Documento de Trabajo

A Dynamic Theory of Common Law Courts

Álvaro Bustos

www.economia.puc.cl

PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE
INSTITUTO DE ECONOMIA

Oficina de Publicaciones
Casilla 76, Correo 17, Santiago
www.economia.puc.cl

A DYNAMIC THEORY OF COMMON LAW COURTS

Álvaro Bustos∗

Documento de Trabajo Nº 352

Santiago, Junio 2008

∗a-bustos@law.northwestern.edu / a-bustos@kellogg.northwestern.edu

INDEX

A Dynamic Theory of Common Law Courts

Álvaro Bustos[*]

First draft: December 2004. This draft: June 2008[†]

Abstract

We develop a model that determines when and how time-consistent and forward-looking courts *should* set and reform legal rules (a normative theory for dynamically efficient courts). We explicitly take into account that: 1) the optimal rules most likely are not the same for all periods of time; 2) courts can only rule at trials; 3) the enforcement strategies of courts determine the litigation strategies of present and future parties in conflict; and 4) the parties in conflict can contract around the rules. As main results, we show that: 1) courts should set those rules that maximize the value of the present parties in conflict (statically efficient rules) only under extreme circumstances; 2) if legal rules are the only control variables, courts should adjust the unconstrained first-best rules for society in order to give the parties incentives to partially correct an inefficient frequency of litigation; 3) there always exists a distribution of the litigation expenses between the parties that generates an optimal frequency of trials in which case courts don't need to bias the rules. The model allows us to analyze the social desirability of two commonly suggested strategies to increase the frequency of shareholders' litigation: adding ambiguity to the law or involving public prosecutors as the N.Y.A.G.'s office or agencies as the S.E.C. In addition, the model also allows us to discuss when courts should set contingent rules (rules that adapt to the states of nature) instead of rigid rules (rules that don't adapt to the states of nature).

Keywords: Efficiency of the Law**,** Myopic Courts, Forward-Looking Courts, Optimal Enforcement Strategies, Optimal Frequency of Trials, Rigid and Contingent Rules.

JEL classification: K20, K22, K40

Cessante ratione, cessat ipsa lex

(when the reason of a rule ceases, so should the rule itself)

Coke CJ's old maxim

"Our corporate law is not static. It must grow and develop in response to, indeed in anticipation of, evolving concepts and needs. Merely because the General Corporation Law is silent as to a specific matter does not mean that it is prohibited."

Supreme Court of Delaware, *Unocal vs Mesa* (493 A.2d 946, 1985)

1   Introduction

Legal scholars and economists suggest that courts are called to set and reform legal rules[1] in order to improve the efficiency of contracts. Courts do that in at least two ways: they fill the gaps left by the contracting parties because it is expensive to write complete set of clauses, and they constrain the behavior of the parties whenever inefficiencies such as abuses of power or collective action problems are possible (see Kraakman and Hansmann [2004] or Becht, Bolton and Roell [2004].) Nevertheless, the fundamental question of *how* courts can accomplish these tasks has yet to be answered. For example, what is the concrete problem faced by a court that has to decide if a legal rule should be preserved or reformed? When and how should courts make these reforms? When should courts be active reformers of the law (activists) instead of strong defenders of its original text (originalists)[2]?

Since the seminal work by Landes and Posner (1976), later extended by Priest (1977), Rubin (1977), Cooter and Kornhauser ([1979], [1980]), which suggests that common law legal rules evolve efficiently,[3] an extensive literature in Law and Economics has studied how judges should set efficient legal rules. As a common characteristic, the majority of this work has concentrated its efforts on studying rules that are statically efficient (rules which are efficient for *current* technological, economical and legal conditions of

---

[1] For example they interpret statutes, decide new issues and overrule former precedents.

[2] Although the popular press (and also part of the literature) commonly refers to a non-activist judge as a conservative judge, we prefer to use the term originalist because ideologically conservative judges may very well behave as activists and overturn precedents. For example, that is the case of Justice Clarence Thomas.

[3] Under a common law legal system inefficient rules are litigated (and then replaced) more frequently than efficient rules. More recent research has shown that this result is not robust if judges maximize personal utilities, are biased, take into account externalities, or face personal costs if a precedent is overruled (see for example Miceli and Cosgel [1993], Harnay and Marciano [2003], Chu [2003] and Gennaioli and Shleifer [2007]).

society, form now on, the environment.) While Easterbrook and Fischel (1991)[4] have suggested that judges should always set the ex-ante most efficient rules for the disputing parties (the rules that the parties would have wanted to write before the dispute took place) Ayres and Gertner (1989), Bebchuk and Shavell (1991), Anderlini *et al* (2003) and Maskin (2005) have suggested that that should be the case only if there are no asymmetries of information and Usman (2002), Bond (2003), Shavell (2003) and Levy (2005) have suggested that that should be the case only if judges are benevolent.

Beyond recent work by Anderlini *et al* (2007), Franks and Sussman (2005) and Genniaoli and Shleifer (2007), as a trend, the literature has given much less attention to the characterization of rules that are dynamically efficient (rules which are efficient for *current and future* conditions of the environment.) Given that in practice, when setting legal rules, courts face not a static but essentially a dynamic problem,[5] this paper intends to contribute to the growing literature by providing time-consistent and forward-looking judges with a normative theory on dynamically efficient rules. The starting point of such theory is to notice that there are at least three considerations that forward-looking courts have to take into account when making a decision that myopic courts do not. First, as environments are in constant evolution the best rule for one period of time may not be the best rule for future periods. Second, unlike legislators, courts cannot modify common law whenever they want but they must wait for a trial to take place to reform a legal rule. Third, the court's rule-setting strategy will affect the future contracting parties litigation strategies.

Anderlini *et al* (2007) develop a model that compares the capacities of common and civil law legal systems to solve the time-inconsistency problem faced by judges (after a trial judges are tempted to set statically and not dynamically efficient rules.) The authors emphasize how precedents act as a commitment device that allow common law to adjust more efficiently to environments that change very often. Although the paper takes into account the evolution of environments, it omits the structural link between trials and rules because it assumes that trials take place every period. Genniaoli and Shleifer (2007) show that even when judges are motivated by personal agendas, legal evolution is, on average, beneficial because it washes out judicial biases and makes the law more precise. Closer to the spirit of our work, Franks and Sussman (2005) analyze the evolution of the bankruptcy law as a mechanism for the standardization of default clauses[6] under a free-contracting regime. One-period lived corporations write debt contracts that determine the probability of liquidation of their assets in the case of bankruptcy. Corporations can either write a standard contract

---

[4] Complementary analysis can be found in Baird and Jackson (1985) and Posner (2003).

[5] Because of the legal doctrine of *stare decisis* (courts are supposed to follow binding precedents) the rules set by a common law court will regulate/affect the future affairs of society.

[6] Default clauses are clauses provided by legislators to fill the gaps left by the contracting parties. While mandatory rules must be always followed, the parties can contract around default rules.

at zero cost or write a new contract paying a fixed cost, in the last case, a trial takes place with certainty and courts are called to accept or reject the new contract. Nevertheless, because the decisions of courts are summarized by a given probability, ultimately, the dynamics of the standards is exogenously given.

In order to develop a framework in which courts repeatedly face trials that resolve disputes of the same kind, we model the decisions of an infinitely-lived, time-consistent and benevolent court facing agents that live for one period, which we take to be corporations. Each corporation is owned by two groups of shareholders. The corporations face business opportunities, which we take to be new acquisitions. The targeted corporations may have more or less efficient charters setting up takeover defenses and courts may be called to rule on these defenses if one of the shareholders group (plaintiff) chooses to sue in response of the other's group (defendant) attempt to reform the charter. Alternatively, the parties can settle their disputes by contracting around the rules. We model the set of legal rules that regulate the decisions of corporations simply as the probability that an acquisition offer is rejected (we call this probability the legal standard of takeover defenses.) A target prefers a high (low) standard whenever it faces a market that with a high (low) probability generates an offer that will reduce its value—an inefficient offer—and with a low (high) probability generates an offer that will increase its value—an efficient offer.[7] As shown by Grossman and Hart (1980), an inefficient offer increases the probability that a corporation could be sold below its current value.[8] In the same line, higher defenses give the target more time to analyze the business opportunity, receive alternative offers or look for a friendly acquirer (a "white knight").[9]

An important characteristic of our framework is that it explicitly models the three roles played by trials in practice. First, at a trial, the court decides if the standard is preserved or reformed (resolve disputes). Second, at a trial, the court corrects/eliminate inefficient antitakeover standards and replace them with efficient ones (improve the quality of the law).[10] And third, at a trial, all the interested agents (the court, current and future corporations) learn about the changes in the environment that can be used to improve the law and/or future contractual agreements (reveal information).[11]

---

[7] Notice that we are referring to the post-acquisition value.

[8] Given that minority shareholders face a significant potential dilution of their positions if they stay with the acquired corporation, they will tender at too low price.

[9] As shown by Scharfstein (1988) the anti-takeover standard needs to be regulated because targeted shareholders have incentives to set defenses that are too high from society's point of view (they want to extract a monopoly rent.) To be more specific, majority shareholders choose the level of dilution of the position of minority shareholders that optimally balances the attraction of more offers with the reduction of the offered price. As a central planer sees an acquisition as a transference of value, it is only interested in increasing the level of activity of takeovers. Consequently, society always want a higher level of dilution than the one majority shareholders will freely choose to set.

[10] Some literature (e.g. Shavell [1997]) argues that trials don't have much value as instances in which the law is constantly improved because the majority of judicial adjudications don't set new precedents. However, this argument ignores the fact that when a court follows a precedent it reaffirms its validity. Consequently, regardless precedents are preserved or reformed, trials give courts opportunities to test the quality of the law.

[11] For example Hua and Spier (2005) mention that the true value of the damages generated by the Exxon Valdez when it

The paper generates two main results. First, unless litigation takes place continuously, society is completely myopic, or the environment doesn't change, courts should not enforce rules that are in the best interest of current litigants. Taking into account the interests of future litigating parties, courts should set rules that are optimally adapted to the states of the environment that are expected to occur before the next trial takes place.

