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The unexpected effects of caps on non-economic damages

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ABSTRACT

This paper focuses on the economic and legal implications of the enactment of caps on non-economic damages on conflicting parties who know that state supreme courts may strike down the caps as unconstitutional within a few years of enactment. We develop a simple screening model where parties have symmetric expectations regarding the probability of a strike down and asymmetric information regarding plaintiff's non-economic harm. Our model makes the following predictions: First, caps may *increase* the length required to resolve disputes if the caps are low enough or the probability of a strike down is large enough. Second, although caps always increase the percentage of disputes that are settled out of courts, they do not necessarily save litigation expenses. Third, when caps increase the length of dispute resolution, they also increase litigation expenses if and only if the settlement negotiation costs are neither too small nor too large. Fourth, while caps always reduce the recoveries of plaintiffs with large claims, caps may *increase* recoveries of plaintiffs with low claims compared to their recoveries in states with no caps. We end by discussing the robustness of the results.

1. Introduction

In the last few decades, dozens of different tort and medical malpractice reforms have been enacted, struck down, and, at times, legislatively repealed or *re*enacted (see Avraham, 2006a). Indeed, tort reform is perhaps one of the foremost legal rights-related items on legislative agendas. Interest groups regularly spend hundreds of millions of dollars promoting or opposing reforms.[1] Pressure for tort reform is also building on the federal level. No fewer than 16 bills to federalize various aspects of medical malpractice law were debated in Congress during the period of Republican control between 1996 and 2006.[2] The most recent bill passed in the Senate was in 2006.[3]

One of the most popular reforms creates caps on non-economic damages such as pain and suffering, loss of consortium, etc. By 2007, 26 states had enacted some type of cap on non-economic damages (Table 1). From 1991 to 2007 alone, caps on non-economic damages were enacted in 14 states.

Proponents of caps on non-economic damages argue that these caps will reduce excessive recoveries, expedite settlement, and reduce overall litigation expenses (see Atiyah (1980) and Rubin (1993) among others). Proponents of tort reform reason that reducing the uncertainty associated with unlimited jury awards for non-economic damages will facilitate out-of-court negotiation (see, e.g., Atiyah, 1980, p. 216). They argue that caps on total recovery incentivize plaintiffs to resolve disputes through less costly out-of-court settlements rather than gamble for big awards from costly trials. Indeed, Watanabe (2006) predicts that reduced uncertainty will shorten the time to settlement.

On the other side, opponents of caps argue that caps often reduce recoveries for the most severely injured plaintiffs, thereby shifting the costs of injuries away from blameworthy parties and onto the most needy tort victims (see Viscusi (1991) p. 107 and ALI (1991) pp. 219–220). They also argue that caps might dilute defendants' incentives to take optimal care (see Arlen, 2000).

However, neither proponents nor opponents of caps on non-economic damages have concerned themselves with the uncertainty surrounding the constitutionality of tort reform caps. Historically, the constitutionality of more than half of the caps on non-economic damages enacted into law met legal challenges on state constitutional grounds within a few years of enactment.[4] In

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[1] Data on interest groups' expenditures on tort reform is available at opensecrets.org. See http://www.opensecrets.org/lobbyists/issuesum.asp?txtname=Torts.

[2] 104 H.R. 3103 (1996), 104 H.R. 956 (1996), 105 H.R. 1091 (1997), 106 H.R. 2242 (1999), 107 H.R. 2563, 107 S. 812, 107 H.R. 4600 (2002), 108 H.R. 5 (2003), 108 S. 2061, 108 S. 11 (2003), 108 S. 2207, 108 H.R. 4280 (2004), 109 H.R. 534 (2005), 109 S. 366, 367, 354, 109 H.R. 5, 109 S. 22.

[3] S. 22, 109th Cong. (2006).

[4] Moreover, in recent years the practice of challenging tort reform in state court has become much more coordinated. The Center for Constitutional Litigation, PC is a

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Table 1
Caps on non-economic damages enacted or struck-down between 1991 and 2005.

State	Cap Size	Enacted	Struck-down
AL	400		1991
IL	500	1995	1997
MT	250	1995	
ND	500	1995	
SD	500	1996	
OH	500	1997	1999
OR	500		1999
ME	400	2000	
MS	500	2003	
OH	500	2003	
OK	300	2004	
TX	250	2004	
FL	450	2004	
TN	250	2005	
NV	350	2005	
WI	350		2005

some states, such as Illinois, Ohio and Wisconsin, caps were struck down by state supreme courts and later reenacted in amended form. Sometimes this cycle repeated itself.[5] Indeed, there is some anecdotal evidence that caps have little impact before being upheld by the state's Supreme Court. For example, the chairman of the ISMIE Mutual Insurance Company, which provides liability insurance for doctors, has recently argued that the impact of tort reform in the states is felt only "after the Supreme Courts in these states have upheld the meaningful reforms" (see Parsons, 2005).

The veil of uncertainty surrounding the constitutionality of reforms between an enactment date and a final ruling by a state's Supreme Court may incentivize litigants differently than scholars generally assume. Specifically, in this paper we show that the possibility of a reform generates asymmetries over the expected recoveries as well as differences over the expected litigation expenses which might lead the parties to delay settlement and consequently increase overall litigation costs. This holds even though parties have identical expectations about the likelihood of a reform's strike down.

In order to study the impact of caps on the time of resolution of disputes and the welfare of the parties (their costs of litigation and recoveries), we develop an asymmetric information-screening model that accounts for the size of the caps on non-economic damages as well as for both parties' (symmetrical) expectations about the probability of the eventual strike down of a cap. We assume that plaintiff and defendant participate in a two *rounds negotiation process*, each round divided into a *period* of settlement and a *period* of trial.[6] We assume that the cap limits possible recoveries during the first round of negotiations but that it may get struck down with some probability during the last period of the second round.[7] In addition, we assume two types of plaintiffs: one with high non-economic harm ("high type") and one with low non-economic harm ("low type"). The plaintiff knows its own type whereas the defendant discovers it only at a trial, where he is forced to pay the plaintiff damages equal to her true harm. The model also considers settlement and litigation costs and includes a discount factor to account for the cost of delayed resolution.

We characterize the solutions of the two round game played by plaintiffs and defendants by distinguishing between three different regimes. First, when plaintiff's damages are Not Capped (we call this a "Regime NC"). Second, when plaintiff's damages are capped yet the plaintiff's expected recovery if she does not wait for the second round is not trimmed by much, because, for example, the caps are likely to be held constitutional (because the trim is low, we call this "Regime LTC"). Third, a regime where Plaintiff's expected recovery if she doesn't wait for the second round is *highly* trimmed, because, for example, the caps is likely to be struck down (we call this a "Regime HTC").

All regimes have the same general features. The defendant needs to decide whether to make a high or a low settlement offer. The high offer induces all type of plaintiffs to settle immediately, which reduces the litigation expenses (no need to face a trial or go for future rounds of negotiation) but forces the defendant to pay the low-type plaintiff too much (more than its true harm). Alternatively, the low offer induces the low type plaintiff to settle immediately (sometimes only with a certain probability), while the high type plaintiff prefers to wait either for a trial or the next round of negotiations, thereby increasing litigation expenses. Naturally, the defendant will decide to make a high offer (which yields a pooling equilibrium) if the probability that he faces a low type plaintiff is lower than a certain bound and will decide to make a low offer (which yields a separating equilibrium) if the probability is bigger than the same bound.

As a baseline, we first characterize the solution of the model when damages are not capped (NC). We identify the bound that separates the high and low offers and straightforwardly conclude that all disputes are resolved in the first round either via settlement in the first period (where all plaintiffs facing the high offer and all low type plaintiffs facing the low offer accept the first offer) or via trial in the second period (where high type plaintiffs facing the low offer reject the first settlement offer).[8] There is no reason for the plaintiff to wait for the second round as her expected recovery is identical, only at a later time.

The novelties in the paper begin when we account for the impact of a cap and the probability of a strike down on recoveries. In that case, not only does the defendant tend to make smaller high offers (because the plaintiff can only recover the cap at trial), but the plaintiff, under certain circumstances, has incentives to reject the initial offer, hoping to recover more if the caps are struck down in the future. These two points will affect the length on the resolution of disputes – sometimes reducing it, some other times increasing it.[9]

national law firm dedicated to challenging tort reforms in states and federal courts. The Center receives most of its revenues from the national trial lawyers' trade group (The American Association of Justice) and from the states' trial lawyer associations. As of December 2007, the Center had 40 tort reform-related cases pending across the United States, with lawyers from the Center helping trial lawyers nationwide who challenge tort reform (see Lynne Marek, A small firm wages a '100 year war' on tort reform: Center is engaged in 40 cases challenging limits on tort claims, National Law Journal, December 10, 2007).

[5] See Table 1 for more detailed information on states that enacted and struck down caps on non-economic damages. For instance, Illinois enacted caps on non-economic damages (735 ILCS 5/2-1115.1) effective on March 9, 1995. The reform limited non-economic damages to $500,000. However, on December 18, 1997, the Illinois Supreme Court affirmed the district court's decision from August 20, 1996 and held that the reform violated the state constitution (*Best v. Taylor Machine Works, Inc., 689 N.E.2d 1057* (*Ill. 1997*)). On August 25, 2005 Illinois legislators again enacted caps on non-economic damages, only to see them struck down on November 13, 2007 by a state trial court. The reform was finally struck down by the Illinois Supreme Court on February 4th 2010.

[6] The first round includes period 1 (settlement) and period 2 (trial). The second round includes period 3 (settlement) and period 4 (trial).

[7] We assume that strike downs happen only during trial and not during settlement; otherwise trials would still take place but with a smaller frequency. Explicitly considering that strike-downs can take place at both instances would only complicate the model without adding significant value.

[8] We assume that courts determine accurate awards so that in court, low type plaintiffs only recover their low value claim. Thus, low type plaintiffs do not gain anything by mimicking high type plaintiffs who reject the settlement offer and choose litigation.

[9] Indeed in Avraham and Bustos (2008) we found that the average time-to-settlement in states with Regime NC is 4.08 years, in states with Regime LTC is 3.26 years, and in states with Regime HTC is 4.4 years. All differences are significant

If the cap is high enough or the probability of a strike down is low enough (we are under regime LTC), then the solution is similar to the one under the no cap regime (Regime NC) in the sense that regardless of whether the defendant makes a high or a low settlement offer, the dispute is resolved in the first round as the plaintiff does not have incentives to wait for the second round. The central difference from regime NC is that under regime LTC defendants find high offers, relative to low offers, more attractive (cheaper) given that now they equal the cap and not the high level of harm.[10] That difference means that the defendant will make the high offer more frequently, inducing more settlements and consequently reducing the time required to solve a dispute, all relative to NC.

On the other hand, if the cap is low enough or the probability of a strike down is high enough (we are under regime HTC), then the high type will always wait for the second round of negotiations when receiving the low offer.[11] If the plaintiff's actual damages exceed the cap considerably or because the probability of a strike down is high enough, she may gain a lot by waiting for a possible constitutional strike down of the caps. This suggests that under regime HTC disputes should always take longer to solve, however, it will not always be the case. The question of what happens to the time needed to resolve a dispute ultimately depends on whether the defendant makes the low or the high offer more frequently than under regime NC. For example, if the defendant always makes the low offer, then the disputes are resolved faster than under regime NC (all the disputes are resolved in the first round and more are settled than under Regime NC). In contrast, if the defendant makes the low offer with the same frequency as in Regime NC, then the opposite holds.[12]

Our analysis shows that determining how an increased number of pooling equilibria (generated by a high offer) solved in the first round balances out with less separating equilibria (generated by a low offer) mainly solved in the second round depends on the magnitude of the following parameters: the legal cost of settlement, the discount factor, and the probability of a strike down. The reason is that these three parameters affect the appeal of a low offer relative to a high offer in the eyes of the defendant. The larger the costs of settlement are, the more likely it is that the defendant makes a high offer as the extra negotiation round becomes too expensive. Similarly, the larger the discount factor and the probability of a strike down are, the more likely the defendant is to make a low offer as making a high offer (required to induce a pooling equilibrium) becomes too expensive. Thus, if the cost of settlement is small enough *or* the discount factor and the probability of a strike down are large enough, the time to settlement is *longer* in Regime HTC than in Regime NC.

