

INCENTIVE STRUCTURES  
FOR CLASS ACTION LAWYERS

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# Incentive Structures for Class Action Lawyers

Alon Klement<sup>1</sup> and Zvika Neeman<sup>2</sup>

**Abstract.** Unlike ordinary litigation where courts rarely interfere with litigants' contractual relations with their lawyers or intervene in settlement decisions, in class actions courts are required to do both. We focus on one explanation for the court's presumed inability to secure just and fair treatment for class members, namely, the court's inferior information vis-à-vis the class attorney concerning the case's merit or probability of success. Using a mechanism design approach, we identify the maximum expected payoff that a class may obtain when the court cannot observe the case's merit. We demonstrate that when the court can observe the lawyer's effort (the number of hours she spent on the case), the optimal payoff can be realized using the lodestar method – a contingent hourly fee arrangement that is currently practiced in many class actions. When the court cannot observe the lawyer's effort, it can still guarantee the same (optimal) expected payment to the class with a menu of percentage fee contracts each consisting of a percentage and a threshold amount below which the lawyer earns no fee, with the threshold increasing with the chosen percentage.

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# Incentive Structures for Class Action Lawyers<sup>1</sup>

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## 1. Introduction

In the past two decades class actions have grown to occupy a considerable share of news headlines, public debates, and legal academic writings. The scope of the modern class action has significantly broadened, and it is now frequently used in various areas of law such as securities, antitrust, civil rights, consumer rights, and mass torts. It is not uncommon that in a single class action millions of plaintiffs may be represented,<sup>4</sup> hundreds of millions of dollars may be at stake,<sup>5</sup> and whole industries may be at risk of liability.<sup>6</sup> Because of its importance the class action has been subjected to deep scrutiny and its efficacy has been repeatedly questioned. While its advocates argue that the class action achieves significant economies of scale in processing a large number of claims that are too small to be filed separately, critics claim that it is routinely abused by lawyers at the expense of represented class members.<sup>7</sup>

Most class actions are ‘lawyer driven’ as the class attorney maintains all but absolute control over the lawsuit. She usually initiates the suit, selects the class representative,

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<sup>4</sup>The Agent Orange class action for example involved more than 2.4 million Vietnam war veterans and their family members, who claimed to suffer various injuries as a result of the veterans’ exposure to the defoliant Agent Orange while in or near Vietnam. See Schuck (1987) and *Ryan v. Dow Chem. Co.*, 781 F. Supp. 902.

<sup>5</sup>For a recent example see *In Re Cendant Corporation Pride Litigation*, 51 F. Supp. 2d 537, a securities class action that was settled for an approximate value of 340 million dollars.

<sup>6</sup>The most dramatic example is the asbestos industry, which has been exposed to numerous class actions since the 1970s, resulting in several defendants turning insolvent. See Hensler et. al. (1985) and *Amchem Products v. George Windsor*, 521 U.S. 591.

<sup>7</sup>See, e.g., Miller (1979).

and controls both the litigation process and settlement decisions. The class representative, while supposedly in charge of the litigation as fiduciary for all those similarly situated, is in reality only a token figurehead with no actual control over the lawsuit.<sup>8</sup> Other class members' involvement is even less significant, as they are inclined to free ride on any litigation investment, sharing its proceeds without bearing the associated costs.<sup>9</sup>

Unlike ordinary litigation where courts rarely interfere with litigants' contractual relations with their lawyers or intervene in settlement decisions, in class actions courts are required to do both. The law requires the court to certify the suit as a class action only if it has found the class to be adequately represented, to approve any proposed settlement only if it is convinced that it is fair and reasonable, and to award the class attorney its share of the recovery in litigation or settlement.<sup>10</sup> The court, operating under its fiduciary duty to the class, is expected to use these powers to secure class members their proper share given the merit of the case.<sup>11</sup>

This paper focuses on one explanation for the court's presumed inability to secure just and fair treatment for class members, namely, the court's inferior information vis-à-vis the class attorney concerning the case's merit or probability of success. Indeed, because lawyers conduct prior investigation and discovery, they are often better informed than the court. Consequently, they are able to extract an information rent at the expense of represented class members.

As we show, minimizing the lawyers' information rent does not imply that the payment of such rent to the lawyer can be entirely avoided. Rational courts, who wish to maximize the class members' expected net payoff should construct attorney fee arrangements that would leave the class attorneys positive rents, over and above their reservation values. Such rents are necessary to induce lawyers whose estimates of the probability of success is high to represent the class and invest the required funds and effort in the case. Our theoretical findings indicate that current fee structures fall short of maximizing the class' expected payoff

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<sup>8</sup>See Macey and Miller (1991). In 1995, Congress passed the Private Securities Litigation Reform Act (PSLRA) which included lead plaintiff provisions encouraging institutional investors to become lead plaintiffs in securities class actions and to assume responsibility for selecting lead counsel for the plaintiff class. However, the efficacy of these provisions has been at best doubtful; see e.g. U.S. Securities and Exchange Commission Office of the General Counsel, Report to the President and the Congress on the First Year of Practice Under the Private Securities Litigation Reform Act of 1995 (April 1997)

<sup>9</sup>Although in some class actions class members may opt out of the class action, their alternative, which is to litigate their claims on their own, is much less promising.

<sup>10</sup>See Federal Rules of Civil Procedure, Rule 23.

<sup>11</sup>See e.g. *Brown v. Phillips Petroleum*, 838 F.2d 451, 456 (10th Cir., 1988).

because they ignore the possibility of screening among lawyers and cases according to their probability of success.

Using a mechanism design approach we first identify the maximum expected payoff that the class may obtain when the court can observe the lawyer's effort (the number of hours she spent on the case) but not the case's merit. We demonstrate that the optimal payoff may be realized using the lodestar method – a contingent hourly fee arrangement which is currently practiced in many class actions. We then derive the optimal fee menu when the court cannot observe the lawyer's effort, and is therefore forced to use a percentage fee.

We find that the class' maximum expected payoff is the same regardless of whether the court can observe the lawyer's effort or not. It is therefore the adverse selection problem (due to the lawyer's private information), that is most crucial in structuring the lawyer's optimal fee. This finding is especially striking when viewed against the extensive attention given by the literature to lawyers' moral hazard problems, both in class actions and in ordinary litigation, and the scant discussion, if at all, devoted to adverse selection issues in these contexts. More practically, our findings support the view that the percentage fee, if structured properly, should be preferred over the alternative lodestar fee. While both are likely to perform equally well in terms of the expected return to class members, the percentage fee is preferable because it entails lower administrative costs.

It should be emphasized, however, that according to our findings, the proper application of both the percentage fee and the lodestar is different from current practice. Optimal application of the lodestar method requires that the hourly fee contingent on winning be multiplied by a *declining* as opposed to a *constant* multiplier as the judgment increases. As for the optimal percentage fee method, it should allow lawyers to choose among a schedule of fees, each consisting of a percentage and a threshold amount below which the lawyer earns no fee, with the threshold increasing with the chosen percentage. A reform is thus necessary under both fee arrangements if optimal results are sought.

Finally, we investigate the optimal regulation of settlement. Because they hold private information, lawyers are able to obtain positive rents in a settlement as well. Moreover, this rent cannot be lower than the respective rent they would earn in litigation, or they would refuse to settle. The question therefore is how to ensure that the share of settlement remaining to the class is not lower than what it would get in court. Given that, as we show, the optimal expected payment to the class is increasing with the optimal expected payment to the lawyer, the class can be secured its maximum expected litigation recovery in settlement as well.

