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Editor:

Prof. Dr. Hans-Theo Normann
Düsseldorf Institute for Competition Economics (DICE)
Phone: +49(0) 211-81-15125, e-mail: normann@dice.hhu.de

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Florian Baumann* Tim Friehe†

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Abstract

This paper analyzes the principal-agent relationship between a plaintiff and his or her lawyer when the lawyer's investment in discovery is private information. The plaintiff uses the level of the contingency fee and potentially also restrictions on settlements to guide the lawyer's decision-making. We show that the plaintiff can increase the lawyer's investment in discovery by disallowing a settlement in the event of unsuccessful discovery, thereby reducing the pair's joint surplus. We establish that such a restriction may indeed be privately optimal for the plaintiff but can cast doubt on the social desirability of the discovery process.

Keywords: litigation; discovery; moral hazard; principal-agent relationship

JEL-Code: K41, H23

*University of Düsseldorf, Düsseldorf Institute for Competition Economics, Universitätsstr. 1, 40225 Düsseldorf, Germany. E-mail: fbaumann@dice.hhu.de.

†University of Bonn, Center for Advanced Studies in Law and Economics, Adenauerallee 24-42, 53113 Bonn, Germany. CESifo, Munich, Germany. E-mail: tim.friehe@uni-bonn.de.

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1 Introduction

1.1 Motivation and main results

Legal proceedings are often laden with private information. For example, defendants may have superior information about their culpability, and plaintiffs may have private information about the level of harm incurred. Asymmetric information is considered to be the most important cause of litigants' failure to arrive at a Pareto-superior settlement before trial commences (e.g., Farmer and Pecorino 2008). The legal institution of discovery is a feature of procedural law intended to decrease informational asymmetries between litigants by, for example, permitting each party to submit questions that the other side must answer and requiring the release of documents relevant to the case. As a result, discovery reduces informational asymmetries, thereby increasing the probability of settlement and lowering the social costs of disputes (e.g., Spier 2007).

Litigants are usually represented by legal counsel, either by mandate or voluntarily. These attorneys are then in charge of the discovery process and submit demands during pretrial negotiations. In fact, a primary motivation for hiring a lawyer is that they have expert knowledge, which implies the presence of informational asymmetries in the principal-agent relationship (Polinsky and Rubinfeld 2003). Anticipating that attorneys will have private information, principals try to design contract terms such that attorneys will act in the principals' best interest. For example, the conventional contingent-fee contract pays the lawyer only in the case of success, arguably creating some alignment between the interests of attorney and client (e.g., Spier 2007).

This paper investigates the discovery process in relation to the informational asymmetries between attorney and client. A lawyer's effort during the discovery process is a hidden action that will reveal with some probability the opponent's private information. The plaintiff (the principal) can influence the attorney's (the agent's) effort expenditure by varying the expected payoffs of the attorney when discovery is successful and unsuccessful. To this end, the principal can use the contingency fee and potentially also restrictions on settlements that will apply when discovery is unsuccessful. Disallowing a settlement when discovery is unsuccessful is surplus-reducing for the plaintiff-lawyer pair, but influences the lawyer's effort during the discovery process by reducing the expected payoffs that will result when discovery is unsuccessful. In other words, such restrictions represent a costly instrument that the client may use to steer the decision-making of the attorney regarding effort during the discovery process. We show that there are circumstances in which the plaintiff indeed benefits from making use of this kind of restrictions.[1]

From a social point of view, the discovery process is considered to be valuable due to its settlement-forcing aspect of ameliorating informational asymmetries between litigants. We show that informational asymmetries between a client and his or her attorney may bring about restrictions on settlements after unsuccessful discovery when clients attempt to make the most of the discovery process. Most importantly, our findings indicate that the use of restrictions by clients can *pervert* the system such that discovery is no longer socially desirable, as the social costs of a dispute would be lower in a regime without discovery.

We analyze a model in which a plaintiff and his or her attorney litigate against a defendant (i.e., a three-player model), building on Watts (1994). The defendant has private information about the expected judgment at trial, which may be traced to private information about either the probability of prevailing at trial or the magnitude of the judgment. The plaintiff's lawyer can invest unverifiable effort into discovery, thereby increasing the probability of revealing the defendant's private information. After successful discovery, the lawyer can make a settlement demand tailored to the defendant's type. When discovery is unsuccessful at revealing this private information, the plaintiff's side may make a take-it-or-leave-it settlement demand that screens defendant types (as in Bebchuk 1984). The central interest of our paper is whether or not the plaintiff may find it optimal under certain circumstances to prevent the lawyer from making a settlement offer (i.e., to restrict the action set of the lawyer) after unsuccessful discovery. We establish that this is indeed sometimes privately optimal for the plaintiff and, at least in our setup, the incentives are strong enough to cast doubt on the social desirability of the institution of discovery.

[1] Our inclusion of restrictions is inspired by Szalay (2005). In his setup, in which the agent is infinitely risk-averse and chooses a continuous action, the principal can restrict the agent's options to extremes (i.e., disallowing some interior levels from the set of possible levels of the action) in order to induce greater effort on the part of the agent in information acquisition. In our setup, restricting the agent implies disallowing any settlement after unsuccessful discovery.

1.2 Related literature

This article builds on previous literature on the attorney-client relationship and the discovery process. Shavell (1989) sets up a framework in which the plaintiff has private information and discovery can facilitate settlements. He additionally considers incentives for the voluntary disclosure of private information, which we abstract from in our model. Cooter and Rubinfeld (1994) provide an analysis of the various repercussions of having discovery based on the optimism framework, also stressing the positive impact of discovery on the probability of settlement. Hay (1994) similarly elaborates on the potential of discovery to produce information that would not come up in court. In the mechanism-design contribution of Mnookin and Wilson (1998) with two-sided asymmetric information, discovery is both imperfect and expensive but allows a more accurate signal of the opponent's type (thereby increasing the probability of settlement by decreasing informational asymmetries). Farmer and Pecorino (2005) consider costly voluntary disclosure and costly mandatory discovery in the screening and signaling setup, establishing that mandatory discovery that perfectly reveals the other party's type may be used in the screening model when costs are not too high. In our model, we focus on the scenario in which a litigant with private information decides whether or not to accept a settlement demand from an opponent (i.e., the screening model). Schrag (1999) analyzes the effect of judicial management of discovery in a setting in which settlement may occur before the discovery process or afterwards, finding that judicial limits on discovery may be socially desirable. Schwartz and Wickelgren (2009) similarly consider two points in time at which settlement may occur in a model with an endogenous filing decision, examining the strategic implications of this setup, for example, with regard to negative expected value suits. In our model, there is no judicial management of discovery, there is only one point in time at which settlement may occur (i.e., after discovery), and there is no filing decision. Summarizing this strand of the literature, we find that discovery is generally valued due to its positive influence on the settlement probability. In contrast, in this paper, we establish that discovery may lower the settlement rate; that is, we identify a possible drawback of discovery resulting from a litigant designing a contract that restricts potential settlements in order to alleviate problems of asymmetric information in the client-attorney relationship.

It has long been recognized that the relationship between client and attorney may be plagued by conflicts of interest (e.g., Miller 1987). For example, Polinsky and Rubinfeld (2002, 2003) are concerned with the incentives to settle and to invest effort in the development of a court case under the contingent-fee contract. The incentives of the lawyer in the negotiation stage may diverge from those of the litigant, but the litigant will often follow the lawyer's recommendations (e.g., Gravelle and Waterson 1993). This issue will also be important in our analysis. This conflict of interest may be mitigated by the use of a bifurcated fee structure, which specifies a share for the attorney in the event of trial that differs from the share in the event of settlement (Hay 1997). Although the conventional contingent-fee contract is by far the most important in practice, we will address the possibility that the plaintiff may make use of different contingency fees in a brief extension of the model.[2] Throughout, we focus on contingency fees only. In contrast, Emons and Garoupa (2006) compare contingency-fees to the conditional-fee arrangement when lawyers choose unobservable effort. In addition to these moral-hazard types of issues – which are also at the heart of the present paper – there have been a number of treatises on adverse selection, such as those of Rubinfeld and Scotchmer (1993) and Dana and Spier (1993). To the best of our knowledge, the research question of our paper – the interaction between the legal institution of discovery and the informational asymmetries between client and attorney – has not been addressed elsewhere. The paper closest to ours is Watts (1994). In that contribution, attorneys can learn about the private information of the opponent, which similarly applies to our setting. However, whereas in Watts (1994) this learning is binary and verifiable, in our setup the lawyer's effort during the discovery process is a continuous and hidden action.