Our model also uncovers two other important effects of caps on parties' welfare. First, it shows that the expected litigation expenses in Regime HTC *may be larger* than the expected litigation expenses in Regime NC. This follows directly from the fact that disputes in Regime HTC may take longer than in Regime NC. Interestingly, it is not always the case that disputes with extended resolutions have larger expected costs because even when settlement costs are higher, in present value, trial costs go down because under Regime HTC trials take place in the second and not in the first round.[13] Even though our results depend on some factors, we are able to determine exactly when caps increase litigation costs. A common complaint about the tort system is that it is inefficient: for every dollar of compensation paid by the defendant, only 50 cents go to the plaintiff; the rest is lost as costs (see Avraham, 2006b, p. 97). The model suggests, counter intuitively, that caps might not only fail to improve the efficiency of the system but may even make it worse.

Second, the model creates additional predictions regarding plaintiffs' awards. Intuitively, high type plaintiffs are always worse off in a caps regime, because they either recover less or recover later. In contrast, the model shows that some low type plaintiffs may be *better off* under a caps regime. Specifically, some low type plaintiffs who used to mimic high type plaintiffs and consequently recover high type awards under Regime NC will only recover the cap under Regimes LTC or HTC, and thus will be worse off. But some other low types (potentially plaintiffs with frivolous lawsuits[14]), who were sorted into the separating equilibria under Regime NC, will fall into the pooling equilibria under Regimes LTC or HTC, thus obtaining a higher award.

We therefore conclude by suggesting that without tailoring caps to the economic and constitutional environment in the state, state legislators may find that enacted caps decreases welfare by increasing overall litigation costs and the time to resolving the disputes. In addition, Caps may decrease welfare by under-compensating the severely injured victims or by over-compensating frivolous plaintiffs.[15]

The rest of the paper is organized as follows. In Section 2, we review the literature. In Section 3, we present the model. In Section 4, we demonstrate our main results. In Section 5, we discuss the robustness of our analysis by considering the possibility that plaintiffs are risk averse, the parties share the litigation expenses, or the parties share bargaining power. In Section 6, we provide our conclusion.

2. Bargaining models and tort reform – literature review

Our paper engages two lines of literature: the literature on bargaining models and the literature on the impact of tort reform.

There is a great deal of theoretical literature on bargaining models of dispute resolution examining why and when parties litigate instead of settle (see, e.g., the surveys by Daughety (2000) and Spier (2005)). Parties may delay or even forgo settlement, even if symmetrically informed, when the relative structure of their litigation costs makes holding out for trial attractive, such as in Spier (2005), where litigation costs are "lumpy". Parties may also forgo settlement when they do not share a common prior belief as to the likely outcome of a trial. (see, e.g., Landes (1971), Posner (1973) or Priest and Klein (1984)). Furthermore, one-sided, asymmetric information regarding a defendant's liability or plaintiff's harm may

at 1% or less.

[10] The analysis is done for the case in which the cap lies between the values of the low and high type plaintiffs. We do not consider the extreme cases in which the cap is lower than the low type plaintiff or higher than the high type plaintiff because the predictions become trivial.

[11] And the low type, knowing that, sometimes decide to mimic that decision.

[12] Recall that under regime HTC, in a separating equilibrium a high type plaintiff always solves her dispute in the second round while under regime NC, the same person would solve it in the first round.

[13] That is captured by Proposition 2. An alternative simplified explanation is: defendants may push for longer dispute resolutions because the reductions in expected awards compensate the increase in litigation expenses or because the reductions in litigation expenses offset the increase in expected awards. The reader should not confuse the result that litigation expenses are larger under a low offer than under a high one with the result that litigation expenses under a high offer may be larger or smaller under HTC than under NC.

[14] That plaintiffs with small claims, even plaintiffs with negative expected value, can extract settlements has been first observed by Bebchuk (1988) and widely discussed in the literature.

[15] We are not suggesting that states should make decisions on the enactment of caps based *only* on our analysis as we don't account for elements such as deterrence, precedents or enforcement which will also impact welfare (maybe increasing it) but we do suggest that authorities should consider the predictions uncovered in this paper in their welfare analysis.

increase the likelihood of a trial (see, e.g., Bebchuk (1984), Nalebuff (1987), Reinganum and Wilde (1986), Spier (1992) or Sieg (2000)). The same result may occur when there is two-sided asymmetric information – that is, both parties have information regarding their liability or harm that their adversary does not possess (see, e.g., Schweizer (1989), or Daughety and Reinganum (1994)). None of these models, however, takes into account the existence of caps, their size, or their constitutionality.

Despite the attention tort reform receives in the political sphere, there is only a couple of law and economics models of it. Existing models usually deal with the impact of tort reform on plaintiffs' recoveries or on physicians' initial behavior (Currie & MacLeod, 2008; Watanabe, 2006). There are also few empirical studies that explore the impact of tort reform on time to settlement. Babcock and Pogarsky (1999) conducted laboratory experiments demonstrating that caps on jury awards encourage settlement. Kessler (1996) explored the causes of delay in settling automobile accident disputes. He found that reform imposing prejudgment interest, originally designed to reduce delay, in fact increases the time to settlement. Recently, Watanabe (2006), using a structural model approach, found that capping jury awards or eliminating the contingency fee rule significantly shortens the expected time to resolution and lowers the expected total legal costs. Overall, however, there is little academic consensus about the actual impact of tort reform on various litigation outcomes such as average awards, frequency of litigation and total payments (see surveys by Danzon (2000) or Kessler and Rubinfeld (2004)). Again, none of these studies takes into account the possibility that the tort reform will be struck down or the impact of the size of the caps on dispute resolution times or recoveries.

3. The model

In this section we present the model in its simplest form. In Section 5 we discuss the robustness of the results to different assumptions. A risk neutral victim (Plaintiff) has a valid claim of x dollars of non-economic harm against a risk neutral negligent wrongdoer (Defendant).[16] While the liability of the wrongdoer is not disputed, there is uncertainty about the amount of the victim's harm. There are two possible types of victims: (1) A victim with high non-economic harm, x_H; and (2) a victim with low non-economic harm, x_L, where $x_H > x_L$. In either case, the defendant cannot observe the plaintiff's actual non-economic harm, x. Instead, he can only estimate (perhaps based on the observable economic harm) the probability, π, that the plaintiff is a low harm type victim. We assume that π is drawn from a probability distribution with density $f(\pi)$.[17]

In order to capture the possibility of acceleration or delay in the resolution of the conflict between the parties, we map the negotiation process over two rounds, each divided into a period of settlement and a period of trial, overall four periods. In the first period the defendant makes a settlement offer (S_1) that the plaintiff can either accept or reject. If the plaintiff accepts S_1, the game ends there. If the plaintiff rejects it, the parties move to the second period. In the second period, the plaintiff either goes to court which would award damages (x_H or x_L) based on the victim's type,[18] or will wait for a new settlement offer in the next round of negotiation. In the second round of negotiation (the third period), the defendant makes a new settlement offer (S_3) that the plaintiff, again, can either accept or reject. If the plaintiff accepts S_3, the game ends there. If the plaintiff rejects it, the parties move to the fourth period. In the fourth period the parties go to court with certainty, and the court would award x_H or x_L according to the victim's damages. The timing of actions is the following:

At $t = 1$ the defendant makes settlement offer (S_1)
- If the plaintiff accepts the offer the dispute ends there
- If the plaintiff rejects the offer the parties move to the second period

At $t = 2$ the plaintiff decides whether to go to court
- If the plaintiff decides to go to court the dispute is resolved there
- If the plaintiff decides not to go to court the parties move to the third period

At $t = 3$ the defendant makes settlement offer (S_3)
- If the plaintiff accepts the offer the dispute ends there
- If the plaintiff rejects the offer the parties move to the fourth period

At $t = 4$ the parties go to court with certainty and the dispute is resolved there

Settlement negotiations and litigation are costly to both parties. Following others (e.g., Spier, 1992), we normalize the plaintiff's costs to be zero. Hence, we assume that the defendant faces a fixed cost c for each settlement offer associated with the pretrial negotiation (for example, if the plaintiff accepts S_1 the defendant incurs c, but if the plaintiff rejects S_1, waits for a new offer at the third period (S_3) and accepts it, the defendant incurs $2c$ in nominal terms). In addition, we assume that the defendant incurs a fixed cost k if the case goes to court (either in period 2 or period 4) with $k > c$, and the parties have the same discount factor which we denote δ. In Section 5, we analyze the robustness of our main result when the parties share the litigation costs and also when the parties share negotiation power.

We compare the negotiation behavior and recoveries of the low type plaintiff and the high type plaintiff in a regime with and without caps on non-economic damages. As its name suggests it, a cap on non-economic damages establishes the maximum amount that can be recovered by plaintiffs in courts for their non-economic harm. We denote it $x^c \in [x_L, x_H]$. Note that the cap is binding in courts only and does not impose any direct limit on the settlement amount.

As was explained in Section 1, caps are routinely struck down by state supreme courts. From this, it follows that rational agents develop expectations that a strike down may take place – not necessarily in their case – sometime prior to the resolution of their case.[19] In reality, these expectations may even change with time. For simplicity, we assume that both parties share the belief that the cap may get struck down with probability α and that the uncertainty is resolved once and for all at $t = 4$.[20] Notice that at the beginning of

[16] In a more general formulation, Plaintiff's claim $X = x_o + x_i$ has two components: an observable component, x_o, which represents the economic harm, such as medical bills, loss of income, etc., and an idiosyncratic unobservable component, x_i which represents the non-economic harm such as pain and suffering, mental anguish, etc. For simplicity we normalize the observable components, x_o, to equal zero and focus on the idiosyncratic component, x_i that we denote x.

[17] The probability distribution is not relevant for the characterization of the game played by plaintiff and defendant but it will be relevant in Section 4 when we compare properties of regimes with and without caps.

[18] The fact that courts can correctly observe plaintiff's true harm is not a strong assumption because it is equivalent to assuming that courts are not systematically biased and get it right, on average. This is the same assumption used by Spier (1992) and Watanabe (2006).

[19] Notice that because the effect of enactment of caps is not retroactive, there is no need to consider the scenario in which caps may be enacted during a negotiations process.

[20] The assumption that both sides have the same beliefs about the probability of a strike down describes reality more accurately as we do not think that, in general, is true that one side has more (or less) information related to the "political desires to eliminate caps" than the other side. The assumptions that beliefs don't evolve

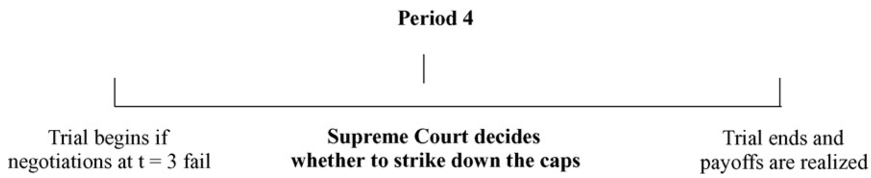

Diagram 1. Resolution of uncertainty in states with caps.

$t=4$ there still is uncertainty about the amount that will be recovered, but before the trial court makes a decision, the uncertainty is resolved by a ruling or by an act by the state's high court.[21] Diagram 1 presents the time line in the fourth period.

Lastly, we define $\bar{x} = \alpha x_H + (1-\alpha)x^c$ as the expected payment obtained by a high type plaintiff if she goes to trial in the fourth period when caps are in place: If the caps are struck down, the high type plaintiff receives her true valuation, x_H, whereas if the caps are upheld she gets the cap, x^c.

3.1. Equilibria

Complete proofs of the equilibria reached in the various regimes (with and without caps) are relegated to Appendix A and an intuitive discussion on the differences between the equilibria is relegated to Section 3.2. Here we summarize the most important characteristics and implications of the equilibria and the parties' strategic behaviors.

Recall that we denote as Regime NC the equilibrium in which there are no caps. When caps are in place, we identify the existence of two types of equilibria. The first equilibrium takes place when the cap is high enough or the expectation of a strike down is low enough. In this equilibrium the present value of the expected payment obtained by a high type plaintiff *is not* significantly trimmed if she decides to settle immediately (first period) instead of waiting for a future resolution of the dispute (third or fourth period). We denote this equilibrium as a regime with caps and low expected trim (Regime LTC).