This paper is the first to formally analyze the class attorney's adverse selection problem and to characterize an optimal fee menu in this context. Both the literature on client-attorney relationship and the class action literature have, to a large extent, ignored the adverse selection problem. The client-attorney literature has primarily focused on moral hazard problems under the hourly fee and the contingent fee. The problem of securing adequate investment by the lawyer was presented by Mitchell and Schwartz (1970) and was further elaborated in Clermont and Currivan (1978). Danzon (1983) has formally presented the same problem, and Hay (1996, 1997a) has characterized the optimal contingent fee in a simple moral hazard framework. The lawyer's private information has been discussed mainly in the narrower context of incentives to bring suits, analyzing whether contingent fees encourage frivolous litigation (see for example, Miceli and Segerson, 1991; Miceli, 1994; Dana and Spier, 1993). We are aware of only two papers that discuss the optimal fee arrangement for lawyers under asymmetric information in ordinary litigation, both assume that the lawyer's effort is observable. Rubinfeld and Scotchmer (1993) analyze a case where the lawyer's quality, taking one of two values – high or low, affects both her reservation payoff and the probability the client would prevail. They then derive the optimal fee schedule, where they assume the lawyer's fee must have a fixed percentage combined with a non-contingent fixed fee. We prove that such a fee structure can indeed be optimal in the different setting of class actions, even when the lawyer's effort is not observable. More recently, Emons (2000) shows that in a model where the lawyer has private information about whether the required level of investment in the case is high or low, an hourly fee is preferable to a contingent fee. As we show, in a more general setting a schedule of percentage fees is capable of achieving optimal results.

There is also a distinct body of literature that analyzes the economics of class actions in general, and the class attorney's incentives in particular. None of these papers, however, discusses the problem of optimal lawyer's fee under an adverse selection problem. Dam (1975) is an early analytic discussion of class actions. Various law review articles discuss agency problems that are particular to the class action context.<sup>12</sup> A somewhat more formal discussion, and an empirical examination of the lodestar and the percentage fee arrangements can be found in Lynk (1990, 1994). Finally, Hay (1997b, 1997c) discusses how to alleviate the danger of low settlement through appropriate judicial regulation of the class attorney fee in settlement. However, he does not discuss the adverse selection problem nor does he characterize the optimal fee in litigation.

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<sup>12</sup>See Coffee (1983, 1985, 1986, 1987), and Macey and Miller (1991).

The analysis presented in this paper relies on methods developed in the mechanism design literature, and in particular, the literature that analyzed the problem of the regulation of a monopolist with unknown cost (see Laffont and Tirole, 1994, and the references therein). In that context, Laffont and Tirole (1986) observed that a regulator that relies on a menu of linear incentive contracts may achieve optimality without having to monitor the monopolist's effort. This result, which is analogous to our result about the possibility of achieving optimality without monitoring the lawyer's effort, was obtained under the assumption that the regulator's objective function is additively separable in the monopolist's type and effort. Consequently, in Laffont and Tirole (1986), the marginal contribution of effort to the objective function is independent of the monopolist's type. At first, it appeared that this result may be generalized to other setups, but additional work (see the discussion in Laffont and Tirole, 1994, pp. 107-8) showed this not to be the case. The work presented in this paper contributes to the mechanism design literature by showing that the range of environments where linear incentive contracts that obviate the need for monitoring effort are optimal can be extended to include environments with multiplicatively separable objective functions. Such environments include the interesting case (discussed in this paper) where the agent's type affects its marginal return from effort.

This paper's analysis is by no means unique to the class action context. It may be applied in the more general setting of ordinary individual litigation. Yet, there are reasons to believe that the adverse selection problem would be more acute in class actions. First, whereas individual clients may choose to pay their lawyers a non-contingent fee, the same cannot be done in class actions, since the class cannot be charged any fee unless a common fund is created. Thus, any information concerning the probability of success is bound to affect the de-facto (contingent) fee in class actions, whereas private clients can always pay their attorneys their reservation fee, thus reducing their incentive to misrepresent the case's merits. Second, lawyers have to compete for individual clients in the market, and are thus often forced to offer them optimal fee arrangements. On the other hand, the class action bar is small – allowing for anti-competitive forces to operate, and its access to each class action is determined by various factors, only few of which have to do with benefits afforded to the class. Finally, individual clients have strong incentives and often have sufficient resources to take adequate measures to directly monitor their attorneys, whereas courts and class representatives lack both.

The rest of the paper proceeds as follows, in the next Section we elaborate further on the special features of class action litigation. In Section 3, we present the general model,

and in Sections 4 and 5, apply it to the cases of the lodestar and percentage fee methods. Concluding remarks are offered in Section 6. All proofs are relegated to the Appendix.

## **2. The Inherent Features of Class Action Attorney Fees**

Several features of the model require preliminary elaboration in order to appreciate their applicability in different legal contexts. This section outlines the common practice in the courts, setting the ground for the assumptions made in the model, the choice of the objective function to be maximized, and the possible instruments that may be used in maximizing this objective function.

### **A. The Court's Objectives in Setting the Attorney's Fee**

In ordinary (not class action) litigation it is rarely the case that courts intervene in the litigants' selection of attorneys, their fee agreements and their settlement decisions. Class actions are exceptional in this respect as the real litigants, the class members, are absent throughout the process. The court's objective in devising the attorney's fee and regulating the settlement decisions is therefore to protect the class and secure its interests. The judge should act as a fiduciary for those who are supposed to benefit from the fund obtained, since typically no one else is available to perform that function. The defendant has no interest in how the fund is distributed among the plaintiffs, and the plaintiff class members rarely become involved. We define the court's objective accordingly, to maximize the class' expected payoff.<sup>13</sup>

Our definition of the court's objective function assumes uniformity among the class members' preferences. It abstracts from the problem of allocating the class recovery, both among the class members, and among alternative uses. And, it implies that class members are only interested in maximizing their expected payoff (and are, therefore, risk neutral), and have no other goals in having their claims litigated. These assumptions are consistent with the situation in many of the securities, antitrust, and consumer class actions. Yet, in some other contexts, especially mass torts, class members may have conflicting interests: they may be risk averse and may also be interested in obtaining non-monetary remedies such as the opportunity to have their day in court and gain an institutional recognition of the wrongs they have suffered. The model should therefore be taken with caution in contexts where maximizing the class welfare is not necessarily equivalent to maximizing its expected payment.

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<sup>13</sup>For broader perspectives on social welfare in the context of ordinary litigation, see Shavell (1997).



## B. Fee Methods Practiced In the Courts

The analysis of this paper is focused on common fund class actions. A common fund class action creates, increases, or preserves, a common fund whose monetary benefits extend to the whole class.<sup>14</sup> The lawyer's fee is paid from the common fund, thus allocating the proceeds from the lawsuit between the class and the lawyer. Since the class is dispersed and class members do not need to actively approve the lawsuit in order to be part of it, the attorney can never collect a fee higher than the actual amount recovered. Any non contingent fee that is paid independently of the suit's outcome is therefore infeasible in this context. For this reason, the two forms of attorney's fees practiced in common fund class actions, the reasonable percentage fee and the 'lodestar' fee, are both contingent on a class victory, and are limited to the amount recovered.

When the court applies the reasonable percentage fee method it determines the lawyer's compensation as a percentage of the total recovery, after considering a set of potentially relevant factors, including the time and labor required to litigate the lawsuit, the risk of losing it, the customary lawyer's fee in the market, the amount involved in the lawsuit, and the awards in similar cases. If the 'lodestar' fee is employed, the lawyer is paid for the labor and costs she spent on the case. The court determines the hours reasonably expended by counsel, multiplies this number by a reasonable hourly rate, and then adjusts the fee based upon the contingent nature or risk in the particular case involved and the quality of the attorney's work.

Underlying both methods is a general standard of reasonableness, by which the lawyer is entitled to a reasonable attorney's fee from the fund as a whole. The choice between the two fee structures is made according to the common practice and precedent in the circuit in which the class action is litigated and the specific context of the suit. Yet, anecdotal evidence from courts' opinions as well as and empirical research suggest that the two methods for calculating the lawyer's fee award lawyers with roughly the same range of dollar amounts, *ceteris paribus* (Lynk, 1994). Furthermore, common fund fees in complex class actions normally constitute between 20% to 30% of the class recovery in common funds of up to \$50 million (Conte, 1993, p. 50).