The legal history provides many examples in which courts seem to have made wrong decisions due to the omission of dynamic considerations. For example, in 1985, the Chancery and Supreme courts of Delaware made a series of legal decisions, as *Moran*[12] and *Smith*[13], that considerably increased the level of anti-takeover regulation, thus making takeovers significantly less attractive. These decisions were a reaction to the wave of takeovers triggered by the financial innovation of junk bonds.[14] This instrument considerably increased the probability that corporations could face inefficient offers.[15] Though sentences as *Moran* and *Smith* seemed justified at the time, today, they seem much more questionable given that the market for high-yield bonds collapsed in 1989 (and with it the wave of takeovers ended) yet these decisions have remained as leading precedents in corporate litigation.[16]

Second, *if legal rules are the only control variable*, forward-looking courts should not set unconstrained first-best rules (the optimal rules if courts were able to initiate trials.) If trials took place with a socially optimal frequency then courts would be able to set first best rules. However, as it was noticed by Shavell ([1997], [1999]), the frequency of litigation is not optimal because the party that triggers the conflict does not internalize the costs of litigation paid by the other party in conflict (we call this externality: contemporaneous) and the current parties in dispute don't internalize the social benefits of a judicial sentence that improves the law (we call this externality: inter-temporal.) In an attempt to bring the frequency of litigation

---

spilled oil in the coasts of Alaska in 1989, estimated later in $2.5 billions, could has been revealed and used to deter similar disasters in the future if the state of Alaska had litigated the case to the merits and not signed a settlement in which Exxon only paid $1 billion.

[12] Moran, a minority member of the board of directors of Household International Inc. and potential acquirer of the firm, impugned the decision of the board of directors to adopt a preferred share purchase rights plan that would make a takeover attempt more difficult by diluting the position of the would-be acquirer (a poison pill.) The Court of Chancery of Delaware upheld, for the first time, that the adoption of the pill was legitimate (500 A.2d 1346, 1985).

[13] Shareholders from Trans Union brought a class action seeking a rescission of a cash-out merger of the company into the New Trans Union. The Supreme Court held that the board of Trans Union violated its fiduciary duties (of protecting the interests of shareholders) when it accepted the merger because it did not act informed, was grossly negligent and failed to disclose all material facts which they knew or should have known before securing stockholders' approval of the merger (488 A.2d 858, 1985). This precedent imposed a higher standard of effort required by the board of directors at the moment of deciding whether an offer should be accepted.

[14] High-yield or subinvestment-grade bonds made possible the massive use of leveraged-buy-outs.

[15] For example, using data from CRSP, we calculated that the frequency with which an acquired corporation listed on the NYSE or NASDAQ was delisted due to financial distress within two years after the merger took place between 1985 and 1989 is double the same frequency between 1990 and 2004.

[16] *Moran* is the *stare decisis* in the use of Poison Pills while *Smith* is an important reference in the determination of the validity of the Business Judgment Rule or a potential violation of Fiduciary Duties (by managers and directors) in mergers and acquisitions.

closer to the optimal level courts must bias the rules in favor or against the preferences of current litigants.

Centrally, the second result uncovers the existence of a structural link between legal rules and frequency of litigation (unlike in Shavell's papers we explicitly link the timing of trials and the value of the standard to the contemporaneous and inter-temporal externalities.) Because we are able to characterize the inter-temporal externality, the model identifies the conditions under which the frequency of litigation would be too high or too low.[17] As general points, we show that the inter-temporal externality is not affected by the distribution of the litigation expenses between the parties in conflict; the inter-temporal externality *increases* (future corporations benefit) with the cost of litigation but *decreases* (future corporations get harmed) with the value of the corporations.

In particular two predictions seem especially relevant. First, as in the case in which the defendant doesn't face litigation expenses the aggregate externality (contemporaneous plus inter-temporal) is negative and in the case in which the defendant faces the totality of the litigation expenses the aggregate externality is positive we conclude that there always exists a distribution of these expenses in which the externalities cancel each other out, corporations generate a socially optimal frequency of trials and courts set unbiased rules.[18]

Second, we show that, contrary to intuition, if the costs of litigation, relative to the value of the corporation, are big enough the frequency with which trials take place is suboptimally low. In this case, courts try to increase the frequency by setting standards that are biased towards the preferences of current litigants. The reason why there would be too few trials is that although a marginal increment in the litigation expenses decreases both the private and social incentives to litigate, the first effect is bigger than the second one.

The main results of the paper open a new angle in the debate whether judges should be activists or originalists (the debate was revived with the nomination and confirmation of John Roberts as the successor of William Renhquist as chief justice of the Supreme Court. At the time, several commentators described Roberts as a conservative that "would not likely push the court to overturn previous decisions.")[19] Our model suggests that the degree of activism of a rational court should depend on the frequency with which trials take place. Specifically, the standard should be reformed less frequently and biased more moderately

---

[17] The common belief among academics (see for example, bebchuck [1988] or Murphy, Shleifer and Vishny [1991]); legislators ("To avoid the expense and delay of having a trial, judges encourage the litigants to try to reach an agreement resolving their dispute." in www.uscourts.gov/understand02/content_6_1.html) and even the general public ("The Most expensive disease in this country is hyperlexis, too many lawsuits chasing too few facts" (Editorial The Wall Street Journal 01/20/92)) is that American society is too litigious. Trials are seen as wasteful activities whose only role is to resolve disputes that could just as easily be settled by the parties themselves. However after we take into account the three before mentioned roles of trials it becomes unclear whether society faces too many or too few of them.

[18] Although Shavell also makes this point, here we provide an *estimable* distribution of the expenses.

[19] Source: broadcasted interviews to Jeffrey Rosen (Professor at George Washington University Law School) and Cass Sunstein (Professor at the University of Chicago Law School) on National Public Radio respectively on the 09/05/05 and 09/10/05.

if trials take place more regularly. Consequently, it is very likely that what is optimum for society is that judges should be activists in certain branches of the law but originalists in the others.

The model also allows us to analyze the social desirability of two strategies suggested by regulators as ways of increasing shareholders litigation.[20] First, we consider the strategy of adding indeterminacy to the law.[21] We show that the pure addition of uncertainty to the law doesn't improve welfare because the kind of trials generated due to ambiguous regulation have the undesirable property of taking place whether the law needs to be improved or whether it does not.[22] However, if the parties in dispute have the option to settle their differences (in which case the standard is not reformed) at a cost that is neither too high nor too low, then a certain level of indeterminacy in the law may be desirable. Settlement gives the parties the option to increase the frequency of trials but the increment may be excessive if the negotiation cost is very low and the increment may be negligible if the same cost is very high. The result suggests that vague standards such as the *Unocal-Revlon* proportionality test[23] are more effective in keeping legal rules up to date if corporations have a degree of discretion to decide when a dispute should end in a trial.

Second, we analyze the role of agencies such as the Securities and Exchange Commission (S.E.C.) or public prosecutors such as the New York Attorney General's Office (N.Y.A.G.) as external generators of trials. We find that their intervention can bias the frequency of trials toward excess whether it is needed or not. The reasons are that these agencies can initiate trials but cannot prevent them from taking place and since the quality of their information is usually lower than the one owned by corporations, there is the risk that litigations will be initiated when they are not needed.

We end the paper discussing when courts should set contingent rules instead of rigid rules. Although we don't provide a complete analysis, we suggest that there exists a trade-off between quality (maximization of corporations value) and adjustment costs (costs from interpreting the meaning of the rules when the environment changes.) While contingent rules are of higher quality than rigid rules they also have associated larger adjustment costs. The relative value of these two effects will determine which rules should be used in each particular branch of the law.

The rest of the paper is organized as follows. In Section 2 we introduce the theoretical framework. In

---

[20] Which for example would be relevant in branches of the law where litigation is believed to be particularly expensive such as corporate, bankruptcy and antitrust law.

[21] As stated by Kamar (1998) "while some indeterminacy in corporate law may be inevitable, the degree of indeterminacy in Delaware law seems too high".

[22] This result must be read carefully because we don't consider that ambiguous but flexible rules allow the law to adapt better to new conditions in the markets.

[23] The *Unocal-Revlon* proportionality test is the standard used by courts to determine whether managers violated their fiduciary duties at the moment of accepting a takeover offer. The test states that managers have to respond with reasonable defensive actions to threats posed to the interestes of shareholders. A priori it is not obvious what is a reasonable defensive action or a posed threat.

Section 3 we describe the problem faced by the court at each trial. In Section 4 we derive our main results. In Section 5 we test the robustness of the results and develop extensions. In Section 6 we conclude and mention avenues for future research.

2   Theoretical Framework

We model the decisions of an infinitely lived court and an infinite sequence of one-period lived parties (P and D) that own a one-period lived corporation[24] in discrete time, all indexed by t on the natural line.[25] For clarity of exposition we explain each of the components of the model separately and add four technical assumptions that simplify the mathematical treatment of the paper. In Section 5 we relax these assumptions and show that the main results are not affected.

2.1   Corporations, state of the environment and the standard

All corporations are identical. Each of them has an initial value W and faces a business opportunity (for example a takeover or a merger offer) with probability b.[26] The corporation has to accept or reject the offer (at this point we don't make a distinction between the parties because they don't directly affect the decision of the corporation.) We distinguish two types of offers: efficient ones (if the corporation accepts the offer it increases its value) and inefficient ones (if the corporation accepts the offer it decreases its value.) Consequently, the corporation can make right decisions (it accepts an efficient offer or rejects an inefficient one) or wrong decisions (it accepts an inefficient offer or rejects an efficient one.) We use this simplified decomposition to write the expected value of each corporation as[27]

$$(1-b)W + b\left[\Pr(\text{right decision})\alpha W + (1 - \Pr(\text{right decision}))0\right]$$

---

[24] The expected life of a corporation is much shorter than the one of a legal system (corporations are dissolved, merged or bought among other options while a legal system will be present along with the existence of a country). Said that, we believe that the qualitative (although not quantitative) results of the paper are preserved if corporations are modeled as long-lived agents. It is true that in that case the incentives of a corporation to generate a trial are changed but the negative and positive externalities persist. Even more, if in our framework corporations were long-lived statically and dynamically efficient rules would differ more starkly.