The second equilibrium takes place when the cap is low enough or the expectation of a strike down is high enough. In this equilibrium the present value of the expected payment obtained by a high type plaintiff *is* significantly trimmed if she decides to settle immediately instead of waiting for a future resolution of the dispute. We denote that equilibrium as a regime with caps and high expected trim (Regime HTC).[22]

A common property in the solutions for every type of regime (NC, LTC and HTC) is that there exists a cutoff probability that the plaintiff is a low type victim such that for any probability, π, smaller than this cutoff value, the solution defines a pooling equilibrium where the defendant ends up paying the same amount of money to both types of plaintiffs. For any probability higher than this cutoff, the solution defines a separating equilibrium where, in general, the defendant ends up paying different amounts of money to the high and the low type victims.[23] As will be explained in more detail below, there are different cutoff probabilities for the no-caps regime (π^{NC}), for the regime with caps and high expected trim (π^{HTC}), and for the regime with caps and low expected trim (π^{LTC}). Fig. 1 summarizes the most important characteristics of the solutions for the regimes with and without caps which we start detailing next.

A regime with no caps (*Regime NC*). When the parties face no caps, there is a unique, perfect Bayesian-equilibrium. When there is a low probability that the defendant faces a low type victim, i.e. when $\pi < \pi^{NC}$, the defendant's offer is δx_H and both types of plaintiffs accept it. In that pooling equilibrium the low type plaintiff benefits from defendant's unwillingness to offer δx_L.[24] Conversely, when there is a high probability that the defendant faces a low type victim, i.e. when $\pi > \pi^{NC}$, the defendant offers δx_L. In that separating equilibrium, the low type settles immediately, because waiting will not yield her a higher recovery, whereas the high type will settle in the second period of the first round of negotiation (litigation) because that will yield her a recovery of $\delta x_H > \delta x_L$.

A regime with caps. When the parties face caps there still exists a unique perfect Bayesian equilibrium, but there are two important differences from Regime NC. First, when caps are in place the maximum that any plaintiff can recover is not δx_H but δx^c. Second, the incentives of the parties to wait for future periods are changed so that parties may end up resolving their disputes in the second round of negotiation (i.e. in third or fourth period).

Appendix A shows that different equilibria take place depending on whether $\alpha(x_H - x^c)/x^c$ is larger or smaller than the cutoff $(1-\delta^2)/\delta^2$ (or equivalently, if x^c is larger or smaller than $\delta^2\bar{x}$). If $\alpha(x_H - x^c)/x^c < (1-\delta^2)/\delta^2$ we are in Regime LTC. If $\alpha(x_H - x^c)/x^c > (1-\delta^2)/\delta^2$ we are in Regime HTC.[25] The expression $\alpha(x_H - x^c)/x^c$ captures the expected nominal disutility (disutility when $\delta = 1$) that the high type plaintiff suffers if she settles in the first period for x^c instead of in the third period for the expected value of $\alpha x_H + (1-\alpha)x^c$. Fig. 2 shows the set of equilibria for Regimes LTC and HTC in the space (α, x^c). Notice how the separation of cases depends on *both* parameters. For example, when $\alpha = 1$, there exists a cutoff value $\delta^2 x_H$ such that for values of the cap smaller than that cutoff we are in Regime HTC, but for values larger than that cutoff we are in Regime LTC. Also observe that the lower the discount factor or the expectation of a strike down are, the less attractive it is for the plaintiff to delay the resolution of the dispute and consequently, and the more likely it is that we are in Regime LTC.

A regime with caps and low trim (*Regime LTC*). When $x^c > \delta^2\bar{x}$, the results that we obtained in the regime without caps are replicated here only that x^c replaces x_H and π^{LTC} replaces π^{NC}. The reason the

through time nor are endogenously determined allow us to measure a first order magnitude of the impact of expectations over the behavior of agents. A rational expectations equilibrium approach would require an extensive description of the role of judges with a consequent deviation in the focus of the paper.

21 As was mentioned in footnote 6 a special law firm, called The Center for Constitutional Litigation, PC, routinely challenges tort reforms in states and federal courts. For example, on November 2007 the law firm got a trial court in Illinois to strike down a medical malpractice reform enacted in August 2005. As of June 2009 the case is still pending at the Illinois Supreme Court. Lawyers in Illinois follow closely such cases and have been developing expectations regarding the probability of strike down at least from the moment the case was filed in the lower court on November 2006, a little over a year after the enactment of the reform. See LeBron v. Gottlieb Memorial Hospital, No. 06-L-12109.

22 Obviously, high (low) trims in recoveries may take place in Regime LTC (HTC) as the equilibria refer to the average value of trims.

23 We will see that in some cases of separating equilibrium both types end up recovering the same. Nevertheless, in those cases, the properties of the solution differ from the properties of a pooling equilibrium.

24 The defendant does not want to incur a second round of negotiations costs, c, and possibly legal costs, k, if the case goes to trial because there are not too many low type victims that will benefit from the high offer they do not deserve.

25 We do not consider the case: $\alpha(x_H - x^c)/x^c = (1-\delta^2)/\delta^2$ because it does not add to the main discussion. The equilibrium strategies are a mix of the strategies that define the LTC and HTC solutions.

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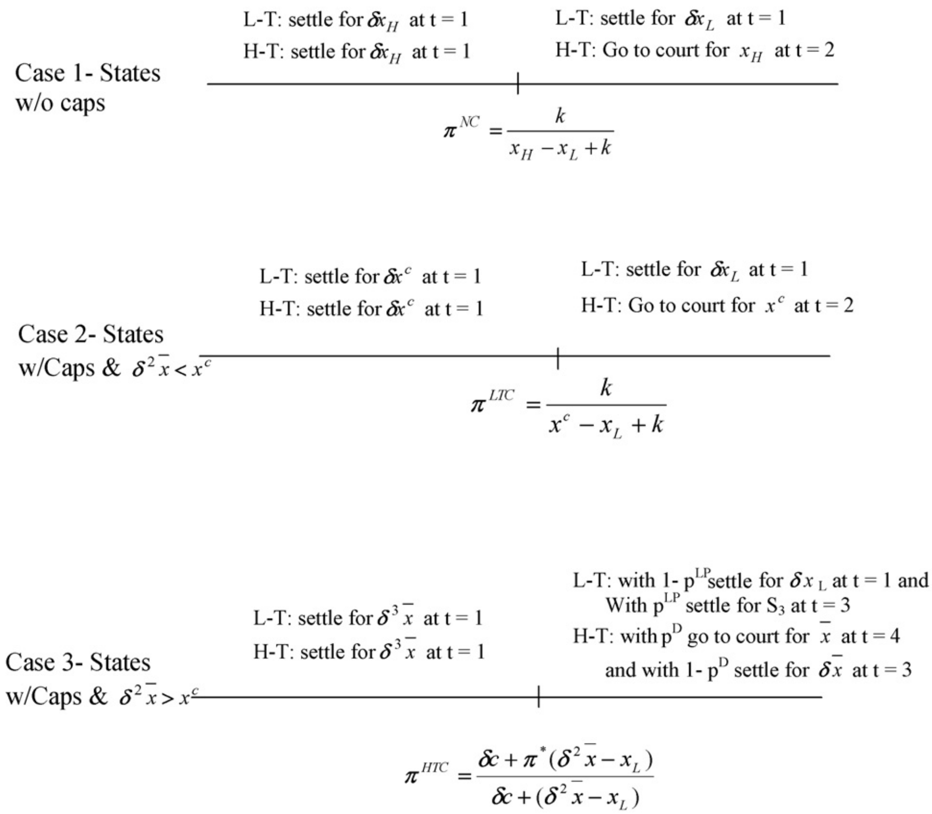

Fig. 1. Equilibria for states with and without caps.

high type is not willing to wait for a third period is simple: The probability of a strike down is not large enough, and/or the caps are large enough relative to her true harm, so the plaintiff does not expect to gain much from waiting.

A regime with caps and high expected trim (*Regime HTC*). When $x^c < \delta^2\bar{x}$ the analysis becomes more nuanced. As in regimes NC and LTC, it is still true that when there is a low probability that the defendant faces a low type victim (i.e. when $\pi < \pi^{HTC}$), there is a pooling equilibrium in which both types of victims receive $\delta^3\bar{x}$ in the first period. However, when there is a high probability that the defendant faces a low type victim (i.e. when $\pi > \pi^{HTC}$), things change in two ways compared to the other regimes. First, the high type victim always waits for the second round (third period) settlement offer (S_3). The reason is that when the defendant offers δx_L in the first period, the plaintiff can only recover δx^c in the second period and *both* expressions are smaller than $\delta^3\bar{x}$, which is what the high type plaintiff expects to recover in the third period (in present value). To see that the high type recovers $\delta^3\bar{x}$, notice that in the third period the defendant mixes between two offers: with probability $p^D = (\delta^2\bar{x} - x_L)/\delta^2(\bar{x} - x_L)$ he offers δx_L in which case the high type plaintiff goes to court and recovers an expected value of $\delta\bar{x}$,[26] or, alternatively, with probability $1 - p^D$ he offers $\delta\bar{x}$ in which case the high type plaintiff accepts it.[27] Second, the low type plaintiff may not only decide to wait in the first period, but also in the second period (the idea is to mimic the high type's decision). The low type settles in the first period for δx_L with probability $1 - p^{LP} = 1 - k(1-\pi)/(\pi(\bar{x} - x_L))$ or settles in the third period for (S_3) with probability p^{LP}.[28] In order to support the mixed strategies equilibrium, the expected (and discounted) value of the recovery in the third period is δx_L.

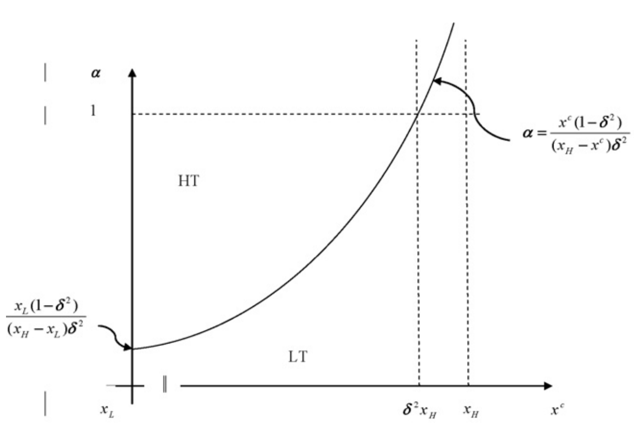

Fig. 2. HTC and LTC equilibria in the space (α, x^c).

3.2. *Preliminary considerations about the equilibria: high offer or low offer?*

Where are the differences in the equilibria under the various regimes ultimately coming from? The answer is that they are originated in the fact that both caps and the probability of a strike down affect the incentives of the defendant to make a high instead of a

[26] The offer δx_L is an option given that the defendant knows that the low type may have mimicked the high type.

[27] That defines S_3.

[28] As usual in these cases, there is no equilibrium in which the low type plaintiff plays a pure strategy because if her strategy is always to wait she recovers only δx_L. In this case the defendant induces the high type to settle in the first period by offering her $\delta^3\bar{x}$ and has certainty that in the second period he is facing the low type. But then, the low type has no incentives to wait, hence the strategy cannot be an equilibrium. In the same way, if her strategy is never to wait she recovers only δx_L for obvious reasons and will always prefer to wait. Again there are incentives to deviate.