Under both the lodestar and the reasonable percentage fee, courts use various techniques when reviewing fee applications to secure accurate reporting of hours. These techniques include auditing and sampling, computerized review of fee submissions, categorized and periodical fee reports, and comparisons with defendants' time records. By using these auditing

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<sup>14</sup>For a comprehensive review of the common fund doctrine, see Conte (1993, pp. 22-30).

techniques, courts are able not only to ensure accurate reporting, but also to better monitor the lawyer's investment, minimizing the moral hazard problems inherent in each of the two fee methods. In the absence of such direct monitoring the lawyer would tend to under-invest in the lawsuit under the reasonable percentage fee since she bears the full cost of any investment, but obtains only part of its expected return. Under the lodestar fee she would tend to over-invest whenever her rent for each working hour is positive. (Note that if the lawyer's rent for each working hour is negative, she would decline to handle the case.) In order to eliminate these moral hazard problems, it is therefore necessary for the court to examine the time the class attorney spent on the case and explicitly regulate it.

We assume below that the court observes the eventual judgment, and determines the lawyer's fee accordingly. We proceed by initially abstracting from the exact form used to award the lawyer's fee, and characterize the optimal fee menu in terms of the lawyer's expected payment as a function of her litigation investment. Then, after deriving the optimal fee menu for the lawyer, we proceed to show that it can be implemented through both fee methods introduced above.

### 3. The Model

A court appoints a lawyer to represent a class in a class action. Conditional on winning, the judgement paid to the class is given by

$$j = w(e) + \varepsilon \geq 0$$

where  $w(e) \geq 0$  describes the way in which the lawyer's effort, denoted by  $e \geq 0$ , affects the expected judgment conditional on winning, and  $\varepsilon$  is a random element with expectation zero that expresses the inherent uncertainty associated with the size of the judgement. The function  $w : \mathbb{R} \rightarrow \mathbb{R}$  is assumed to be increasing, differentiable, and concave, and such that  $w(0) \geq 0$ , and  $\lim_{x \nearrow \infty} w'(x) = 0$ . The judgement's value in case of not winning is assumed to be zero.

The lawyer's expert opinion about the merit of the suit is summarized by her estimate of the probability of winning the case. We denote her estimate by  $p$ . Thus, the expected value of the judgement when a lawyer whose estimate is  $p$  exerts the effort  $e$  is given by

$$E [p(w(e) + \varepsilon)] = pw(e).$$

The model can be generalized to allow for the lawyer's effort to also affect her estimate of the probability of winning the case. Specifically, the lawyer's estimated probability of winning

the case may be given more generally by  $p \cdot \pi(e)$  where  $\pi(e) : \mathbb{R} \mapsto [0, 1]$  is increasing in the lawyer's effort, differentiable, and such that the function  $\pi(e) w(e)$  is concave in the lawyer's effort. This generalization will not change the qualitative features of our results.

We make the following assumptions about  $j, p, e$ , and  $\varepsilon$ . The judgement  $j$  is observable and verifiable. It provides the basis for determining the lawyer's fee for handling the class action. The lawyer's estimate  $p$  is known only to herself. We assume that the court, being less knowledgeable about the merit of the case, believes that  $p \in [0, 1]$  is distributed according to some distribution function  $F$  with density  $f$ . We assume that  $F$  is such that  $\frac{1}{p} \left( 1 + \frac{\int_p^1 x f(x) dx}{p^2 f(p)} \right)$  is non-increasing in  $p$ . Note that this assumption is satisfied unless the density  $f(p)$  decreases "too fast" (faster than  $\frac{1}{p^3}$ ) on some interval.<sup>15,16</sup> The (unconditional) expected judgement,  $pw(e)$ , is increasing in the effort  $e$  that is exerted by the lawyer. Finally, we assume that the "noise" term,  $\varepsilon$ , has an expectation of zero conditional on any lawyer's effort,  $E[\varepsilon|e] = 0$ . Note that since any systematic bias in  $\varepsilon$  can be incorporated into the lawyer's effort or into the function  $w(\cdot)$ , this assumption entails no loss of generality. However, the *distribution* of  $\varepsilon$  may depend on the "strategy" employed by the lawyer in conducting the trial. As we show below, this does not affect our results.

The lawyer's payoff from handling the class action is given by

$$t - ce$$

where  $t$  denotes the payment to the lawyer (the lawyer's fee), and  $c > 0$  denotes the lawyer's per-unit cost of effort. The analysis can be easily generalized to allow for lawyer's costs that are convex in effort without changing the results. We assume that the lawyer is an expected utility maximizer. Note that this implies that she is risk neutral with respect to money. We normalize the lawyer's opportunity cost to zero.

The payoff to the class is given by

$$j - t$$

when the judgement is  $j$  and the lawyer is paid  $t$ . We assume (see the discussion in Section 2 above) that the court designs the incentive scheme for the lawyer trying to maximize the

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<sup>15</sup>For example, this sufficient condition is satisfied by all Beta distributions with parameter  $\beta \leq 1$ . (A Beta distribution with parameters  $\alpha, \beta > 0$  has a density proportional to  $x^{\alpha-1} (1-x)^{\beta-1}$  for  $x \in [0, 1]$ . It is the only named distribution with support on the unit interval we are familiar with.)

<sup>16</sup>This assumption plays a similar role to that of the standard monotone hazard rate property. Namely, it facilitates the analysis by ensuring that the optimal incentive scheme fully separates the different lawyers' types (no bunching). See Myerson (1981), Guesnerie and Laffont (1984), and Bulow and Roberts (1988) for a discussion about how the problem can be solved without this assumption.

expected payoff to the class subject to the ex-post constraint that

$$0 \leq t \leq j.$$

That is, the lawyer cannot be paid more than the realized judgement. She is also subject to a limited liability constraint – she cannot be asked to pay the class out of her own pocket. Note that this latter constraint, although usually satisfied in practice, is not mandated by law and may therefore be relaxed.

To simplify the discussion, we assume first that the lawyer’s effort is observable to the court. We have in mind the following scenario. Upon appointing the lawyer, the court asks her to reveal her estimate of the merit of the case. Depending on the lawyer’s report of her estimate, denoted  $\hat{p}$ , the court determines the effort required from the lawyer  $e(\hat{p})$ , and a fee schedule (that may depend on the lawyer’s reported estimate) that specifies the payment to the lawyer as a function of the realized judgement  $t_{\hat{p}}(j)$ . The lawyer is not paid anything if she does not win the case for the class. Equivalently, the court may reward the lawyer after it renders its judgement according to a fee schedule that depends on the observable effort exerted by the lawyer  $t_{e(\hat{p})}(j)$ .

By the revelation principle,<sup>17</sup> no loss of generality is involved with restricting our attention to incentive compatible contracts of the form  $\{T(p), e(p)\}_{p \in [0,1]}$  where the lawyer truthfully reports her type  $p \in [0, 1]$ , is asked to exert effort  $e(p) \geq 0$ , and receives an expected payment conditional on winning the case  $T(p)$ . The expected utility to a lawyer of type  $p$  who exerts effort  $e$  and receives an expected payment conditional on winning  $T$  is therefore given by  $pT - ce$ . Since the lawyer’s estimate of the merit of the case  $p$  is not observable to the court, for a menu of contracts  $\{T(p), e(p)\}_{p \in [0,1]}$  to indeed be incentive compatible for the lawyer, or to induce truthful revelation, it must be that,

$$pT(p) - ce(p) \geq pT(\hat{p}) - ce(\hat{p}) \quad \forall p, \hat{p} \in [0, 1].$$

Furthermore, if we assume in addition that the lawyer can guarantee herself a payoff of zero by refusing to handle the case, then we must impose an additional constraint to express the fact that the lawyer must voluntarily agree to the terms of the contract, or,

$$pT(p) - ce(p) \geq 0 \quad \forall p \in [0, 1].$$

Otherwise, the lawyer may be better off not taking the case.

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<sup>17</sup>See, e.g., Myerson (1985).

We have expressed the lawyer's expected payment conditional on winning,  $T(p)$ , as a function of the lawyer's estimate of the merit of the case. Note, however, that if  $e(p)$  is (strictly) increasing in  $p$ , as is the case in the optimal solution, then it is possible to invert  $e(p)$  and thus to express  $T(p)$  more naturally as a function of the effort exerted by the lawyer, rather than her estimate of the merit of the case.

