GOVERNANCE AND THE EFFICIENCY OF ECONOMIC SYSTEMS
GESY

Discussion Paper No. 214

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Oliver Gürtler*
Matthias Kräkel **

September 2007

*Oliver Gürtler, Department of Economics, BWL II, University of Bonn, Adenauerallee 24-42, D-53113 Bonn, Germany,
oliver.guertler@uni-bonn.de, phone: +49-228-739214

**Mathias Kräkel, Department of Economics, BWL II, University of Bonn, Adenauerallee 24-42, D-53113 Bonn, Germany,
m.kraekel@uni-bonn.de, phone: +49-228-739211

Financial support from the Deutsche Forschungsgemeinschaft through SFB/TR 15 is gratefully acknowledged.

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Speaker: Prof. Konrad Stahl, Ph.D. · Department of Economics · University of Mannheim · D-68131 Mannheim,
Phone: +49(0621)1812786 · Fax: +49(0621)1812785

Double-Sided Moral Hazard, Efficiency Wages and Litigation*

Oliver Gürtler† Matthias Kräkel‡

Abstract

We consider a double-sided moral hazard problem where each party can renege on the signed contract since there does not exist any verifiable performance signal. It is shown that ex-post litigation can restore incentives of the agent. Moreover, when the litigation can be settled by the parties the pure threat of using the legal system may suffice to make the principal implement first-best effort. As is shown in the paper, this finding is rather robust. In particular, it holds for situations where the agent is protected by limited liability, where the parties have different technologies in the litigation contest, or where the agent is risk averse.

Key Words: double-sided moral hazard; efficiency wage; litigation contest; settlement

JEL Classification: D86, J33, K41.

*We would like to thank Patrick Bolton and Mathias Dewatripont for helpful comments. Financial support by the Deutsche Forschungsgemeinschaft (DFG), grant SFB/TR 15 ("Governance and the Efficiency of Economic Systems"), is gratefully acknowledged.

†Department of Economics, BWL II, University of Bonn, Adenauerallee 24-42, D-53113 Bonn, Germany, e-mail: oliver.guertler@uni-bonn.de, phone: +49-228-739214.

‡Department of Economics, BWL II, University of Bonn, Adenauerallee 24-42, D-53113 Bonn, Germany, e-mail: m.kraekel@uni-bonn.de, phone: +49-228-739211.

1 Introduction

In many contractual relationships, effort choice by an agent is observable by him and the principal but unverifiable by a third party. If there does not exist any verifiable performance signal in this situation, a double-sided moral hazard problem will arise: Given that the agent has to move first by choosing effort, the principal will ex-post withhold any payment by claiming that the agent has only exerted poor effort. Given that the principal should be the first mover who has to pay the agent before the latter one chooses effort we have just the reversed problem. Now the agent optimally chooses zero effort after having received the principal's payment. Since in both cases the first-moving party anticipates the opportunistic behavior of the second mover, no contractual relationship will form in equilibrium.

However, in practice contracts are signed even in situations in which the parties cannot rely on a verifiable performance signal. In our paper, this somewhat puzzling observation is explained by the possibility that a contracting party can go to court if the other party has reneged on the contract. We show that a litigation can be used to restore performance incentives of the agent. Moreover, when the litigation can be settled by the parties the pure threat of using the legal system may suffice to make the principal implement first-best efforts.[1] As is shown in the paper, this finding is rather robust. Settlement will typically lead to the first-best outcome even in situations where the agent is protected by limited liability, where the parties have different technologies in the litigation contest, or where the agent is risk averse. Furthermore, the settlement solution will in general not depend on whether litigation costs are allocated according to the American

[1]Note that in practice a large number of lawsuits are settled; see, for example, Spier (forthcoming).

Rule (i.e. each party has to bear its own litigation costs) or according to the English Rule (i.e. the losing party must pay for both its own costs and those of the winner).

The contract considered throughout the paper is rather simple since the only verifiable information is whether the agent and the principal have signed a contract and what payments are made by the principal. However, if one party has reneged on the contract it can be sued by the other party. In that situation, both parties participate in a litigation contest in which resources can be invested to produce evidence for one's case. Given the means of evidence for both parties, the court will decide for or against the defendant with a certain probability. The contract consists of three parts. First, it contains a lump-sum payment by the principal given to the agent ex-ante when the contract is signed. Second, the principal specifies a certain effort level which is requested from the agent; effort is unverifiable but via a litigation contest the betrayed party gets the chance to enforce the contract. Finally, the contract specifies a bonus which is paid to the agent as a kind of deferred compensation if the agent has chosen the promised effort. Note that without litigation we still have a double-sided moral hazard problem as the principal may claim a low effort level in order to withhold the ex-post bonus, and the agent may shirk by choosing zero effort although he has accepted the contract and received the lump-sum wage by the principal.

In the literature, we can find different approaches to cope with the problem of double-sided moral hazard due to unverifiable effort. Perhaps, the most prominent approach is based on the use of implicit agreements (or reputation) which may become self-enforcing within a repeated-game setting. Unfortunately, self-enforcement needs several additional assumptions to hold for the dynamic contract. Another approach is given by rank-order tournaments. Here the double-sided moral hazard problem is solved by the principal's commitment to pay certain tournament prizes which have been fixed in advance (Malcomson 1984). However, tournament contracts need at least two agents who perform identical tasks. Moreover, idiosyncratic problems like favoritism and bribes, sabotage, or collusion may make the use of tournaments rather unattractive. Similar to tournaments, the two contracting parties may involve a third party.[2] For example, as the principal can observe (but not verify) the agent's effort he can credibly commit himself to pay a prespecified bonus either to the agent (in case of sufficient effort) or to a third party (in case of a poor effort choice).[3] If the third party is risk neutral it can pay a lump sum to the principal ex-ante so that it makes zero expected profits. However, again side contracting, favoritism and related problems may imply that this third-party solution does not work.

The approach suggested in this paper only needs the basic assumption that contracting parties can make use of the legal system if one of them has broken the contract. Going to court gives the injured party a positive probability to enforce the contract. Interestingly, on the one hand high transaction costs of the litigants (e.g. fees for lawyers) can improve the use of an initial lump-sum payment to the agent as an incentive device since these costs would considerably harm the agent when being sued by the principal. On the other hand, we can show that eliminating transaction or litigation costs by settlement leads to the first-best solution in a broad setting of possible contractual problems including limited liability and risk aversion. Hence, the approach used in this paper has the nice properties that it is fairly realistic and rather robust to cope with the problem of double-sided moral hazard.

[2]In case of a tournament, each agent serves as a third party for the principal when contracting with another agent since the principal must pay off the high winner prize to one of the agents.

[3]See, for instance, MacLeod (2003).

Our paper combines three strands in the economic literature. First, it is related to the work on litigation and settlement.[4] This strand of literature typically considers an abstract situation in which an injurer has harmed another party and then addresses topics like the private information of the single parties, the structure of the settlement process, the optimal design of damage awards and the impact of allocating litigation costs on the probability of a trial. While this literature offers a precise economic analysis of the legal procedure of litigation and settlement, the focus is usually not on principal-agent contracts as a specific application. However, our paper is structured in the reversed manner. We only use litigation and settlement as abstract instruments to enforce contractual agreements without discussing legal details, and rather focus on the optimal contract design.

The second strand of literature deals with litigation contests.[5] In this literature, the two litigants invest resources (like fees for lawyers) to win the trial. The more resources they invest the higher will be their probability of winning but also their costs. Within a game-theoretic analysis the strategic behavior of the two contestants is analyzed. The papers on litigation contests ask, for example, how simultaneous versus sequential moving of the litigants, the delegation to lawyers or the use of different rules of allocating legal costs influence the litigants' equilibrium strategies. Our paper also uses a contest game to sketch the litigation process. However, the main part of the paper is based on the general contest-success function introduced by Dixit (1987) and not on the special case of a Tullock or logit-form contest which is typically

[4] See, among many others, Shavell (1982, 1989), Reinganum and Wilde (1986), Spier (1994a, 1994b), Daughety and Reinganum (2002). For an overview see Spier (forthcoming).