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low settlement offer in the first period. To see that more explicitly, notice that in any of the regimes, the defendant is indifferent between making the high or the low offer when

$$\underbrace{\pi S_L + \pi E_L + (1-\pi)S_H + (1-\pi)E_H + c}_{\text{Low Offer}} = \underbrace{S_H + c}_{\text{High Offer}} \tag{1}$$

That is, the defendant is indifferent when the sum of the offer (S_H) plus the first round negotiation costs (c), in the case of a high offer is equal to the sum of the expected plaintiff recoveries (S_L for the low-type and S_H for the high-type) and the first round negotiation costs (c) plus the expected future litigation expenses (E_L for the low-type and E_H for the high-type) in the case of a low offer. Where we have used the generic variables S and E to refer to settlement offers and expected expenses for any regime. Rearranging the term in (1) we get:

$$\pi^{\text{cutoff}} = \frac{E_H}{(E_H - E_L) + (S_H - S_L)} \tag{2}$$

Going back to the characteristics of the equilibria described in Section 3.1, we notice that for both Regime NC and Regime LTC future expenses associated to the high offer are 0 for the low type and exactly δk for the high type. The only difference between these regimes is given by the spread in the recoveries expected by the high and the low type plaintiffs. While under regime NC that spread is $\delta(x_H - x_L)$ under regime LTC is $\delta(x^c - x_L)$, which allows us to understand why $\pi^{NC} = k/(k + x_H - x_L) < \pi^{LTC} = k/(k + x^c - x_L)$. In other words, there are more pooling equilibria under regime LTC than under regime NC because the high settlement offer is cheaper in the second case.

The comparison between the set of equilibria generated under Regime HTC and the set of equilibria generated under the other two regimes requires more elaboration. First, from Appendix A we know that the expected litigation expenses are given by $\pi^{HTC}E_L + (1-\pi^{HTC})E_H = (1-\pi^{HTC})[(\delta^2 c/(1-\pi^*)) + \delta^3 p^D k]$ and that the spread on expected recoveries is given by $S_H - S_L = \delta^3\bar{x} - \delta x_L$ which from (1) above allows us to identify the value of π^{HTC} as[29]:

$$\pi^{HTC} = \frac{[(\delta c/(1-\pi^*)) + p^D\delta^2 k]}{[(\delta c/(1-\pi^*)) + p^D\delta^2 k] + (\delta^2\bar{x} - x_L)} \tag{3}$$

where $\pi^* = k/(k + \bar{x} - x_L)$. This time, the differences between the cutoffs under regime HTC and regimes NC/LTC (which are very similar) are at two levels. First, in terms of the size of the high offer only, defendants are more inclined to make the high offer under regime HTC than under regime NC but less than under regime LTC because $x_H > \delta^2\bar{x} > x^c$. Second, in regimes NC and LTC the expected overall legal expenses are $(1-\pi)\delta k + c$, whereas under Regime HTC, they are $(1-\pi)\delta[(\delta c/(1-\pi^*)) + p^D\delta^2 k] + c$. The first expression in the square bracket represents the defendant's negotiation costs in the third period. The second expression in the square bracket represents the litigation costs that might take place in the fourth period.

REMARK: Notice that the negotiation costs are always larger under Regime HTC than under Regimes NC or LTC as $(1-\pi)\delta[(\delta c/(1-\pi^*))] + c > c$. In addition, as $p^D\delta^2 < 1$, the litigation costs in Regime HTC are always smaller than in Regimes NC or LTC. As we will explain with more detail later, the higher negotiation costs in Regime HTC is what causes this regime to sometimes be more costly than Regime NC.

Taken together, these differences between recoveries spread and expected litigation expenses may suggest that we are not able to conclude whether or when π^{HTC} is smaller or larger than the two other cutoffs. Nevertheless, we are able to make some observations. First we notice that π^{HTC} is an increasing function of c because the higher the litigation expenses are, the less attractive it is for the defendant to make the low offer δx_L (that offer may induce the plaintiff to wait and thus generate an extra round of negotiations). Second, we also notice that π^{HTC} is decreasing with δ and α because the smaller $\delta^3\bar{x}$ is, the more attractive it is for the defendant to make the high offer (the one that induces the pooling equilibrium).[30] Third and final, from inspection of (3), we realize that if $c = 0$ and $\delta = \alpha = 1$ it is the case that $\pi^{HTC} = \pi^{NC}$.

Taken together, these properties imply that it is always true that there are more pooling equilibria under Regime HTC than under Regime NC (π^{NC} does not depend on c, δ or α). In addition, if the settlement costs, c, are large enough, there are more pooling equilibria under Regime HTC than under Regime LTC (i.e. $\pi^{HTC} > \pi^{LTC}$). But if the settlement costs, c, are small enough, the opposite is true (i.e. $\pi^{HTC} < \pi^{LTC}$). We summarize the former analysis in the next two Lemmas.

Lemma 1. π^{HTC} is strictly increasing in c but strictly decreasing in δ and α.

Proof. See Appendix B. □

Lemma 2.

(a) For all values of c, δ and α, $\pi^{NC} < \pi^{LTC}$ and $\pi^{NC} < \pi^{HTC}$
(b) For all values of δ and α, $\pi^{HTC} > \pi^{LTC}$ if $c > \pi^*(((\delta^2\bar{x} - x_L)(\bar{x} - x^c))/\delta(x^c - x_L))$ but $\pi^{HTC} \in [\pi^{NC}, \pi^{LTC}]$ if $c \in [0, \pi^*(((\delta^2\bar{x} - x_L)(\bar{x} - x^c))/\delta(x^c - x_L))]$.

Proof. Part (a) follows from the former analysis. Part (b) follows from straightforward algebra. □

4. Results

4.1. Do caps accelerate or delay settlement?

We start by asking whether caps reduce the time required by the parties to resolve their disputes after we account for parties' expectation that the caps may get struck down some time after they are enacted. In this section, we show that because caps and the associated constitutional uncertainty change the incentives faced by the defendant to make a high or a low settlement offer, it is true that: (1) the expected length of disputes in LTC states is always shorter than equivalent disputes in states without caps, but (2) the expected length of disputes in HTC states may be longer than equivalent disputes litigated in states without caps. This last possibility is realized when settlement costs, c, are low and expected recoveries, $\delta^3\bar{x}$, are high.

To start, note that, from the perspective of the social planner who knows that π is drawn from the distribution $f(\pi)$, the expected lengths of resolution of disputes (number of periods) for regimes NC and LTC are given by

$$\begin{aligned} L^{NC} &= \int_0^{\pi^{NC}} f(x)\,dx + \int_{\pi^{NC}}^1 \{x + 2(1-x)\} f(x)\,dx \\ &= 1 + \int_{\pi^{NC}}^{\pi^{LTC}} (1-x)f(x)\,dx + \int_{\pi^{LTC}}^1 (1-x)f(x)\,dx, \end{aligned} \tag{4}$$

[29] Fig. 1 shows a different expression for π^{HTC} only because we have explicitly replaced the value of p^D.

[30] At first, this looks counterintuitive as the larger δ or α are, the more the defendant expects to pay in litigation expenses if the plaintiff decides to wait. Nevertheless δ and α also determine how much the defendant pays the plaintiff if the dispute is resolved in the first period which is $\delta^3\bar{x}$ and this last effect dominates the first one. See the proof of proposition 1 for more details.

and

$$L^{LTC} = \int_0^{\pi^{LTC}} f(x)\,dx + \int_{\pi^{LTC}}^1 \{x + 2(1-x)\} f(x)\,dx$$
$$= 1 + \int_{\pi^{LTC}}^1 (1-x) f(x)\,dx, \qquad (5)$$

respectively. Both expressions tell us that plaintiffs resolve the dispute in at most two periods. For π smaller than the cutoff, all plaintiffs accept the defendant's first period settlement offer. For π larger than the cutoff, low type plaintiffs resolve the dispute in one period while high types proceed to the second period – litigation. By inspection, we notice that (4) and (5) are dissimilar only in the limits of the integrals (the cutoffs). As we know that $\pi^{LTC} > \pi^{NC}$, it is straightforward to conclude that disputes under Regime LTC are resolved more quickly than are disputes under Regime NC, because Eq. (5) (Regime LTC) has one fewer term than does Eq. (4) (Regime NC) (corresponding to the high type plaintiffs who solve the dispute in one period under Regime LTC as opposed to two periods under Regime NC).

We proceed in the same way to compare the length of dispute resolution under Regimes NC and HTC. First, we write the expression for the length of dispute resolution under Regime HTC:

$$L^{HTC} = \int_0^{\pi^{HTC}} f(x)\,dx + \int_{\pi^{HTC}}^1 \{(1 - p^{LP} + 3p^{LP})x$$
$$+ (4p^D + 3(1-p^D))(1-x)\} f(x)\,dx$$
$$= 1 + \int_{\pi^{HTC}}^1 \left(\frac{2(\bar{x} - x_L + k)}{\bar{x} - x_L} + \frac{\delta^2 \bar{x} - x_L}{\delta^2(\bar{x} - x_L)} \right) (1-x) f(x)\,dx, \qquad (6)$$

The expression tells us that first, in a pooling equilibrium (π smaller than the cutoff) all the plaintiffs solve the dispute in one period. Second, in a separating equilibrium (π larger than the cutoff) the low type plaintiffs settle their dispute in one period with probability $1 - p^{LP}$ but in three periods with probability p^{LP}. Third, high types either settle in period 3 with probability $1 - p^D$ or go to trial in period 4 with probability p^D.

Then, if we rewrite (4) as

$$L^{NC} = 1 + \int_{\pi^{NC}}^{\pi^{HTC}} (1-x) f(x)\,dx + \int_{\pi^{HTC}}^1 (1-x) f(x)\,dx \qquad (4')$$

we notice that there are two dissimilarities between (4′) and (6) which push the length of resolution of disputes in different directions. First, the difference in the limit of the integral tells us that all the high type plaintiffs with $\pi \in [\pi^{NC}, \pi^{HTC}]$ who used to go to trial under Regime NC in the second period, under Regime HTC settle in the first period with certainty.[31] That first effect reduces the length of resolution of disputes under Regime HTC. Second, the difference in the argument of the integral tells us that the low type plaintiffs with $\pi \geq \pi^{HTC}$ may take longer than one period to solve their dispute while high type plaintiffs with $\pi \geq \pi^{HTC}$ resolve their disputes in the third or fourth and not in the second period as was the case in Regime NC and is seen in (4′). That second effect increases the length dispute resolution under Regime HTC. In other words, under regime HTC more plaintiffs face a high offer than under regime NC but plaintiffs that receive the low offer resolve their dispute in longer periods of time than under regime NC. Which effects dominates depends on how frequently is the low offer made (or alternatively, how large is π^{HTC}.

[31] There are no differences for the low type plaintiffs.

In Appendix B, we show that the resolution length in Regime HTC is longer than that in Regime NC under certain conditions: (1) The discount factor, δ, and the expectation of a strike down, α, are not too low, and (2) the cost of negotiation is not too high. The result is valid regardless of the values of the recoveries, the cap, and the distribution of beliefs about plaintiff's type. The reason why the results are conditional on the values of c, δ and α is as follows: If the costs of negotiation, c, are not very high the defendant is more inclined to make a low value offer that will induce the plaintiff to wait for a second round, because that extra round of negotiations is not too expensive. On the other side, if the discount factor and the expectation of a strike down, δ and α respectively, are large, the defendant is again more inclined to make a low value offer that will induce the plaintiff to wait for a second round, but this time because the offer that the plaintiff demands for *not waiting*, $\delta^3 \bar{x}$, becomes larger.[32]

The following proposition summarizes the analysis above.

Proposition 1 (Time of dispute resolution).

(a) *Expected dispute resolution is shorter in Regime LTC than in Regime NC.*
(b) *There exists* $(\bar{c}, \bar{\alpha}, \bar{\delta})$ *such that for all* (c, α, δ) *satisfying* $c < \bar{c}$, $\alpha > \bar{\alpha}$ and $\delta > \bar{\delta}$ *the expected time of dispute resolution is longer in Regime HTC than in Regime NC.*

Proof. See Appendix B. □

REMARK: Avraham and Bustos (2008) provide empirical evidence that supports the veracity of Proposition 1. For example, in Illinois, which is an HTC state, the length of resolution of disputes went *up* by about 4% after the enactment of caps.

Notice that while the model provides a simple way to classify states as Regimes LTC or HTC, as an empirical matter it is not easy to find proxies for the probability of a strike down, α, and for a high-type claim, x_H. In Avraham and Bustos (2008), we use the political composition of the states' Supreme Courts as a proxy for α (under the assumption that liberal courts, measured in various ways, are more likely to strike down the reform) and the distribution of awards in a state as the basis for estimating x_H.