[25] Although it is harder to work in discrete time instead of continuous time (the literature of sticky prices with endogenous adjustment time provides a framework to analyze problems as ours, see Reis [2004] or Bonomo and Carvalho [2004]) we have choosen the first option to make the model more intuitive.

[26] In reality, this probability is endogenously determined by the legal framework as modeled by Schnitzer (1991).

[27] The formulation treats equivalently benefits due to right acceptances and rejections as well as losses due to wrong rejections and acceptances. Our results don't depend on this imposed symmetry and simplifies the analysis considerably.

It is explicit that the value of a corporation that makes the wrong decision goes to 0 while the value of a corporation that makes the right decision increases proportionally with $\alpha > 1$. In the case of take-overs this parameter can be interpreted as the premium obtained by the targeted shareholders when the transaction takes place.[28]

We identify the probability of a right decision in the following way. We characterize an offer as the random price $P(t)$ uniformly distributed in $[0, 1]$ at which a raider offers to buy the corporation[29] such that there exists a parameter $\theta(t) \in [0, 1]$ which determines when the offer is inefficient: $P(t) < \theta(t)$ and when is efficient: $P(t) \geq \theta(t)$.[30] In other words, the probability of receiving an inefficient offer is $\int_0^{\theta(t)} dP(t) = \theta(t)$. Next, we define the legal standard $s(t) \in [0, 1]$ as the probability that an offer is rejected if the decision is *completely* determined by the set of legal rules such that if $P(t) < s(t)$ the corporation has to reject the offer but if $P(t) \geq s(t)$ it has to accept it. In other words, the probability of rejecting an offer is $\int_0^{s(t)} dP(t) = s(t)$.

If the decision of the corporation was completely determined by the standard, the probability of a right decision would be given by $1 - |s(t) - \theta(t)|$. Nevertheless, as we know that in practice the standard *doesn't completely* determine that decision, we define the probability of a right decision as[31]

$$\Pr\left(\text{right decision}\right) = 1 - F((s(t) - \theta(t))^2)$$

where $F : [0, 1] \rightarrow [0, 1]$ captures the degree in which the regulation affects the final decision. At this point we prioritize tractability of the model and assume that

Technical Assumption 1: $F(x) = x$.

REMARK (Standard) In practice, many corporate decisions are strongly affected, although off course not completely determined, by the set of rules enacted by legislators (statutes) and courts (case law) that are usually written into the charters of the corporation (what we call the standard.) For example the capacity of a manager to reject a takeover strongly increases if a poison pill is in place or the board of directors is staggered, equally, shareholders can get more or less involved in the decision process depending on how easy it is for them to call meetings or to vote.

---

[28] Black and Grundfest (1988) suggest that this premium ranges between 1.3 and 1.5.

[29] The strong assumption that offers are randomly generated is partially mitigated by the fact that in average raiders break even in acquisitions (see Gilson and Black [1995]).

[30] The cut-off $\theta(t)$ can be interpreted as the initial value of the corporation normalized by its expected maximum (post-acquisiton) value. This last value will depend on the capacity of the raider to improve the management, generate synergies or exploit tax benefits in the acquired corporation (in a period of high level of inefficient activity, the maximum post-acquisition value is smaller than the same value in a period of low level of inefficient activity.)

[31] This expression penalizes in the same way too stringent ($s(t) > \theta(t)$) or too soft standards ($s(t) < \theta(t)$).

Within this framework the expected value of corporation t turns to be an increasing function on how well the law tracks the state of the environment represented by the parameter $\theta(t)$

$$
\begin{aligned}
U(s(t), \theta(t)) &= (1 - b(1 - \alpha))W - b\alpha W (s(t) - \theta(t))^2 \\
&= \widetilde{W} - b\alpha W (s(t) - \theta(t))^2
\end{aligned}
$$

where $\widetilde{W} = (1 - b(1 - \alpha))W$. In order to introduce the notion that the environment is in constant change we notice that at every period a corporation may face inefficient offers with a high or low probability.[32] In terms of the model we assume that $\theta(t) \in \{\theta_L, \theta_H\}$ with $0 < \theta_H < \theta_L < 1$ follows a Markov process with transition probabilities

$$
\begin{aligned}
q_1 &= \Pr[\theta(t+1) = \theta_L \mid \theta(t) = \theta_L] \\
q_0 &= \Pr[\theta(t+1) = \theta_L \mid \theta(t) = \theta_H]
\end{aligned}
$$

and $\Lambda = q_1 - q_0 > 0$.

2.2 Information process

The parties and the court have the same information which is summarized by the following sufficient statistic: $p(t) = \Pr[\theta(t) = \theta_L \mid \Omega_t]$ where Ω_t is the information available at the beginning of period t. Although in reality agents are able to extract information about the environment from the decisions of former corporations facing business opportunities, here we restrict the sources of information only to trials (in Section 5 we allow the parties to learn outside the litigation process)

Technical Assumption 2: All agents learn the true state of the environment at trials which are the only sources of information.

REMARK (Information and the Standard) The assumption that the parties in conflict learn about the state of the environment at trials should not be understood literally as that the parties learn about the economy and the markets. That may be true for the judge but clearly not for the parties. What the

---

[32] There are two reasons why this is the case. First, changes in markets may generate or eliminate rent opportunities (Shleifer and Vishny [1991] suggest that the wave of takeovers of the '80s was most likely triggered by an inefficient level of diversification of corporations initiated in the '60s.) Second, financial innovations (like high yield bonds or bridge loans), technological progress (like computers or internet) and also changes in the characteristics of corporations (like the use of Special Purpose Units in mergers) may alter the level of activity and the type of offers faced by the targets.

parties learn at a court room is whether the legal framework/standard still is or not adequate for the new environment. And that will be determined by the expert analysis of the judge.

At trials, agents realize that $\theta(t) = \theta_H \implies p(t) = 0$ or that $\theta(t) = \theta_L \implies p(t) = 1$. Given the information process we index $p(t)$ by the state of the environment most recently revealed to all agents in the following way

$$p_H(t) = \Pr\left[\theta(t) = \theta_L \mid \Omega_t, \text{at the last trial environment was revealed } \theta_H\right]$$

$$p_L(t) = \Pr\left[\theta(t) = \theta_L \mid \Omega_t, \text{at the last trial environment was revealed } \theta_L\right]$$

In the periods without a trial (we call it a cycle) beliefs are adjusted according to the Markovian process $p_n(t+1) = p_n(t)q_1 + (1 - p_n(t))q_0$ which becomes $p_H(t) = q_0(1 - \Lambda^{t-1})/(1 - \Lambda)$ when, at the last trial, the environment was revealed to be High or $p_L(t) = \left[q_0 + (1 - q_1)\Lambda^{t-1}\right]/(1 - \Lambda)$ when it was revealed to be Low. Notice that $p_H(t) < p_L(t)$ for all t and both processes converge to the same stationary probability $p^* = q_0/(1 - \Lambda)$. During a cycle the Markovian process generates an information decay process.[33] That is, at time t, the probability that the state of the environment coincides with the one that was discovered at the trial is smaller than the same probability at time $t - 1$. Consequently, the expected value of a corporation facing standard $s(t)$ and having beliefs $p_n(t)$ is given by

$$
\begin{aligned}
V(s(t), p_n(t)) &= p_n(t)U(s(t), \theta_L) + (1 - p_n(t))U(s(t), \theta_H) \\
&= \widetilde{W} - b\alpha W \left[p_n(t)(s(t) - \theta_L)^2 + (1 - p_n(t))(s(t) - \theta_H)^2\right]
\end{aligned}
$$

Notice the loss-function shape of the last expression. The value of the corporation is penalized by the distance of the standard to the current state of the environment. It is clear from the information decay process that the expected value of a corporation will constantly decrease due to the belief that the law is becoming less adequate for the current environment.

---

[33] Harris and Holmstrom (1987) have the same property in a model in which an infinitely lived lender has to decide every period whether to pay a cost to collect information about the quality of an infinitely lived borrower to whom is deciding to finance.

2.3 The court

In our model, there is a unique[34] and time-consistent court that acts as a central planner (the obvious analogy is the Supreme Court.) Although we recognize that the court faces different incentives before and after a trial takes place[35] and we discuss that in Sections 4 and 5, at this point we assume that

Technical Assumption 3: The court commits to the strategy that maximizes the value of all corporations at $t = 1$.

The court can only reform the legal standard at trial. More specifically, whenever it resolves a dispute it decides whether to preserve or modify the current standard. We denote this decision the enforcement strategy $s(\theta(t)) = s_n : \{\theta_L, \theta_H\} \longrightarrow [0, 1]$. For parsimony we refer to the opposite standard of s_n as s_{-n}.

2.4 Parties, attempts to reform the standard and the litigation process

We consider that at the beginning of period t, D owns a fraction ν_1 of the corporation while P owns a fraction $1 - \nu_1$. If the standard is modified (either because the parties (D, P) agree to do that or because the court decides that at a trial) the ownership of the corporation is changed such that now D owns a fraction $\nu_2 > \nu_1$ and P owns a fraction $1 - \nu_2 < 1 - \nu_1$.

REMARK (Distributional effects) Disputes about the content of corporate law often end in trials due to strong conflicts of interest among the corporate constituents. Managers, minority shareholders and outsiders want to set "tougher" standards than shareholders, minority shareholders and insiders respectively. Managers oppose a reduction of the standard because that would expose them to loose their jobs or the control of the corporation. That logic generated a trial in *Revlon*.[36] Minority Shareholders do the same because a takeover would dilute their positions. That logic generated a trial in *Weinberger*.[37] And creditors see a takeover as a threat to the value of their securities because the corporation will be perceived as a riskier institution. That logic generated a trial in *Nabisco*.[38]

---

[34] In reality there is a multiplicity of courts. The U.S. judicial system is organized in a three-hierarchical structure: trial courts, appeal courts and supreme courts. In addition to the regular state and federal systems there are specialized courts in bankruptcy, trade and commerce among other areas.

[35] As we mentioned in the introduction, Riboni (2006) analyzes in detail the different ways in which common and civil law address the potential time-(in)consistency of courts' decisions.