[5] See, for example, Tullock (1975, 1980), Katz (1988), Farmer and Pecorino (1999), Bernardo et al. (2000), and Wärneryd (2000) on the analysis of litigation contests. Moreover, the paper is also in line with those contest papers that start with the assumption of missing property rights which leaves room for struggling; see, e.g., Skaperdas (1992), Konrad (2002).

considered in the literature on litigation contests.

Our paper is most closely related to Bernardo, Talley and Welch (2000) who also combine a principal-agent relationship with a litigation contest. However, their paper differs in several respects from ours. They consider a more special setting for the principal-agent model (with two effort levels and two different outcomes) and the litigation contest (a Tullock or logit-form type). Moreover, their contract does not specify a bonus for the agent when being successful. Instead, the possibility of suing the agent in case of a low outcome as well as legal presumptions are analyzed as substitutes for a missing incentive scheme. Bernardo et al. assume that the damage is exogenously given but in our paper the damage is endogenously determined by the contract that should be enforced. Furthermore, in the paper by Bernardo et al., only the agent may renege on the contract whereas in our model either party can break the agreement. Since Bernardo et al. consider a hidden-action model, the agent is also sued if output is low but he has chosen high effort. However, in our paper, we assume an incomplete-contract framework with double-sided moral hazard, i.e. each party may break the contract. We assume that the agent's effort is perfectly observable by the principal but unverifiable; the agent can only be successfully sued if he indeed has chosen low effort.

Finally, our paper is related to the literature on efficiency wages as introduced by Becker and Stigler (1974) and Shapiro and Stiglitz (1984). An efficiency wage is a rather high wage which can serve three different purposes – prevent the agent from shirking, decrease a firm's rate of fluctuation, or work against adverse selection when filling vacant positions with candidates from outside. In the last decade, the shirking approach within the concept of efficiency wages has been reconsidered by contract theorists. Tirole (1999,

p. 745), Laffont and Martimort (2002, p. 174) and Schmitz (2005) speak of efficiency wages when workers are protected by limited liability and are paid a positive rent for incentive reasons. In our model, the agent receives a lump-sum payment at the beginning of the contractual relationship which is also in general associated with a positive rent. However, our approach more closely follows the original notion of efficiency wages by Becker-Stigler and Shapiro-Stiglitz: In these papers, the authors (implicitly) assume that there is not any verifiable performance signal because otherwise the principal would have used explicit incentive contracts. This important assumption is in line with the main assumption of our paper but clearly differs from the approach by Tirole, Laffont-Martimort and Schmitz who focus on explicit incentive schemes based on a verifiable performance signal.

Our paper is organized as follows. In the following section, the model is described. Section 3 deals with the optimal contract under litigation, whereas Section 4 focuses on settlement. Section 5 discusses the robustness of the previous findings, analyzing the implications of asymmetric contest-success technologies, legal presumptions, risk aversion and the replacement of the American Rule of allocating legal costs with the English Rule. The final section concludes.

2 The Model

We consider a contractual relationship between an agent A ("he") and a principal P ("she"). Both are assumed to be risk neutral.[6] If A accepts the contract offered by P, he will exert effort $e \geq 0$ which determines P's output (in monetary terms) $q = e$, i.e. effort choice is identical with output.

[6] In Section 5, we consider a risk-averse agent.

In order to have a non-trivial incentive problem, we assume that effort e is observable by both A and P but unverifiable to a third party. Effort entails costs for A which are described by $c(e)$ with $c'(e), c''(e) > 0$ and $c(0) = 0$. To guarantee an interior solution we assume that $c'(0) = 0$ and $c'(e) = \infty$ if $e \to \infty$. Both contracting parties, A and P, have zero reservation values.

In the following, we consider contracts of the form $\left(w, \hat{e}, \hat{b}\right)$. The wage w is a fixed payment to A at the beginning of the relationship when the contract is signed.[7] $\hat{e}$ denotes the effort level that is requested by P. Finally, $\hat{b}$ stands for the bonus which is promised A by P in case of having chosen $e \geq \hat{e}$. We can show that under the optimal contract both w and $\hat{b}$ are non-negative although the agent is not protected by limited liability (see the Appendix). Hence, w.l.o.g. we will restrict the following analysis to contracts with $w \geq 0$ and $\hat{b} \geq 0$. Note that the setting describes a double-sided moral hazard problem. Without further provisions, no one would have an incentive to stick to the contract because of the unverifiability of e. On the one hand, P can always save labor costs $\hat{b}$ by claiming that $e < \hat{e}$ irrespective of the chosen effort level. On the other hand, A can anticipate P's behavior and, moreover, he can choose $e = 0$ to minimize effort costs without any sanctions so far.

In practice, we often observe fixed payments and promised bonuses without the existence of verifiable performance signals. Instead, there exist legal institutions like labor courts which may enforce contractual claims. In order to focus on this topic, we assume that, if one party reneges on its contractual promise, it can be sued by the other party. Technically, we will consider a litigation contest between A and P. Each party i ($i = A, P$) can invest monetary expenditures $x_i \geq 0$ to produce evidence in its favor and, hence,

[7] Hence, signing of the contract is verifiable.

to win the contest. For example, x_i may describe fees for lawyers or money for expert opinions and documentary evidence.[8] Let $p(x_A, x_P)$ denote the probability of A to win the litigation contest, that is $p(x_A, x_P)$ describes the probability that the court decides in favor of party A. Therefore, P's winning probability is given by $1 - p(x_A, x_B)$. Following Dixit (1987), we assume (i) $p(x_A, x_P) = 1 - p(x_P, x_A)$, (ii) that $p(x_A, x_P)$ is twice continuously differentiable with $p_1 > 0$, $p_{11} < 0$, $p_2 < 0$, $p_{22} > 0$ and (iii) that $p_{12} > 0 \Leftrightarrow p > 0.5$.[9] Assumption (i) states that both parties apply the same contest-success technology (symmetry assumption). For example, A and P have the same access to the market for lawyers and experts. According to assumption (ii), spending resources x_i has positive but diminishing marginal effects on one's own probability of winning the contest. Finally, assumption (iii) is very intuitive, too. If, initially, A chooses higher expenditures, a marginal increase in x_P makes it more attractive for A to increase x_A as well. This is due to the more intense competition the increase in P's expenditures has caused. Similarly, if, initially, $x_A < x_P$, an increase in x_P makes the contest more uneven so that it is beneficial for the agent to invest less. Note that assumption (iii) together with Young's theorem implies that $p_{21} > 0 \Leftrightarrow p > 0.5$, which can be interpreted analogously. Notice further that assumption (iii) is fulfilled for the two most frequently used specifications of $p(x_A, x_P)$, the logit-form contest-success function[10] and the probit-form contest-success function[11].

In order to focus on the disciplining role of litigation, we introduce two further assumptions: First, we abstract from the possibility of opportunistic

[8] We abstract from fixed costs for the parties when filing a complaint. Of course, if such costs are too high, creating incentives by litigation will not work.

[9] Here, subscripts of $p(\cdot, \cdot)$ denote the respective partial derivatives.

[10] See Tullock (1980). For a formal proof that assumption (iii) is fulfilled in both kinds of contests see Dixit (1987).