We begin by characterizing the optimal incentive scheme for the lawyer in the class of incentive schemes where the lawyer's payment is contingent upon her winning the case.<sup>18</sup> Denote  $\psi(p) = \int_p^1 xf(x)dx$  and note that  $\psi'(p) = -pf(p)$ . Define the effort function  $e^*(p)$  as follows: for every  $p \in [0, 1]$  such that  $\frac{c}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right) > w'(0)$ , let  $e^*(p) = 0$ ; and for every  $p \in [0, 1]$  such that  $\frac{c}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right) \leq w'(0)$ , let  $e^*(p)$  be defined as the solution,  $e$ , of the following equation,

$$\frac{c}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right) = w'(e).$$

Note that our assumption that  $\frac{1}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right)$  is non increasing in  $p$  implies that  $e^*(p)$  is non decreasing in  $p$ . Note also that if  $w'(0) = \infty$ , then  $e^*(p) > 0$  for every  $p > 0$ .

**Proposition 1.** *The optimal incentive scheme for the lawyer in the class of incentive schemes where the lawyer's payment is contingent upon her winning the case is given by  $\{T^*(p), e^*(p)\}_{p \in [0,1]}$  where  $e^*(p)$  is described above, and*

$$T^*(p) = c \left( \int_0^p \frac{e^{*'}(p)}{x} dx \right).$$

It is straightforward to verify that if the merit of the case  $p$  was perfectly observable to the court, then it would have optimally required the lawyer to exert the effort level  $e^{FB}(p)$  that solves the equation

$$pw'(e^{FB}(p)) = c$$

when such a solution exists and to exert zero effort otherwise. We refer to  $e^{FB}(p)$  as the "first-best" effort. The fact that the lawyer's estimate is not observable to the court distorts the lawyer's effort away from this first-best level in a way that is standard in mechanism design literature:  $e^*(p) \leq e^{FB}(p)$  for every  $p \in [0, 1]$ , but the difference between the two is decreasing in  $p$ , and  $e^*(1) = e^{FB}(1)$ . Note that if  $w'(0) < \infty$  lawyers with low estimates of

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<sup>18</sup>Identifying the best among all general incentive schemes that include both contingent and non-contingent payments is an open problem. However, as explained in subsection 2.B above, non contingent payments are infeasible in class actions.

the merit of the case may be prevented from handling the suit under the first best outcome simply because their cost of handling the case is too high relative to the expected judgement. When  $w'(0) < \infty$  the range of exclusion may increase under the optimal solution for the class. That is, under the optimal incentive scheme, some lawyers with low estimates of the merit of the case are inefficiently prevented from handling the case. The intuition for the optimality of  $e^*(p)$  and  $T^*(p)$  is the following. The court wants lawyers with high estimates of the merit of the case, who have a correspondingly higher marginal return to effort, to exert more effort. By promising lawyers a higher expected payment conditional on winning if they agree to work harder, the court provides incentives for the lawyers to be truthful about their estimates. Lawyers with high estimates do not want to pretend to have low estimates because while this would allow them to work less, it also implies that they would receive a lower expected payment or may even be prevented from handling the suit. Lawyers with low estimates do not want to pretend to have higher estimates because, upon doing so, they would be asked to exert a higher level of effort. They would also receive a higher expected payment conditional on winning, but since their estimate is low, their overall expected payment is too low to justify the hard work.

#### 4. The Lodestar Fee Arrangement

We show that the optimal menu of contracts  $\{T^*(p), e^*(p)\}_{p \in [0,1]}$  can be implemented through the lodestar contingent hourly fee arrangement. We define a function  $h(e)$  that, conditional on the lawyer winning the case, relates the observed number of lawyer's hours worked to the payment to the lawyer such that

$$h(e) = T^*(e^{*-1}(e))$$

where  $e^{*-1}(\cdot)$  denotes the inverse function of  $e^*(\cdot)$ . Under the lodestar fee arrangement, a lawyer who has been observed to exert the effort  $e$ , is paid  $h(e)$  upon winning the class action. A lawyer whose estimate of the merit of the case is  $p$  will choose to exert the effort  $e^*(p)$ . If she chooses a different level of effort  $e' = e^*(p') \neq e^*(p)$ , her payment upon winning would equal  $T^*(e^{*-1}(e')) = T^*(p')$ , contradicting incentive compatibility.

Under common practice of the lodestar arrangement, the lawyer's hourly rate is multiplied by a *constant* risk multiplier. The next proposition shows that optimality requires the court to set a *decreasing* or 'sliding' multiplier.

**Proposition 2.** *The function  $h(e)$  is concave in the lawyer's effort.*

The marginal contingent hourly fee  $h'(e)$  is thus decreasing in the number of hours worked. Intuitively, for the first fraction of an hour worked, the lawyer is paid her cost of effort,  $c$ , multiplied by the highest possible multiplier,  $\frac{1}{p_{\min}}$ .<sup>19</sup> This multiplier decreases as the lawyer's estimate of the merit of the case increases until it equals 1 for any hour worked beyond the first-best level of effort of a lawyer whose estimate of the probability of winning is 1.

A possible problem with the optimal lodestar method as described in this section, is that in case of winning, the realized judgement may not be high enough to cover the lawyer's fees (thus violating the constraint  $t \leq j$ ). This problem will not occur if the variance of the noise term  $\varepsilon$  is "small enough." To the extent that  $\varepsilon$  may indeed be negative and large in absolute value, lawyers must be paid a higher hourly fee in those cases where the realized judgement is high enough so that they still receive an expected payment  $T^*(p)$  conditional on winning. The optimal fee arrangement would then require the court to be knowledgeable about the distribution of the noise  $\varepsilon$ .

## 5. The Percentage Method

In this section we show it is possible to implement the optimal incentive scheme through a menu of linear contracts even in the case where the court cannot verify the number of hours the lawyer worked. Such contracts obviate the need to monitor the lawyer's effort, and are therefore less costly to implement compared to the lodestar method.<sup>20</sup>

We assume hereafter that the function  $\frac{\int_p^1 xf(x)dx}{p^2f(p)} = -\frac{\psi(p)}{p\psi'(p)}$  is decreasing in  $p$ .<sup>21</sup> Define  $b^*(p)$  to be the share of realized judgement that induces a lawyer of type  $p$  to voluntarily choose the optimal effort level  $e^*(p)$ . That is, for every  $p \in [0, 1]$ ,  $b^*(p)$  is such that  $\arg \max_{e \geq 0} \{pb^*(p)w(e) - ce\} = e^*(p)$ . The concavity of the function  $w(\cdot)$  implies that for  $p$

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<sup>19</sup>The number  $p_{\min} \geq 0$  refers to the lowest estimate that a lawyer may have with respect to the merit of the case and still be allowed to handle the case.

<sup>20</sup>Note that with linear contracts the expected payment to the lawyer as well as the expected payment to the class are both independent of the distribution of  $\varepsilon$  and are therefore also independent of the degree of "riskiness" of the legal strategy employed by the lawyer.

<sup>21</sup>The assumption is satisfied if  $f(p)$  decreases at a rate that is slower than  $\frac{1}{p^2}$ . While plausible, this assumption is slightly stronger than the assumption that  $\frac{1}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right)$  is non-increasing that was needed to establish the monotonicity of the effort function  $e^*$ . Like the weaker assumption, this assumption is also satisfied for all Beta distributions with parameters  $\beta \leq 1$ .

such that  $e^*(p) > 0$ ,

$$b^*(p) = \frac{c}{pw'(e^*(p))},$$

and for  $p$  such that  $e^*(p) = 0$ ,  $b^*(p) = 0$ . Our assumptions imply that  $b^*(p)$  is increasing in  $p$ .<sup>22</sup>

Consider the following menu of linear incentive schemes that describe the lawyer's payment: the lawyer is allowed to choose the fraction she gets out of the realized judgement in case of winning,  $b^*(p)$ , together with a threshold amount  $w(e^*(p)) - \frac{T^*(p)}{b^*(p)}$  below which she earns no fee. That is, the menu of incentive schemes consists of the following contingent contracts that relate the lawyer's fee to the judgement in the trial when the lawyer wins the case for the class,

$$\{\max\{b^*(p)(j - w(e^*(p))) + T^*(p), 0\}\}_{p \in [0,1]}.$$

The lawyer has to choose one contingent incentive scheme from this menu. The next proposition establishes the optimality of this menu of incentive schemes.