[36] Bidder for corporations stock brought action to enjoin certain defensive actions taken by the target corporation and others. The Supreme Court of Delaware held among other things that (2) actions taken by directors in the instant case did not meet that standard and (6) when sale of the company becomes inevitable, duty of board of directors changes from preservation of the corporate entity to maximization of the company's value at a sale for the stockholders' benefits (506 A.2d 173, Del 1985).

[37] A former shareholder of UOP Inc. brought a class action against the corporation challenging the UOP's minority shareholders by a cash-out merger between UOP and its majority owner, The Signal Companies, Inc. The Chancellor held that the terms of the merge were fair to the Plaintiff and the other minority shareholders of UOP (457 A.2d 701, Del 1983).

[38] Courts have developed complete doctrines in order to regulate each of these conflicts of interest. For example, under the duties of care and loyalty (fiduciary duties) managers are required to satisfy a standard of effort when they make decisions

REMARK (Reason for a trial) There are four theories that explain why parties litigate on the merit and don't settle their differences: 1) there are asymmetries of information; 2) parties have different expectations on the decision of the court; 3) one party is a behavioral type and 4) the parties search the expertise of the court. In our paper we adhere to the fourth theory. At any time in which the parties believe that the law is not adequate for the current environment they will call for the judicial expertise and authority of a judge to determine the new appropriate regulatory setting.

The details of what the parties must decide during the period are described in the following three-stage game:

Stage 1: D decides to attempt a change of the standard or preserve the current standard. In the case of a change attempt: if the standard is s_n, D proposes standard s_{-n}.

Stage 2: If D initiated a change then P decides whether to accept the new standard or sue D.

Stage 3: If P sues D then D makes P a take-it-or-leave-it settlement offer S. If P accepts the offer the corporation adopts the new standard. If P doesn't accept the offer the parties go to court who decides the new standard. If the court changes the standard, D must compensate the harm suffered by P which is equivalent to the reduction in the value of her share in the corporation ($h = (1 - \nu_1)U(s_L, \theta_H) - (1 - \nu_2)U(s_H, \theta_H)$ if the standard is s_L and $h = (1 - \nu_1)U(s_H, \theta_L) - (1 - \nu_2)U(s_L, \theta_L)$ if the standard is s_H).[39]

Notice that if the standard is changed by mutual agreement of the parties or P accepts a settlement offer (we denote any of these two options: contracting around the old standard) *society keeps facing the old standard* because the court has made no decision.

We denote the aggregate cost of litigation (faced by both parties) as $c < W$. From that amount, D pays fc, with $f \leq 1$ while P pays $(1 - f)c$. In addition, although in reality legal disputes happen both before the target faces the offer (as was the case in *Moran*) and during the time in which the offer is taking place (as was the case in *Lynch*)[40], at this point we assume that only the first option is possible (as with the other

---

on behalf of shareholders, under the doctrine of entire fairness, majority shareholders are required to assure that the interests of minority shareholders are protected during a merger (a change in control and ownership of a corporation must protect the interests of *all* shareholders (a fair deal) and must be done at a price that is beneficial for *all* shareholders (a fair price)) and under the doctrine of antifraud standards, shareholders are required to protect the interests of creditors whenever the corporation changes ownership.

[39] Although in corporate disputes, injunction is the usual remedy, in our context that would imply that the court obviates the distributive effects (over the parties welfare) of its decision.

[40] Shareholder (Kahn) brought action against controlling shareholder (Alcatel) to recover for breach of fiduciary duties to shareholders and corporation acquired by controlling shareholder (Lynch). According to Kahn, Alcatel dictated the terms of the merger; made false, misleading and inadequate disclosures; and paid an unfair price. The Supreme Court held that the exclusive standard of judicial review in examining propriety of interested, cash-out merger transaction by controlling or dominating shareholder is "entire fairness", and that the burden to prove entire fairness never shifted from controlling shareholder (638 A.2d 1110, Del 1994).

assumptions, we relax it in Section 5)

Technical Assumption 4: The three-periods game (ergo, the trial if any) takes place before corporations face a business opportunity.

As we will see when we present the solution of the problem, in equilibrium there are situations in which the parties contract around the standard, however, as we are mainly interested in keeping track of the court interventions we denote the litigation strategy as the function $l(p_n(t), s(t)) = l_n(t) : [0,1]^2 \longrightarrow \{0,1\}$ in which $l_n(t) = 1$ means that a trial takes place at time t while $l_n(t) = 0$ means the contrary.

2.5 Dynamics of the System and Timing of Actions

Our problem is stationary and not path dependent.[41] That implies that the number of periods in a cycle is deterministic. The randomness of the process is given by the uncertainty of the state of the environment that is revealed at future trials (which consequently makes random the timing of trials after the current cycle ends.) We define the periodicity $\tau_n \geq 1$, as the number of periods in which the system has standard s_n[42] or equivalently, the number of corporations that don't innovate in their charters when the standard is s_n. Often we will refer to the frequency of litigation $1/\tau_n \in [0,1]$ instead of the periodicity. We also take this opportunity to explicitly write the timing of the actions that take place every period.

1. Environment realizes $\theta(t)$. Not observed by the agents.

2. Agents adjust their beliefs: $p(t-1) \to p(t)$.

3. Parties D and P, owners of corporation t, facing standard $s(t-1)$ and having beliefs $p(t)$, play a three stage-game and decide $l(t)$.

4. If $l(t) = 1$ then a trial takes place, cost fc is paid by D, cost $(1-f)c$ is paid by P, $p(t)$ becomes 1 or 0 and the Court decides $s(t)$.

5. If $l(t) = 0$ then a trial doesn't take place, no information is revealed.

6. A business opportunity takes place or not, the payments of the game are realized and discounted at the beginning of the period.

---

[41] This may seem a major limitation in a model of common law in which judges are obliged to follow precedents. Nevertheless, as Atiyah and Summers (1987) point out, there is an even deeper principle of common law that precedes path dependence: substantivity. The American common law legal system is committed to use socioeconomic and/or political arguments to justify any application or interpretation of the law. It is not enough to apply the law because it is the law (formal principle). As the quality of legal rules should be constantly tested, path dependence would be the attribute of the law only if that proves to be adequate for the times. Under this considerations, our model can be interpreted in the following way: Whenever judges decide to preserve the standard they are following precedents but whenever decide to reform it they are updating the law to the new requirements of times.

[42] A high τ_n means that the standard s_n is unfrequently litigated.

3   The Court sets the standards

In this Section we formulate the problem faced by the court when it has to decide what standards to set each time a trial takes place. Nevertheless, first, we study the behavior of the disputing parties. That is, we derive the parties litigation strategies.

3.1   Litigation strategies

Due to the information decay process, the probability that the current standard is inadequate (or obsolete) constantly increases with time. That implies that the probability that D attempts a change of the standard increases with time as well. P may benefit from the update of an obsolete standard but faces the cost of reducing its share in the company. It is easy to show that P's utility is always reduced if she accepts D's *first attempt* to change the standard. By first attempt we mean the following: we will show that there exists cut-off beliefs about the state of the environment (upper bound if the standard is low and lower bound if the standard is high) such that any belief beyond those cutoffs induce D to attempt a reform. First attempt refers to the first time in which beliefs hit the cutoffs.

P has two ways of responding to an innovation that reduces her utility. She can accept the innovation or challenge it by suing D. A lawsuit takes place when the expected benefits of a legal dispute (standards update with complete information and compensation from inequity effects) dominate the litigation costs of the same. For obvious reasons, in the case of a lawsuit, the parties go ahead for a court ruling instead of settling their dispute if and only if the litigation costs are not large. Consequently, as a general description of the litigation strategies, regardless whether the standard is high or low, we have that an attempt to change the standard triggers a trial with certainty if the litigation cost is lower than a certain threshold but the parties contract around D's attempt if the litigation cost is higher than the same threshold. In that last case the standard is not reformed and parties $(D, P)_{t+1}$ face the same standard that parties $(D, P)_t$ faced before. The next lemma summarizes the solution of the three-stage game. We relegate the details to Appendix A.

Lemma 1: *(Litigation strategies)*

i) when $s(t-1) = s_L$ there exists costs of litigation $c_{L_1} \leq c_{L_2}$ and periodicities of litigation τ_L, $\overline{\tau}_L$, and $\overline{\overline{\tau}}_L$ such that if $c > c_{L_2}$, D initiates a change that is accepted by P when $t = \overline{\overline{\tau}}_L$; if $c \in [c_{L_1}, c_{L_2}]$, D initiates a change that ends in a settlement when $t = \overline{\tau}_L$ and if $c < c_{L_1}$, D initiates a change that ends in

a trial when $t = \tau_L$, where τ_L is defined as

$$\tau_L = \arg\min_{\tau \in \mathbb{N}} \left\{ (1 - p_L(\tau + 1)) \left(V(s_H, 0) - V(s_L, 0) \right) \geq fc \right\}$$

ii) when $s(t-1) = s_H$ there exists costs of litigation $c_{H_1} \leq c_{H_2}$ and periodicities of litigation τ_H, $\overline{\tau}_H$, and $\overline{\overline{\tau}}_H$ such that if $c > c_{H_2}$, D initiates a change that is accepted by P when $t = \overline{\overline{\tau}}_H$; if $c \in [c_{H_1}, c_{H_2}]$, D initiates a change that ends in a settlement when $t = \overline{\tau}_H$ and if $c < c_{H_1}$, D initiates a change that ends in a trial when $t = \tau_H$, where τ_H is defined as

$$\tau_H = \arg\min_{\tau \in \mathbb{N}} \left\{ p_H(\tau + 1)(V(s_L, 1) - V(s_H, 1)) \geq fc \right\}$$

Proof: See Appendix A.