[11] See, e.g., Lazear and Rosen (1981).

suing, i.e. A (P) can only successfully sue P (A) if $e \geq \hat{e}$ ($e < \hat{e}$) and $b < \hat{b}$.[12] Second, we assume that the court will only decide to enforce or rescind the contract $\left(w, \hat{e}, \hat{b}\right)$ but not to impose an obligation to pay further damages on the defendant. Otherwise, setting draconian sanctions can solve the incentive problem. Formally, if A sues P in case of $e \geq \hat{e}$ and $b < \hat{b}$, P has to pay A the promised bonus $\hat{b}$ with probability $p(x_A, x_P)$.[13] This damage measure is called expectation damages in legal practice.[14] Expectation damages compensate the injured party such that it is in the same position as it would be under the performed contract. Higher damages than $\hat{b}$ are not allowed. According to common law, a liquidated damage clause will not be enforced if the purpose of the clause is pure punishing the breach of contract. If P sues A in case of $e < \hat{e}$, A has to pay back w to P with probability $1 - p(x_A, x_P)$. Higher damages than w are not feasible. According to the expectation measure, A should perfectly compensate P for the promised output so that P has the same economic position as if the contract has been fulfilled. However, if it is not possible to award damages measured in this way, the court will enforce damages that give the injured party the same position it had at the time of contracting (reliance measure).[15] By following the reliance-damages rule, we assume that the court does not know the underlying production technology and, hence, enforces refunding of w.

The timing of the model is the following:

[12] Of course, payments w and b by P are verifiable.

[13] Note that we do not consider the case that P pays a positive bonus $b \in \left(0, \hat{b}\right)$ when reneging on the contract which would result in a damage $\hat{b} - b$. If A has chosen effort $e < \hat{e}$, P has to pay no bonus to A by contract. Hence, any positive bonus clearly indicates that A has fulfilled the contract.

[14] See Shavell (1980) and Rogerson (1984) on expectation damages, reliance damages and restitution damages.

[15] Since P has not spent further reliance expenditures in our model, the reliance measure and the restitution measure coincide here; see Shavell (1980, p. 471).

1	2	3	4	5
P offers contract $\left(w, \hat{e}, \hat{b}\right)$	A accepts or rejects	A chooses effort e	P chooses bonus b	possible litigation

First P offers a contract $\left(w, \hat{e}, \hat{b}\right)$. Then A decides whether to accept or reject the contract. If A rejects P's offer, the game will end. If A has accepted, then he will choose his unverifiable effort $e \geq 0$. Then P decides on the verifiable payment $b \geq 0$ to A. Finally, any contracting party can sue the other one. However, by assumption, only if a party has reneged on the contract, it can be successfully sued with a positive probability.

3 Contract Choice and Litigation

We solve the game by backward induction and start with the litigation stage. Suppose that $i \in \{A, P\}$ has not fulfilled the contract so that $j \in \{A, P\} \setminus \{i\}$ can go to court. In this case, $i = A$ ($i = P$) has to pay the damage $D = w$ ($D = \hat{b}$) to j if $j = P$ ($j = A$) wins the litigation contest. Player j's expected utility from suing i is given by

$$D \cdot p\left(x_j, x_i\right) - x_j \tag{1}$$

whereas i's objective function in the contest is described by[16]

$$-D \cdot p\left(x_j, x_i\right) - x_i. \tag{2}$$

[16] Recall that, by assumption (i), $p\left(\cdot, \cdot\right)$ is symmetric so that a permutation of subscripts does not change the results.

Note that it is optimal for either player to choose $x_i = x_j = 0$, if $D = 0$. Note further that both objective functions are strictly concave. We assume that for any strictly positive value of D an interior solution for the litigation contest exists.[17] The interior solution is characterized by the first-order conditions

$$D \cdot p_1(x_j, x_i) = 1 \quad \text{and} \quad -D \cdot p_2(x_j, x_i) = 1. \tag{3}$$

Recall that, due to the symmetry assumption, we have $p(x_j, x_i) = 1 - p(x_i, x_j)$. Differentiation with respect to x_i yields $p_2(x_j, x_i) = -p_1(x_i, x_j)$. Inserting into (3) gives

$$D \cdot p_1(x_j, x_i) = D \cdot p_1(x_i, x_j) = 1. \tag{4}$$

Hence, we have a symmetric solution $(x_j, x_i) = (x^*, x^*)$ being described by

$$D \cdot p_1(x^*, x^*) = 1. \tag{5}$$

It is easy to see that x^* is monotonically increasing in D and can be written as[18]

$$x^* := X(D) \quad \text{with} \quad X'(\cdot) > 0. \tag{6}$$

Existence of an interior solution implies that the expected gain from participating in the litigation contest is non-negative:

$$G(D) := \frac{D}{2} - X(D) \geq 0. \tag{7}$$

[17] Later, we apply the widely used contest-success function that has been introduced by Tullock. If the power parameter is not too large, an interior solution will always exist in the Tullock contest.

[18] To prove this, we make use of the implicit function theorem, from which we obtain $\frac{\partial x^*}{\partial D} = -\frac{p_1(x^*,x^*)}{D[p_{11}(x^*,x^*)+p_{12}(x^*,x^*)]}$. As $p_{11}(x^*, x^*) < 0$ and $p_{12}(x^*, x^*) = 0$, we have $\frac{\partial x^*}{\partial D} > 0$.

At stage 4 of the game, P chooses a bonus payment $b \geq 0$ for A. If A has chosen $e < \hat{e}$ before, P will follow the contract and choose $b = 0$. If A has chosen $e \geq \hat{e}$, again $b = 0$ will be P's optimal response: according to (7), it is more favorable for P to take part in the litigation contest than directly paying $\hat{b}$. Altogether, in stage 4 P has the dominant action, not to pay $b = \hat{b}$ but $b = 0$ instead.

At the third stage, A has to decide on his effort choice e. Of course, A will either choose $e = 0$ or exactly $e = \hat{e}$. In any case, A anticipates that P will not pay $b = \hat{b}$ in the next stage. If A decides to shirk ($e = 0$), he will be sued by P and forgoes the possibility to take part in the litigation contest on $\hat{b}$. If A sticks to the contract and chooses $e = \hat{e}$, he will retain the fixed payment w for sure and gets the expected gain $G\left(\hat{b}\right)$. Hence, A's expected utility from shirking is given by

$$EU_A\left(e = 0\right) = \frac{w}{2} - X\left(w\right), \tag{8}$$

and his expected utility from sticking to the contract by

$$EU_A\left(e = \hat{e}\right) = w + \frac{\hat{b}}{2} - X\left(\hat{b}\right) - c\left(\hat{e}\right). \tag{9}$$

By comparing (8) and (9), we obtain the no-shirking condition or incentive constraint $EU_A\left(e = \hat{e}\right) \geq EU_A\left(e = 0\right) \Leftrightarrow$

$$\left[\frac{w}{2} + X\left(w\right)\right] + \left[\frac{\hat{b}}{2} - X\left(\hat{b}\right)\right] \geq c\left(\hat{e}\right). \tag{IC}$$

Condition (IC) shows that incentives for choosing $e = \hat{e}$ arise for two reasons: The first term in brackets denotes A's benefit from avoiding a litigation contest on refunding w. The second term in brackets describes A's expected gain from participating in a litigation contest on $\hat{b}$; A would lose this option value in case of shirking ($e = 0$).

Notice that the agent's participation constraint is given by

$$w + \left[\frac{\hat{b}}{2} - X\left(\hat{b}\right)\right] \geq c\left(\hat{e}\right), \tag{PC}$$

which is automatically implied by constraint (IC). Hence, in the optimum A always earns a non-negative rent and so always accepts the contract at stage 2. Alternatively, it can be argued that the agent can always ensure a non-negative payoff by accepting the contract and choosing $e = 0$. Hence, he will never reject a contract offer.