**Proposition 3.** *If the noise term  $\varepsilon$  is not “too small,” the menu of linear contingent contracts described above is optimal. It induces a lawyer whose type is  $p$  to exert the optimal effort  $e^*(p)$  and receive an expected payment conditional on winning the case  $T^*(p)$ . Also, the threshold  $w(e^*(p)) - \frac{T^*(p)}{b^*(p)}$  is increasing in  $p$ .*

We conclude this section with the following three observations: First, because the lawyer's marginal fraction of the suit  $b^*$  is smaller or equal to one and the threshold is non negative, the class always receives some payment when the lawyer wins the case. Second, in case the realized judgment  $j$  is low, or the noise term  $\varepsilon$  is small (specifically, when  $b^*(p)j < b^*(p)w(e^*(p)) - T^*(p)$ ), the lawyer receives no fee. Maintaining the lawyer's incentives requires that in this case the lawyer pays the difference  $b^*(p)w(e^*(p)) - T^*(p) - b^*(p)j$  to the class. Otherwise, the lawyer's expected contingent payment may be larger than  $T^*(p)$ . This will not pose any problem if the noise term  $\varepsilon$  is such that,

$$\varepsilon \geq -\frac{T^*(p)}{b^*(p)},$$

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<sup>22</sup>This follows from Proposition 1 (according to which for  $p$  such that  $\frac{c}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right) \leq w'(0)$ ,  $\frac{c}{p} \left(1 - \frac{\psi(p)}{p\psi'(p)}\right) = w'(e^*(p))$ ), and the assumption that  $-\frac{\psi(p)}{p\psi'(p)}$  is decreasing in  $p$ .



which implies that as a percentage of the expected judgement in case of winning the suit, noise is smaller or equal to

$$1 - \frac{w(e^*(p)) - \frac{T^*(p)}{b^*(p)}}{w(e^*(p))}.$$

For example, for one specification of parameters,<sup>23</sup> this implies that for any estimate  $p$ , the noise must be smaller or equal than 14% of the expected judgement. Another way of overcoming this difficulty is to implement the same incentive scheme with the lawyer making contingent lump sum payments to the class that ensure that her expected payment conditional on winning the case is exactly  $T^*(p)$ . That is, the menu of contingent incentive schemes has to be changed to

$$\{b^*(p)(j - w(e^*(p))) + T^*(p)\}_{p \in [0,1]}.$$

With such a scheme, again when the noise  $\varepsilon$  is small, the lawyer may have to pay the class out of her pocket. However, as mentioned before, the constraint that the lawyer's payment be non negative is not mandated by law and may therefore be relaxed.<sup>24</sup>

Finally, a “boundedly rational” court may only employ a few contingent contracts as opposed to the continuum of contingent contracts in the optimal menu of contingent contracts. For one specification of parameters (mentioned in footnote 20), it can be shown that if the class or court employs only one contingent contract, namely the “best” contingent share contract without monitoring effort, expected payment to the class falls by only 4% relative to the optimal menu of contingent contracts.

## 6. Discussion of Settlement Regulation

Most class actions settle.<sup>25</sup> When asked to approve a proposed settlement a court examines whether it is fair and reasonable given its estimate of the case's expected litigation value. The court's task then is to ensure that the class would earn at least the net expected payoff

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<sup>23</sup>Specifically for the case where  $c = 1$ ,  $w(e) = 50e - e^2$  for  $e \in [0, 25]$ , and  $w(e) = 625$  for  $e > 25$ , and  $p \in [0, 1]$  is distributed according to the symmetric Beta distribution  $f(p) = 6p(1 - p)$ .

<sup>24</sup>Another possibility is to implement the same incentive scheme with a non-contingent lump sum payment (equal to  $p(b^*(p)w(e^*(p)) - T^*(p))$ ). This modification may be preferable because with contingent lump sum payments, a lawyer who realizes that  $\varepsilon$  is likely to be small so that the lawyer's share of the eventual judgement may be smaller than the lump sum payment she has to make may prefer to lose the case.

<sup>25</sup>For example, in its study of class actions terminated between 1992 to 1994 in four federal district courts, Willging et. al. (1996) have found settlement rates ranging from 53 to 64 percent in class actions.

it would have earned had the case proceeded to trial. Given this definition of the court’s objective, however, settlement regulation is closely related to the lawyer’s fee structure in litigation. Under the optimal fee structure the lawyer’s expected payoff,  $pT^*(p) - ce^*(p)$ , and the class’ expected payoff,  $p(w(e^*(p)) - T^*(p))$ , are both increasing in the lawyer’s estimate of the case’s merit  $p$ . For any proposed settlement,  $S$ , the court can therefore find an estimate  $p$  such that  $S$  equals the joint surplus to the class and the lawyer  $pw(e^*(p)) - ce^*(p)$  at that  $p$ , and allocate the settlement between the lawyer and the class accordingly, giving  $pT^*(p) - ce^*(p)$  to the lawyer and  $p(w(e^*(p)) - T^*(p))$  to the class.<sup>26</sup> Since for whatever estimate she may have the lawyer would be willing to settle if and only if her payoff in settlement is at least as high as her expected payoff in litigation, the class would be secured its expected payoff in litigation.

## 7. Conclusion

The ongoing debate about which fee arrangement best serves class action members’ interests – the lodestar or the percentage fee – has usually tried to identify which of those methods is better suited for solving the court’s moral hazard problem. Assuming that the court’s problem is mainly due to its inability to accurately determine the lawyer’s investment in the case, commentators as well as courts have considered the issue of under- or over-investment to be the most crucial problem in client-attorney relations in general, and in class-action litigation in particular. This paper demonstrates that in some cases the fact that the lawyer may have access to private information concerning her ability and the merits of the case may be of much greater significance. Indeed, our conclusion that the maximal expected payoff to the class is identical regardless of whether the lawyer’s effort can be observed or not implies that the “adverse selection” or “screening” problem faced by the court is more significant than the moral hazard problem.

Our results support the inclination of many courts to return to the percentage fee method, and make less use of the lodestar. Our results also show that in order to optimize the class members’ expected payoff, courts should use fee menus to screen among lawyers according to their ability and information. If the percentage fee is preferred then lawyers should be offered a choice among various combinations of percentages and threshold judgments below which they earn no fee.<sup>27</sup> Lawyers who prefer a higher share of the class’ recovery would have

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<sup>26</sup>We assume for simplicity that the lawyer incurs no costs before trial. Adjusting for the case where her discovery costs are positive but independent of the lawyer’s type is straightforward.

<sup>27</sup>In a recent class action against Sotheby’s and Christie’s the court has auctioned the class attorney

to agree to a larger threshold, thus inducing higher investment on their part. If the lodestar fee is practiced, then courts should use a sliding multiplier, rendering a higher hourly rate for the first hours spent, which decreases as more time is invested.

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position. Bidders were required to submit a threshold amount below which they would earn no fee, where their fee for any additional amount would be 25%. Although the implied menu of fee schedules is such that all schedules have the same slopes, this structure is not unlike the one we propose. See *In re. Auction Houses Antitrust Litigation*, 197 F.R.D. 91 (2000)

## Appendix

**Proof of Proposition 1.** The proof proceeds through three lemmas. We begin in Lemma 1 by characterizing incentive compatible menus of contracts. Next, in Lemma 2 we prove that the optimal menu of contracts is continuous. We then characterize absolutely continuous incentive compatible menus of contracts in Lemma 3 and proceed to identify the optimal absolutely continuous menu of contracts. Finally, we show that the optimal absolutely continuous menu of contracts is also optimal among all continuous contracts.

Recall our notation of  $T(p)$  as the expected payment conditional on winning and  $e(p)$  as the effort to a lawyer of type  $p$  under some incentive scheme. We begin with the a characterization of incentive compatibility.