4.2. Welfare implications

In this section, we analyze implications to parties' welfare from our model. We ask questions such as whether caps increase parties' total legal costs, or cause plaintiffs to recover more or less. In order to answer these questions, we start by noticing that caps tend to increase the percentage of disputes that are settled rather than litigated. Later, we show that relative to Regime NC, Regime LTC tends to reduce litigation expenses while Regime HTC tends to *increase* them. Finally, we show that in both Regime LTC and HTC, plaintiffs with high value claims typically end worse off, while plaintiffs with low value claims may end better or worse off compared to similar plaintiffs in Regime NC.

4.2.1. Proportion of disputes settled

As was discussed above, it is commonly thought that caps will increase the fraction of disputes that are settled instead of litigated. Because the expected recovery in a trial is smaller, the parties would prefer to settle and save the cost of trials more frequently. Our model offers a slightly different reason why caps increase the fraction of disputes settled. In our model, caps drive defendants

[32] For continuity there exist a value of $\pi^{HTC} \in [\pi^{NC}, 1]$ for which the length of the dispute resolution is the same under NC and under HTC. It is enough to notice that when c becomes very large π^{HTC} tends to 1 and when c is 0 and $\delta = \alpha = 1$ then $\pi^{HTC} = \pi^{NC}$.

to make *high offers* (offers that induce both types of plaintiffs to settle in the first period) more frequently than in the no-caps case because the "high offers" required to induce a settlement (pooling equilibria) are lower – consequently more attractive – when caps are in place.[33]

More formally, under Regime NC, trials take place only for $\pi > \pi^{NC}$ and a high type plaintiff. Under Regime LTC, trials take place only for $\pi > \pi^{LTC}$ and a high type plaintiff. Because $\pi^{LTC} > \pi^{NC}$, it is clear that the set of pairs of defendants and plaintiffs that resolve their disputes through settlement is higher in the regime with caps and low trim than in the no-caps regime. Analogously, under Regime HTC, trials take place with probability p^D only for $\pi > \pi^{HTC}$ and a high type plaintiff. Because $\pi^{HTC} > \pi^{NC}$, it is clear that the set of pairs of defendants and plaintiffs that resolve their disputes through settlement is higher in the regime with caps and high trim than in the no-caps regime.

4.2.2. Do caps increase or decrease litigation expenses?

Given that disputes are solved more quickly and are more likely to be settled than litigated under Regime LTC than under Regime NC, it is not surprising that litigation expenses (costs of negotiation and trial) are lower under Regime LTC. However, the same does not hold for the comparison between regimes NC and HTC. Proposition 1 proved that regime HTC may have longer times of resolution of disputes than regime NC, ergo we may expect that litigation expenses will increase as well. However, we will show that a longer time of resolution of disputes is not enough to conclude that legal costs are larger. For example, if the reduction in the proportion of trials that take place in the second round is large enough to dominate the increase in the negotiation costs (both characteristics of the HTC solution) then, the total legal costs will be smaller.

To see that we first write the expressions for the expected costs of litigation in regimes NC and HTC respectively

$$E^{NC} = c + \int_{\pi^{NC}}^{\pi^{HTC}} (1-x)\delta k f(x)\,dx + \int_{\pi^{HTC}}^{1} (1-x)\delta k f(x)\,dx \tag{7}$$

$$E^{HTC} = c + \int_{\pi^{HTC}}^{1} \{xp^{LP}\delta^2 c + (1-x)(\delta^2 c + p^D\delta^3 k)\} f(x)\,dx \tag{8}$$

There are three main dissimilarities between (7) and (8). First, disputes are settled instead of litigated in a higher proportion in Regime HTC than in Regime NC. This "settlement effect" is captured by the expression $\int_{\pi^{NC}}^{\pi^{HTC}} (1-x)\delta k f(x)\,dx$, which appears in (7) but not in (8) and represents the extra costs of litigation for Regime NC. Second, trials under Regime HTC take place at the fourth instead of the second period. This implies that the trial costs lower under Regime HTC. This "trial effect" is captured by the difference between $(1-x)p^D\delta^3 k$ in (8) and $(1-x)\delta k$ in (7) $(1-x)p^D\delta^3 k < (1-x)\delta k$. Third, disputes may be resolved over longer periods of time, which implies additional costs of negotiation under Regime HTC. This "length effect" is captured by the expression $xp^{LP}\delta^2 c + (1-x)\delta^2 c$, which is in (8) but not in (7).

While the first two effects (the "settlement effect" and the "trial effect") tend to decrease litigation expenses under Regime HTC relative to Regime NC, the third effect (the "length effect") tends to increase them. As a result, caps may actually increase rather than reduce litigation expenses.

Proposition 1 provides the starting point for determining when the "length effect" will dominate the "settlement" and "trial" effects. If $c = 0$, $\delta = 1$ and $\alpha = 1$, then total legal expenses are equal under both regimes. The reason is that the "length effect" disappears when $c = 0$, the "trial effect" disappears when $\delta = 1$ and the "settlement effect" disappears when in addition to $c = 0$ and $\delta = 1$ it is also true that $\alpha = 1$.[34] Once one realizes that E^{HTC} is a concave function on the value of c,[35] and is a strictly increasing function of δ and α, one can conclude that Regime HTC generates more litigation expenses than Regime NC if the negotiation costs and/or the discount factor together with the expectations of a strike down are neither too small nor too large.

The following proposition summarizes the analysis above.

Proposition 2 (Litigation expenses).

(a) *Expected litigation expenses are smaller in Regime LTC than in Regime NC.*
(b) *There exists* $(c^+, \alpha^+, \delta^+)$ *and* $(c^*, \alpha^*, \delta^*)$ *such that for all* (c, α, δ) *satisfying* $c \in [c^+, c^*]$, $\alpha \in [\alpha^*, \alpha^+]$, $\delta \in [\delta^*, \delta^+]$ *the expected litigation expenses are larger in Regime HTC than in Regime NC.*

Proof. See Appendix B. □

A comparison of $(c^*, \alpha^*, \delta^*)$ from Proposition 2 with $(\bar{c}, \bar{\alpha}, \bar{\delta})$ from Proposition 1 shows that because $L^{HTC}(c = 0,\ \delta = 1.\ \alpha = 1) > L^{NC}$ but $E^{HTC}(c = 0,\ \delta = 1,\ \alpha = 1) > E^{NC}$ then may be true that $\bar{c} > c^*$, $\bar{\alpha} < \alpha^*$ and $\bar{\delta} < \delta^*$. That means that for all cases in which $c \in [c^*, \bar{c}]$ the expected time of resolution of disputes (all else being equal) is longer in Regime HTC than in Regime NC but the litigation expenses are *not* increased. The same holds for all cases in which $\alpha \in [\bar{\alpha}, \alpha^*]$ and/or $\delta \in [\bar{\delta}, \delta^*]$. We can intuitively reach the same conclusion: a longer time of resolution of disputes in Regime HTC than in Regime NC does not necessarily imply that the legal costs are larger when we consider our discussion of whether the defendant makes a high or a low settlement offer. *In general* the defendant makes the low offer instead of the high offer because the reduction in paid awards (each type is paid her true harm) more than fully offsets the increase in litigation expenses. But as in the comparison between HTC and NC regimes what changes is the frequency with which the low offer is made, it could also be the case that the defendant faces an increase in paid awards (because the high offer is made more frequently than under regime NC) which is compensated by a *reduction* in litigation expenses. Otherwise, the defendant would rather not extend the time needed to resolve disputes.

We acknowledge that Proposition 2 only takes into account short-term effects. That is, the additional litigation costs incur only within the time period in which the uncertainty surrounding the cap is unresolved.[36] This means that even if HTC induces short term increase in litigation expenses, this increase may be offset by long term reductions in expenses in the future after the uncertainty is resolved and the HTC regime becomes either LTC or NC *permanently*. Accordingly, society may save costs by enacting caps. While this observation is correct, one has to remember that as a matter of fact, the average time to resolving the uncertainty surrounding the constitutionality of caps in the U.S. is about 10 years (see Avraham, 2006a,b). Moreover, as it is stated in the next lemma and proved in Appendix B, even when we take into account long-term effects, part (b) of Proposition 2 still holds.

Lemma 3. If there is an infinite sequence of pairs of plaintiffs and defendants such that the uncertainty about the cap is resolved in the game played by the first pair then there exists $(c^+, \alpha^+, \delta^+)$ and $(c^*,$

[33] In addition, in Regime HTC the high type plaintiff may decide to settle in the third period whereas in Regime NC, if the high type does not settle in the first period she would go to trial in the second period.

[34] The recovery of the high type plaintiff is x_H regardless of the value of the cap because the cap will be struck down for sure. As we mentioned before, when the parameters take these particular values we have that $\pi^{NC} = \pi^{HTC} = k/(x_H - x_L + k)$.

[35] The length increases for small values of c but decreases for large values of c.

[36] We thank Tom Kelly for pointing it out to us.

α^*, δ^*) such that for all $c \in [c^+, c^*]$, $\alpha \in [\alpha^*, \alpha^+]$, $\delta \in [\delta^*, \delta^+]$ the expected litigation expenses are larger in a Regime HTC than in a Regime NC.

Proof. See Appendix B. □

Evidently, the parameters in Lemma 3 are more stringent than Proposition 2. That is, (α^*, δ^*) which are defined by Lemma 3 are larger than the equivalent values which were defined by Proposition 2, and (c^*) which was defined by Lemma 3 is smaller than the equivalent value which was defined by Proposition 2. This is because after a period in which society experiences a welfare loss due to uncertainty in the constitutionality of the caps (increase in litigation expenses), there is a period in which it experiences a gain due to the elimination of that uncertainty (decrease in litigation expenses). Lemma 3 shows that there always exist cases in which the aggregate effect is negative.

4.2.3. Do caps increase or decrease plaintiffs' recoveries?

At this point, we wonder whether caps have any systematic effects on the recoveries obtained by plaintiffs. One may expect that plaintiffs should be able to recover less in states with caps. Indeed, that is the overall effect. Nevertheless, when we distinguish by the type of the plaintiff, we uncover an unexpected result. Unlike high type plaintiffs, who always recover less when caps are in place, low type plaintiffs may recover the same, more, or less when caps are in place, depending on various factors.

Some low type plaintiffs may recover less because high type plaintiffs also recover less. Recall that in a pooling equilibrium low type plaintiffs recover the same dollar amount as high type plaintiffs. Hence, low type plaintiffs who would have been pooled with high type plaintiffs will recover in any of the caps regimes less than they would in Regime NC.

Some other low type plaintiffs may recover more because they are included in pooling equilibria under the caps regimes (low types recover δx^c in LTC and $\delta^3\bar{x}$ in HTC in the case of pooling equilibria), rather than included in the separating equilibria, as they would under the no caps regime (where low types recover only δx_L). This follows from the fact that the cutoff that divides pooling from separating equilibrium are larger under the cap regimes than the no cap regime. Proposition 3 summarizes this point:

Proposition 3 (Recoveries).

(a) *For all values of π high type victims receive lower recoveries in regimes with caps (whether LTC or HTC) than in a regime without caps.*
(b) *For all values of $\pi < \pi^{NC}$, low type victims receive smaller recoveries in regimes with caps (whether LTC or HTC) than in a regime without caps. For all values of $\pi \in [\pi^{NC}, \max(\pi^{LTC}, \pi^{HTC})]$ low type victims receive larger or equal (expected) recoveries in regimes with caps (whether LTC or HTC) than in a regime without caps. For all values of $\pi > \max(\pi^{LTC}, \pi^{HTC})$, low type victims receive equal (expected) recoveries in regimes with caps (whether LTC or HTC) and without caps.*

Proof. See Appendix B. □

REMARK: It has been observed by many that high-type plaintiffs would be under-compensated if subjected to caps. For example, Viscusi (1991), pp. 97 argued that the effect of caps is that "victims with major injuries would be limited in making their claims, while those with minor injuries would be unaffected." As a result, victims of brain damage, para- or quadriplegia, and cancer will be the most disadvantaged. For these reasons, among others, a study by the American Legal Institute (ALI) rejected caps (see ALI (1991), pp. 219–220). Our study is the first to formally show (in addition to the under-compensation of high-type plaintiffs) the possibility that caps will cause victims with minor injuries to be over-compensated, and not simply "unaffected".