Finally, at stage 1, P chooses the optimal contract $\left(w^*, \hat{e}^*, \hat{b}^*\right)$. She can implement a positive effort level by choosing w and $\hat{b}$ according to condition (IC). In the optimum, (IC) holds with equality since P does not want to waste money. Formally, this means that P chooses $\left(w^*, \hat{e}^*, \hat{b}^*\right)$ in order to maximize

$$\hat{e} - w - \frac{\hat{b}}{2} - X\left(\hat{b}\right) \tag{10}$$

subject to

$$\left[\frac{w}{2} + X\left(w\right)\right] + \left[\frac{\hat{b}}{2} - X\left(\hat{b}\right)\right] = c\left(\hat{e}\right). \tag{11}$$

It is easy to see that the solution to the maximization problem depends on the function $X\left(D\right)$. Therefore, it is impossible to say something about the solution $\left(w^*, \hat{e}^*, \hat{b}^*\right)$ without imposing some additional structure on $X\left(D\right)$. If, however, additional assumptions about $X\left(D\right)$ are introduced, we obtain nice and clear-cut results, as the following proposition shows:

Proposition 1 *There exist two cut-off values, $\bar{x} > 0$ and $\tilde{x} > 0$ with $\bar{x} > \tilde{x}$, such that the following holds: (i) If $X'\left(D\right) \geq \bar{x}$, $\forall D \geq 0$, the optimal con-*

tract is of the form $\left(w^* > 0, \hat{e}^* > 0, \hat{b}^* = 0\right)$. *Given that a litigation contest is not completely dissipative* ($G(D) > 0$)*, the agent will earn a strictly positive rent. (ii) If* $X'(D) \leq \tilde{x}$, $\forall D \geq 0$, *the optimal contract is of the form* $\left(w^* = 0, \hat{e}^* > 0, \hat{b}^* > 0\right)$. *In this case, the agent will receive zero rent. (iii) Otherwise, both* w^* *and* $\hat{b}^*$ *may be strictly positive.*

Proof. The Lagrangian to the principal's maximization problem is

$$L = \hat{e} - w - \frac{\hat{b}}{2} - X\left(\hat{b}\right) + \lambda\left(\left[\frac{w}{2} + X(w)\right] + \left[\frac{\hat{b}}{2} - X\left(\hat{b}\right)\right] - c(\hat{e})\right),$$

with λ as the Lagrange-multiplier. As Kuhn-Tucker conditions, we obtain

$$\begin{aligned}
\frac{\partial L}{\partial \hat{e}} &= 1 - \lambda c'(\hat{e}^*) \leq 0 \quad (= 0, \text{ if } \hat{e}^* > 0) \\
\frac{\partial L}{\partial w} &= -1 + \lambda\left(\frac{1}{2} + X'(w^*)\right) \leq 0 \quad (= 0, \text{ if } w^* > 0) \\
\frac{\partial L}{\partial \hat{b}} &= -\frac{1}{2} - X'\left(\hat{b}^*\right) + \lambda\left(\frac{1}{2} - X'\left(\hat{b}^*\right)\right) \leq 0 \quad \left(= 0, \text{ if } \hat{b}^* > 0\right).
\end{aligned}$$

We begin by noting that the first condition must be binding. Otherwise, we had $\hat{e}^* = 0$, which implies $\lambda \to \infty$, as $c'(0) = 0$. From $\lambda \to \infty$, it follows that $\frac{\partial L}{\partial w} > 0$, for all w. This, in turn, implies $w^* \to \infty$, which is clearly not optimal for P. Moreover, at least one of the remaining two conditions must bind, too. Otherwise, we would have $w^* = \hat{b}^* = 0$, which, in turn, implies $\hat{e}^* \to 0$ and, accordingly, $\lambda \to \infty$. As argued before, this yields $\frac{\partial L}{\partial w} > 0$, which is a contradiction to $w^* = 0$.

Now, let $X'(D)$ be so high (i.e. $X'(D) \geq \bar{x}$) that the following condition always holds:

$$\frac{\partial L}{\partial w}=-1+\lambda\left(\frac{1}{2}+X'(w^*)\right)>\frac{\partial L}{\partial \hat{b}}=-\frac{1}{2}-X'\left(\hat{b}^*\right)+\lambda\left(\frac{1}{2}-X'\left(\hat{b}^*\right)\right)$$
$$\Leftrightarrow \lambda\left[X'(w^*)+X'\left(\hat{b}^*\right)\right]+X'\left(\hat{b}^*\right)>\frac{1}{2}$$

In this case, the Kuhn-Tucker conditions directly imply $w^*>0$ and $\hat{b}^*=0$. Further, note that $\bar{x}>0$, as otherwise, the condition $\frac{\partial L}{\partial w}>\frac{\partial L}{\partial \hat{b}}$ did not necessarily hold. Similarly, if $X'(D)$ is so low (i.e. $X'(D)\leq\tilde{x}$) that

$$\frac{\partial L}{\partial w}<\frac{\partial L}{\partial \hat{b}}\Leftrightarrow \lambda\left[X'(w^*)+X'\left(\hat{b}^*\right)\right]+X'\left(\hat{b}^*\right)<\frac{1}{2}$$

always holds, we obtain $w^*=0$ and $\hat{b}^*>0$ from the Kuhn-Tucker conditions. Moreover, as λ is finite (which follows from $\hat{e}^*>0$), the corresponding cut-off value $\tilde{x}$ is positive, too.

Finally, if $X'(D)$ lies in-between the two cut-off values, we cannot rank $\frac{\partial L}{\partial w}$ and $\frac{\partial L}{\partial \hat{b}}$ unambiguously, which means that both, w^* and $\hat{b}^*$, may be strictly positive.

In case (i), A can ensure himself a payoff $G(w)=\frac{w}{2}-X(w)$ by choosing $e=0$. Accordingly, A's net payoff from choosing $e=\hat{e}>0$ and bearing costs $c(\hat{e})$ must be at least $G(w)$, for, otherwise, A would deviate to $e=0$. This payoff and, therefore, A's rent is strictly positive unless the litigation contest is completely dissipative. In case (ii), we have $w^*=0$. Inserting into (11) yields $\left[\frac{\hat{b}}{2}-X\left(\hat{b}\right)\right]=c(\hat{e})$ so that (PC) becomes binding. ■

The proposition shows that in some situations the principal will only use a wage payment w as incentive device. In this case, the agent always receives a positive rent (unless $X(w)=\frac{w}{2}$) so that we can speak of an efficiency wage w. Intuitively, the agent can always ensure himself a payoff $\frac{w}{2}-X(w)$

by choosing zero effort. Hence, $\frac{w}{2} - X(w)$ represents a lower bound for the agent's equilibrium payoff. If $X(w) < \frac{w}{2}$, this lower bound is strictly positive and the agent receives a rent. By setting $w^* = 0$ and $\hat{b}^* > 0$, this lower bound for the agent's payoff becomes zero and so does his rent. This explains why there are also situations in which the principal makes only use of a deferred compensation $\hat{b}$. Finally, the principal may use an optimal mix of both instruments w and $\hat{b}$ as well.