**Lemma 1.** *A menu of contracts  $\{T(p), e(p)\}_{p \in [0,1]}$  is incentive compatible if and only if  $e(p)$  and  $T(p)$  are non decreasing in  $p$ , and*

$$pT(p) - ce(p) = \int_0^p T(x) dx + K \quad (\text{A1})$$

for some constant  $K$ .

**Proof.** Denote the lawyer's expected utility under the menu of contracts  $\{T(p), e(p)\}$  when she reports her type truthfully by  $U(p) = pT(p) - ce(p)$ . Fix some  $p, \hat{p} \in [0, 1]$ ,  $p > \hat{p}$ . Incentive compatibility implies,

$$U(p) = pT(p) - ce(p) \geq pT(\hat{p}) - ce(\hat{p})$$

and

$$U(\hat{p}) = \hat{p}T(\hat{p}) - ce(\hat{p}) \geq \hat{p}T(p) - ce(p).$$

It follows that

$$T(\hat{p})(p - \hat{p}) \leq U(p) - U(\hat{p}) \leq T(p)(p - \hat{p}),$$

and because  $p > \hat{p}$ ,

$$T(\hat{p}) \leq \frac{U(p) - U(\hat{p})}{p - \hat{p}} \leq T(p). \quad (\text{A2})$$

It follows that  $T(p)$  is non decreasing in  $p$  and therefore a.e. continuous (and differentiable) (see, e.g., Royden, 1988, p. 100). We show that  $e(p)$  must be non-decreasing. Suppose otherwise that there exist some  $\hat{\hat{p}} > \hat{p}$ , such that  $e(\hat{\hat{p}}) < e(\hat{p})$ . It follows that

$$T(\hat{p})p - ce(\hat{p}) < T(\hat{\hat{p}})p - ce(\hat{\hat{p}})$$

for every  $p \in [0, 1]$ , and in particular for  $p = \hat{p}$ . A contradiction to incentive compatibility.

Taking the limit of (A2) as  $\hat{p} \rightarrow p$  we obtain,

$$U'(p) = T(p) \quad a.e.$$

from which it follows that<sup>28</sup>

$$U(p) = U(0) + \int_0^p T(x) dx$$

for every  $p \in [0, 1]$ . This equality imposes the following restriction on  $T(\cdot)$  and  $e(\cdot)$ , namely,

$$pT(p) - ce(p) = U(p) = U(0) + \int_0^p T(x) dx.$$

for every  $p \in [0, 1]$ .

We now prove that any menu of contracts with non decreasing  $T(\cdot)$  and  $e(\cdot)$  where  $T(\cdot)$  satisfies (A1) is incentive compatible. Given our assumption, incentive compatibility is satisfied if

$$U(p) = pT(p) - ce(p) \geq pT(\hat{p}) - ce(\hat{p}) \quad \forall p, \hat{p} \in [0, 1]$$

if

$$\int_0^p T(x) dx + K \geq T(\hat{p})(p - \hat{p}) + \int_0^{\hat{p}} T(x) dx + K \quad \forall p, \hat{p} \in [0, 1],$$

if

$$\int_{\hat{p}}^p T(x) dx \geq T(\hat{p})(p - \hat{p}) \quad \forall p, \hat{p} \in [0, 1].$$

It is straightforward to verify that this inequality follows from the assumption that  $T(p)$  is non decreasing in  $p$ . ■

We continue by proving that an optimal incentive scheme must be continuous.

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<sup>28</sup>More precisely, for this to follow,  $U(\cdot)$  has to be absolutely continuous (see, e.g., Royden (1988, p. 110). Absolute continuity of  $U$  follows from the Lipschitz condition (Royden, 1988, p. 112) which is satisfied because

$$\begin{aligned} |U(p) - U(\hat{p})| &\leq \max\{T(p), U(\hat{p})\} |p - \hat{p}| \\ &\leq T(1) |p - \hat{p}|. \end{aligned}$$

**Lemma 2.** *If a menu of contracts in which a lawyer of type  $p$  receives an expected payment conditional on winning of  $T(p)$  and exerts an effort  $e(p)$  is individually rational for the lawyer and optimal for the client, then  $e(p)$  and  $T(p)$  are continuous in  $p$ .*

**Proof.** Suppose that the conditions of the lemma are satisfied, but  $e(p)$  is not continuous in  $p$ . Recall that incentive compatibility implies that  $e(p)$  is non-decreasing in  $p$ . It follows that there exists some  $p^* \in [0, 1]$  such that if we denote  $e' = \lim_{p \nearrow p^*} e(p)$ ,  $T' = \lim_{p \nearrow p^*} T(p)$ , and  $e'' = \lim_{p \searrow p^*} e(p)$ ,  $T'' = \lim_{p \searrow p^*} T(p)$ , then

$$e' \leq e(p^*) \leq e''$$

where at least one of the preceding inequalities is strict. The idea of the proof is to show that the lawyer can exert an effort that lies “between”  $e'$  and  $e''$  that the client strictly prefers and the lawyer doesn’t mind switching to. Since this is a mechanism design problem where the client can instruct the lawyer what to do in case of indifference, this implies a contradiction to the optimality of the menu of contracts.

Incentive compatibility implies that for every  $p' < p^* < p''$

$$p'T(p') - ce(p') \geq p'T(p'') - ce(p'').$$

Taking the limit as  $p'' \searrow p^*$ , it follows that,

$$p'T(p') - ce(p') \geq p^*T'' - ce'',$$

and taking the limit as  $p' \nearrow p^*$ , it follows that

$$p^*T' - ce' \geq p^*T'' - ce''.$$

Similarly, also

$$p^*T'' - ce'' \geq p^*T' - ce',$$

from which it follows that

$$p^*T' - ce' = p^*T(p^*) - ce(p^*) = p^*T'' - ce''.$$

Suppose that  $e(p^*) < e''$ . (A similar argument applies in case  $e' < e(p^*)$ ). We show that the client can introduce an additional fee schedule that will increase the expected payment from a lawyer of type  $p^*$  and will not affect other lawyers’ incentives.

Let  $\bar{e} = \frac{1}{2}e(p^*) + \frac{1}{2}e''$ . Define  $\bar{T}$  such that  $p^*\bar{T} - c\bar{e} = p^*T'' - ce'' = p^*T^* - ce^*$ . Note that  $T(p^*) < \bar{T} < T''$ , and, a lawyer whose type is  $p^*$ , is indifferent among the choices  $\{T(p^*), e(p^*)\}$ ,  $\{T', e'\}$ ,  $\{T'', e''\}$ , and  $\{\bar{T}, \bar{e}\}$ . The new fee schedule introduced by the client induces a lawyer of type  $p^*$  to exert an effort  $\bar{e}$  and receive an expected payment conditional on winning  $\bar{T}$ . We show it does not affect other lawyers' incentives. For every  $p > p^*$ ,

$$pT(p) - ce(p) \geq pT'' - ce'' > p\bar{T} - c\bar{e},$$

where the first inequality follows from incentive compatibility, and the second from definition of  $\bar{T}$ . For every  $p < p^*$ ,

$$pT(p) - ce(p) \geq pT(p^*) - ce(p^*) > p\bar{T} - c\bar{e},$$

where as before, the first inequality follows from incentive compatibility, and the second from the fact that  $\bar{T} > T^*(p^*)$  and therefore

$$\begin{aligned} pT(p^*) - ce(p^*) &= p^*T(p^*) - ce(p^*) - (p^* - p)T^*(p^*) \\ &> p^*T(p^*) - ce(p^*) - (p^* - p)\bar{T} \\ &= p^*\bar{T} - c\bar{e} - (p^* - p)\bar{T} \\ &= p\bar{T} - c\bar{e}. \end{aligned}$$

Note that the fact that the lawyer whose type is  $p^*$  is indifferent among the choices  $\{T(p^*), e(p^*)\}$ ,  $\{T', e'\}$ ,  $\{T'', e''\}$ , and  $\{\bar{T}, \bar{e}\}$  implies that

$$p^*(\bar{T} - T(p^*)) = c(\bar{e} - e(p^*)), \tag{A3}$$

and

$$p^*(T'' - \bar{T}) = c(e'' - \bar{e}). \tag{A4}$$

Now, optimality of the lawyers' choices for the client requires that the client does not benefit from introducing the new fee schedule that induces  $\{\bar{T}, \bar{e}\}$ . This implies that,

$$p^*(w(\bar{e}) - \bar{T}) \leq p^*(w(e(p^*)) - T(p^*)),$$

or,

$$p^*(w(\bar{e}) - w(e(p^*))) \leq p^*(\bar{T} - T(p^*)).$$

And, similarly, also,

$$p^*(w(\bar{e}) - w(e'')) \leq p^*(\bar{T} - T'').$$

Thus, using (A3) and (A4), it follows that

$$\frac{w(\bar{e}) - w(e(p^*))}{\bar{e} - e(p^*)} \leq \frac{c}{p^*}$$

and,

$$\frac{w(e'') - w(\bar{e})}{e'' - \bar{e}} \geq \frac{c}{p^*}.$$

A contradiction to the strict concavity of  $w(e)$ .