1.3 Plan of the paper

Section 2 presents our model. Section 3 describes the scenario without informational asymmetries between the plaintiff and his or her lawyer as a benchmark. Throughout our analysis in this and later sections, there is private information on the part of the defendant about the ex-

[2] On contingency fees, see also Santore and Viard (2001) and, for experimental studies, Cotten and Santore (2012) and McKee et al. (2007). Basic principal-agent models suggest that the plaintiff should sell his or her case to the lawyer for a fixed amount. However, such a contract is prohibited by law virtually everywhere, for example, by the common law doctrine "champerty" in the US (Cooter and Ulen 2004: 404). In addition, such arrangements may be barred due to the budget constraint of the lawyer. For a recent economic analysis, see Daughety and Reinganum (2013).

pected damages. Section 4 presents the analysis with asymmetric information between plaintiff and lawyer; that is, a setting in which the lawyer determines effort and the settlement demand in order to maximize private payoffs. In this case, the plaintiff chooses the contingency fee and possibly also a restriction on settlements after unsuccessful discovery in order to influence the decisions made by the lawyer. Section 5 briefly discusses the potential implications for the social costs of disputes, and Section 6 revisits the central findings in a numerical illustration. Section 7 describes an extension that considers a contract featuring different levels of state-contingent contingency fees. Section 8 concludes.

2 The model

We consider a model with three players: the plaintiff, his or her attorney, and the defendant.[3] The plaintiff and the defendant are involved in a lawsuit. The attorney is managing the case for the plaintiff.[4] Information is asymmetrically distributed, in that the defendant has certain private information about the expected judgment at trial, denoted x, whereas the plaintiff and his or her attorney ex ante only know that the expected judgment will come from the interval $[\underline{x}, \bar{x}]$ according to the cumulative distribution function $F(x)$, where $f(x) = F'(x)$. For an interior solution of the optimal settlement offer, we follow Hua and Spier (2005) (among others) in assuming that $(1 - F(x))/f(x)$ is decreasing in x. In addition, we assume that pursuing the case in court is always beneficial for the plaintiff, such that $\underline{x} > c_P$,[5] and denote with X the ex-ante expected judgment, $X = \int_{\underline{x}}^{\bar{x}} x dF(x)$. In the event of a trial, costs c_P will be incurred by the plaintiff-lawyer pair, while the defendant will bear costs of c_D. The conflict between the parties may be settled out of court before a trial is held. Settlement is not associated with additional costs for the conflicting parties. Before settlement or trial, the lawyer can invest in discovery. Discovery is associated with costs $C(k) = ak^2/2$ and perfectly reveals the private information of the defendant with probability k (nothing is learned otherwise), where k is a

[3]The judge, in the event of a trial, is not an active decision-maker but is simply represented as assessing the suitable level of judgment.

[4]Our approach in this regard follows, for instance, Watts (1994) and is in line with the empirical results discussed in Thomason (1991).

[5]Nalebuff (1987) provides an analysis of the case in which this assumption need not hold.

choice variable of the lawyer, who also bears the full costs of the discovery process.[6] The level of k chosen is private information on the part of the lawyer.

Regarding the contractual relationship between the plaintiff and his or her lawyer, we assume that the plaintiff proposes a contingent-fee contract to the attorney. The contract specifies that the attorney will receive a share β, $1 > \beta > 0$, of any settlement amount or judgment, but will bear the costs of discovery $C(k)$ and litigation costs c_P in the event of a trial. For example, Daughety and Reinganum (forthcoming) assume the same contingent-fee arrangement with one share irrespective of settlement or trial. The central interest of our paper is whether or not the plaintiff may also find it optimal to pre-emptively prevent his or her lawyer from making a settlement offer (i.e., to restrict the action set of the lawyer) after unsuccessful discovery in order to influence effort incentives. For reasons of simplicity, we pursue our interest in cases in which settlement is either allowed or disallowed by considering a probability of restricting the lawyer denoted r, $0 \leq r \leq 1$, that will be endogenously determined by the plaintiff. Specifically, r denotes the probability that the lawyer will not be allowed to make a settlement offer to the defendant in the event that discovery is unsuccessful. When proposing the contract terms β and r, the plaintiff takes into account the fact that the attorney will accept the contract only if the expected payment is at least as high as that resulting from the best outside option, which pays U.[7] There is no possibility for the lawyer to drop the case later on (as in, e.g., Daughety and Reinganum forthcoming).

The timing of the model is as follows. At Stage 0, the plaintiff offers a contract to the lawyer with terms (β, r). At Stage 1, the lawyer accepts the contract (if the implied expected payoff is at least as high as U). Upon acceptance of the contract, at Stage 2, the lawyer determines

[6] We follow Shavell (1989), among others, in assuming that the probability of revealing private information during discovery is not correlated with the defendant's type. The assumption that discovery implies the perfect revelation of the defendant's private information is similarly employed by Schwartz and Wickelgren (2009). In reality, discovery might only allow an updated estimation of the level of the expected judgment at trial without eliminating the other side's private information. However, the simplifying assumption is not critical to our results. The results would be qualitatively unchanged if, for example, discovery yielded the information that the true level of x came from a subset of $[\underline{x}, \bar{x}]$.

[7] To avoid trivial solutions, we assume that the lawyer's outside option does not exceed the ex-ante expected maximum surplus obtainable by the plaintiff-lawyer pair. Otherwise, any offer yielding non-negative expected payoffs for the plaintiff would be rejected by the lawyer.

his or her investment in the discovery process. At Stage 3, the discovery process reveals the private information of the defendant with probability k. At stage 4, when discovery has been *successful*, the lawyer makes a settlement demand, knowing the defendant's level of expected liability x. In contrast, when discovery has been *unsuccessful*, the lawyer makes a settlement demand $\hat{x}$ against the distribution of defendant types with probability $1-r$, whereas he or she must proceed to trial directly with probability r. Finally, at Stage 5, the lawyer's settlement demand (if any) is either accepted by the defendant or the trial ensues. The game tree is depicted in Figure 1, where N denotes nature, P the plaintiff, L the plaintiff's lawyer, and D the defendant; payoff vectors are such that the first entry pertains to the plaintiff, the second to the lawyer, and the third to the defendant.

[FIGURE 1 ABOUT HERE]

3 Benchmark: The outcome without agency costs

We will first consider the scenario in which the principal-agent relationship between the plaintiff and his or her attorney is not plagued by informational asymmetries (contrary to our description in Section 2). More specifically, we assume that the plaintiff can write directly into the contract both the verifiable level of effort during the discovery process and the settlement demand in case discovery proves unsuccessful. This is done in order to derive a benchmark for comparison with our later analysis. Nevertheless, the defendant still has private information about the level of the expected judgment.

The ex-ante expected payoffs for the plaintiff (π^P) are given by

$$\pi^P = (1-\beta)\left[k(X+c_D)+(1-k)\left[rX+(1-r)\left[(1-F(\hat{x}))(\hat{x}+c_D)+\int_{\underline{x}}^{\hat{x}} xf(x)dx\right]\right]\right], \quad (1)$$

comprising the following elements: The factor $(1-\beta)$ indicates the share of any payments obtained from the defendant that remain with the plaintiff. The discovery process reveals the defendant's private information with probability k, in which case the settlement demand $x+c_D$ will be made, rendering the defendant indifferent between acceptance and rejection and leading to $X+c_D$ as the ex-ante expected settlement. Discovery will be unsuccessful with probability

$(1-k)$. In that case, the plaintiff will disallow settlement with probability r, leading to a trial and the expected judgment X. With probability $1-r$, the plaintiff will allow a settlement demand to be made after unsuccessful discovery. In making a settlement demand against the distribution of defendant types, the lawyer screens the various types into two groups. A settlement demand s will be accepted by defendants for whom $x + c_D \geq s$ holds, whereas defendants for whom $x + c_D < s$ applies will reject the settlement. The indifferent defendant type $\hat{x}$ divides the population of defendants.