According to Proposition 1, the optimal contract crucially depends on $X'(D)$. To understand this, note that $X'(D)$ can be interpreted as a measure of rent or gain dissipation in the respective litigation contest: The higher $X'(D)$ (for all $D \geq 0$) the larger will be the amount of expenditures chosen in the contest and, hence, the larger will be the dissipation rate (i.e. the lower will be the gain $G(D)$ from participating in the litigation contest). Recall that, in equilibrium, the use of w for incentivizing A does not lead to a litigation which implies zero litigation costs for P. Moreover, if A shirks by choosing $e = 0$ he will gain $G(w)$ from the subsequent litigation contest on refunding w. The higher the dissipation rate the less attractive will be shirking and the more effective will be creating incentives via an efficiency wage w. However, a positive bonus $\hat{b}$ always implies that a litigation contest takes place and that P has to bear litigation costs $X\left(\hat{b}\right)$. Altogether, if $X'(D)$ is generally high so that resource dissipation in the contest is large (i.e. $X'(D) \geq \bar{x}$, $\forall D \geq 0$) the principal will only use efficiency wages w as incentive device: $w^* > 0$ and $\hat{b}^* = 0$. If, on the contrary, the dissipation rate is generally low in a litigation contest (i.e. $X'(D) \leq \tilde{x}$, $\forall D \geq 0$) the principal will solely rely on deferred compensation $\hat{b}$ to generate incentives so that we obtain $w^* = 0$ and $\hat{b}^* > 0$ in equilibrium.

It should be noted that there are two special cases, in which the first-best effort e^{FB} is implemented.[19] In the first situation, we have complete dissipation in the contest, and hence $X(w) = \frac{w}{2}$. In this case, the agent does not receive a rent, if incentives are induced via w. Moreover, if he shirks and chooses $e < 0$ his expected benefits from shirking, $w/2$, are completely eliminated by the respective litigation costs $X(w) = w/2$. Consequently, the threat of litigation would be so effective that P prefers to induce efficient incentives since she can extract all efficiency gains in this situation. In the second case, $X(D) = 0$ so that there is no rent dissipation at all. Here, the downside of the bonus payment disappears and the first-best solution is implemented by choosing $w^* = 0$ and $\frac{\hat{b}^*}{2} = c\left(e^{FB}\right)$.

To illustrate our previous results, we now consider a parameterized contest-success function $p(x_A, x_P)$ which is widely used in the contest literature, in particular for modeling litigation contests:[20]

$$p(x_A, x_P) = \begin{cases} \dfrac{x_A^\alpha}{x_A^\alpha + x_P^\alpha} & \text{if } x_A + x_P > 0 \\ 1/2 & \text{otherwise} \end{cases} \tag{12}$$

with $\alpha \in [0, 2]$ guaranteeing an interior solution.[21] For the special case of contest-success function (12), the first-order conditions (3) lead to a symmetric equilibrium with both A and P spending resources

$$x^* := X(D) = \frac{D\alpha}{4} \tag{13}$$

[19]Note that here e^{FB} describes the effort maximizing $e - c(e)$, i.e. first-best effort in case of a risk-neutral agent. In Section 5, e^{FB} denotes the efficient effort choice of an agent who may be risk-averse.

[20]See, among many others, Tullock (1975, 1980), Katz (1988), Farmer and Pecorino (1999), Bernardo et al. (2000), Wärneryd (2000), Hirshleifer and Osborne (2001), Konrad (2007), pp. 35-46.

[21]Notice that the Tullock contest-success function is not twice continuously differentiable at $x_A = x_P = 0$. However, $X(D)$ is continuous everywhere.

and realizing an expected gain

$$G(D) = \frac{D}{2}\left(1 - \frac{\alpha}{2}\right) \tag{14}$$

from participating in the litigation contest. Hence, P maximizes

$$\hat{e} - w - \hat{b}\frac{2+\alpha}{4} \tag{15}$$

$$\text{subject to} \qquad w\frac{2+\alpha}{4} + \hat{b}\frac{2-\alpha}{4} = c\left(\hat{e}\right). \tag{16}$$

Equation (16) shows that P can induce the same incentive level by either spending one unit of w or $\frac{2+\alpha}{2-\alpha}$ units of $\hat{b}$. By substituting for $\hat{b} = \frac{2+\alpha}{2-\alpha}w$ in (15) we can see that creating incentives via $\hat{b}$ is more costly than via w as long as $\frac{(2+\alpha)^2}{4(2-\alpha)} > 1 \Leftrightarrow \alpha > \bar{\alpha} := \sqrt{20} - 4$. Hence, the optimal contract is $(w^* > 0, \hat{e}^*, 0)$ for $\alpha > \bar{\alpha}$, $\left(w^* \geq 0, \hat{e}^*, \hat{b}^* \geq 0\right)$ for $\alpha = \bar{\alpha}$, and $\left(0, \hat{e}^*, \hat{b}^* > 0\right)$ for $\alpha < \bar{\alpha}$. These findings are very intuitive. They directly correspond to the results of Proposition 1 on the cutoffs $\bar{x}$ and $\tilde{x}$.[22] If α gets higher, more resources are wasted in the litigation contest. As explained before, P then gains from relying more strongly on w and reducing $\hat{b}$.

Recall that the first-best effort, $e^{FB} = c'^{-1}(1)$, is only implemented in the two extreme cases of no or full rent dissipation, i.e. $\alpha = 0$ and $\alpha = 2$. In all other cases, the induced effort is inefficiently low, as the following corollary (which can be derived using (15) and (16)) shows.

Corollary 1 *Let $p(x_A, x_P)$ be described by (12). There exists a cut-off value*

[22] Here we have $\bar{x} = \tilde{x} = \frac{\sqrt{20}-4}{4}$.

$\bar{\alpha}$ *so that* P *implements an effort level* $\hat{e}^* < e^{FB}$ *by choosing*

$$\left(w^*, \hat{e}^*, \hat{b}^*\right) = \begin{cases} \left(\frac{4c(\hat{e}^*)}{2+\alpha}, c'^{-1}\left(\frac{2+\alpha}{4}\right), 0\right), & \text{if } \alpha > \bar{\alpha} \\ \left(w^*, c'^{-1}\left(\frac{\sqrt{5}-1}{2}\right), \hat{b}^*\right) \text{ with} & \\ w^*\frac{\sqrt{5}-1}{2} + \hat{b}^*\frac{3-\sqrt{5}}{2} = c\left(c'^{-1}\left(\frac{\sqrt{5}-1}{2}\right)\right), & \text{if } \alpha = \bar{\alpha} \\ \left(0, c'^{-1}\left(\frac{2-\alpha}{2+\alpha}\right), \frac{4c(\hat{e}^*)}{2-\alpha}\right), & \text{if } \alpha < \bar{\alpha} \end{cases}$$

with $\alpha \in (0, 2)$.

4 Settlement

For the two parties as a whole, a litigation contest represents a pure waste of resources. It is therefore not unreasonable to think that the principal and the agent settle a conflict peacefully instead of going to court. We capture this possibility in the following way: Before a litigation contest takes place, the two parties meet and bargain for a settlement. The outcome of this bargaining process is assumed to be the Nash-bargaining solution, with $\beta \in [0, 1]$ denoting the principal's bargaining power and $1 - \beta$ the agent's.[23] This implies that settlement will always take place, because it represents a more efficient way to solve the conflict than the litigation contest.

Besides the possibility of settlement, the model is the same as in Section 2. As before, we assume w.l.o.g. that $w, \hat{b} \geq 0$ so that A sues P for $\hat{b}$, if P refuses to pay this bonus (after the agent has chosen the demanded effort) and P sues A for w, if the agent does not work as hard as initially promised.