Because in the case that $c > \min\{c_{L_1}, c_{H_1}\}$ we converge to a scenario in which society doesn't face trials at all[43] and the conclusions are not interesting we perform the analysis of the paper with the understanding that $c \leq \min\{c_{L_1}, c_{H_1}\}$. That is, any attempt to reform the standard ends with a court ruling. Notice that if we allowed for heterogeneity in the characteristics of the corporations (e.g. W is drawn from a certain distribution) we would retrieve the more accurate description of reality in which some disputes settle and others go to trial.[44]

3.2 The Problem faced by the Court

A benevolent, forward-looking and time-consistent court who at a trial discovers that the state of the environment is θ_n with $n \in \{H, L\}$, sets the standard s_n that optimally regulates corporations affairs for τ_n periods knowing that the standard s_{-n} optimally regulates corporations affairs for τ_{-n} periods (in other words, the court chooses the standard s_n that maximizes the expected value of current and future corporations knowing that a corporation will generate a trial in τ_n periods and at that trial the standard may be preserved or replaced by s_{-n}.) Hence, the court solves

---

[43]If $c \in \left[\min\{c_{L_1}, c_{H_1}\}, \max\{c_{L_1}, c_{H_1}\}\right]$ there will be trials until the moment in which the court discovers that the state of nature has changed, if $c > \max\{c_{L_1}, c_{H_1}\}$ trials never take place.

[44]We didn't explore a model with heterogeneous firms because the definition of heterogeneity would have been idiosyncratic, ergo the results as well.

$$\max_{s_n} \upsilon_n \tag{1}$$

s.t.:

$$\tau_H = \arg\min_{\tau \in \mathbb{N}} \{p_H(\tau+1)(V(s_L,1) - V(s_H,1)) \geq fc\} \tag{2}$$

$$\tau_L = \arg\min_{\tau \in \mathbb{N}} \{(1 - p_L(\tau+1))(V(s_H,0) - V(s_L,0)) \geq fc\} \tag{3}$$

$$s_L, s_H \in [0,1]; \tau_L, \tau_H \geq 1; n \in \{H,L\}; p(1) \in \{1,0\} \text{ given}$$

The expected values of current and future corporations (υ_L and υ_H) are defined by the following system of Bellman equations[45]

$$\upsilon_L = r(s_L, \tau_L) - \delta^{\tau_L}c + \delta^{\tau_L}[p_L(\tau_L+1)\upsilon_L + (1 - p_L(\tau_L+1))\upsilon_H] \tag{4}$$

$$\upsilon_H = r(s_H, \tau_H) - \delta^{\tau_H}c + \delta^{\tau_H}[p_H(\tau_H+1)\upsilon_L + (1 - p_H(\tau_H+1))\upsilon_H] \tag{5}$$

Each equation tells us that υ_n is equal to the expected value of the corporations during the first cycle in which standard s_n is in place (the $\tau-$periods return function $r_n = r(s_n, \tau_n) = \sum_{t=1}^{\tau_n} \delta^{t-1}V(s_n, p_n(t))$ minus the cost $\delta^{\tau_n}c$ incurred in the trial that ends the cycle) plus the expected value of the corporations including litigation expenditures associated to the future cycles ($\delta^{\tau_n}[p_n(\tau_n+1)\upsilon_L + (1 - p_n(\tau_n+1))\upsilon_H]$). The system of equations defines the following closed form expressions for υ_L and υ_H

$$\upsilon_L = \frac{(1 - \delta_H(1-p_H))(r_L - \delta_L c) + \delta_L(1-p_L)(r_H - \delta_H c)}{(1 - \delta_L p_L)(1 - \delta_H) + \delta_H p_H(1 - \delta_L)}$$

$$\upsilon_H = \frac{\delta_H p_H(r_L - \delta_L c) + (1 - \delta_L p_L)(r_H - \delta_H c)}{(1 - \delta_L p_L)(1 - \delta_H) + \delta_H p_H(1 - \delta_L)}$$

with $\delta_L \equiv \delta^{\tau_L}; \delta_H \equiv \delta^{\tau_H}; p_L \equiv p_L(\tau_L+1)$ and $p_H \equiv p_H(\tau_H+1)$.

The solution of (1) defines a Nash equilibrium (indeed a perfect Bayesian equilibrium (PBE) when δ is big enough.)[46] The uncertainty of the problem is given by the timing at which trials take place. At equilibrium, agents know τ_H and τ_L but they don't know what will be the state of the environment revealed at the next

---

[45] The characteristics of the dynamic programing problem that defines those equations are: the state variable is the state of nature revealed at a trial $\theta(z) \in \{\theta_L, \theta_H\}$, the control variable is the standard $s_n \in \{s_L, s_H\}$, the law of motion is $p_n(\tau_n+1) = \Pr[\theta(z+1) = \theta_L \mid \theta(z) = \theta_n]$ with $p(1)$ given, the $\tau-$periods return functions are $r_n = r(s_n, \tau_n) = \sum_{t=1}^{\tau_n} \delta^{t-1}V(s_n, p_n(t))$ and the discount factors are δ^{τ_n}.

[46] We don't have SPE because the information sets are not singleton. Before trials take place corporations don't know what standard will be set by the Court.

trial (and consequently what will be the next standard.) Inequalities (2) and (3) are the incentive constraints faced by corporations when they decide to generate a trial or not. Notice that because the litigation strategy determines the values of τ_H and τ_L we have omitted $l_n(t)$. As an initial condition, we assume that a trial takes place at $t = 1$ with certainty.

We end this section establishing a technical result that will prove useful later.

Lemma 2: *(Objective function) v_n is quasi-concave in τ_n and strictly concave in s_n.*

Proof: See Appendix A.

4   Main Results

In this section we present our main results. In order to do that, we solve (1) in three steps. First, we determine the solution of a legal system in which the court is myopic $(\delta = 0)$.[47] After that, in a second step we determine the standard and frequency of trials that a central planer would like to impose in society, that is we determine the first best common law legal system. Finally we solve (1) distinguishing that only the court can enforce the standards while corporations decide when to generate trials. As the solution will turn to be a combination between the myopic and the first best solutions we will refer to it as the second best solution.

4.1   Myopic Courts

A myopic court[48] adjudicates cases as if judicial sentences didn't have effects either in the welfare of future corporations or in the future enforcement of the law. The system still has dynamics because corporations decide when to litigate. The solution is trivially characterized as follows

Myopic Court Solution: *A myopic court $(\delta = 0)$ sets standards that perfectly track the environment $s_n^M = \theta_n$ and corporations generate trials with periodicities $\tau_n^M = \lfloor \ln \left(1 - c/c_n^M \right) / \ln \Lambda \rfloor + 1$ where $c_H^M = \lfloor \alpha b W p^* (\theta_H - \theta_L)^2 \rfloor / f$; $c_L^M = \left[\alpha b W (1 - p^*)(\theta_H - \theta_L)^2 \right] / f$ and $n \in \{H, L\}$.[49]*

A myopic court sets standards that perfectly track the state of the environment because they maximize the value of the litigating corporation. The result is consistent with the traditional view in which courts should enforce the contract that the parties would have wanted to write before they faced the conflict. If

---

[47] Many legal scholars would agree that in reality judges behave more myopically than forward-looking. For example Cooter and Kornhauser (1980) say that "it is difficult to contend that judges have insight beyond that displayed in their written opinions, and these opinions reflect a calculus of economic costs and benefits only in a narrow class of cases".

[48] In this case it becomes irrelevant whether there is one or many judges.

[49] $\lfloor x \rfloor$ is the maximum integer smaller than or equal to $x \in \mathbb{R}$.

the myopic court wasn't benevolent or didn't act completely informed then the standards would not track the environment any more.[50] Notice that the role of myopic courts is not negligible because they don't just enforce current rules but they reform them at any time when they have become obsolete.

Trials are initiated by the first corporation (defendant) which incentive constraint becomes active, that is when[51]

$$\overline{p}^c(s_H^M, s_L^M) = 1 - \frac{fc}{V(s_H^M, 0) - V(s_L^M, 0)} \tag{6}$$

and

$$\underline{p}^c(s_H^M, s_L^M) = \frac{fc}{V(s_L^M, 1) - V(s_H^M, 1)} \tag{7}$$

where $\overline{p}^c = q_0(1 - \Lambda^{\tau_L^M})/(1 - \Lambda)$ and $\underline{p}^c = \left[q_0 + (1 - q_1)\Lambda^{\tau_H^M}\right]/(1 - \Lambda)$. The frequency of litigation increases with the expected value of the corporation ($\alpha b W$) but decreases with the cost of litigation (c) as well as with the fraction of the costs paid by D (f). Notice that if $c > \max\{c_L^M, c_H^M\}$, litigation never takes place.[52] In addition, the longer the environment is in one state (captured by the value of p^*) the less frequently the associated standard is litigated (society wants to stay longer with this standard.)

However, efficiency minded courts are forward looking agents ($\delta > 0$) who take into account the future implications of their adjudications. Next, we analyze what is different in a dynamic framework.

4.2   First Best Solution

In this Section we assume that a central planner can simultaneously initiate trials and enforce the standard. First we show that for any fixed frequency of trials a central planer does not want to set a standard that tracks the environment unless the parameters of the model adopt extreme values. Second we show that for any fixed standard a central planer does not want to generate trials with the same frequencies as corporations. Third we combine both results and characterize the standards and frequencies of trial that define the first best common law legal system.

4.2.1   First Best Standards

Suppose that a central planner faces exogenously given periodicities of litigation τ_n. In this case, when a trial takes place, a central planner sets the standard that maximizes the value of all corporations during a

---

[50] For example, if in our model the court observes the true state of nature with probability $1 - e$ it sets standards $s_L^M(e) = (1 - e)\theta_L + e\theta_H$ and $s_H^M(e) = e\theta_L + (1 - e)\theta_H$.

[51] Although strictly speaking, the next relations are inequalities, w.l.o.g., to simplify notation and the rest of the analysis we write them as identities.

[52] Obviously if $\min\{c_{L_1}, c_{H_1}\} < \max\{c_L^M, c_H^M\}$, the last bound is not relevant.

cycle (the $\tau-$periods return functions). That is

$$s_H^{FB}(\tau_H) = (1 - A(\tau_H)) p^* \theta_L + (1 + A(\tau_H)) (1 - p^*) \theta_H \tag{8}$$

$$s_L^{FB}(\tau_L) = (1 + A(\tau_L)) p^* \theta_L + (1 - A(\tau_L)) (1 - p^*) \theta_H \tag{9}$$

with $A(\tau) = \frac{1-\delta}{1-\delta\Lambda} \frac{1-(\delta\Lambda)^\tau}{1-\delta^\tau}$. A central planner doesn't want to set standards that track the environment anymore. Given that they will regulate the affairs of corporations for τ_n periods the optimum is to set combinations of both states of the environment. Figure 1 shows the graphical representation of (8) and (9).