5. Robustness of the results

In this section we check the robustness of our main result (as stated in Proposition 1, caps uncertainty may delay the resolution of disputes) when we consider that: (1) Plaintiffs are risk averse; (2) the parties share negotiation and litigation costs and; (3) Defendants do not have all the negotiation power.[37]

5.1. Plaintiffs are risk averse

Consider now that Plaintiffs have utility function $u(x)$ which is strictly continuous, increasing and concave in x, that is $u'(x) > 0$ and $u''(x) < 0$. Then the solution of the settlement and litigation game played by the Plaintiff and the Defendant is as before, but in this case, both the settlement offers and the cutoff beliefs that divide the pooling and separating equilibria change. When there are no-caps the defendant offers either $w_H = u^{-1}(\delta u(x_H))$ or $w_L = u^{-1}(\delta u(x_L))$ which are the amounts that make the high and the low type plaintiffs indifferent between settlement and trial. Directly from there, we get that $\pi^{NC} = [\delta x_H - w_H + \delta k]/[\delta x_H - w_L + \delta k]$. Following the same logic, when there are caps and $u(x^c) > \delta^2[\alpha u(x_H) + (1-\alpha)u(x^c)] = \delta^2\bar{u}(\alpha)$, that is, when we are in the LTC regime, the defendant offers either $w_c = u^{-1}(\delta u(x^c))$ or w_L in which case $\pi^{LTC} = [\delta x^c - w_c + \delta k]/[\delta x^c - w_L + \delta k]$. In contrast, when $u(x^c) < \delta^2\bar{u}(\alpha)$, then we are in the HTC regime. In that case, in the first period the defendant offers either $\bar{w}_1 = u^{-1}(\delta^3\bar{u}(\alpha))$ or w_L and in the second period he offers w_L with probability $p^D = [\delta^2\bar{u}(\alpha) - x_L]/\delta^2[\bar{u}(\alpha) - x_L]$ and $\bar{w}_2 = u^{-1}(\delta\bar{u}(\alpha))$ with probability $(1-p^D)$. Thus, $\pi^{HTC} = [\delta c + \pi^*(\delta^2\bar{w}_2 - w_L)]/[\delta c + (\delta^2\bar{w}_2 - w_L)]$ with $\pi^* = [\delta\bar{x} - \bar{w}_2 + \delta k]/[\delta\bar{x} - w_L + \delta k]$.

It is easy to verify that when $u(x) = x$ we retrieve the expressions for the original model. In addition, because $\pi^{HTC} > \pi^{NC}$ then (4) and (6) are still valid.[38] What is different? The settlement offers as well as the defendant's willingness to make high offers will depend on the plaintiff's risk aversion. To see that more explicitly, suppose that $u(x) = 1 - e^{-Ax}$ where A is the coefficient of absolute risk aversion. Then $w_n = -\ln[1 - \delta(1 - e^{-Ax_n})]/A$ with $n \in \{L, c, H\}$ and $\partial\pi^{LTC}/\partial A = (\partial w_c/\partial A)([w_L - w_c]/[\delta x^c - w_L + \delta k]) > 0$. That means that the more risk averse the plaintiff is the more pooling equilibria will take place. The reason is that the larger is A the smaller is the size of the high offers needed by the defendant to induce settlement ($\partial w_c/\partial A < 0$). In addition, the larger A is, the smaller is the difference between the equilibrium under a no-caps and an LTC equilibrium. But most importantly, although Proposition 1 holds for all values of A (it is enough to notice that $\pi^{HTC} = \pi^{NC}$ when $c = 0$, $\alpha = 1$ and $\delta = 1$ regardless of As value) the more risk averse the plaintiff is, the less likely it is that caps will delay dispute resolution as in all the regimens, more and more disputes will be resolved right away (first round).

5.2. Parties share negotiation and litigation costs

In Section 3 we assumed that the defendant faces all the negotiation and litigation costs. Suppose now that the defendant faces

[37] To avoid extending this section excessively we don't provide full details of the solutions, instead we focus on their most important characteristics.

[38] The order relation holds because $\delta c(1 - \pi^{NC}) > (\delta^2\bar{w}_2 - w_L)(\pi^{NC} - \pi^*)$ follows from the concavity of $u(x)$. That (4) and (6) are valid is derived from the same logic of Proposition 1 (if c is small enough, and both α and δ are large enough then the expected time of dispute resolution is longer in Regime HTC than in Regime NC).

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only a fraction $f \in [0,1]$ of the negotiation and litigation costs while the plaintiff faces the other fraction $(1-f)$.

The first obvious difference from the solution of the model presented in Section 3 is that now the defendant does not need to offer δx_H or δx_L as the plaintiff will accept anything above $\delta x_H - (1-f)k$ or $\delta x_L - (1-f)k$ respectively. However, the proportion of separating and pooling equilibria under Regimes NC and LTC does not change (in other words π^{NC} and π^{LTC} are as before). The reason is that the difference in litigation costs in the case that the defendant makes a high offer instead of a low offer still is equal to k.[39] In Section 3, we presented the criteria that separates LTC and HTC regime and the definition of π^{HTC}. In the more general case, the criteria that separates LTC and HTC regimes is $x^c = \delta^2\bar{x} + (1-f)[k(1-\delta^2) - c\delta]$, which means that there will be more states with HTC regime if and only if $c/k < (1-\delta^2)/\delta$ (obviously we retrieve the original solution when $f = 1$). On the other hand, the new π^{HTC} is a decreasing function on f.[40] The reason is that the smaller f is (the larger the fraction of negotiation and litigation expenses paid by the plaintiff), the smaller the settlement offer the defendant needs to make to induce the plaintiff to settle (assuming that the defendant still has all the bargaining power) – ergo, making the high settlement offer more attractive. Nevertheless, the smaller f is, the smaller is the fraction of negotiation and litigation expenses paid by the defendant – ergo, making the low settlement offer more attractive. Putting together these two effects suggest that $f < 1$ may accelerate or delay the resolution of disputes more or less than when $f = 1$. However, what remains is that the uncertainty surrounding caps constitutionality may delay the resolution of disputes. In other words, Proposition 1 still holds because when the negotiation costs are low enough, defendants will not make the high offers much more frequently than in the no caps case, and when expected recoveries are large enough, high type plaintiffs (and consequently low type as well) will be willing to wait for the second round of negotiation-trial.

5.3. *Bargaining power*

Finally, suppose that the defendant does not have all the bargaining power as we assumed in Section 3 but instead the plaintiff has bargaining power represented by a parameter $\theta \in [0,1]$. In that case, in a one round game when caps are not in place, the defendant will offer either $(1-\theta)\delta x_H + \theta(\delta x_H + \delta k) = \delta(x_H + \theta k)$ or $\delta(x_L + \theta k)$ which means that a pooling equilibrium takes place if and only if $\pi < (1-\theta)k/(x_H - x_L + (1-\theta)k) = \pi(\theta)$. That inequality tells us that the stronger the plaintiff's bargaining power is, the less frequently the defendant makes the high offer because the plaintiff demands too much.

Although the previous paragraph may suggest that nothing changes substantially, the truth is that under these new considerations Proposition 1 does not always hold. The reason is that a high type plaintiff knows that she can recover at least $\delta^3(x_H + \theta k)$ by waiting to the second round but can recover only δx_H in the first round's trial (notice that she cannot recover $\delta(x_H + \theta k)$ because in that case the defendant will rather force the plaintiff to wait for the second round by making a low settlement offer). If the high type plaintiff waits, then the low type may also wait, which indicates that even when there are no caps, the solution would look like the solution under the HTC regime of the model presented in Section 3. This means that caps would always have the effect of accelerating the resolution of disputes. Nevertheless, for this to hold we need $\delta^2(x_H + \theta k) > x_H$. That is, δ and θ must be large enough. If instead, for example $x^c < \delta^2(\bar{x} + k) < \delta^2(x_H + k) < x_H$ then for all values of θ, high type plaintiffs will not be willing to wait for the second round offer (as they can get more in the first round trial). Then we are back into the solution of the model presented in Section 3 (notice that the bargaining power may determine whether we are in the LTC or the HTC regimes).

The bottom line is that: if the discount factor is large enough, then caps will delay the dispute resolution if and only if the plaintiff bargaining power is low enough (Proposition 1 holds). Otherwise, caps always accelerate dispute resolution (Proposition 1 does not hold). However, if the discount factor is small enough, then even when the plaintiff's bargaining power is maximum (theta equals 1), caps may delay dispute resolution (Proposition 1 holds) as concluded in Section 4.

6. Conclusions

The finding that parties delay settlements in the shadow of caps may seem counterintuitive. After all, caps reduce the uncertainty associated with jury awards, and are therefore expected to ease settlements. In contrast, we showed that if the parties expect that caps will be struck down in the near future, they might delay settlement. In Avraham and Bustos (2008), we test some of our predictions empirically and find supporting evidence. There we show that (a) when the caps are relatively small and the probability of their strike down is large, parties delay settlements, until the fate of the caps becomes clear, and (b) that when the caps are high and the probability of their strike down is small, parties will expedite their settlements, relative to states with no caps.

From a welfare perspective, Proposition 2 is probably the most important theoretical finding of this paper: Low Expected Trim Caps decrease legal expenses, whereas High Expected Trim Caps *may* increase them. While our model deals with the short run, the insight that there exists an ex ante cutoff probability of a strike-down due to unconstitutionality of the caps, α, above which enacting caps will be welfare decreasing remains true even when the long run is considered. But that cutoff will naturally be higher the longer the time period considered. An intuitive policy implication emerges from this analysis: States legislatures that believe the high court of their state is highly likely to strike down the reform and care about the short term effects of settlement delays, may be better off enacting relatively high caps or not enacting them at all.

Our model suggests that caps hit plaintiffs with large claims the hardest because they either receive lower recoveries if the caps are struck down, or delayed settlements if the caps are not. Interestingly, the model predicts that, in some circumstances, High Expected Trim caps may make plaintiffs with small claims (perhaps plaintiffs with frivolous lawsuits) better off as it enables them to sometimes receive the same settlement offer that plaintiffs with high claims receive, which is higher than what they would get in regime with no caps. Since there are no nation-wide datasets which contain plaintiffs' original claims, nor do we have data on plaintiffs' characteristics, it seems difficult to empirically test these predictions.[41]

[39] To see that notice that in terms of the settlement costs, the defendant saves $(1-f)k$ when he makes the high offer but in terms of litigation costs the defendant pays fk when he makes the low offer, as a net effect $(1-f)k + fk$ gives us k.

[40] $\pi^{HTC} = [\delta fc + (1-\pi^*)(H(f) + \Psi(f))]/[\delta fc + (1-\pi^*)H(f) - (x_L - (1-f)k)]$ in which $H(f)$ and $\Psi(f)$ are decreasing functions of f, with $H(1) + \Psi(1) = \pi^*(\delta^2\bar{x} - x_L)/(1-\pi^*)$ and $H(1) = \delta^2\bar{x}/(1-\pi^*)$.

[41] In a previous study, Avraham (2007) showed that cases subject to caps on non-economic damages that were not struck down have lower average recoveries by 65–72%. Yet, Avraham (2007) did not distinguish between high claims victims and low claims victims. In an empirical analysis (not reported here) we defined claims as being high or low based on the fields of the physicians. We found weak support for the model's predictions. While we find that Low Expected Trim caps significantly reduce high-claim plaintiffs' recoveries, we find that High Expected Trim Caps increased the recovery of victims with low claims by 10%, yet this increase was not found to be significant.

Lastly, while our model explicitly deals with caps on non-economic damages, similar analysis should hold for other tort reforms which effectively cap plaintiff's recovery, such as other types of caps, the collateral source reform, and joint-and-several liability reform.

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Appendix A. Characterization of the equilibria

A.1. Solution for states without caps

At $t=4$. High type plaintiff recovers x_H while low type plaintiff recovers x_L. By its side, the defendant pays recovery plus negotiation and litigation costs $c+k$.