The model is solved by backward induction, hence we start with the possible litigation contest for $\hat{b}$ at the end of the game. If it comes to this

[23] Note that β need not equal 1. A party's bargaining power in the settlement process may thus differ from the ex ante bargaining power at the initial contract negotiation stage.

contest, the agent will be successful with probability $\frac{1}{2}$ and receive a payoff of $\frac{\hat{b}}{2} - X\left(\hat{b}\right)$. Similarly, the principal's payoff from the contest will be given by $-\frac{\hat{b}}{2} - X\left(\hat{b}\right)$. Note that these payoffs also represent the parties' threat or disagreement utilities in the settlement process, in which they can save a total amount of $2X\left(\hat{b}\right)$. As mentioned before, this gain is always captured and settlement always occurs. Together with our assumption on the parties' relative bargaining powers, this implies that the agent's payoff in the settlement stage is

$$\begin{aligned} EU_A^S &= \frac{\hat{b}}{2} - X\left(\hat{b}\right) + (1-\beta)\, 2X\left(\hat{b}\right) \\ &= \frac{\hat{b}}{2} + (1-2\beta)\, X\left(\hat{b}\right), \end{aligned} \tag{17}$$

while P receives

$$\begin{aligned} EU_P^S &= -\frac{\hat{b}}{2} - X\left(\hat{b}\right) + 2\beta X\left(\hat{b}\right) \\ &= -\frac{\hat{b}}{2} - (1-2\beta) X\left(\hat{b}\right). \end{aligned} \tag{18}$$

As $X\left(\hat{b}\right) \leq \frac{\hat{b}}{2}$, the principal's payoff exceeds $-\hat{b}$, no matter how the ex post bargaining power is distributed. Hence, she is again better off by not sticking to her promise and so by refusing to pay out the bonus. This is of course anticipated by A and must be incorporated into his incentive and participation constraints. If A sticks to his promise and chooses effort $\hat{e}$, he suffers from the effort costs $c(\hat{e})$, but can keep the fixed wage w and additionally gets EU_A^S from the settlement process described before. If, on the other hand, he deviates to $e = 0$, he is sued by the principal. Here, the conflict is again settled and the agent gets a payoff $w - \frac{w}{2} + (1-2\beta)\, X(w)$.

Thus, the agent's incentive constraint is given by

$$w - c(\hat{e}) + \frac{\hat{b}}{2} + (1-2\beta)\, X\left(\hat{b}\right) \geq w - \frac{w}{2} + (1-2\beta)\, X\left(w\right) \tag{19}$$
$$\Leftrightarrow \frac{w}{2} - c(\hat{e}) + \frac{\hat{b}}{2} + (1-2\beta)\left(X\left(\hat{b}\right) - X\left(w\right)\right) \geq 0.$$

Since $w - \frac{w}{2} + (1-2\beta)\, X\left(w\right) \geq 0$, the participation constraint is always implied by the incentive constraint so that the latter constraint binds in the optimum. The principal's optimization problem at the contracting stage can therefore be written as

$$\max_{\hat{e},\hat{b},w}\ \hat{e} - w - \frac{\hat{b}}{2} - X\left(\hat{b}\right) \boldsymbol{+2\beta X\left(\hat{b}\right)} \tag{20}$$
$$\text{s.t.}\ \left[\frac{w}{2} + X\left(w\right) \boldsymbol{-2\left(1-\beta\right) X\left(w\right)}\right] + \left[\frac{\hat{b}}{2} - X\left(\hat{b}\right) \boldsymbol{+2\left(1-\beta\right) X\left(\hat{b}\right)}\right] = c\left(\hat{e}\right).$$

The bold expressions indicate the changes in the maximization problem due to the possibility of settlement. Settlement affects the situation in three ways: First, P directly gains from the settlement, as the costly litigation contest at the end of the game does not take place and the principal receives part of the saved resources (unless her ex post bargaining power β is zero). Second, it becomes more difficult to incentivize the agent via w. In the model in Section 2, part of the incentive was provided by the resources $X\left(w\right)$ that A had to bear in the litigation contest, if deviating from the promised effort. Due to the settlement process, this disciplining device becomes less strong and the incentive constraint harder to fulfill. Finally, it becomes more attractive to use $\hat{b}$ as an incentive device. This is due to the fact that the agent, in contrast to the previous model, need not enter a costly litigation contest to get a share of $\hat{b}$. In turn, he reacts more strongly to this kind of incentive.

Altogether, all these effects make the use of $\hat{b}$ relatively more attractive for the principal. Indeed, under a mild additional assumption, she is even able to implement the first-best solution by solely relying on $\hat{b}$, as shown in the following proposition:

Proposition 2 *Let settlement of the conflict be possible and* $\frac{\bar{b}}{2}+(1-2\beta)\,X\left(\bar{b}\right) \geq c\left(e^{FB}\right)$*, with* $\bar{b} \in \arg\max_{\hat{b}\geq 0} \frac{\hat{b}}{2}+(1-2\beta)\,X\left(\hat{b}\right)$*. Then, the principal will always set* $w^*=0$, $\frac{\hat{b}^*}{2}+(1-2\beta)\,X\left(\hat{b}^*\right)=c(e^{FB})$ *and* $\hat{e}^*=e^{FB}$*. In this way, she will obtain the first-best surplus as profit.*

Proof. Let $w^*=0$. Then, the incentive constraint reduces to (recall that $X(0)=0$)

$$\frac{\hat{b}}{2}+(1-2\beta)\,X\left(\hat{b}\right)=c\left(\hat{e}\right).$$

This can be inserted into the principal's objective function, which then can be rewritten as

$$EU_P=\hat{e}-c(\hat{e}).$$

It directly follows that the principal receives the complete surplus to be produced. She chooses $\hat{e}$ in order to maximize this surplus, which leads to the first-best solution, $\hat{e}^*=e^{FB}$. Clearly, the principal could never receive more than the first-best surplus. Therefore, the initial choice of $w^*=0$ was optimal, too.[24] Finally, note that the incentive constraint becomes $\frac{\hat{b}^*}{2}+(1-2\beta)\,X\left(\hat{b}^*\right)=c(e^{FB})$. This, however, can only be fulfilled, if $\frac{\hat{b}}{2}+(1-2\beta)\,X\left(\hat{b}\right)\geq c(e^{FB})$, for some $\hat{b}\geq 0$. ■

As discussed before, incentives can be provided via w or $\hat{b}$. In Section 3, the trade-off between these two instruments was the following: If the agent is incentivized via w, the principal has to leave him a rent or, in other words, has

[24] Note that this also justifies our assumption $w,\hat{b}\geq 0$ at the beginning of this section.

to pay him an efficiency wage. If $\hat{b}$ is used as an incentive device, a litigation contest takes place, in which resources are wasted. With settlement, however, a litigation contest is prevented and the litigation costs are not incurred. Accordingly, this downside to the use of deferred compensation $\hat{b}$ disappears and a pure bonus contract (with $w^* = 0$) is optimal. Moreover, as such a contract yields no contractual frictions, the first-best solution is achieved.[25]

Notice that the additional restriction imposed is indeed a rather mild one. It states that the agent's compensation payment in the settlement process can become so high (if the bonus is determined appropriately) that the first-best effort costs are covered. This is always the case, if the agent's ex post bargaining power is at least 0.5 or if the litigation contest is not excessively wasteful. Given a contest-success function of the form (12), for instance, the condition is always fulfilled for $\alpha < 2$, no matter how the ex post bargaining power is distributed. Hence, only in exceptional cases the condition may be violated.

Proposition 2 is quite remarkable in light of the assumptions that effort is unverifiable and the contract cannot be enforced, if the parties do not spend resources for the production of evidence. What makes it even more remarkable is the fact that, in equilibrium, no such resources are spent. Hence, the pure threat of going to court and trying to enforce a claim legally helps the parties to overcome all contractual problems. Furthermore, note that optimal payments w^* and $\hat{b}^*$ are non-negative. Thus, even if the agent is protected by limited liability, the principal will implement first-best effort:

Corollary 2 *Let the condition of Proposition 2 be satisfied. If A is protected by limited liability in the sense of $w \geq 0$ and $w + \hat{b} \geq 0$, again P will induce*

[25] Note that this argumentation is similar to the argumentation in the special case from Section 3, where a litigation contest took place, but no resources were dissipated, i.e. where $X(D) = 0$.

efficient incentives $\hat{e}^* = e^{FB}$.