The lawyer will only accept the contract when the expected payoff is at least as high as that of his or her outside option given by U. Analogous to the case of the plaintiff, the expected payoffs are described by

$$\begin{aligned}\pi^L =& k\beta(X + c_D) + (1-k)r(\beta X - c_P) \\ &+ (1-k)(1-r)\left[(1-F(\hat{x}))\beta(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} (\beta x - c_P) f(x)dx\right] - ak^2/2. \end{aligned} \tag{2}$$

The contingent-fee contract stipulates that the lawyer will receive a share β of any judgment or settlement amount, and that in the event of a trial, the litigation costs c_P will remain with the lawyer (e.g., Polinsky and Rubinfeld 2002). In addition, the lawyer bears the discovery costs $ak^2/2$.

Without agency costs, the plaintiff seeks to implement the level of investment in discovery k, the settlement demand $s = \hat{x} + c_D$, and the restriction probability r that maximize the joint surplus, and then chooses β in order to fulfill $\pi^L \geq U$. Differentiation of the surplus $S = \pi^P + \pi^L$ with respect to $(k, \hat{x}, r)$ yields

$$\frac{\partial S}{\partial k} = X + c_D - \left[(1-F(\hat{x}))(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} (x - c_P) f(x)dx\right] - ak \tag{3}$$

$$\frac{\partial S}{\partial \hat{x}} = (1-k)(1-r)\left[(1-F(\hat{x})) - f(\hat{x})(c_P + c_D)\right] \tag{4}$$

$$\frac{\partial S}{\partial r} = (1-k)\left[X - c_P - \left[(1-F(\hat{x}))(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} (x - c_P) f(x)dx\right]\right]. \tag{5}$$

The first observation that can be made is that (5) is non-positive for all levels of r. This holds because a surplus-maximizing settlement demand against the distribution of defendant types necessarily yields a (weakly) higher joint surplus than going to court for all defendant types. The joint payoff in the state of the world in which the settlement is restricted, given by $X - c_P$, is in fact a lower bound for the expected payoff when the settlement is not restricted. This implies that the plaintiff will set $r = 0$ in the optimum, since $r > 0$ unambiguously reduces the expected joint surplus by restricting freedom of choice.

For the other two variables, we assume interior solutions, such that the surplus-maximizing effort during the discovery process is given by

$$k^{FB} = a^{-1}\Delta^{FB}, \tag{6}$$

where

$$\Delta^{FB} = c_D + \int_{\hat{x}}^{\bar{x}} (x - (\hat{x} + c_D))dF(x) + F(\hat{x})c_P. \tag{7}$$

Intuitively, higher trial costs increase the effort during the discovery process. This also applies to higher trial costs for the defendant, since the plaintiff can extract them after successful discovery. Higher trial costs for the plaintiff lower the attractiveness of the state of unsuccessful discovery, thereby mandating a higher effort level.

The surplus-maximizing settlement demand in the event of unsuccessful discovery is implicitly defined by

$$(1 - F(\hat{x}^{FB})) = f(\hat{x}^{FB})(c_P + c_D). \tag{8}$$

This is the standard condition found in the settlement literature that disregards attorney-client conflicts of interest; it indicates the trade-off between a higher settlement payment when the demand is accepted and the increase in trial costs when the demand is not accepted (see, e.g., Spier 2007). Note from (4) that the optimal value of $\hat{x}$ is independent of the discovery process and the restriction parameter r.

After having determined the optimal level of the endogenous variables $(k, \hat{x}, r)$, the plaintiff ensures the lawyer's participation by setting the level of β to fulfill

$$\pi^L(k^{FB}, \hat{x}^{FB}, r^{FB}) = U. \tag{9}$$

We summarize the main results of this section as follows:

Proposition 1 *The plaintiff will not restrict the settlement option after unsuccessful discovery (i.e.,* $r^{FB} = 0$*) when the level of effort* k *and the settlement offer* $\hat{x}$ *are contractible variables. The surplus-maximizing levels of effort during the discovery process and of the settlement demand after unsuccessful discovery are defined by* (6) *and* (8)*.*

4 The outcome with agency costs

In this section, we explicitly take into consideration the fact that the lawyer generally manages the case for the plaintiff and has an informational advantage relative to the plaintiff due to their different levels of expertise. Specifically, in our context, the lawyer has private information about the level of effort during the discovery process and determines the settlement demand after unsuccessful discovery to maximize his or her own expected payoffs (such that the level of k and $\hat{x}$ are no longer contractible).[8] The key difference to the previous section will thus be that the levels of β and r are decisive for the lawyer's incentives in making these two decisions. Our central interest is whether or not the plaintiff will under some circumstances restrict the action set of the lawyer in this more realistic setting. In the previous section, we have established that this will never occur absent an agency problem.

In contrast to the description of the benchmark case, it is now important to take the specific timing of the game into account. The game tree is illustrated in Figure 1. Applying backward induction, we start our analysis at Stage 4 of the interaction, when the settlement offer is made by the plaintiff's lawyer.

4.1 Stage 4: Settlement or trial

When discovery has been *successful*, the private information of the defendant is now also known by the lawyer. The lawyer maximizes private payoffs by asking for a settlement amount of $x + c_D$.[9] This demand makes the defendant indifferent between settling and proceeding to trial. We assume that the defendant accepts the demand and the case is settled.

When discovery has been *unsuccessful*, we must distinguish between two states of the world. With probability r, the lawyer will not be allowed to settle after unsuccessful discovery. Instead, a trial will ensue, implying an expected payoff of $(1 - \beta)X$ for the plaintiff and $\beta X - c_P$ for the

[8] Whereas k is unobservable for the plaintiff, the settlement demand is in principal observable. Nevertheless, the plaintiff usually lacks the expertise to judge the appropriateness of the settlement demand. With respect to the settlement demand, we follow the standard approach in the literature (see, e.g., Spier 2007).

[9] We do not consider the possibility that the plaintiff's attorney and the defendant will collude against the plaintiff.

attorney. With probability $1-r$, the state of the world is one in which the lawyer can settle after unsuccessful discovery. The settlement demand is determined by the lawyer in order to maximize π^L. Focussing on interior solutions, we find that the settlement demand $\hat{x}$ that solves

$$(1-F(\hat{x})) = f(\hat{x})(c_P/\beta + c_D) \tag{10}$$

is selected. For $\beta < 1$ and given that $(1-F(x))/f(x)$ decreases in x, condition (10) shows that the lawyer makes settlement demands that are too low in comparison to the demand maximizing the joint surplus (see (8)). This divergence relative to the surplus-maximizing settlement demand results from the fact that the lawyer bears litigation costs in full, while otherwise participating only according to the share β (e.g., Polinsky and Rubinfeld 2002). The surplus-maximizing settlement demand results only if $\beta = 1$. Note that under the contingent-fee contract, the plaintiff privately prefers a settlement demand higher than the one that maximizes the joint surplus because he or she no longer takes into account the trial costs c_P. Moreover, it is clear that the lawyer will make a settlement demand that is acceptable for all defendant types (i.e., $\hat{x} = \underline{x}$ results as a corner solution) when his or her share β falls below a lower threshold value.[10] The constraint (10) implies that[11]

$$\frac{d\hat{x}}{d\beta} = \frac{(1-F(\hat{x})) - f(\hat{x})c_D}{f(\hat{x})\beta + f'(\hat{x})(\beta c_D + c_P)} = \frac{f(\hat{x})c_P/\beta}{f(\hat{x})\beta + f'(\hat{x})(\beta c_D + c_P)} > 0, \tag{11}$$

that is, the lawyer settles (weakly) less often for a higher contingency fee.

Lemma 1 *Assume that the plaintiff and his or her attorney have agreed on a contingent-fee contract (β, r). Then, the lawyer's settlement demand in the event of unsuccessful discovery falls short of the surplus-maximizing demand $\hat{x}^{FB}$ when $\beta \in (0,1)$, whereas the plaintiff would prefer a settlement demand higher than the surplus-maximizing demand. The lawyer's settlement demand is increasing in the level of β and is independent of the level of the probability r.*

The above analysis describes Stage 4. Nature determines in Stage 3 whether or not the investment in discovery yields a success. In Stage 2, which will be analyzed next, the level of effort during the discovery process is chosen by the lawyer.

[10] Formally, this threshold is defined by $\underline{\beta} = \frac{f(\underline{x})c_P}{(1-F(\underline{x}))-f(\underline{x})c_D}$.

[11] For a maximum, $f(\hat{x})\beta + f'(\hat{x})(\beta c_D + c_P) > 0$ holds according to the second-order condition.