At $t=3$. We denote π_3 the Bayesian update of the probability that the plaintiff is the low type at the beginning of the third period. The cost faced by the defendant C conditional on the third period settlement offer S_3 is given by

$$\text{If } S_3 < \delta x_L \text{ then } C = \delta[\pi_3 x_L + (1-\pi_3)x_H + k] + c \quad \text{(O1)}$$

$$\text{If } S_3 \in [\delta x_L, \delta x_H] \text{ then } C = \pi_3 S_3 + \delta[(1-\pi_3)(x_H + k)] + c \quad \text{(O2)}$$

$$\text{If } S_3 \geq \delta x_H \text{ then } C = S_3 + c \quad \text{(O3)}$$

In the calculation of C, we used the fact that no plaintiff accepts a settlement offer lower than the discounted value of his harm (what she obtains at period 4). That structure of settlement offers implies that $S_3=\delta x_L$ if and only if $\pi_3 > k/(x_H - x_L + k)$, otherwise $S_3=\delta x_H$ (to see that note that $S_3=\delta x_L$ in (O2) dominates any offer in (O1) or (O2). Hence, in order to determine when he should offer δx_L or δx_H the defendant only needs to determine when $\pi_3\delta x_L + \delta[(1-\pi_3)(x_H+k)]$ is smaller or larger than δx_H. In the case, the defendant offers $S_3=\delta x_L$, the low type plaintiff settles while the high type goes to trial, in the case that he offers $S_3=\delta x_H$, both settle. The negotiation costs are irrelevant.

At $t=2$. High type plaintiff recovers x_H while low type plaintiff recovers x_L. High type plaintiff never waits for $t=3$ because she knows that at that time she can only recover δx_H. The dominant strategy of the high type immediately implies that $\pi_3=1$, hence the low type plaintiff does not have incentives to wait for $t=3$ as she gets $S_3=\delta x_L$ with certainty. By its side, at $t=2$, the defendant pays recovery plus litigation cost k.

At $t=1$. The high (low) type plaintiff accepts all settlement offers higher or equal than δx_H (δx_L) while he rejects all inferior offers. As the defendant knows that the plaintiff can get these same amounts in the second period but in that case he pays the litigation cost, he induces either both types or the low type to settle immediately. In other words, he makes settlement offer δx_L when $\pi\delta x_L + (1-\pi)\delta(x_H+k) + c < \delta x_H + c$ and settlement offer δx_H when $\pi\delta x_L + (1-\pi)\delta(x_H+k) + c > \delta x_H + c$. Or;

If $\pi > k/(x_H - x_L + k) = \pi^{NC}$ then $S_1=\delta x_L$. In that case, while the low type plaintiff settles in the first period, the high type plaintiff litigates in the second and gets δx_H. Neither of them wants to wait for a third period because in that case they get the same amounts.[42]

If $\pi < k/(x_H - x_L + k) = \pi^{NC}$ then $S_1=\delta x_H$. Both types settle in the first period.

A.2. Solution for states with caps

Unlike in the solution for states without caps, here we distinguish two cases.

First Case: If $\delta^2\bar{x} < x^c$ (caps and low expected trim) then

At $t=4$. The solution is the same that in the case without caps but instead of recovering x_H the high type expects to recover $\bar{x}$.

At $t=3$. The solution is the same that in the case without caps but instead of offering δx_L and δx_H the defendant offers δx_L and $\delta\bar{x}$.

At $t=2$. The solution is the same that in the case without caps but instead of recovering x_H the high type expects to recover $\bar{x}$.

At $t=1$. The strategies of the defendant and the plaintiffs are the same that in the case without caps with the following exceptions. First, instead of offering δx_L and δx_H the defendant offers δx_L or δx^c and second, the high type plaintiff accepts all settlement offers higher or equal than δx^c (not δx_H) while litigate all inferior offers. The settlement offer in the first period depends on the probability that the plaintiff is a low type.

If $\pi > k/(x^c - x_L + k) = \pi^{LTC}$ then $S_1=\delta x_L$. While the low type plaintiff settles, the high type gets more going to trial. Both actions take place in the first period.

If $\pi < k/(x^c - x_L + k) = \pi^{LTC}$ then $S_1=\delta x^c$. Both types settle in the first period.

Second Case: If $\delta^2\bar{x} > x^c$ (caps and high expected trim) then

At $t=4$. High type plaintiff expects to recover $\bar{x}$ while low type plaintiff recovers x_L. By its side, the defendant pays recovery plus negotiation and litigation costs $c+k$.

At $t=3$. As in the case without caps, the plaintiffs settle only if they get at least the discounted value of their expected recovery at trial in $t=4$. That is δx_L and $\delta\bar{x}$ respectively. The strategy followed by the defendant is the same as in the case without caps with two differences: first, instead of offering δx_L and δx_H he offers δx_L and $\delta\bar{x}$; second, it may be the case that he randomizes between these two offers. More specifically

$$S_3 = \begin{cases} \delta x_L \text{ if } \pi_3 > \pi^* \\ \delta\bar{x} \text{ if } \pi_3 < \pi^* \\ \text{randomizes between } \delta x_L \text{ and } \delta\bar{x} \text{ if } \pi_3 = \pi^* = k/(\bar{x} - x_L + k) \end{cases}$$

The defendant could randomize at $t=3$ because at time $t=2$ both plaintiffs may decide to wait for the second settlement offer. The high type has incentives to wait for a third period if she gets offer δx_L at $t=1$ as she cannot recover more than δx^c by going to trial at $t=2$ and the low type has incentives to wait for a third period because she can get more by mimicking the high type.

We define p^D as the probability that the defendant offers δx_L in the third period, p^{LP} as the probability that the low type plaintiff waits at the first period for the third period if she receives offer δx_L and p^{HP} as the probability that the high type plaintiff waits at the first period for the third period if she receives offer δx_L. Although we need to wait for the considerations made by the defendant at period 1 to determine the exact value of these probabilities, at this point we notice that due to Bayes rule

$$\pi_3 = \frac{p^{LP}\pi}{p^{LP}\pi + p^{HP}(1-\pi)} = \pi^*$$

[42] Notice that plaintiffs' strategy of randomizing between first period settlement and second period trial does not support a mixed-strategies equilibrium (after all they get the same payoff) because in that case the defendant can always increase the settlement offer by ε, induce the plaintiffs to accept immediately and save the extra negotiation and litigation costs.

Hence it is true that

$$p^{LP} = \frac{\pi^*}{1-\pi^*}\frac{1-\pi}{\pi}p^{HP}$$

At $t=2$. High type plaintiffs never go to trial because by waiting for a second round of settlement/trial they guarantee a recovery of $\delta^3\bar{x}$ which is larger than δx^c. Low type plaintiffs wait for period 3 if and only if $\pi_3 \le \pi^*$ (we will see in the analysis at $t=1$ that it is always true that $\pi_3=\pi^*$, hence the low type plaintiff never goes to trial.) You may think that cannot be true because in the case of a mixed strategies solution, the low type gets δx_L both in the second and third periods, consequently the defendant can always save future litigation costs by offering the plaintiff ε more either at $t=1$ or $t=2$ and inducing her to accept immediately. But, remember that in the second period the plaintiff cannot get more than her true harm, and notice that there is no equilibrium if the defendant always accepts the first period offer.

At $t=1$. The defendant chooses between offering δx_L and $\delta^3\bar{x}$. If the probability that the plaintiff is low type is small enough, the defendant offers $\delta^3\bar{x}$, because in that case both plaintiffs accept it right away (as they don't expect to get more if they wait) and the defendant saves in future litigation expenses. Instead, if the probability that the plaintiff is low type is high enough the defendant offers δx_L because in that case some plaintiffs accept and the defendant saves in settlement payments. Hence, there exists π^{HTC} such that

$$S_1 = \begin{cases} \delta x_L \text{ if } \pi > \pi^{HTC} \\ \delta^3\bar{x} \text{ if } \pi < \pi^{HTC} \end{cases}$$

Obviously π^{HTC} is the belief that makes the defendant indifferent between the two offers. More specifically, the belief that satisfies

$$\begin{aligned}&\pi\left[\left(1-p^{LP}\right)\delta x_L + p^{LP}\delta^2\left(p^D\delta x_L + (1-p^D)\delta\bar{x} + c\right)\right]\\ &\quad +(1-\pi)\Big[(1-p^{HP})\delta(x^c+k) + p^{HP}\delta^2(p^D\delta(\bar{x}+k)\\ &\quad +(1-p^D)\delta\bar{x}+c\Big]^{+c=\delta^3\bar{x}+c} \end{aligned} \tag{A1}$$

The left hand side expression corresponds to the defendant's expected cost if the offer is δx_L. The right hand side expression corresponds to the defendant's expected cost if the offer is $\delta^3\bar{x}$. The right hand side expression is completely determined because in the case that the offer is $\delta^3\bar{x}$ both types of plaintiff accept it immediately. The left hand side expression is not completely determined because we need to calculate the values of p^D, p^{LP} and p^{HP}. First, it is easy to see that $p^{HP}=1$ because the high type plaintiff never accepts offer δx_L as in the third period she can make $\delta^3\bar{x}$ (remember that the high type never goes to trial in the second period as $\delta^3\bar{x} > \delta x^c$). Second, notice that there is no equilibrium that supports a pure strategy for the low type plaintiffs. For if the low type always accept δx_L, the defendant knows at $t=3$ that he is dealing with high types and offer $\delta\bar{x}$. As $\delta^3\bar{x} > \delta x_L$ the low type has incentives not to accept at $t=1$ and then that strategy cannot be an equilibrium. On the other side, if the low type always rejects δx_L and gets $S_3 \ge \delta x_L$ as expected recovery in the third period the defendant can offer $S_3+\varepsilon$ and induce her to settle in the first period, saving the extra litigation expenses, hence $S_1=\delta x_L$ cannot be an equilibrium.

Now we calculate the values of p^D and p^{LP}. Given that the low type follows a mixed strategy, she must be indifferent between waiting and settling when he is offered δx_L and that happens if and only if $\delta x_L = \delta^3(p^D x_L + (1-p^D)\bar{x})$. That identity allows us to determine that

$$p^D = \frac{\delta^2\bar{x} - x_L}{\delta^2(\bar{x}-x_L)}$$

In addition, because $p^{HP}=1$ we know that

$$p^{LP} = \frac{\pi^*}{1-\pi^*}\frac{1-\pi}{\pi}$$

Replacing those expressions in (A1) we get that

$$\pi^{HTC}\left[x_L + \frac{\pi^*}{1-\pi^*}\frac{1-\pi^{HTC}}{\pi^{HTC}}\delta c\right] + (1-\pi^{HTC})[\delta^2\bar{x} + p^D\delta^2 k + \delta c] = \delta^2\bar{x}$$

$$\pi^{HTC} = \frac{(\delta c/(1-\pi^*)) + \delta^2 p^D k}{(\delta c/(1-\pi^*)) + \delta^2 p^D k + (\delta^2\bar{x} - x_L)} = \frac{\delta c + \pi^*(\delta^2\bar{x} - x_L)}{\delta c + (\delta^2\bar{x} - x_L)}$$

which leads us to conclude that:

If $\pi < ((\delta c + \pi^*(\delta^2\bar{x} - x_L))/(\delta c + (\delta^2\bar{x} - x_L))) = \pi^{HTC}$ then $S_1 = \delta^3\bar{x}$. Both types settle in the first period.

If $\pi > ((\delta c + \pi^*(\delta^2\bar{x} - x_L))/(\delta c + (\delta^2\bar{x} - x_L))) = \pi^{HTC}$ then $S_1=\delta x_L$ and $S_3 = \begin{cases}\delta x_L \text{ with } p^D \\ \delta\bar{x} \text{ with } 1-p^D\end{cases}$. The high type plaintiff always wait for the third period in which case she settles when she receives offer $\delta\bar{x}$ but goes to trial when receives offer δx_L. The low type settles in the first period with probability $p^{LP} = \frac{\pi^*}{1-\pi^*}\frac{1-\pi}{\pi}$ otherwise she settles in the third period, that is, with probability $1-p^{LP}$.

