life</td>
<td>1123</td>
<td>0.30</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>property casualty</td>
<td>1123</td>
<td>0.33</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>corporate acc.</td>
<td>1123</td>
<td>0.16</td>
<td>0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>expert</td>
<td>1123</td>
<td>0.26</td>
<td>0.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>commut. dist.</td>
<td>1123</td>
<td>25.08</td>
<td>27.30</td>
<td>0.00</td>
<td>286.00</td>
</tr>
<tr>
<td>commut. time</td>
<td>1123</td>
<td>22.97</td>
<td>20.07</td>
<td>0.00</td>
<td>158.00</td>
</tr>
<tr>
<td>west &amp; berlin</td>
<td>1123</td>
<td>0.75</td>
<td>0.43</td>
<td></td>
<td></td>
</tr>
<tr>
<td>office size</td>
<td>1123</td>
<td>3.22</td>
<td>1.73</td>
<td>1.00</td>
<td>12.00</td>
</tr>
<tr>
<td>dist. next office</td>
<td>1123</td>
<td>54.87</td>
<td>24.42</td>
<td>10.80</td>
<td>121.00</td>
</tr>
</tbody>
</table>

Pay components in percent of total income

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>fixed salary</td>
<td>1123</td>
<td>0.57</td>
<td>0.06</td>
<td>0.36</td>
<td>0.71</td>
</tr>
<tr>
<td>monthly var. pay</td>
<td>1123</td>
<td>0.31</td>
<td>0.04</td>
<td>0.20</td>
<td>0.52</td>
</tr>
<tr>
<td>one-time bonuses</td>
<td>1123</td>
<td>0.12</td>
<td>0.08</td>
<td>0.00</td>
<td>0.39</td>
</tr>
</tbody>
</table>
Table 3: Hazard rate estimate

<table>
<thead>
<tr>
<th></th>
<th>$\lambda(t)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>tenure(2003)</td>
<td>0.081</td>
</tr>
<tr>
<td></td>
<td>(2.27)*</td>
</tr>
<tr>
<td>home_work</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td>(1.84)</td>
</tr>
<tr>
<td>constant</td>
<td>2.913</td>
</tr>
<tr>
<td></td>
<td>(6.25)**</td>
</tr>
<tr>
<td>LR Chi</td>
<td>10.58 (at 1 % Level)</td>
</tr>
<tr>
<td>Observations</td>
<td>223</td>
</tr>
</tbody>
</table>

Standard errors in parentheses; * significant at 5%; ** significant at 1%;
Table 4: SEM-estimates for the full observation period

<table>
<thead>
<tr>
<th></th>
<th>fixed_salary</th>
<th>variable_pay</th>
<th>production</th>
<th>total_income,</th>
</tr>
</thead>
<tbody>
<tr>
<td>survival</td>
<td>14.188</td>
<td>-13.573</td>
<td>553.058</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.55)**</td>
<td>(6.09)**</td>
<td>(2.25)*</td>
<td></td>
</tr>
<tr>
<td>total_income</td>
<td>-0.040</td>
<td>1.030</td>
<td></td>
<td>(0.82)</td>
</tr>
<tr>
<td></td>
<td>(24.02)**</td>
<td></td>
<td>(2.56)*</td>
<td></td>
</tr>
<tr>
<td>west &amp; berlin</td>
<td>1,937.980</td>
<td>-1,917.743</td>
<td>167,966.204</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(7.06)**</td>
<td>(7.92)**</td>
<td>(9.00)**</td>
<td></td>
</tr>
<tr>
<td>age in 2003</td>
<td>64.384</td>
<td>-65.028</td>
<td>-3,589.052</td>
<td>(6.29)**</td>
</tr>
<tr>
<td></td>
<td>(7.36)**</td>
<td></td>
<td>(3.07)**</td>
<td></td>
</tr>
<tr>
<td>life(2004)</td>
<td>-6.992</td>
<td></td>
<td></td>
<td>(0.09)</td>
</tr>
<tr>
<td>fixed_salary</td>
<td></td>
<td></td>
<td></td>
<td>1.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(248.39)**</td>
</tr>
<tr>
<td>variable_pay</td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(483.02)**</td>
</tr>
<tr>
<td>p_c</td>
<td></td>
<td></td>
<td>199,833.507</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(11.12)**</td>
<td></td>
</tr>
<tr>
<td>life</td>
<td></td>
<td></td>
<td>234,772.147</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(12.16)**</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>22,382.457</td>
<td>-21,946.117</td>
<td>465,258.664</td>
<td>-198.205</td>
</tr>
<tr>
<td></td>
<td>(12.37)**</td>
<td>(13.69)**</td>
<td>(9.24)**</td>
<td>(2.56)*</td>
</tr>
<tr>
<td>Observations</td>
<td>883</td>
<td>883</td>
<td>883</td>
<td>883</td>
</tr>
</tbody>
</table>

Standard errors in parentheses; * significant at 5%; ** significant at 1%;
Table 4: SEM-estimates for year 2003 only

<table>
<thead>
<tr>
<th></th>
<th>fixed_salary</th>
<th>variable_pay</th>
<th>production</th>
<th>total_income</th>
</tr>
</thead>
<tbody>
<tr>
<td>survival</td>
<td>14.251</td>
<td>-16.728</td>
<td>926.051</td>
<td></td>
</tr>
<tr>
<td>(2.12)*</td>
<td>(2.33)*</td>
<td>(2.18)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total_income</td>
<td>-0.056</td>
<td>1.079</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.34)</td>
<td>(6.17)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>west_and_berlin</td>
<td>1,984.103</td>
<td>-2,053.862</td>
<td>162,531.848</td>
<td></td>
</tr>
<tr>
<td>(3.16)**</td>
<td>(3.07)**</td>
<td>(4.57)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>age in 2003</td>
<td>54.041</td>
<td>-52.812</td>
<td>-3,507.370</td>
<td></td>
</tr>
<tr>
<td>(3.12)**</td>
<td>(2.87)**</td>
<td>(1.65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p_c</td>
<td></td>
<td></td>
<td>148,810.482</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(4.15)**</td>
<td></td>
</tr>
<tr>
<td>fixed_salary</td>
<td></td>
<td></td>
<td></td>
<td>1.003</td>
</tr>
<tr>
<td>(42.10)**</td>
<td></td>
<td></td>
<td></td>
<td>(57.51)**</td>
</tr>
<tr>
<td>variable_pay</td>
<td></td>
<td></td>
<td></td>
<td>1.025</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(1.42)</td>
</tr>
<tr>
<td>life</td>
<td></td>
<td></td>
<td>430,049.618</td>
<td></td>
</tr>
<tr>
<td>(11.86)**</td>
<td></td>
<td></td>
<td></td>
<td>(1.42)</td>
</tr>
<tr>
<td>constant</td>
<td>23,276.834</td>
<td>-24,161.147</td>
<td>443,145.279</td>
<td>-542.880</td>
</tr>
<tr>
<td>(3.71)**</td>
<td>(3.60)**</td>
<td>(4.86)**</td>
<td>(1.42)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>224</td>
<td>224</td>
<td>224</td>
<td>224</td>
</tr>
</tbody>
</table>

Standard errors in parentheses; * significant at 5%; ** significant at 1%;