4.2 Stage 2: Discovery process

The lawyer can use the discovery process to try to obtain information that will reveal the expected judgment against the defendant. However, this is costly for the plaintiff's attorney. The level of effort is private information held by the lawyer, and k is chosen in order to maximize π^L, such that the chosen value k^* solves

$$k^* = a^{-1}\Delta^L, \tag{12}$$

where

$$\Delta^L = \beta\left[c_D + (1-r)\int_{\hat{x}}^{\bar{x}}(x-(\hat{x}+c_D))dF(x)\right] + rc_P + (1-r)F(\hat{x})c_P. \tag{13}$$

In comparison, the corresponding term from the benchmark case in Section 3 was[12]

$$\Delta^S = c_D + (1-r)\int_{\hat{x}}^{\bar{x}}(x-(\hat{x}+c_D))dF(x) + rc_P + (1-r)F(\hat{x})c_P. \tag{14}$$

As a result, for a given pair $(\hat{x}, r)$, the attorney internalizes only a part of the benefit that successful discovery implies for the plaintiff-attorney pair, whereas the costs of the discovery process remain in full with the lawyer.

The level of effort is an increasing function of the share β and the probability r because[13]

$$\frac{\partial\Delta^L}{\partial\beta} = c_D + (1-r)\int_{\hat{x}}^{\bar{x}}(x-(\hat{x}+c_D))dF(x) > 0 \tag{15}$$

$$\frac{\partial\Delta^L}{\partial r} = -\beta\int_{\hat{x}}^{\bar{x}}(x - c_P/\beta - (\hat{x}+c_D))dF(x) > 0. \tag{16}$$

The term in (15) is always strictly positive and proportional to the increase in the plaintiff's expected payoffs π^P resulting from a higher investment in effort. To see that this term is positive, note that it may be rearranged as $\int_{\hat{x}}^{\bar{x}}(1-r)(x-\hat{x})dF(x)+c_D[1-(1-r)(1-F(\hat{x}))] > 0$. This also indicates that *ceteris paribus*, the plaintiff always benefits from higher effort. The term in (16) is always strictly positive, since $\hat{x}$ is determined by the attorney in Stage 4 to maximize private payoffs. To see this formally, note that $\int_{\hat{x}}^{\bar{x}}(x - c_P/\beta - (\hat{x}+c_D))dF(x) < 0$ can be rearranged to $\int_{\underline{x}}^{\bar{x}}(\beta x - c_P)dF(x) < (1-F(\hat{x}))\beta(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}}(\beta x - c_P)dF(x)$, which holds true.

[12]Note that for Δ^{FB} we already made use of $r^{FB} = 0$.

[13]There is no indirect effect of β via $\hat{x}$ due to the envelope theorem.

The involvement of the lawyer during the discovery process may thus be influenced by the two contract terms (β, r). For the subsequent analysis, it is interesting to explore how these two instruments interact in their influence on k. From $\partial^2 \Delta^L / \partial\beta\partial r$, we find that the levels of r and β are substitutes (complements) when

$$\Gamma = \int_{\hat{x}}^{\bar{x}} (x - (\hat{x} + c_D))dF(x) > \ (<) \, 0. \tag{17}$$

The change in Γ with $\hat{x}$ is given by $-((1-F(\hat{x}))+c_D f(\hat{x})) < 0$. This indicates that, regarding the lawyer's investment in discovery, the relationship between the two characteristics of the contract may itself be dependent on the endogenously determined level of the settlement demand (and therefore on β). More precisely, for low β (and therefore low $\hat{x}$), the instruments may be substitutes, whereas for high levels of β, they may be complements.

Lemma 2 *Assume that the plaintiff and his or her attorney have agreed on a contingent-fee contract (β, r). Then, the level of effort during the discovery process is less than the surplus-maximizing level for a given pair $(\hat{x}, r)$. The plaintiff prefers an effort level higher than the surplus-maximizing level. The lawyer's effort level is increasing at a diminishing rate in the level of β and increasing linearly with the level of the probability r.*

Proof. The first claim follows from a comparison of (13) and (14). Due to the positive derivative of payoffs with respect to k, the plaintiff always benefits from higher effort. The fact that k^* is strictly concave in β follows from $\partial^2 \Delta^L / \partial\beta^2 = -(1-r)((1-F(\hat{x})) + c_D f(\hat{x})) < 0$. The linearity with respect to r follows from $\partial^2 \Delta^L / \partial r^2 = 0$. ■

It is interesting to note that the sign of Γ shows whether or not the plaintiff directly benefits from restricting the lawyer's possibility to make settlement demands in the event of unsuccessful discovery (i.e., independent of its effect on the lawyer's effort investment in discovery and abstracting from its consequences regarding the lawyer's participation constraint). Note that $\Gamma > 0$ can be stated as

$$\int_{\underline{x}}^{\bar{x}} xdF(x) > (1 - F(\hat{x}))(\hat{x} + c_D) + \int_{\underline{x}}^{\hat{x}} xdF(x) \tag{18}$$

indicating that the lawyer's settlement demand may indeed be so low from the plaintiff's perspective that the positive impact of gaining c_D in the case of a settlement is clearly dominated.

In this regard, assume that c_D allows for $\hat{x}_c \in (\underline{x}, \bar{x})$ such that

$$\Gamma = \begin{cases} > 0 & \text{if } \hat{x} < \hat{x}_c \\ \leq 0 & \text{if } \hat{x} \geq \hat{x}_c \end{cases} \tag{19}$$

The inequality in (18) will certainly be reversed when $\hat{x}$ fulfills $(1 - F(\hat{x})) = f(\hat{x})c_D$, which is the settlement demand that maximizes the plaintiff's payoffs π^P and is greater than $\hat{x}^{FB}$. As a result, it is not generally guaranteed that $\hat{x}_c < \hat{x}^{FB}$, such that there may be no implementable $\hat{x}$ leading to $\Gamma < 0$.[14]

4.3 Stage 1: The contract offer

In this section, we consider the contract that is offered by the plaintiff to his or her lawyer, which is characterized by the terms (β, r). The plaintiff maximizes π^P subject to the individual-rationality constraint of the lawyer and the incentive-compatibility constraints describing the levels of $(\hat{x}, k)$ selected by the lawyer for given (β, r). We proceed in several steps. First, we investigate the values of $\hat{x}$ and k that are feasible according to the lawyer's incentive-compatibility constraints. Subsequently, we delineate the repercussions of changes in $\hat{x}$ and k on the payoffs of the plaintiff and the lawyer. Finally, we use our findings to investigate the plaintiff's problem of optimal contract design.

Implementable values of $\hat{x}$ and k based on the incentive-compatibility constraints

In order to determine the terms of the optimal contract, we take an indirect approach closely linked to our analysis of the benchmark case in Section 3. In the following analysis, we assume that the plaintiff directly chooses the level of the settlement demand $\hat{x}$ and the level of effort during the discovery process k, acknowledging the levels of β and r that are required to implement this selection. There is a one-to-one relationship between the levels of $(k, \hat{x})$ and the levels of (β, r) that induce them, which can be identified by inverting the incentive-compatibility constraints, conditions (10) and (12). This inversion yields $\beta(\hat{x})$ and $r(\hat{x}, k)$. The fact that both

[14]For example, the condition $\int_{\hat{x}}^{\bar{x}} (x - (\hat{x} + c_D))dF(x) > 0$ is always fulfilled for a uniform distribution of x as long as $c_P \geq c_D$ and $\beta \in (0, 1)$.

$r \in [0,1]$ and $\beta \in [0,1]$ implies that the set of feasible $(k, \hat{x})$ is given by

$$A = \{(k, \hat{x}) \in [0,1] \times [\underline{x}, \hat{x}^{FB}] | \beta(\hat{x}), r(\hat{x}, k) \in [0,1]\}. \tag{20}$$

The largest $\hat{x}$ that is an element of A is $\hat{x}^{FB}$ for $\beta = 1$.