Appendix B. Proofs

Proof of Lemma 1. If we differentiate (3) with respect to c we have that

$$\frac{\partial\pi^{HTC}}{\partial c}(x_L - \delta^2\bar{x}) + (1-\pi^{HTC})\frac{\delta}{1-\pi^*} - \frac{\partial\pi^{HTC}}{\partial\delta}\left[\frac{c\delta}{1-\pi^*} + p^D\delta^2 k\right] = 0$$

which implies that

$$\text{sign}\left(\frac{\partial\pi^{HTC}}{\partial c}\right) = \text{sign}\left(\frac{1-\pi^{HTC}}{1-\pi^*}\right)\delta = +$$

If we differentiate (3) with respect to δ we have that

$$-\pi^{HTC}2\delta\bar{x} + \frac{\partial\pi^{HTC}}{\partial\delta}(x_L - \delta^2\bar{x}) + \frac{1-\pi^{HTC}}{\bar{x}-x_L}[c(k+\bar{x}-x_L) + 2\delta\bar{x}k]$$
$$-\frac{\partial\pi^{HTC}}{\partial\delta}\left[\frac{c\delta(k+\bar{x}-x_L)}{\bar{x}-x_L} + \frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}k\right] = 0$$

which implies that

$$\begin{aligned}\text{sign}\left(\frac{\partial\pi^{HTC}}{\partial\delta}\right) &= \text{sign}\left(\frac{1-\pi^{HTC}}{\bar{x}-x_L}[c(k+\bar{x}-x_L)+2\delta\bar{x}k] - 2\pi^{HTC}\delta\bar{x}\right)\\ &= \text{sign}\left(\left(\frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}\right)[c(k+\bar{x}-x_L)+2\delta\bar{x}k]\right.\\ &\qquad\left. -2\delta\bar{x}\left[\frac{c\delta(k+\bar{x}-x_L)}{\bar{x}-x_L} + \frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}k\right]\right)\\ &= \text{sign}\left(\left(\frac{-\delta^2\bar{x}-x_L}{\bar{x}-x_L}\right)(k+\bar{x}-x_L)c\right) = -\end{aligned}$$

If we differentiate (3) with respect to α we have that

$$-\pi^{HTC}\delta^2(x_H - x^c) + \frac{\partial\pi^{HTC}}{\partial\alpha}(x_L - \delta^2\bar{x})$$
$$+\frac{1-\pi^{HTC}}{\bar{x}-x_L}[(x_H - x^c)(x_L(1-\delta^2) - \delta c)k]$$
$$-\frac{\partial\pi^{HTC}}{\partial\alpha}\left[\frac{c\delta(k+\bar{x}-x_L)}{\bar{x}-x_L} + \frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}k\right] = 0$$

which implies that

$$\begin{aligned}\operatorname{sign}\left(\frac{\partial\pi^{HTC}}{\partial\alpha}\right) &= \operatorname{sign}\left(\frac{1-\pi^{HTC}}{\bar{x}-x_L}[(x_H-x^c)(x_L(1-\delta^2)-\delta c)k]-\pi^{HTC}\delta^2(x_H-x^c)\right)\\ &= \operatorname{sign}\left(\left(\frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}\right)[(x_H-x^c)(x_L(1-\delta^2)-\delta c)k]-\delta^2(x_H-x^c)\left[\frac{c\delta(k+\bar{x}-x_L)}{\bar{x}-x_L}+\frac{\delta^2\bar{x}-x_L}{\bar{x}-x_L}k\right]\right)\\ &= \operatorname{sign}\left(\left(\frac{x_H-x^c}{\bar{x}-x_L}\right)((\delta^2\bar{x}-x_L)(1-\delta^2)(x_L-k\delta^2)-\delta c(k+2(\delta^2\bar{x}-x_L)))\right)=-\square\end{aligned}$$

Proof of Proposition 1. Part (a): The proof is direct by inspection of (4) and (5).

Part (b): Notice that $\pi^{HTC}(c=0,\ \delta=1,\ \alpha=1)=\pi^{NC}$. Additionally, as the argument of the integral in (6) is always larger than the argument of the integral in (4) we have that $L^{HTC}(c=0,\ \delta=1,\ \alpha=1)>L^{NC}$. On the other hand it is simple to see that $L^{HTC}(c=k,\delta=1,\bar{x}-x_L<<k)<L^{NC}$ because π^{HTC} gets arbitrarily close to 1 which implies that all disputes under regime HTC are resolved at $t=1$ while some disputes are solved at $t=2$ under regime HTC. Consequently, it is enough to show that L^{HTC} is decreasing in c, it is increasing in δ and it is increasing in α when $c=0$ and $\delta=1$. The conclusion follows from an argument of continuity.

First, notice that

$$\frac{\partial L^{HTC}}{\partial c}=-\left(\frac{2(\bar{x}-x_L+k)}{\bar{x}-x_L}+p^D\right)(1-\pi^{HTC})f(\pi^{HTC})\frac{\partial\pi^{HTC}}{\partial c}<0$$

because $(\partial\pi^{HTC}/\partial c)>0$ as was shown in Lemma 1. Next, notice that

$$\begin{aligned}\frac{\partial L^{HTC}}{\partial\delta} &= \int_{\pi^{HTC}}^{1}\frac{2(\bar{x}-x_L)x_L}{\delta^3(\delta^2\bar{x}-x_L)}(1-x)f(x)\,dx\\ &\quad-\left(\frac{2(\bar{x}-x_L+k)}{\bar{x}-x_L}+p^D\right)(1-\pi^{HTC})f(\pi^{HTC})\frac{\partial\pi^{HTC}}{\partial\delta}>0\end{aligned}$$

because $(\partial\pi^{HTC}/\partial\delta)<0$ as was shown in Lemma 1 and finally, notice that

$$\begin{aligned}\left.\frac{\partial L^{HTC}}{\partial\alpha}\right|_{c=0,\delta=1} &= \int_{\pi^{HTC}}^{1}\frac{2(x_H-x_L)k}{(\bar{x}-x_L)^2}(1-x)f(x)\,dx\\ &\quad-\left(\frac{2(\bar{x}-x_L+k)}{\bar{x}-x_L}+1\right)(1-\pi^{HTC})f(\pi^{HTC})\frac{\partial\pi^{HTC}}{\partial\alpha}>0\end{aligned}$$

because $\left.\frac{\partial\pi^{HTC}}{\partial\alpha}\right|_{c=0,\delta=1}=-\frac{(x_H-x^c)k}{(\bar{x}-x_L)^2}<0.$ □

Proof of Proposition 2. Part (a): Proposition 2 tells us that the fraction of disputes resolved at trial instead of settlement is larger under Regime NC than under Regime LTC. As trials are more expensive than settlements, it is direct that litigation expenses are higher under Regime NC than under Regime LTC.

Part (b): Expected litigation expenses under Regime NC are

$$E^{NC}=c+\int_{\pi^{NC}}^{1}(1-x)\delta kf(x)\,dx$$

While expected litigation expenses under Regime HTC are

$$c+\int_{\pi^{HTC}}^{1}\{xp^{LP}\delta^2c+(1-x)(\delta^2c+p^D\delta^3k)\}f(x)\,dx$$

$$E^{HTC}=c+\int_{\pi^{HTC}}^{1}(1-x)\left(\frac{\delta^2c}{1-\pi^*}+\delta^3p^Dk\right)f(x)\,dx$$

First notice that E^{HTC} coincide with E^{NC} when $c=0$; $\delta=1$; $\alpha=1$. Next we show the behavior of $E^{HTC}-c$ with respect to c, δ and α when we start at point $c=0$; $\delta=1$; $\alpha=1$.

$$\begin{aligned}\left.\frac{\partial(E^{HTC}-c)}{\partial c}\right|_{\delta=1,\alpha=1} &= \int_{\pi^{HTC}}^{1}\frac{x_H-x_L+k}{x_H-x_L}(1-x)f(x)\,dx\\ &\quad-\frac{(1-\pi^{NC})(x_H-x_L+k)}{x_H-x_L}cf(\pi^{HTC})\end{aligned}$$

As the first expression is decreasing in c while the second one increasing in c, we conclude that $E^{HTC}-c$ first increases and later decreases with that variable.

$$\left.\frac{\partial(E^{HTC}-c)}{\partial\delta}\right|_{c=0,\alpha=1}=\int_{\pi^{HTC}}^{1}\frac{2\delta^2x_H}{\delta^2(x_H-x_L)}(1-x)f(x)\,dx$$

which is positive for all values of δ and

$$\left.\frac{\partial(E^{HTC}-c)}{\partial\alpha}\right|_{c=0,\delta=1}=(1-\pi^{NC})k^2\frac{(x_H-x^c)(x_H-x_L)}{(\bar{x}-x_L)^2}f(\pi^{NC})$$

which is positive for all values of α. Then, by a continuity argument, there must exist (c^+,α^+,δ^+) *and* (c^*,α^*,δ^*) *such that for all* $c\in[c^+,c^*]$, $\alpha\in[\alpha^*,\alpha^+]$, $\delta\in[\delta^*,\delta^+]$ it is true that E^{HTC} is larger than E^{NC}. □

Proof of Proposition 3. Part (a): In Regime NC high-type plaintiffs recover δx_H for all values of π. In Regime LTC high-type plaintiffs recover δx^c for all values of π. In Regime HTC high-type plaintiffs recover $\delta^3\bar{x}$ for all values of π. As $x_H>\delta^2\bar{x}>x^c$ then the result follows.

Part (b): For all values of $\pi<\pi^{NC}$ the low-type plaintiffs recover δx_H in Regime NC which is larger than the maximum recovered in Regimes LTC and HTC given by $\max\{\delta^3\bar{x},\delta x^c\}$. For all values of $\pi\in[\pi^{NC},\ \max\{\pi^{HTC},\ \pi^{LTC}\}]$ the low-type plaintiffs recover δx_L in Regime NC which is smaller than δx^c which is what they recover in Regime LTC and smaller than $\delta^3\bar{x}$ which is what they recover in Regime HTC. Finally, for all values of $\pi>\max\{\pi^{HTC},\pi^{LTC}\}$ the low-type plaintiffs recover an expected value of δx_L in all regimens.□

Proof of Lemma 3. We provide details for the derivation of α^*, the analysis is analogous for c^* and δ^*. We show that for all values of c and δ there exists $\alpha^*\in[0,1]$ such that for all $\alpha>\alpha^*$ the expected litigation expenses are larger in a Regime HTC than in Regime NC. The rest of the proof follows as in Proposition 2.

We call $E^{NC}(x)$ the litigation expenses in a cycle of 4 periods when there are no-caps and the recoveries of the high type is x; E^{LTC} the litigation expenses in a cycle of four periods when the caps involve low expected trim and $E^{HTC}(\alpha)$ the litigation expenses in a cycle of four periods when the caps involve high expected trim and the caps are stroke down with probability α.

Then, in an infinite horizon litigation expenses in HTC are higher than in NC if and only if:

$$E^{HTC}(\alpha)+\alpha\sum_{i=1}^{\infty}(\delta^4)^i LE^{NC} +(1-\alpha)\sum_{i=1}^{\infty}(\delta^4)^i LE^{NC}(x^c) > \sum_{i=1}^{\infty}(\delta^4)^i E^{NC}(x_{\mathrm{H}})$$

which is equivalent to

$$E^{HTC}(\alpha)-E^{NC}(x_{\mathrm{H}}) > (1-\alpha)[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)]\sum_{i=1}^{\infty}(\delta^4)^i$$

$$E^{HTC}(\alpha)-E^{NC}(x_{\mathrm{H}}) > (1-\alpha)[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)]\frac{\delta^4}{1-\delta^4}$$

$$\alpha > \frac{[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)](\delta^4/(1-\delta^4))-[E^{HTC}(\alpha)-E^{NC}(x_{\mathrm{H}})]}{[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)](\delta^4/(1-\delta^4))}$$

The last inequality is satisfied for all the values of $\alpha > \alpha^*$ where α^* is implicitly defined by

$$\alpha^* = \frac{[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)](\delta^4/(1-\delta^4))[E^{HTC}(\alpha^*)-E^{NC}(x_{\mathrm{H}})]}{[E^{NC}(x_{\mathrm{H}})-E^{NC}(x^c)](\delta^4/(1-\delta^4))}$$

Notice that $\alpha^* \in [0, 1]$ because the right hand side expression is decreasing in α. It takes a value larger than 1 when $\alpha = 0$ and a value smaller than 1 when $\alpha = 1$ (because $E^{HTC}(0) - E^{NC}(x_{\mathrm{H}}) < 0$ as indeed we are in a case of LTC and $E^{HTC}(1) - E^{NC}(x_{\mathrm{H}}) > 0$). $\square$

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