[Figure 1 here]

The higher are the frequencies of litigation, the smaller is the discount factor or the higher is the persistence of the environment then the closer are the first best standards to the true states of the environment. The intuition is direct. The longer is the time in which a standard is in place, the higher is the net present value of future corporations or the more likely is that the environment will evolve the more relevant is that the standard properly regulates the *future* states of the environment. In particular, we identify the extreme cases in which a forward-looking court sets the same standards that a myopic court. That happens when: i) trials take place every period; ii) judges are extremely impatient or iii) the environment doesn't evolve. The next proposition formalizes these considerations

Proposition 1 *(In general, first best standards don't track the environment) Unless $\delta = 0$ or $\tau_H = \tau_L = 1$ or $q_0 = 1 - q_1 = 0$ courts should not set standards that are optimal for current times $(s_n^{FB} = s_n^M)$. In addition, the higher the frequency of litigation $(1/\tau_n)$, the higher the persistence of the environment at the corresponding state $(p^*$ in the case of θ_L and $1 - p^*$ in the case of $\theta_H)$ or the lower the discount factor (δ) the closer the first best standards to the myopic standards.*

Proof: See Appendix A.

4.2.2 Frequencies of Litigation

Now, let's assume that the standards s_H and s_L faced by corporations and the central planer are exogenously given. We ask: is the periodicity with which society wants to have trials $\tau_n^{FB}(s_H, s_L)$ smaller or bigger than the periodicity $\tau_n^c(s_H, s_L)$ with which single corporations would want to have them? In their decisions

to initiate trials, defendants don't take into account two externalities. First, a sentence of the court that improves the law not only affects the utility of current corporations but the utility of future ones as well. We call this externality "inter-temporal". Second, the costs paid by the defendant don't cover the totality of the expenses generated in a litigation. We call this externality "contemporaneous".

First we show that the inter-temporal externality is always positive (we will see that this is not evident.) Next, noticing that the contemporaneous externality is always negative we conclude that trials take place too frequently if and only if the later dominates the former. Finally, the most relevant, we discuss the scenarios in which one or the other externality dominates.

The optimal value of all corporations can be expressed as follows[53]

$$v(s_n, p_n) = v_n(p) = \max \left\{ V(s_n, p) + \delta v_n(p^+), \begin{bmatrix} pV(s_L, 1) + (1-p)V(s_H, 0) - c \\ +\delta \left(pv_L(q_1) + (1-p)v_H(q_0) \right) \end{bmatrix} \right\} \quad (10)$$

That is, at every period a court decides whether it is more efficient to preserve the current standard or generate a trial to verify whether the standard should be modified (notice that $v_L(1) = v_L$ and $v_H(0) = v_H$). Functions in (10) define cut-off beliefs after which a central planer generates a trial with certainty. The cut-off beliefs are the ones that make a central planer indifferent between litigation and no litigation. That is[54]

$$\left(1 - \bar{p}^{FB}\right)\left(V(s_H, 0) - V(s_L, 0)\right) = fc + (1-f)c + \underbrace{\delta \left[v_L(\bar{p}^{FB+}) - \left(\bar{p}^{FB} v_L(q_1) + (1 - \bar{p}^{FB})v_H(q_0)\right)\right]}_{\Sigma_L} \quad (11)$$

or

$$\bar{p}^{FB}(s_H, s_L) = 1 - \frac{fc + (1-f)c + \Sigma_L}{V(s_H, 0) - V(s_L, 0)} \quad (12)$$

and

$$\underline{p}^{FB}\left(V(s_L, 1) - V(s_H, 1)\right) = fc + (1-f)c + \underbrace{\delta \left[v_H(\underline{p}^{FB+}) - \left(\underline{p}^{FB} v_L(q_1) + (1 - \underline{p}^{FB})v_H(q_0)\right)\right]}_{\Sigma_H} \quad (13)$$

---

[53] Problem (1), without restrictions (2) and (3), can be writen as a dynamic programming problem in which the state variables are the beliefs of the agents and the current standard, the control variable is litigation l_n, the law of motion is the Markovian process $p_n^+ = p_n q_1 + (1 - p_n)q_0$ with initial conditions $p_H(1) = 0$ and $p_L(1) = 1$, the return function is $V(s_n, p_n)$ and the discount factor is δ.

[54] Again, w.l.o.g., we write the expressions as identities.

or

$$\underline{p}^{FB}(s_H, s_L) = \frac{fc + (1-f)c + \Sigma_H}{V(s_L, 1) - V(s_H, 1)} \qquad (14)$$

We notice that the only difference in the problems faced by a single corporation and the society when they have to reform the standard s_n is $E_n = (1-f)c + \Sigma_n$ (compare (12) and (14) with (6) and (7)). Clearly, $(1-f)c$ corresponds to the contemporaneous externality and Σ_n corresponds to the inter-temporal externality. The central question is: what determines the sign of this externality? We start answering that question by showing the next result[55]

Lemma 3 *(The inter-temporal externality is always positive) If the cost of litigation is such that society wants to generate trials with a finite frequency and the standards s_L and s_H are such that $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$ then $\Sigma_n \leq 0$.*

Proof: See Appendix A.

The formal proof of the lemma rests on the fact that $v_n(p)$ are convex functions.[56] As usual, the details can be found in Appendix A. In order to see more clearly the interaction between the externalities we impose symmetry in the model ($p^* = \frac{1}{2}$ which means that $\tau_H = \tau_L = \tau$ and $v_L = v_H = v(\tau) = \frac{r(\tau) - \delta^\tau c}{1 - \delta^\tau}$). Then, we rewrite (11) as[57]

$$(1 - p(\tau + 1))(V(s_H, 0) - V(s_L, 0)) = fc + (1-f)c \underbrace{- \frac{\delta - \delta^\tau}{1 - \delta^\tau} c}_{CE(c)} + \underbrace{V(s_L, 1) - \frac{1 - \delta}{1 - \delta^\tau} r(\tau)}_{VE(W)} \qquad (15)$$

where we have decomposed the inter-temporal externality in two effects $\Sigma_L = CE(c) + VE(W)$. The first expression corresponds to the change in the litigation costs paid by future corporations because a trial takes place this period instead of the next one (we call it the cost effect) while the second one refers to the change in the value of future corporations due to the same reason (we call it the value effect.) We emphasize the next properties

---

[55] The result is not conditional on $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$. We impose this relation to eliminate shapes of the value function that may be optimal in problem (10) but cannot be optimal in problem (1).

[56] The formal proof of the Lemma requires to show existence and uniqueness of (10). The analysis closely follows Harris and Holmstrom (1987). The novelty which makes our problem more challenging is that the function

$$v(p) = \begin{cases} v_H(p) & \text{if} & p \in [0, p^*] \\ v_L(p) & \text{if} & p \in [p^*, 1] \end{cases}$$

can be discontinuous at p^*.

[57] In order to derive Σ_L we have used the following identities: $v(1) = v_L$; $v_H(0) = v_H$; $v_L(1) = V(s_L, 1) + \delta v_L(q_1)$; $v_H(0) = V(s_H, 0) + \delta v_H(q_0)$ which implies that $v_L(\overline{p}^{FB+}) = \overline{p}^{FB+} v_L(1) + (1 - \overline{p}^{FB+}) v_H(0) - c$. Notice that because in the symmetric case $v(1) = v_L = v_H(0) = v_H = v$, the inter-temporal externality becomes just $[(1-\delta)v - \delta c - V(s_L, 1)]$. The analysis for (13) is equivalent.

22

- The cost effect is always negative (future corporations benefit with trials) because future corporations save the cost of not having to pay for the trial that ends the current cycle ($\frac{\delta}{1-\delta^\tau}c$). Even when future corporations face the extra cost of having to pay sooner for the trial that ends the new cycle ($\frac{\delta^\tau}{1-\delta^\tau}c$) the first effect dominates the second one. Directly from that, the inter-temporal externality decreases on c (as we show it later, it is true that c increases the periodicity of litigation τ, but as $-\frac{\delta-\delta^\tau}{1-\delta^\tau}$ is decreasing on τ so is $CE(c)$ on c.)

- The value effect is always positive (future corporations don't benefit with trials) because future corporations don't increase their value with a trial taking place the current period ($\frac{1-\delta}{1-\delta^\tau}r(\tau)$) as much as if the trial (or equivalently the update of the law) would have taken place in the next period ($V(s_L, 1)$).[58] Directly from that, the inter-temporal externality increases on αbW (as we shoe it later, it is true that αbW decreases the periodicity of litigation τ, but as $-\frac{1-\delta}{1-\delta^\tau}r(\tau)$ is increasing on τ so is $VE(W)$ on αbW.)

- The importance of lemma 3 is that it tells us that, at equilibrium, the cost effect always dominates the value effect, ergo, at equilibrium, the inter-temporal externality is positive (negative sign).

- When $\tau = 1$ $CE(c) = VE(W) = 0$, which obviously means that the inter-temporal externality Σ is 0 when trials take place every period.

- The value effect $VE(W)$ decreases (increases) with s_L (with s_H) because the closer are the standards to the true state of the environment the larger is the difference between the benefits enjoyed by the current and future corporations.[59]

But there is a second externality, this time negative, that a single corporation/defendant doesn't internalize in its decision to trigger a dispute, that is, the cost faced by the plaintiff $(1 - f)c$. A priory it is not

---

[58] Notice that when the length of a cycle is τ instead of $\tau + 1$ (the standard is updated more frequently) the expected value of all corporations as well as the aggregate cost of litigation increase (because $\frac{r(\tau)}{1-\delta^\tau} > \frac{r(\tau+1)}{1-\delta^{\tau+1}}$ and $\frac{\delta^\tau c}{1-\delta^\tau} > \frac{\delta^{\tau+1} c}{1-\delta^{\tau+1}}$) but the highest increment in value and in litigation costs are faced by the first corporation!