Given the assumed specific effort cost function, we can state r using (12) as

$$r(\hat{x}, k) = \frac{\beta(\hat{x})\,[c_D + \Gamma] + F(\hat{x})c_P - ak}{\beta(\hat{x})\Gamma - (1 - F(\hat{x}))c_P}. \tag{21}$$

We can also state $\beta(\hat{x})$ using (10) as

$$\beta(\hat{x}) = \frac{f(\hat{x})c_P}{(1 - F(\hat{x})) - f(\hat{x})c_D}. \tag{22}$$

From our discussion of the later stages of the game and equations (21) and (22), we can deduce that $\partial\beta/\partial\hat{x} > 0$, $\partial r/\partial k > 0$, $\partial r/\partial\hat{x} < 0$, and $\partial^2 r/\partial k^2 = 0$. Moreover, we know that $\partial^2 r/\partial\hat{x}\partial k > (<)\,0$ when $\Gamma > (<)\,0$. To induce a higher settlement offer, the plaintiff must increase the contingent-fee rate β. At the same time, this higher β allows a decrease in the restriction probability r while still maintaining the lawyer's discovery effort at the same level. The sign of the cross-derivative reflects whether r and β are substitutes or complements with regard to incentivizing higher effort in discovery. Any partial increase in the lawyer's effort in the discovery process requires a linear increase in the restriction probability r.

Implications of $\hat{x}$ and k on expected payoffs

We first turn to the level of effort during the discovery process. The plaintiff's expected payoffs are affected by an increase in the level of investment in the following way (when we take $\beta(\hat{x})$ and $r(\hat{x}, k)$ into account):

$$\begin{aligned} \frac{d\pi^P}{dk} &= \underbrace{\frac{\partial\pi^P}{\partial k}}_{>0} + \underbrace{\frac{\partial\pi^P}{\partial r}}_{?}\underbrace{\frac{\partial r}{\partial k}}_{>0} \\ &= (1-\beta)\,[c_D + (1-r)\Gamma] + (1-\beta)(1-k)\Gamma\frac{\partial r}{\partial k}. \end{aligned} \tag{23}$$

A higher level of k has a positive direct impact. This is a necessary consequence of the fact that the attorney bears the effort costs in full. In addition, an increase in k for a given level of $\hat{x}$ requires an increase in the probability of restriction r, which has a positive (negative) payoff effect when $\Gamma > (<) 0$. This finding indicates that the plaintiff's payoff is maximized at the highest possible k as long as $\hat{x} < \hat{x}_c$. In other words, the plaintiff welcomes both the higher level of k and the implied higher level of the probability of restricting the lawyer when Γ is positive. Regarding the direct effect of a higher level of the lawyer's effort during discovery, it must be noted that a higher level of $\hat{x}$ connotes a higher level of k for any r. As a result, it may be expected that the plaintiff's incentives to increase k via an increase in r will be less pronounced for high levels of $\hat{x}$. The effect that Γ decreases in $\hat{x}$ reinforces this conjecture.

We next turn to the level of the settlement demand. The plaintiff's expected payoffs are affected by an increase in the settlement demand after unsuccessful discovery in the following way (taking $\beta(\hat{x})$ and $r(\hat{x}, k)$ into account):

$$\begin{aligned}\frac{d\pi^P}{d\hat{x}} =& \underbrace{\frac{\partial \pi^P}{\partial \hat{x}}}_{>0} + \underbrace{\frac{\partial \pi^P}{\partial r}}_{?} \underbrace{\frac{\partial r}{\partial \hat{x}}}_{<0} + \underbrace{\frac{\partial \pi^P}{\partial \beta} \frac{d\beta}{d\hat{x}}}_{<0} \\ =& (1-\beta)(1-k)(1-r)\left[(1-F(\hat{x})) - f(\hat{x})c_D\right] + (1-\beta)(1-k)\Gamma \frac{\partial r}{\partial \hat{x}} \\ &- \left[kc_D + (k(1-r)+r)\Gamma + (1-F(\hat{x}))(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} x dF(x)\right] \frac{d\beta}{d\hat{x}}.\end{aligned} \tag{24}$$

The first term is positive for any $\hat{x} \in A$ due to the fact that the lawyer's settlement demand will always fall short of what maximizes π^P. The size of this effect is diminishing with $\hat{x}$. For a given β, this direct effect is diminishing with k and r, as a suitable settlement demand is less important when discovery is more likely to be successful or restrictions are more likely to apply. It is important to note that the plaintiff seeks to implement the lowest possible level of $\hat{x}$ when $r = 1$ is optimal. This follows because when $r = 1$, a higher level of $\hat{x}$ is no longer directly payoff-relevant, whereas a higher β is necessary to ensure implementation. In contrast, when $r < 1$, the plaintiff may have an interior $\hat{x}$ that maximizes π^P. The second term in (24) indicates the effect of the implied decrease in r. Its overall effect on the plaintiff's expected profits is negative (positive) when the partial effect of an increase in r is beneficial (detrimental) for the plaintiff. Finally, the last term indicates a reduction in the plaintiff's expected profits due to the necessity of guaranteeing the lawyer a higher share of any revenues.

In general, the slope of the plaintiff's indifference curve given by

$$\frac{dk}{d\hat{x}} = -\frac{d\pi^P/d\hat{x}}{d\pi^P/dk} \tag{25}$$

may be either positive or negative. The indifference curve will have a positive slope when the plaintiff requires a higher level of k in order to tolerate a higher level of $\hat{x}$ (since the latter requires an increase in β). The indifference curve could also have a negative slope, such that the level of k must decrease when the settlement demand is raised. Whereas a higher level of k is always desirable for $\hat{x} \leq \hat{x}_c$, it is ambiguous whether or not the plaintiff would benefit from a higher level of $\hat{x}$.

Turning to the lawyer, we find that marginal changes in $(\hat{x}, k)$ have the following payoff implications:

$$\begin{aligned}
\frac{d\pi^L}{dk} =& \underbrace{\frac{\partial \pi^L}{\partial k}}_{=0} + \underbrace{\frac{\partial \pi^L}{\partial r}\frac{\partial r}{\partial k}}_{<0} \\
=&(1-k)\left[\beta\Gamma - c_P(1-F(\hat{x}))\right]\frac{\partial r}{\partial k} = -(1-k)a \qquad (26)\\
\frac{d\pi^L}{d\hat{x}} =& \underbrace{\frac{\partial \pi^L}{\partial \hat{x}}}_{=0} + \underbrace{\frac{\partial \pi^L}{\partial r}\frac{\partial r}{\partial \hat{x}}}_{>0} + \underbrace{\frac{\partial \pi^L}{\partial \beta}\frac{d\beta}{d\hat{x}}}_{>0} \\
=&(1-k)\left[\beta\Gamma - c_P(1-F(\hat{x}))\right]\frac{\partial r}{\partial \hat{x}} \\
&+ \left[kc_D + (k(1-r)+r)\Gamma + (1-F(\hat{x}))(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} x dF(x)\right]\frac{d\beta}{d\hat{x}}. \qquad (27)
\end{aligned}$$

The direct effect of a higher level of k and $\hat{x}$ is zero, because we are considering combinations $(\hat{x}, k)$ that are privately optimal for the lawyer given the contract terms. The higher level of the probability of restrictions that is required to induce an increase in k for a given $\hat{x}$ decreases the lawyer's expected payoff. In contrast, a higher level of $\hat{x}$ increases the lawyer's expected payoffs via both indirect channels, as it is associated with a lower probability of restriction and a higher contingency fee. As a result, the slope of the lawyer's indifference curve is always positive, since a higher k must be compensated by a higher $\hat{x}$. This slope is given by

$$\frac{dk}{d\hat{x}} = -\frac{d\pi^L/d\hat{x}}{d\pi^L/dk}. \qquad (28)$$

An increase in $\hat{x}$ follows only when the level of β is increased. This higher level of β makes the lawyer more tolerant when it comes to increases in the level of the probability of imposing restrictions, r.