Finally, continuity of  $T(p)$  follows from continuity of  $e(p)$  upon recalling that as showed in the proof of the previous proposition,  $pT(p) - ce(p) = U(p) = U(0) + \int_0^p T(x) dx$ , which, as an indefinite the integral, is also (absolutely) continuous (Royden, 1988, p. 110). ■

To simplify the analysis, we now restrict our attention to the case where  $e(p)$ , the effort chosen by a lawyer of type  $p$ , is not only continuous as implied by optimality, but is absolutely continuous.<sup>29</sup> This allows us to obtain the following relationship.

**Lemma 3.** *If a menu of contracts  $\{T(p), e(p)\}_{p \in [0,1]}$  is incentive compatible and the function  $e(p)$  is absolutely continuous, then*

$$T(p) = c \left( \int_0^p \frac{e'(x)}{x} dx + K \right) \quad (\text{A5})$$

for some constant  $K$ . Conversely, if  $e(p)$  is absolutely continuous and  $T$  is given by A5, then the menu of contracts  $\{T(p), e(p)\}_{p \in [0,1]}$  is incentive compatible.

**Proof.** By Lemma 1,

$$pT(p) - ce(p) = \int_0^p T(x) dx + K$$

for some constant  $K$  for every  $p \in [0, 1]$ . Differentiating this equation with respect to  $p$ , we obtain that

$$T'(p) = \frac{ce'(p)}{p}$$

holds at every  $p \in [0, 1]$  at which  $T(\cdot)$  and  $e(\cdot)$  are differentiable. Absolute continuity of  $e(p)$  then implies that we may integrate the previous equation to obtain

$$T(p) = c \left( \int_0^p \frac{e'(x)}{x} dx + K \right)$$

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<sup>29</sup>Absolute continuity is a stronger property than continuity. See Royden (1988, p. 108) for a definition and (p. 111) for an example of a continuous, monotone, and nondecreasing function that is not absolutely continuous.



for some constant  $K$  (Royden, 1988, p. 110).

Conversely, we show that any menu of contracts with absolutely continuous and non decreasing  $T(\cdot)$  and  $e(\cdot)$  where  $T(\cdot)$  satisfies (A5) is incentive compatible. Given our assumption, incentive compatibility is satisfied if

$$p \int_0^p \frac{e'(x)}{x} dx - e(p) \geq p \int_0^{\hat{p}} \frac{e'(x)}{x} dx - e(\hat{p}) \quad \forall p, \hat{p} \in [0, 1],$$

if

$$p \int_{\hat{p}}^p \frac{e'(x)}{x} dx \geq e(p) - e(\hat{p}) \quad \forall p, \hat{p} \in [0, 1],$$

and because  $e$  is absolutely continuous, if

$$\int_{\hat{p}}^p e'(x) \left( \frac{p}{x} - 1 \right) dx \geq 0 \quad \forall p, \hat{p} \in [0, 1].$$

Now, if  $p > \hat{p}$ , this follows from the fact that  $p \geq x$  and  $e' \geq 0$ , and if  $p < \hat{p}$ , it follows from the fact that  $p \leq x$  and  $e' \geq 0$ . ■

We can now characterize the optimal incentive scheme for the lawyer. We first solve for the optimal absolutely continuous incentive scheme for the lawyer and then show that it is in fact optimal among all incentive schemes.

The client's problem is given by:

$$\max_{T(\cdot), e(\cdot)} \int_0^1 p (w(e(p)) - T(p)) dF(p) \tag{A6}$$

subject to the incentive compatibility and voluntary participation constraints for the lawyer. By Lemma 3 and the voluntary participation constraint for the lawyer, we may restrict our attention to menus of contracts  $\{T(p), e(p)\}$  where  $e(p)$  is non-decreasing,  $e(0) = 0$ , and  $T(\cdot)$  is given by (A5) with  $K = 0$ .<sup>30</sup>

Substituting (A5) with  $K = 0$  for  $T$ , we obtain,

$$\begin{aligned} \int_0^1 p (w(e(p)) - T(p)) dF(p) &= \int_0^1 \left( pw(e(p)) - pc \int_0^p \frac{e'(x)}{x} dx \right) dF(p) \\ &= \int_0^1 \left( w(e(p)) - c \int_0^p \frac{e'(x)}{x} dx \right) pdF(p) \end{aligned}$$

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<sup>30</sup> $e(0) = 0$  follows from the fact that a lawyer with type  $p = 0$  exerts zero effort under any incentive scheme.  $K \geq 0$  follows from the voluntary participation constraint for the lawyer (or the constraint that  $T \geq 0$ ) and  $K = 0$  follows from the fact that the client wants to set the lawyer's expected payment to be as small as possible.

which, by changing the order of integration of the second term, is equal to,

$$\int_0^1 \left( pw(e(p)) - \frac{ce'(x)\psi(x)}{xf(x)} \right) f(x) dx \quad (\text{A7})$$

where  $\psi(x) = \int_{p=x}^1 pf(p)dp$ .

The Pontryagin maximum principle for optimal control (Seierstad and Sydsæter, 1987, Theorem 1, pp. 75-76) implies that if  $e^*$  maximizes A7, then the control function  $e^{*'} maximizes the Hamiltonian associated with A6, from which it follows that$

$$\frac{c}{p} \left( 1 - \frac{\psi(p)}{p\psi'(p)} \right) = w'(e^*(p)) \quad \text{for } p \in [0, 1] \text{ satisfying } \frac{c}{p} \left( 1 - \frac{\psi(p)}{p\psi'(p)} \right) \leq w'(0), \quad (\text{A8})$$

and

$$e^*(p) = 0 \quad \text{for } p \in [0, 1] \text{ satisfying } \frac{c}{p} \left( 1 - \frac{\psi(p)}{p\psi'(p)} \right) > w'(0). \quad (\text{A9})$$

The concavity of the Hamiltonian associated with A7 with respect to  $e$  and  $e'$  then implies the converse (see Seierstad and Sydsæter, 1987, Theorem 4, pp. 105-106). Namely, a function  $e^*$  that satisfies A8 and A9 also maximizes A7. Note that except possibly at the point  $p$  where  $\frac{c}{p} \left( 1 - \frac{\psi(p)}{p\psi'(p)} \right) = w'(0)$ ,  $e^*(p)$  is everywhere differentiable, from which it follows that it must also be absolutely continuous. And, our assumption that  $\frac{1}{p} \left( 1 - \frac{\psi(p)}{p\psi'(p)} \right)$  is non-increasing in  $p$  implies that  $e^*$  is non-decreasing in  $p$  from which it follows by Lemma 3 that the incentive scheme  $e^*(p)$  and  $T^*(p) = c \left( \int_0^p \frac{e^{*'}(x)}{x} dx \right)$  is incentive compatible and individually rational.