5 Discussion

5.1 Litigation Contest

Up to now, we have assumed a completely symmetric contest-success technology so that the likelihood of winning the litigation does not depend on the identity of the investing party or whether the party was the one that has reneged on the contract or not. However, in practice the litigants may have access to lawyers and experts of different quality. Moreover, the party that has broken the contract should have a lower winning probability than the other party. Finally, legal presumptions may apply which either favor the plaintiff or the defendant. Altogether, in such asymmetric litigation contests A and P usually have different expected gains of participating in the contest. Let $G_A(w)$ and $G_A\left(\hat{b}\right)$ ($G_P(w)$ and $G_P\left(\hat{b}\right)$) denote A's (P's) expected gains of participating in a litigation contest on w and $\hat{b}$, respectively. Now conditions (10) and (11) can be rewritten as

$$\hat{e} - w - \hat{b} + G_P\left(\hat{b}\right) \tag{10'}$$

$$w - G_A(w) + G_A\left(\hat{b}\right) = c(\hat{e}). \tag{11'}$$

Inspection of (10') and (11') shows that $G_P(w)$ is irrelevant on the equilibrium path as shirking of A is prevented by incentive constraint (11'). The other three values, however, are important for the creation of incentives via litigation. Incentive constraint (11') shows that inducing incentives via w will become very effective if A is a weak player in the w-contest (i.e. if $G_A(w)$ is small).[26] However, the more A is favored (P is discriminated) in the contest on $\hat{b}$ and, hence, the higher $G_A\left(\hat{b}\right)$ (the lower $G_P\left(\hat{b}\right)$) the more effective (the more costly) will be inducing incentives via $\hat{b}$ according to (11') (according to (10')).

We can also sketch the implications of risk-averse parties. From tournament theory we know that a contestant's risk premium may increase in his effort level which then leads to less investment and, therefore, lower effort costs in the contest.[27] While low litigation costs make participation in a litigation contest rather attractive, a risk-averse player naturally dislikes a risky income lottery as defined by a contest. However, in principal-agent relationships, the agent is typically more risk averse than the principal. If A is sufficiently risk averse, creating incentives via w can become very effective since sticking to the contract guarantees A the deterministic income w whereas shirking leads to a risky income lottery when being sued by P. Hence, the use of efficiency wages w seems to become relatively more attractive (compared to a bonus payment) to P in combination with a considerably risk-averse agent A.

Finally, the applicability of litigation contests as an incentive device also depends on the way litigation costs are allocated among the parties. So far, the so-called American Rule has been applied which makes each party bear its own litigation costs. Contrary to that rule, the English Rule dictates that the contest loser must pay for both his own costs and those of the winner.

[26] In this part of the discussion we abstract from the fact that expected gains also endogenously vary with w or $\hat{b}$, respectively.

[27] See Kräkel (forthcoming) for the case of a quadratic utility function.

When applying the English Rule, (1) and (2) have to be rewritten as

$$D \cdot p(x_j, x_i) - (x_j + x_i) \cdot (1 - p(x_j, x_i)) \tag{1'}$$

and

$$-(D + x_j + x_i) \cdot p(x_j, x_i). \tag{2'}$$

The first-order conditions

$$\begin{aligned} (D + x_j + x_i)\, p_1(x_j, x_i) - (1 - p(x_j, x_i)) &= 0 \\ \text{and} \qquad -(D + x_j + x_i)\, p_2(x_j, x_i) - p(x_j, x_i) &= 0 \end{aligned}$$

together with the symmetry assumption $p(x_j, x_i) = 1 - p(x_i, x_j) \Rightarrow p_2(x_j, x_i) = -p_1(x_i, x_j)$ lead again to a symmetric equilibrium $(x_j, x_i) = (x^*, x^*)$ which is now described by

$$2(D + 2x^*)\, p_1(x^*, x^*) = 1.$$

A comparison with equation (5) immediately shows that, for a given damage D, both parties invest more resources under the English Rule than under the American Rule.[28] Hence, going to court becomes less attractive under the English Rule which has direct implications for P's objective function (10') and the corresponding incentive constraint (11'). Since for given values of w and $\hat{b}$ all three gains decrease under the English Rule, the use of an efficiency wage w becomes more effective (see (11')) whereas setting incentives via $\hat{b}$ becomes less effective (see (11')) and more costly (see (10')). Hence, replacing the American Rule with the English Rule unambiguously favors the use of efficiency wages w instead of deferred compensation $\hat{b}$.

[28] See also, among many others, Farmer and Pecorino (1999).

5.2 Settlement

In Section 4, we have seen that, in general, the first-best solution will be implemented by P if settlement is feasible before the litigation contest starts. This interesting result is quite robust, as we will show in this subsection. We begin by assuming $w^* = 0$ and $\hat{b}^* \geq 0$. Then, it is easy to see that the principal's optimization problem can more generally be written as

$$\max_{\hat{e},\hat{b}} \hat{e} - t\left(\hat{b}\right) \tag{21}$$
$$\text{s.t. } U\left(t\left(\hat{b}\right)\right) = c\left(\hat{e}\right).$$

Here, $t\left(\hat{b}\right)$ denotes a transfer payment from P to A in the settlement stage which depends on the promised bonus that the principal refuses to pay ex post. Further, $U(\cdot)$ is the agent's utility of income, which is assumed to satisfy $U(0) = 0$. Note that this problem also contains problem (20) as a special case where specific assumptions about $t\left(\hat{b}\right)$ and $U(\cdot)$ have been made. Notice further that it is reasonable to assume $t(0) = 0$: If the principal does not promise to pay a positive bonus, then she will not pay anything in the settlement process, too. If, additionally, $t\left(\hat{b}\right)$ is continuous and there exists $\hat{b}$ such that $U\left(t\left(\hat{b}\right)\right) \geq c\left(e^{FB}\right)$, the first-best solution will always be implemented. To see this, note that the first-best effort e^{FB} is defined as the effort to be implemented, if e is verifiable and, hence, there are no contractual problems.[29] In such a situation, the principal exactly compensates the agent for his effort costs – measured in utility terms – so that A just earns his zero reservation utility, and implements that effort level which maximizes the remaining surplus. In other words, P makes A's participation constraint

[29] For the first-best solution under risk aversion see, for example, Mas-Colell, Whinston and Green (1995), p. 481.

just bind as P has all the bargaining power and extracts the whole surplus from the contract relationship without any contractual frictions.

Interestingly, this solution is identical with the solution to problem (21) given by

$$\hat{e}^* = e^{FB} \in \arg\max \left\{\hat{e} - U^{-1}\left(c\left(\hat{e}\right)\right)\right\} \tag{22}$$
$$\text{with } U^{-1}\left(\cdot\right) \text{ as the inverse of } U$$
$$\text{and } U\left(t\left(\hat{b}^*\right)\right) = c\left(e^{FB}\right).$$

The principal uses $\hat{b}$ in order to fine-tune the agent's transfer payment $t\left(\hat{b}\right)$ such that the agent is exactly compensated for his effort costs in utility terms, i.e. $U\left(t\left(\hat{b}\right)\right) = c\left(\hat{e}\right) \Leftrightarrow t\left(\hat{b}\right) = U^{-1}\left(c\left(\hat{e}\right)\right)$. The principal then implements the effort level that maximizes total surplus $\hat{e} - U^{-1}\left(c\left(\hat{e}\right)\right)$. As there are no efficiency losses, the first-best outcome can be achieved. Note that the agent's income is not risky (because there is no uncertainty regarding $t\left(\hat{b}\right)$). Hence, first-best implementation is even possible if the agent is risk-averse.