The plaintiff's problem of optimal contract design

The plaintiff seeks to maximize expected private payoffs by determining the levels of $\hat{x}$ and k subject to the incentive compatibility constraints expressed in $\beta(\hat{x})$ and $r(\hat{x}, k)$ and subject to the participation constraint. The Lagrange function is

$$L = \pi^P + \lambda[\pi^L - U] + \mu_0 r(\hat{x}, k) + \mu_1(1 - r(\hat{x}, k)), \tag{29}$$

using the Lagrange multipliers λ, μ_0, and μ_1. In the optimum, $\mu_0 > 0$ when $r(\hat{x}, k) = 0$, $\mu_1 > 0$ when $r(\hat{x}, k) = 1$, and $\mu_0 = \mu_1 = 0$ when $r(\hat{x}, k) \in (0, 1)$.[15] We obtain the following conditions (together with $\partial L/\partial\lambda \geq 0$, $\lambda \geq 0$, and $\partial L/\partial\lambda \times \lambda = 0$):

$$\begin{aligned}
\frac{\partial L}{\partial k} =& \frac{\partial \pi^P}{\partial k} + \left[\frac{\partial \pi^P}{\partial r} + \lambda \frac{\partial \pi^L}{\partial r}\right]\frac{\partial r}{\partial k} + (\mu_0 - \mu_1)\frac{\partial r}{\partial k} = 0 \\
&= (1-\beta)\left[c_D + (1-r)\Gamma\right] + (1-k)\left[(1-\beta(1-\lambda))\Gamma - \lambda c_P(1-F(\hat{x}))\right]\frac{\partial r}{\partial k} + (\mu_0 - \mu_1)\frac{\partial r}{\partial k} = 0 \qquad (30) \\
\frac{\partial L}{\partial \hat{x}} =& \frac{\partial \pi^P}{\partial \hat{x}} + \left[\frac{\partial \pi^P}{\partial r} + \lambda \frac{\partial \pi^L}{\partial r}\right]\frac{\partial r}{\partial \hat{x}} + \left[\frac{\partial \pi^P}{\partial \beta} + \lambda \frac{\partial \pi^L}{\partial \beta}\right]\frac{d\beta}{d\hat{x}} + (\mu_0 - \mu_1)\frac{\partial r}{\partial \hat{x}} = 0 \\
=&(1-\beta)(1-k)(1-r)\left[(1-F(\hat{x})) - f(\hat{x})c_D\right] + (1-k)\left[(1-\beta(1-\lambda))\Gamma - \lambda c_P(1-F(\hat{x}))\right]\frac{\partial r}{\partial \hat{x}} \\
&- (1-\lambda)\left[kc_D + (k(1-r)+r)\Gamma + (1-F(\hat{x}))(\hat{x}+c_D) + \int_{\underline{x}}^{\hat{x}} x dF(x)\right]\frac{d\beta}{d\hat{x}} + (\mu_0 - \mu_1)\frac{\partial r}{\partial \hat{x}} = 0. \qquad (31)
\end{aligned}$$

In order to ensure that $r < 1$ (such that $\partial L/\partial k = 0$ with $\mu_1 = 0$), we deduce from (30) that it is necessary but not sufficient to have

$$\left[(1-\beta(1-\lambda))\Gamma - \lambda c_P(1-F(\hat{x}))\right] < 0 \tag{32}$$

in the optimum (i.e., it must be costly for the plaintiff to increase k by means of the probability r). This is impossible when restricting the lawyer has a direct positive effect for the plaintiff ($\Gamma > 0$) and a loosening of the participation constraint has only a mild effect on the plaintiff's payoffs ($\lambda \approx 0$); in contrast, the condition is always fulfilled when $\lambda \to 1$, irrespective of the sign of Γ. Note that $\lambda \in (0, 1]$ because the plaintiff will adapt the contract in order to mitigate the effect of a higher level of the lawyer's reservation utility. When (32) applies, relatively higher marginal benefits from a marginal increase in $\hat{x}$ arise in (31), since a higher settlement demand makes more discovery possible without the need to resort to a high level of r.

[15] Similar constraints for $\beta(\hat{x})$ do not have to be imposed, as $U > 0$ ensures that $\beta(\hat{x}) > 0$, and the assumption that U is lower than the maximal joint surplus guarantees that $\beta(\hat{x}) < 1$ in the optimum.

When the lawyer's indifference curve resulting from the participation constraint ($\pi^L = U$) describes combinations $(\hat{x}, k)$ for which $\hat{x} < \hat{x}_c$, then the plaintiff desires a higher k (since $d\pi^P/dk > 0$). To achieve this end, the plaintiff may make use of r (depending on the exchange rate implied by the lawyer's indifference curve). The use of restrictions is particularly appealing to the plaintiff when the lawyer's reservation utility is very small. The reasoning is as follows: without restrictions, the β necessary to fulfill the lawyer's participation constraint is low, resulting in a low $\hat{x}$ and k. Consequently, settlement after unsuccessful discovery (which is likely due to the low k) is especially unfavorable for the plaintiff. Thus, the plaintiff may be more willing to accept the increase in the level of β required in order to make the lawyer tolerate an increase in the level of r. The possibility of restricting the lawyer may mean that the lawyer's participation constraint will be binding in cases in which the lawyer would obtain a rent without this additional instrument. In contrast, the use of restrictions is not appealing for the plaintiff when the lawyer's reservation utility is very high. This follows from the fact that the β necessary to fulfill the lawyer's participation constraint is already high, implying a high $\hat{x}$ and k. As a result, the plaintiff will not be willing to accept the increase in the level of β required in order to make the lawyer tolerate an increase in the level of r. When U is approaching the maximal level of the joint surplus, then $\hat{x} \to \hat{x}^{FB}$ and $r \to 0$ must follow.

We are interested in the circumstances under which the plaintiff will prevent the lawyer from making a settlement demand after unsuccessful discovery. The preceding argument suggests that low reservation utilities on the part of the lawyer are conducive to the use of such restrictions. In general, the lawyer must be compensated for the plaintiff's use of the probability r via a higher level of $\hat{x}$ (i.e., β) in order to avoid violation of the participation constraint. The necessary increase in the level of $\hat{x}$ for a given rise in k is described by the slope of the lawyer's indifference curve. When the increase required by the attorney's participation constraint falls short of the plaintiff's willingness to increase $\hat{x}$ for a higher k, then the probability r will be set equal to one. The plaintiff's willingness to increase $\hat{x}$ may also be equal to the increase required for some interior r, or fall short of it for all levels of r. The slopes of the respective indifference curves differ for several reasons. First, there are direct effects of a higher $\hat{x}$ and a higher k with regard to the plaintiff's payoffs, as both are set too low from the plaintiff's perspective. Second, the marginal effect of an increase in the level of r is different for the lawyer than it is for the plaintiff, since the lawyer bears litigation costs in full in the event of a trial.

Proposition 2 *Assume that the plaintiff and his or her attorney have agreed on a contingent-fee contract* (β, r)*, and that the plaintiff's preferred settlement demand is lower than* $\hat{x}_c$ *for all* $k \in A$*. (1) When the plaintiff's indifference curve is flatter than the lawyer's indifference curve reflecting his or her participation constraint (i.e., when* $-d\pi^P/d\hat{x} \left/ d\pi^P \right. /dk < -d\pi^L/d\hat{x} \left/ d\pi^L \right. /dk$*) for all relevant combinations* $(\hat{x}, k)$*, we obtain* $r = 1$ *and* $\hat{x}$ *to fulfill the participation constraint of the lawyer. (2) When the plaintiff's indifference curve is steeper than the lawyer's indifference curve reflecting his or her participation constraint (i.e., when* $-d\pi^P/d\hat{x} \left/ d\pi^P \right. /dk > -d\pi^L/d\hat{x} \left/ d\pi^L \right. /dk$*) for all relevant combinations* $(\hat{x}, k)$*, we obtain* $r = 0$ *and* $\hat{x}$ *to fulfill the participation constraint of the lawyer. (3) A combination of* $r \in (0, 1)$ *and* $\hat{x}$ *fulfilling the lawyer's participation constraint results when the plaintiff's indifference curve is tangent to the lawyer's indifference curve reflecting his or her participation constraint.*

In Section 6, we will present a numerical example to illustrate our results.

5 Impact of discovery on the level of social costs

Discovery is an institution with the primary purpose of decreasing the impact of informational asymmetries between litigants in order to make settlement easier to achieve (Cooter and Rubinfeld 1994). In the preceding section, we have described how discovery may create circumstances under which plaintiffs find it privately beneficial to prevent lawyers from making settlement demands after unsuccessful discovery. Whether or not this aspect may impair the attractiveness of discovery as an instrument to lower litigation costs will be discussed in this section.