[59] It is easy to verify that the result holds

$$
\begin{aligned}
\frac{\partial VE(W)}{\partial s_L} &= -2\alpha bW \left\{ (s_L - \theta_L) - \frac{1-\delta}{1-\delta^\tau} \sum_{t=1}^{\tau} \delta^{t-1} \left[p_L(t)(s_L - \theta_L) - (1 - p_L(t))(\theta_H - s_L) \right] \right\} \\
&= -\alpha bW \left\{ -\theta_L + \frac{1-\delta}{1-\delta^\tau} \sum_{t=1}^{\tau} \delta^{t-1} \left[p_L(t)\theta_L + (1 - p_L(t))\theta_H \right] \right\} \\
&= -\alpha bW \left\{ \frac{1-\delta}{1-\delta^\tau} \sum_{t=1}^{\tau} \delta^{t-1} \left[(1 - p_L(t))(\theta_H - \theta_L) \right] \right\} < 0
\end{aligned}
$$

23

clear which of these externalities dominates, hence, directly from the comparison of (12) and (14) with (6) and (7) we conclude that

Proposition 2 *(Inefficient frequency of trials) For any standards s_L and s_H such that $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$ and cost of litigation $c > 0$ if $E_n < (>)0$ then society wants a frequency of litigation greater (smaller) than or equal to the one corporations will freely generate.*

We postpone the sensitivity analysis of the aggregate externality (E_n) for the end of the Section, after we have presented the second best solution. At this point we just want to notice that if the private and social costs of litigation are the same then unambiguously society wants a higher frequency of litigation.

Corollary 1 *(Contemporaneous externality doesn't exist) If $f = 1$ then for any standards s_L and s_H such that $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$ and cost of litigation $c > 0$ society wants a frequency of litigation that is bigger than or equal to the one corporations will freely generate.*

4.2.3 First-Best Common Law Legal System

A central planer decides the optimal standard *and* the optimal frequency of litigation for each state of the environment. Hence the problem faced by a central planer is (1) without constraints

$$\max_{s_n, \tau_n} \upsilon_n \tag{16}$$

$$s_L, s_H \in [0, 1] \, ; \tau_L, \tau_H \geq 1$$

Although now the standards are functions of the frequencies of litigation, the solution of (16) was characterized in 4.2.1-4.2.2 and it is summarized as follows

First Best Solution: *A central planer who is able to generate trials sets standards $s_H^{FB}(\tau_H^{FB})$ and $s_L^{FB}(\tau_L^{FB})$ defined by (8) and (9) with τ_L^{FB} and τ_H^{FB} implicitly defined by the system*

$$(\tau_H^{FB}, \tau_L^{FB}) = \arg\min_{\tau_L, \tau_H \geq 1} \left\{ \begin{array}{l} \frac{\Delta r_L}{\Delta \tau_L} + \frac{\Delta(\delta_L p_L)}{\Delta \tau_L}(\upsilon_L - \upsilon_H) + \frac{\Delta \delta_L}{\Delta \tau_L}(\upsilon_H - c) \geq 0 \\ \frac{\Delta r_H}{\Delta \tau_H} + \frac{\Delta(\delta_H p_H)}{\Delta \tau_H}(\upsilon_L - \upsilon_H) + \frac{\Delta \delta_H}{\Delta \tau_H}(\upsilon_H - c) \geq 0 \end{array} \right\}$$

Proof: See Appendix A.

The first best solution preserves the attributes of the myopic solution. Standards are set after cycles of deterministic lengths τ_H^{FB} and τ_L^{FB}. There exists costs of litigation $\{c_L^{FB}, c_H^{FB}\}$ beyond which a central planer

would prefer not to litigate because it is too expensive.[60] The frequency with which one standard is litigated decreases with the cost of litigation (as a fraction of the expected value of a corporation) and decreases with the persistence of the environment at the corresponding state (for technical details see corollaries 2 and 3 in the appendix.) Notice that because a larger $c/\alpha bW$ decreases the inter-temporal externality, the effect on changes of these parameters on the utility of the corporation that generates the trial dominates the same effect on the utility of future corporations.

However, in reality corporations and not courts are the ones that initiate trials. Given the differences between the private and social incentives to generate litigation, what standards should courts set?

4.3   Second Best Solution (Forward-looking Courts)

Forward looking courts face a trade off in their rule makers role. On one side they would like to set the first best rules for society but on the other side they know that if they do that, corporations will not generate trials with a socially optimal frequency. Courts cannot initiate trials, hence they are not able to correct this distortion directly, but they can use the standards as instruments to provide the right incentives. More specifically, we show that if the aggregate externality associated to the generation of trials is positive (negative) a forward-looking and time consistent court encourages (discourages) litigation by biasing first-best rules closer to (further away from) the preferences of corporations.

4.3.1   Second Best Standards

Although problem (1) tells us that courts decide the standards while corporations decide the timing of trials, it is clear that through restrictions (2) and (3), courts also decide the timings. Consequently, the optimal value of all corporations can be written as[61]

$$v(s_n(p),p) = v_n(p) = \max \left\{ V(s_n(p),p) + \delta v_n(s_n(p^+),p^+), \left[\begin{array}{c} pV(s_L(p),1) + (1-p)V(s_H(p),0) - c \\ +\delta\left(pv_L(s_L(p),q_1) + (1-p)v_H(s_H(p),q_0)\right) \end{array} \right] \right\}$$
(17)

As, with (10), at every period the court decides if it is more efficient to preserve the current standard

---

[60] If the inter-temporal externality dominates the contemporaneous one then the maximum cost that society is willing to pay in order to generate a trial is bigger than the maximum cost that corporations are willing to pay. But if the opposite is true then for some ranges of the cost of litigation, corporations are willing to generate trials but the society is not.

[61] Problem (1), this time taking into consideration restrictions (2) and (3), can be writen as a dynamic programming problem in which the state variables are the beliefs of the agents plus the current standard, the control variable is litigation l_n, the law of motion is the Markovian process $p_n^+ = p_n q_1 + (1-p_n)q_0$ with initial conditions $p_H(1) = 0$ and $p_L(1) = 1$, the return function is $V(s_n(p_n),p_n)$ and the discount factor is δ.

or generate a trial to verify whether the standard should be modified, the only difference with (10) is that now, the standards are not constants but functions of the state variable. Then the indifference conditions between litigation and no litigation define the following identities

$$
\left(1-\overline{p}^{SB}\right)\left(V(s_H(\overline{p}^{SB}),0)-V(s_L(\overline{p}^{SB}),0)\right) = \left\{ \begin{array}{c} fc + (1-f)c+ \\ \underbrace{\delta\left[\upsilon_L(s_L(\overline{p}^{SB+}),\overline{p}^{SB+}) - \upsilon_L(s_L(\overline{p}^{SB}),\overline{p}^{SB+})\right]}_{\Gamma_L} \\ \underbrace{\delta\left[\upsilon_L(s_L(\overline{p}^{SB}),\overline{p}^{SB+}) - \left(\begin{array}{c} \overline{p}^{SB}\upsilon_L(s_L(\overline{p}^{SB}),q_1)+ \\ (1-\overline{p}^{SB})\upsilon_H(s_L(\overline{p}^{SB}),q_0) \end{array}\right)\right]}_{\Sigma_L^{SB}} \end{array} \right\}
$$

or equivalently

$$
\left(1-\overline{p}^{SB}\right)\left(V(s_H(\overline{p}^{SB}),0) - V(s_L(\overline{p}^{SB}),0)\right) = fc + (1-f)c + \Gamma_L + \Sigma_L^{SB} \tag{18}
$$

and

$$
\underline{p}^{SB}(V(s_L(\underline{p}^{SB}),1) - V(s_H(\underline{p}^{SB}),1)) = \left\{ \begin{array}{c} fc + (1-f)c+ \\ \underbrace{\delta\left[\upsilon_H(s_H(\underline{p}^{SB+}),\underline{p}^{SB+}) - \upsilon_H(s_H(\underline{p}^{SB}),\underline{p}^{SB+}))\right]}_{\Gamma_H} \\ \underbrace{\delta\left[\upsilon_H(s_H(\underline{p}^{SB}),\underline{p}^{SB+}) - \left(\begin{array}{c} \underline{p}^{SB}\upsilon_H(s_H(\underline{p}^{SB}),q_1)+ \\ (1-\underline{p}^{SB})\upsilon_H(s_H(\underline{p}^{SB}),q_0) \end{array}\right)\right]}_{\Sigma_H^{SB}} \end{array} \right\}
$$

or equivalently

$$
\underline{p}^{SB}\left(V(s_L(\underline{p}^{SB}),1) - V(s_H(\underline{p}^{SB}),1)\right) = fc + (1-f)c + \Gamma_H + \Sigma_H^{SB} \tag{19}
$$

From our analysis of the first best solution we recognize the contemporaneous and inter-temporal externalities Σ_L^{SB} and Σ_H^{SB} (obviously evaluated at the second best standards and frequencies). The new expressions in (18) and (19) are Γ_L and Γ_H which correspond to the indirect marginal effects of τ on the $\tau-$period return functions. More specifically, those effects are $\frac{1}{\delta^{\tau_n}}\frac{\Delta r_n}{\Delta s_n}\frac{\Delta s_n}{\Delta \tau_n}$ where $\frac{\Delta s_n}{\Delta \tau_n} = \left|\frac{fc}{\alpha bW(\theta_H - \theta_L)}\left[\frac{1}{1-p_n(\tau+1)} - \frac{1}{1-p_n(\tau+2)}\right]\right|$ and $\frac{\Delta r_n}{\Delta s_n} = 2\alpha bW\sum_{t=1}^{\tau_n}\delta^t\left[p_n(t)(s_n - \theta_L) - (1 - p_n(t))(\theta_H - s_n)\right]$. Because in the first best solution $\frac{\Delta r_n}{\Delta s_n} = 0$

we have that Γ_L and Γ_H don't appear in (11) or (13).