Besides problem (20), the model considered in this subsection allows for the possibility of an asymmetric litigation contest as well as the application of the English rule as special cases. If, for instance, the litigation contest becomes asymmetric, both the disagreement points as well as the gain from settlement will change. This affects the agent's transfer payment and, accordingly, his incentives. This, however, is anticipated by the parties. Therefore, they simply change the agreed bonus such that the old incentives are reinstalled. Consequently, even in an asymmetric situation, the first-best solution is implemented.[30] The same holds for the English rule.

[30] Note, however, that this argumentation only applies, if, under the changed contest rules, there exists still a bonus satisfying $U\left(t\left(\hat{b}\right)\right) > c\left(e^{FB}\right)$.

6 Conclusion

In this paper, a contractual relationship is considered which is characterized by double-sided moral hazard, i.e. both the agent and the principal may behave opportunistically. However, afterwards the injured party gets the chance to go to court. In that situation, a litigation contest takes place where each party can invest resources to win the case. We can show that the litigation contest restores the incentives for the agent which would be completely absent without the legal system. Moreover, if the parties can settle the conflict the pure threat of litigation will lead to the implementation of first-best effort in a wide range of settings.

The paper offers a first attempt to combine a principal-agent relationship based on an incomplete contract which cannot make use of a verifiable performance signal with the possibility of using the legal system to enforce contractual agreements ex-post. The presented model could be extended in several respects. In particular, we could assume that the agent's probability of winning the case is an increasing function of chosen effort. Now, we would have an additional trade-off since choosing effort is advantageous for the agent concerning a possible litigation, but is detrimental for him since exerting effort again results in costs which are described by a monotonically increasing and convex function. Furthermore, the rather abstract modelling of litigation and settlement could be enriched by borrowing more details from the existing economic literature on litigation and settlement procedures cited in the introduction.

Appendix

In this Appendix, we consider the basic model from Section 2 and prove that the parties never gain from choosing negative values for w or $\hat{b}$. Note first that it does not make sense to determine both wage parameters negatively, as the agent would always reject such a contract.

We therefore start with a situation, where $w \leq 0$ and $\hat{b} > 0$. Note that this changes the model in one way, as now P will not start a litigation contest, if A under-provides effort, but anything else will remain unchanged. Hence, A's incentive constraint changes to

$$w + \frac{\hat{b}}{2} - X\left(\hat{b}\right) - c\left(\hat{e}\right) \geq w$$

which is always implied by the participation constraint

$$w + \frac{\hat{b}}{2} - X\left(\hat{b}\right) - c\left(\hat{e}\right) \geq 0,$$

because of $w \leq 0$. Accordingly, the participation constraint always binds in the optimum. The principal now receives the total surplus

$$\hat{e} - c\left(\hat{e}\right) - 2X\left(\hat{b}\right)$$

and maximizes this surplus subject to the constraint $w \leq 0$, or, using the binding participation constraint, to

$$c\left(\hat{e}\right) - \left(\frac{\hat{b}}{2} - X\left(\hat{b}\right)\right) \leq 0.$$

Suppose w to be strictly negative, i.e. the constraint $w \leq 0$ to be slack. If $\hat{e} < e^{FB}$, the principal could marginally increase $\hat{e}$ and increase her profit without violating the constraint. Thus, we must have $\hat{e} = e^{FB}$ in case of $w < 0$ in the optimum. Recall that $\frac{\hat{b}}{2} - X\left(\hat{b}\right)$ has been defined as $G(\hat{b})$. Note that $G(0) = 0$ and that $G(\hat{b})$ is continuous, as both, $\frac{\hat{b}}{2}$ and $X\left(\hat{b}\right)$ are continuous, too.[31] Notice further that the assumptions $\hat{e}^* = e^{FB}$ and $w^* < 0$ imply that there exists $\hat{b}$ such that $G(\hat{b}) > c\left(e^{FB}\right)$. P chooses the lowest possible value of $\hat{b}$ for implementing a certain effort level since $\hat{e} - c(\hat{e}) - 2X\left(\hat{b}\right)$ monotonically decreases in $\hat{b}$ (i.e. $X'\left(\hat{b}\right) > 0$). From $G(0) = 0$ and the continuity of $G(\hat{b})$, it follows that the lowest value for $\hat{b}$ fulfilling $G(\hat{b}) \geq c\left(e^{FB}\right)$ lies at a point, where the constraint binds. This in turn implies that $\hat{e} = e^{FB}$ and $w^* < 0$ cannot hold at the same time in the optimum, as, in this case, the principal could reduce $\hat{b}$ to the lowest $\hat{b}$ solving $w^* = 0$. Hence, in the optimum we will never have $w^* < 0$ and $\hat{b}^* > 0$. Intuitively, by increasing w from a negative value to zero, the principal would either gain from being able to induce a more efficient effort level or by reducing $\hat{b}$ and, accordingly, the litigation costs.

It remains to show that the parties are never interested in determining $\hat{b}$ negatively, but $w > 0$. If $\hat{b} < 0$, the agent promises the principal to pay her a bonus, if he sticks to his effort choice. However, the agent is never going to pay the bonus: In case of having chosen $e < \hat{e}$, A does not have to pay $|\hat{b}|$. In case of $e \geq \hat{e}$, A prefers being sued by the principal (resulting in payoff $\frac{\hat{b}}{2} - X\left(-\hat{b}\right) < 0$) to paying the bonus (resulting in payoff $\hat{b} < 0$). The incentive constraint of the agent (concerning the effort choice) is then given by[32]

$$w + \frac{\hat{b}}{2} - X\left(-\hat{b}\right) - c(\hat{e}) \geq \frac{w}{2} - X(w).$$

[31] $X(\cdot)$ is continuous, as $p(\cdot,\cdot)$ was assumed to be twice continuously differentiable. See condition (5).

[32] Note that in case of $e < \hat{e}$, P cannot simply claim that $e \geq \hat{e}$ in order to forego suing A on w but suing A on $\hat{b}$ later on. This somewhat paradoxical scenario is excluded by the assumption that only real actions can be circumstantiated with a positive probability.

This constraint again implies the participation constraint

$$w + \frac{\hat{b}}{2} - X\left(-\hat{b}\right) - c\left(\hat{e}\right) \geq 0$$

and is therefore binding in the optimum. As a consequence, P maximizes

$$\hat{e} - w - \frac{\hat{b}}{2} - X\left(-\hat{b}\right)$$

subject to

$$\left[\frac{w}{2} + X\left(w\right)\right] - \left[-\frac{\hat{b}}{2} + X\left(-\hat{b}\right)\right] = c\left(\hat{e}\right).$$

Define $\tilde{b} := -\hat{b}$. Then, the maximization problem is given by

$$\begin{aligned} \max_{\hat{e},\tilde{b},w} \;\; & EU_P = \hat{e} - w + \frac{\tilde{b}}{2} - X\left(\tilde{b}\right) \\ \text{s.t.} \;\; & \left[\frac{w}{2} + X\left(w\right)\right] - \left[\frac{\tilde{b}}{2} + X\left(\tilde{b}\right)\right] = c\left(\hat{e}\right). \end{aligned}$$

It can easily be seen that we can induce a fixed increase in the agent's effort either by increasing w or by decreasing $\tilde{b}$ by the same amount. Note, however, that $\frac{\partial EU_P}{\partial w} = -1$ and $-\frac{\partial EU_P}{\partial \tilde{b}} = -0.5 + X'\left(\tilde{b}\right)$. The principal's profit is therefore always reduced more strongly by an increase in w than by the corresponding decrease in $\tilde{b}$. In the optimum, $\tilde{b}$ is thus always determined at its lowest possible level, i.e. $\tilde{b}^* = 0$. As $\tilde{b} = -\hat{b}$, this means that the parties are never interested in choosing $\hat{b} < 0$ and $w > 0$, which completes our proof.

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