Let us first assume that there is no discovery in our model. In such a scenario, the lawyer will make a settlement offer $\hat{x}^{ND}$ at Stage 4, which will be accepted with probability $(1 - F(\hat{x}^{ND}))$, given that it will be less costly for defendants with high levels of expected judgment than the expected outcome of a trial. As a result, we can determine the social costs of the dispute *without discovery* to be

$$SC^{ND} = F(\hat{x}^{ND})(c_P + c_D). \tag{33}$$

In contrast, the discovery process allows settlement in all cases in which discovery is successful. When discovery is unsuccessful, settlement may still occur with probability $(1 - F(\hat{x}))$

following a settlement demand of $\hat{x}$. We also consider that plaintiffs may disallow settlement demands after unsuccessful discovery. The social costs of the dispute *with discovery* can be represented as

$$SC^D = (1-k)\left[r(c_P + c_D) + (1-r)F(\hat{x})(c_P + c_D)\right] + ak^2/2. \tag{34}$$

It follows quite naturally that the social costs of a dispute are lower in the regime with discovery when $\hat{x}^{ND} \approx \hat{x}$, $r = 0$, and k is chosen in a socially optimal way, suggesting the social desirability of the institution of discovery. The conditions $\hat{x}^{ND} = \hat{x}$ and $r = 0$ would be applicable, for example, when there is no principal-agent conflict between the plaintiff and his or her lawyer. However, the formulation of the two social cost functions makes it clear that a high level of r could reverse the ranking, making discovery socially *undesirable*.

When the regime with discovery involves no plaintiff-imposed restrictions (i.e., with $r = 0$), it is to be expected that $\hat{x}^{ND} \neq \hat{x}$. The fact that an increase in the share β increases both $\hat{x}$ and k in the regime with discovery whereas it increases only $\hat{x}$ in the regime without discovery might suggest that $\hat{x} > \hat{x}^{ND}$. If that were the case, then this reality alone would offset the advantages of a regime with discovery to some extent, as the probability of trial would be higher when discovery is unsuccessful, $F(\hat{x}) > F(\hat{x}^{ND})$. However, the plaintiff's payoffs will be weakly greater in the regime with discovery, implying that ceding a greater share to the lawyer is also associated with higher costs for the plaintiff. This (at least) dampens the effect on $\hat{x}$ and makes it more likely that discovery will only be socially undesirable when it induces plaintiffs to restrict their lawyers' settlement attempts.

The numerical example detailed in the next section will illustrate the possible effects of the institution of discovery on the level of social costs.

6 A numerical example

In this section, we will show the results of a numerical example. Our example will illustrate how the plaintiff's incentive to restrict his or her lawyer is influenced by the lawyer's outside option, as well as demonstrating that the possibility of restricting the lawyer may indeed make discovery socially undesirable because of the higher implied social costs. We assume that the expected judgment is uniformly distributed on the interval $[4, 16]$, such that $X = 10$. The litigation costs are given by $c_P = 2$ and $c_D = 1$. The parameter determining the lawyer's effort costs is set to $a = 9/2$. We present our results as a function of the reservation utility of the lawyer. This is reasonable, because we can thereby encompass scenarios in which the plaintiff is not highly constrained by the individual-rationality constraint of the lawyer and contrast them with the case in which the lawyer receives almost the entire surplus.

[FIGURE 2 ABOUT HERE]

Figure 2 illustrates our key interest, namely the level of the probability r that is privately optimal for the plaintiff (bold curve). We find that the plaintiff sets $r = 1$ when the lawyer's outside utility falls below a certain threshold, whereas it is irrelevant as an instrument when the reservation utility of the lawyer is sufficiently high. A value of $r \in (0, 1)$ results for some interior levels of U. In this context, one must remembered that the use of the probability r reduces the surplus of the plaintiff-attorney pair, which restricts its use when U is very high. The level of the surplus-maximizing effort during the discovery process is represented in Figure 2 as a benchmark (dotted curve), and the level of k that results when agency costs are present is also shown (dashed curve). As argued above, the likelihood of discovery with agency costs is always strictly less than that without agency costs. Interestingly, the relationship between the reservation utility U and k is not monotonous. Basically, the lawyer's investment in discovery increases in U due to the accompanying increase in the contingency fee. However, in the interval where r is continuously adjusted from one to zero, this effects dominates, and k decreases as well. Finally, the graph shows the intuitive result that higher levels of outside utility require the plaintiff to grant the lawyer a higher level of β (thin curve). Here, it becomes obvious that the increase in β with U is dampened in the interval where the restriction probability is reduced.

[FIGURE 3 ABOUT HERE]

The concern that the plaintiff's restrictions on the lawyer may lower the attractiveness of discovery as an institution is addressed in Figure 3. In this figure, we show the level of expected social costs that are associated with a dispute in a regime with discovery (dashed curve) in comparison to the level of social costs when there is no discovery (solid curve). For high levels of U, the ranking of social costs is as expected. The additional possibility to induce settlement by means of a discovery process that lowers information asymmetries yields lower social costs. However, we find that the plaintiff's use of restrictions reverses this intuitive ranking for low levels of the reservation utility of the lawyer, as suggested in the previous section.

7 Extension

In our previous analysis, the plaintiff offered a contingent-fee contract specifying the share β and the probability r. Our key interest was the extent to which plaintiffs will actually use the additional (but surplus-reducing) instrument of restrictions (i.e., the probability r). We have shown that there are circumstances under which the plaintiff finds it privately beneficial to make use of this option. Although relatively rare in practice, at times contingent-fee contracts stipulate two different shares, one in the event of a settlement and another in the event of a trial.[16] Indeed, it has been argued that it is beneficial for the plaintiff to use different rates (Hay 1997). With respect to our setup, it would be natural to be curious about the extent to which our results are robust to an extension along these lines, given that the number of admitted instruments the plaintiff can use is relatively small.

In order to show that our main result regarding the use of restrictions by plaintiffs is robust to such an extension, we will briefly present numerical results for the case in which we allow four different levels of β; that is, we remain within the boundaries of the contingent-fee contract. β^D will be applied to settlements after successful discovery. In addition, we consider β^{FT} as the share that will apply if discovery is unsuccessful and the lawyer is forced to proceed to trial. Finally, we consider β^T and β^S for the scenarios of trial and settlement after unsuccessful discovery when allowed. In addition to these four different shares, the plaintiff may still make use of the probability r.

[16] Hensler et al. (1991, 136) find for their sample that more than two-thirds of contingency contracts stipulate a unitary contingency fee.

In this scenario, the objective functions of the plaintiff and the lawyer can be stated as

$$\begin{aligned}\pi^P =& k(1-\beta^D)(X+c_D)+(1-k)r(1-\beta^{FT})X \\ &+(1-k)(1-r)\left[(1-F(\hat{x}))(1-\beta^S)(\hat{x}+c_D)+\int_{\underline{x}}^{\hat{x}}(1-\beta^T)xf(x)dx\right] \end{aligned} \tag{35}$$

$$\begin{aligned}\pi^L =& k\beta^D(X+c_D)+(1-k)r(\beta^{FT}X-c_P) \\ &+(1-k)(1-r)\left[(1-F(\hat{x}))\beta^S(\hat{x}+c_D)+\int_{\underline{x}}^{\hat{x}}(\beta^T x-c_P)f(x)dx\right]-ak^2/2. \end{aligned} \tag{36}$$

It is clear that β^T and β^S influence the level of $\hat{x}$, allowing for a much more precise steering of the lawyer's decision regarding the level of the settlement demand, where any interior extremum will be a maximum for the lawyer only if $2\beta^S > \beta^T$ when x is uniformly distributed. From the preceding analysis, it follows that being able to more precisely determine the level of $\hat{x}$ will decrease the attractiveness of using the probability of restriction r for the plaintiff. Remember that $\Gamma > 0$ held when the settlement demand was very inappropriate from the plaintiff's perspective; this increased the marginal benefits of using $r > 0$. With β^D and β^{FT}, the plaintiff has additional instruments to influence the attorney's selection of the effort level during the discovery process.

The influence of these additional instruments is indeed apparent in the extent to which plaintiffs rely on the surplus-reducing restrictions r. For the parameter values used above, $r = 0$ is optimal for the plaintiff when $U \geq 1.433$. However, $r = 1$ is optimal for the plaintiff for levels of the reservation utility U that are below this threshold. In contrast, in the setting with only one contingency fee, restricting the lawyer becomes optimal for the plaintiff for U falling below a threshold of approximately 4.0.

8 Conclusion

Discovery is an aspect of procedural law that is intended to decrease informational asymmetries between litigants, thereby increasing the probability of settlement and decreasing the social costs of disputes. This paper shows that informational asymmetries between clients and attorneys may bring about contract designs that in some sense pervert the institution of discovery. We have established that when discovery has not been successful the plaintiff may prevent the lawyers from settling; this serves as a means of motivating the lawyer to exert proper effort during the discovery process. Although restricting lawyers in this way is always surplus-reducing for the client-attorney pair, it may be used in equilibrium by the plaintiff as an incentive device.