Finally, we have showed that  $e^*$  is the maximizer of A6 among all absolutely continuous functions, by Lemma 2, it is left to show that  $e^*$  (together with  $T^*$  that is given by A5 with  $K = 0$ ) is also the maximizer of A6 among all continuous functions. This follows from the fact that the objective function A6 is continuous in  $e$  and  $T$ , and every continuous function on  $[0, 1]$  can be approximated as closely as desired in the supnorm topology by absolutely continuous functions.<sup>31</sup> ■

**Proof of Proposition 2.** By Proposition 1, the optimal expected payment to the lawyer conditional on winning is given by

$$\begin{aligned} h(e) &= T^*(e^{*-1}(e)) \\ &= c \int_0^{e^{*-1}(e)} \frac{e^{*'}(x)}{x} dx. \end{aligned}$$

Differentiating  $h(e)$  once yields

$$h'(e) = \frac{ce^{*'}(e^{*-1}(e))}{e^{*-1}(e)} \cdot \frac{de^{*-1}(e)}{de}.$$

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<sup>31</sup>A similar argument is employed by Laffont and Tirole (1986, Appendix C, step 2, p. 639).

Because for every function  $f$ ,  $\frac{d(f^{-1}(y))}{dy} = \frac{1}{f'(x)}$ ,  $\frac{de^{*-1}(e)}{de} = \frac{1}{e^{*'}(e^{*-1}(e))} = \frac{1}{e^{*'}(p)}$  where  $p$  is such that  $e^*(p) = e$ , and it follows that

$$h'(e) = \frac{c}{e^{*-1}(e)}.$$

Differentiating  $h(e)$  twice therefore yields

$$\begin{aligned} h''(e) &= -\frac{c}{((e^*)^{-1}(e))^2} \cdot \frac{de^{*-1}(e)}{de} \\ &= -\frac{c}{((e^*)^{-1}(e))^2} \cdot \frac{1}{e^{*'}(p)} \leq 0 \end{aligned}$$

because in the non-exclusion range for  $p$ ,  $e^*(p)$  is increasing. ■

**Proof of Proposition 3.** Observe that if the noise  $\varepsilon$  is not too small (so that  $b^*(p)(j - w(e^*(p))) + T^*(p) \geq 0$ ) the expected payment to a lawyer who exerts effort  $e^*(p)$  under a contingent contract  $\max\{b^*(p)(j - w(e^*(p))) + T^*(p), 0\}$  is equal to  $pT^*(p)$ .

The proof relies on the following lemma.

**Lemma 4.** For every  $p, \hat{p}, \widehat{p} \in [0, 1]$ , a lawyer of type  $p$  prefers to exert the effort  $e^*(\hat{p})$ , under the contingent contract  $T^*(\hat{p}) + (j - w(e^*(\hat{p})))b^*(\hat{p})$ , than to exert the effort  $e^*(\widehat{p})$ , under the contingent contract  $T^*(\widehat{p}) + (j - w(e^*(\widehat{p})))b^*(\widehat{p})$ .

**Proof.** The lemma is satisfied if and only if,

$$pT^*(\hat{p}) - ce^*(\hat{p}) \geq p \left[ b^*(\widehat{p})w(e^*(\hat{p})) - b^*(\widehat{p})w(e^*(\widehat{p})) + T^*(\widehat{p}) \right] - ce^*(\widehat{p})$$

for every  $p, \hat{p}, \widehat{p} \in [0, 1]$ , if and only if,

$$T^*(\hat{p}) - T^*(\widehat{p}) \geq b^*(\widehat{p}) \left( w(e^*(\hat{p})) - w(e^*(\widehat{p})) \right), \quad (\text{A10})$$

for every  $p, \hat{p}, \widehat{p} \in [0, 1]$ .

By definition of  $b^*$ ,  $b^*(p)w'(e^*(p)) = \frac{c}{p}$  for every  $p \in [0, 1]$ . Multiplying both sides by  $e^{*}$ , it follows that,

$$b^*(p)w'(e^*(p))e^{*'}(p) = \frac{ce^{*'}(p)}{p} \quad (\text{A11})$$

for every  $p \in [0, 1]$ . Thus, for every  $\hat{p}, \widehat{p} \in [0, 1]$ ,

$$\int_{\widehat{p}}^{\hat{p}} \frac{ce^{*'}(p)}{p} dp = \int_{\widehat{p}}^{\hat{p}} b^*(p)w'(e^*(p))e^{*'}(p) dp.$$

Recalling that  $b^*(p)$  is increasing in  $p$ , and for every  $p \in [0, 1]$ ,

$$T^{*'}(p) = \frac{ce^{*'}(p)}{p}, \quad (\text{A12})$$

it follows that if  $\hat{p} > \hat{\bar{p}}$ ,

$$\begin{aligned} T^*(\hat{p}) - T^*(\hat{\bar{p}}) &= \int_{\hat{\bar{p}}}^{\hat{p}} \frac{ce^{*'}(p)}{p} dp \\ &= \int_{\hat{\bar{p}}}^{\hat{p}} b^*(p)w'(e^*(p))e^{*'}(p) dp \\ &\geq b^*(\hat{\bar{p}}) \int_{\hat{\bar{p}}}^{\hat{p}} w'(e^*(p))e^{*'}(p) dp \\ &= b^*(\hat{\bar{p}}) \left( w(e^*(\hat{p})) - w(e^*(\hat{\bar{p}})) \right). \end{aligned}$$

And if  $\hat{p} < \hat{\bar{p}}$ ,

$$\begin{aligned} T^*(\hat{p}) - T^*(\hat{\bar{p}}) &= \int_{\hat{\bar{p}}}^{\hat{p}} \frac{ce^{*'}(p)}{p} dp \\ &= - \int_{\hat{p}}^{\hat{\bar{p}}} \frac{ce^{*'}(p)}{p} dp \\ &= - \int_{\hat{p}}^{\hat{\bar{p}}} b^*(p)w'(e^*(p))e^{*'}(p) dp \\ &\geq -b^*(\hat{\bar{p}}) \int_{\hat{p}}^{\hat{\bar{p}}} w'(e^*(p))e^{*'}(p) dp \\ &= b^*(\hat{\bar{p}}) \int_{\hat{p}}^{\hat{\bar{p}}} w'(e^*(p))e^{*'}(p) dp \\ &= b^*(\hat{\bar{p}}) \left( w(e^*(\hat{\bar{p}})) - w(e^*(\hat{p})) \right). \end{aligned}$$

■

Now, suppose the menu of contracts is not incentive compatible. There exists some  $p \in [0, 1]$  such that a lawyer of type  $p$  prefers to choose the contract  $T^*(\hat{p}) + (j - w(e^*(\hat{p})))b^*(\hat{p})$ ,  $\hat{p} \neq p$ , and exert the effort  $\hat{e}$ . By the previous lemma, the lawyer  $p$  is even better off exerting the effort  $\hat{e} = e^*(\hat{p})$  under the contract  $T^*(\hat{p}) + (j - w(e^*(\hat{p})))b^*(\hat{p})$ .<sup>32</sup> But this contradicts the incentive compatibility of the menu  $\{T^*(p), e^*(p)\}_{p \in [0,1]}$  since it implies that a lawyer of type  $p$  prefers to exert the effort  $e^*(\hat{p})$  and receive an expected payment conditional on winning  $T^*(\hat{p})$ , than to exert the effort  $e^*(p)$ , and receive an expected payment conditional on winning  $T^*(p)$ .

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<sup>32</sup>For every  $p$ , the lawyer's optimal choice of effort is increasing in  $b^*$ , thus, if  $\hat{p} < p$  then  $e^*(\hat{p}) < \hat{e} < e^*(p)$ , and if  $\hat{p} > p$  then  $e^*(\hat{p}) > \hat{e} > e^*(p)$ . The existence of  $\hat{p}$  follows from the continuity of  $e^*$ .

Finally, to see that the threshold  $w(e^*(p)) - \frac{T^*(p)}{b^*(p)}$  is increasing in  $p$  note that,

$$\begin{aligned} \frac{d}{dp} \left[ w(e^*(p)) - \frac{T^*(p)}{b^*(p)} \right] &= w'(e^*(p))e^{*'}(p) - \frac{b^*(p)T^{*'}(p) - T^*(p)b^{*'}(p)}{(b^*(p))^2} \\ &\geq w'(e^*(p))e^{*'}(p) - \frac{ce^{*'}(p)}{pb^*(p)} \\ &\geq 0, \end{aligned}$$

by (A12) and (A11). ■

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