The finding that litigants may restrict lawyers' options has important policy implications. We have established that the effect of disallowing settlements after unsuccessful discovery may be strong enough to dominate the possible advantages of discovery, creating circumstances in which the social costs of the dispute would be lower if discovery were banned. Our analysis does not question the desirability of discovery per se, but rather highlights that accompanying regulation may be necessary under some circumstances. Potential welfare benefits arising from legal restrictions on private contracts when private information is present and important has already been discussed by Aghion and Hermalin (1990), among others. In the present scenario, it would be necessary to require litigants make serious attempts to arrive at a settlement agreement. The enforcement of such a requirement would probably pose serious difficulties.

The present paper analyzes the interaction between discovery and the particularities of the client-attorney relationship, seeking to establish the possibility that socially undesirable contract design could call into question the social desirability of discovery. The setting employed to make this point was kept simple in a number of ways. For instance, we did not consider the possibility that the likelihood of revealing private information during the discovery process could be related to the defendant's type. Moreover, in our discussion of social costs, we have not addressed the fact that discovery may improve primary incentives because it improves the accuracy of payments in either a settlement or a trial. In addition, we have maintained that the plaintiff will always stick to the announced restriction of the lawyer's action set. Despite these restrictions, our study points out important implications of the institution of discovery for contract design. Nevertheless, addressing these limitations of the present study is a promising avenue for future research.

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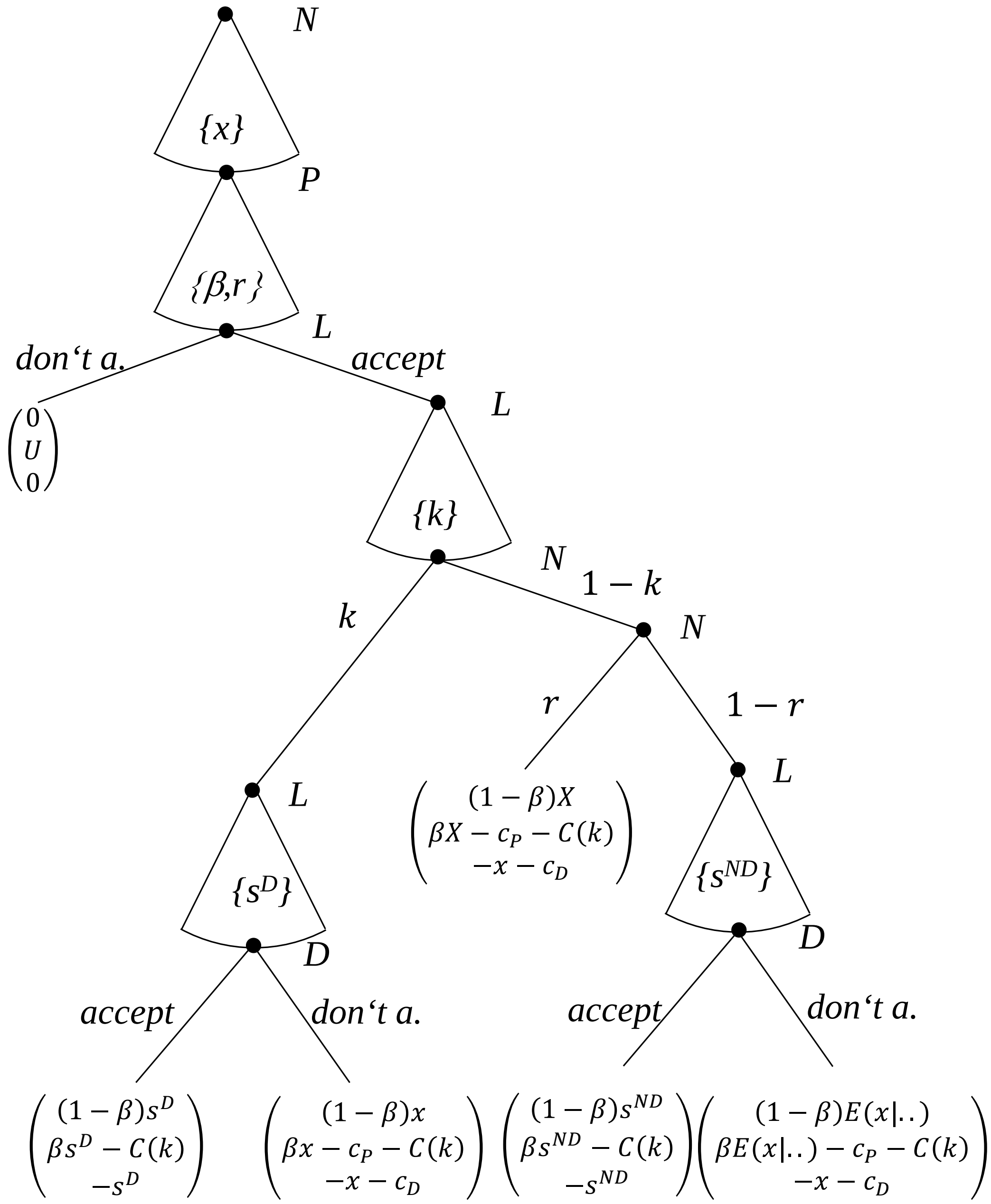

Figure 1: Game Tree.

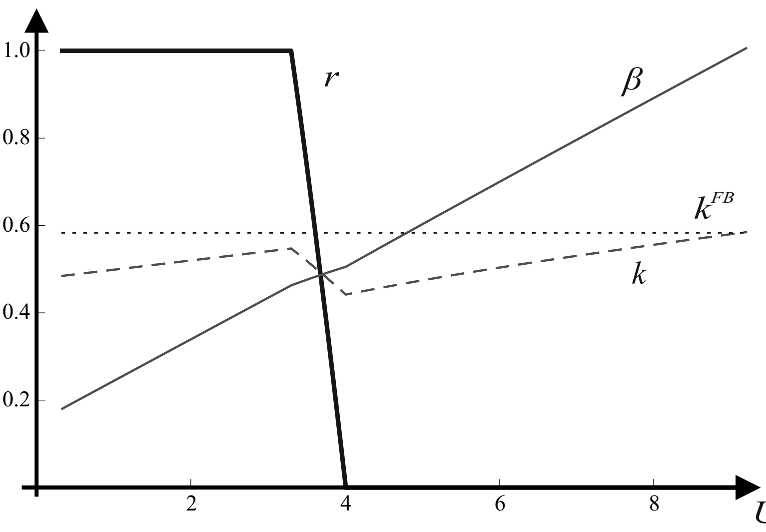

Figure 2: Level of surplus-maximizing and second-best k and r; level of β as a function of U

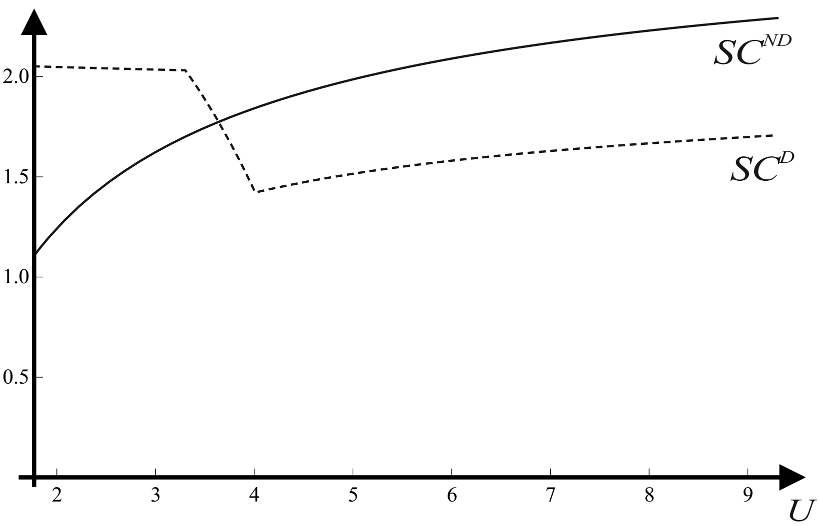

Figure 3: Level of social costs with and without discovery as a function of U

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