In addition, as at the solution (2) and (3) hold, we know that

$$\Gamma_n + E_n^{SB} = 0 \qquad (20)$$

which implies that

$$s_H^{SB}(\tau_H) = s_H^{FB}(\tau_H) - \frac{E_H^{SB} \delta^{\tau_H}}{2\left(\frac{\Delta s_H}{\Delta \tau_H}\right)\left(\frac{\delta - \delta^{\tau_H}}{1-\delta}\right)} \qquad (21)$$

$$s_L^{SB}(\tau_L) = s_L^{FB}(\tau_L) + \frac{E_L^{SB} \delta^{\tau_L}}{2\left(\frac{\Delta s_L}{\Delta \tau_L}\right)\left(\frac{\delta - \delta^{\tau_L}}{1-\delta}\right)} \qquad (22)$$

The expressions for the second best standards uncover the structural link between the second best standards and the aggregate externality discussed in the first best solution. If the aggregate externality (evaluated at the second best solution) is 0 the first and second best standards coincide. If the externalities are positive (E_H^{SB} and E_L^{SB} are negative) the second best standards are closer to the states of the environment than the first best standards, the opposite if the externalities are negative (E_H^{SB} and E_L^{SB} are positive). Figure 2 shows the behavior of the second best standards in the symmetric case ($p^* = \frac{1}{2}$ which means that $\tau_H = \tau_L = \tau$; $E_L^{SB} = E_H^{SB}$ and $\frac{\Delta s_H}{\Delta \tau_H} = \frac{\Delta s_L}{\Delta \tau_L}$) when the aggregate externalities are positive. Notice that there is an inflexion point such that for periodicities of litigation (you may also think in terms of $c/\alpha bW$) larger than a certain threshold, it becomes more important for courts to set standards that will help correct the inefficient frequency of litigation (closer to θ_n) than directly maximize the value of the corporations (closer to s_n^{FB})

[Figure 2 here]

The former analysis was performed on the understanding that externalities E_L and E_H are evaluated at the second best solutions. For consistency in the presentation of our results we are equally interested on determining the link that exists between the second best standards and the externalities evaluated at the *first best solution*. Fortunately, that link is direct from (20). Because we know that $\frac{\partial E_L}{\partial s_L} < 0$ and $\frac{\partial \Gamma_L}{\partial s_L} < 0$ but $\frac{\partial E_H}{\partial s_H} > 0$ and $\frac{\partial \Gamma_H}{\partial s_H} > 0$ (notice that we can take derivatives as the standards are continuous variables) we can immediately describe the second best standards in terms of the first best standards and the first best aggregate externalities.

For example, if E_L is negative, (20) is satisfied if and only if s_L^{SB} gets closer to θ_L than what s_L^{FB} is (by reducing s_L^{FB} we increase E_L and Γ_L, such that, at the second best solution E_L still is negative although

smaller than at the first best solution, while Γ_L is positive.) Formally, we have that

Proposition 3 *(The first best standards are biassed) If $E_n^{FB} < (>)0$ courts set second best standards (s_n^{SB}) closer to (further away from) the ideal standards for current corporations (s_n^M) than what society would ideally want to set (s_n^{FB}).*

Proof: See Appendix A

Let's see next that indeed courts bias first best standards as a way to encourage (discourage) litigation by setting standards closer to (further away from) what is optimal for corporations (s_n^M) when corporations generate too few (many) trials.

4.3.2 Frequencies of Litigation

From (18) and (19) we directly obtain expressions for the cut-off beliefs after which corporations initiate trials with certainty (remember that $\Gamma_n + E_n^{SB} = 0$.) Those are

$$\overline{p}^{SB}(s_H^{SB}, s_L^{SB}) = 1 - \frac{fc}{V(s_H^{SB}, 0) - V(s_L^{SB}, 0)} \tag{23}$$

and

$$\underline{p}^{SB}(s_H^{SB}, s_L^{SB}) = \frac{fc}{V(s_L^{SB}, 1) - V(s_H^{SB}, 1)} \tag{24}$$

Proposition 3 together with a direct comparison of (23) and (24) with (6) and (7) allows us to conclude that if the first best aggregate externality is negative, the court sets standards that generate trials with a frequency that is larger than the frequency generated by the first best standards (that is $\overline{p}^{SB}(s_H^{SB}, s_L^{SB}) > \overline{p}^c(s_H^{FB}, s_L^{FB})$ and $\underline{p}^{SB}(s_H^{SB}, s_L^{SB}) > \underline{p}^c(s_H^{FB}, s_L^{FB})$). The opposite is true if the first best aggregate externality is positive.

At this point we could be tempted to suggest that the second best frequencies are intermediate points between the first best and the corporation frequencies. And indeed it is always true that

$$\overline{p}^{SB} = \mu \overline{p}^{FB} + (1 - \mu)\overline{p}^c$$

where $\mu = \frac{fc}{E_L^{FB}} \left[\frac{V(s_H^{FB}, 0) - V(s_L^{FB}, 0)}{V(s_H^{SB}, 0) - V(s_L^{SB}, 0)} - 1 \right] > 0$ and

$$\underline{p}^{SB} = \mu' \underline{p}^{FB} + (1 - \mu')\underline{p}^c$$

28

where $\mu' = \frac{fc}{E_H^{FB}} \left[\frac{V(s_L^{FB},1)-V(s_H^{FB},1)}{V(s_L^{SB},1)-V(s_H^{SB},1)} - 1 \right] > 0$. Nevertheless, it is not always the case that $\mu, \mu' \in [0,1]$. [62]

4.3.3 Second-Best Common Law Legal System

If we join the analysis of the second best standards and frequencies of litigation we conclude that the second best solution is characterized as follows

Second Best Solution: *A time-consistent court sets standards $s_H^{SB}(\tau_H^{SB})$ and $s_L^{SB}(\tau_L^{SB})$ defined by (21) and (22) and corporations generate trials with periodicities τ_L^{SB} and τ_H^{SB} implicitly defined by the system*

$$(\tau_H^{SB}, \tau_L^{SB}) = \underset{\tau_L, \tau_H \in \mathbb{N}}{\arg\min} \left\{ \begin{matrix} \frac{\Delta r_L}{\Delta \tau_L} + \frac{\Delta r_L}{\Delta s_L}\frac{\Delta s_L}{\Delta \tau_L} + \frac{\Delta(\delta_L p_L)}{\Delta \tau_L}(v_L - v_H) + \frac{\Delta \delta_L}{\Delta \tau_L}(v_H - c) \geq 0 \\ \frac{\Delta r_H}{\Delta \tau_H} + \frac{\Delta r_H}{\Delta s_H}\frac{\Delta s_H}{\Delta \tau_H} + \frac{\Delta(\delta_H p_H)}{\Delta \tau_H}(v_L - v_H) + \frac{\Delta \delta_H}{\Delta \tau_H}(v_H - c) \geq 0 \end{matrix} \right\}$$

Proof: See Appendix A.

REMARK Notice that (1) admits a unique solution. It may seem that there are two solutions; one that defines low frequency of litigation and another that defines high frequency of litigation but only one of them maximizes social welfare.[63] The reason of uniqueness is that the problem can be re-formulated as if the court was able to directly set the frequencies of litigation instead of the standards. Because whenever the court set standards, through the incentive constraints (2) and (3) it equivalently determines the frequencies of litigation, the system of reaction functions defined by the original problem coincides with the system of Bellman equations defined by the problem in which the court sets the frequency of litigations. Then, the Contract Mapping Theorem assures the existence of a unique solution (see the characterization of the second best solution in the appendix for details.)

4.4 Too many or too few trials?

Proposition 3 implies that the court should bias the standards in favor of the current litigants if and only if the frequency of litigation is suboptimally low. But when is the frequency of litigation too low? or more specifically, when is the first best aggregate externality negative?

---

[62] Notice that if $E_L^{FB} = (1-f)c + \Sigma_L^{FB} < 0$ then $\mu = -\frac{fc}{E_L^{FB}} \underbrace{\left[1 - \underbrace{\frac{V(s_H^{FB},0)-V(s_L^{FB},0)}{V(s_H^{SB},0)-V(s_L^{SB},0)}}_{<1} \right]}_{>1} > 0$ but we cannot conclude whether μ is larger or smaller than 1.

[63] If the discount factor is big enough then the solution is not only a NE but also a PBE because if the court deviates from its committed strategy it ends up setting standards that reduce welfare. In that sense there is a direct analogy between our problem and the repeated game faced by two firms that want to form a cartel. As it is well known by the literature (see Abreu, Pearce and Stacchetti [1990] and Fudenberg, Levine and Maskin [1994]), the cartel (cooperative outcome) can only be sustained if the reduction in the continuation value (future payoffs) induced by a one-period deviation is big enough to outweigh the benefits obtained by the deviation (non-cooperative outcome). That is the case when the discount factor is close enough to one.

4.4.1 Optimal distribution of litigation expenses

It is easy to see that the contemporaneous externality decreases with f while the inter-temporal externality is not affected (notice from (11) or (13) that society only cares about c). The bigger is the fraction of the total costs paid by the current corporation the more likely is that the frequency of trials will be too low from the social point of view. Interestingly, the fact that defendants generate a trial every period if they don't face litigation costs ($f = 0$) together with the fact that society always want to have more trials than the corporations when defendants face the totality of the litigation expenses ($f = 1$) tell us that there always exists a cut-off value $\overline{f}$ at which the inter-temporal and contemporaneous externalities cancel each other out. At this level, the frequency of litigation is efficient and the court does not need to distort the rules in order to provide incentives. That is

Proposition 4 *(Bound of the private costs of litigation) For all set of parameters there exists $\overline{f}_n \in [0, 1]$ such that $E_n = 0$. In particular, if $p^* = \frac{1}{2}$ then $\overline{f}_L = \overline{f}_H = \min\left[\frac{\alpha bW(\theta_H - \theta_L)^2}{4c}\frac{1-\delta}{1-\delta\Lambda}\frac{1-(\delta\Lambda)^{\tau^{FB}}}{(1-\delta^{\tau^{FB}})(1-\Lambda^{\tau^{FB}})}, 1\right]$.*

Proof: See Appendix A.

Shavell ([1997], [1999]) already suggested that legislators can correct potentially inefficient frequencies of litigation by subsidizing or taxing the litigation expenses paid by the parties, nevertheless, in these papers, the suggested subsidy or tax depends on the *effort* made by the parties to deter future accidents, which ultimately make the expressions non-estimable.

4.4.2 The direct effect of litigation expenses

Along with intuition we have already proven that the corporations and first best frequencies of litigation decrease with c. Next, we show the less intuitive result that conditional on the values of f and δ not being too small, if the total litigation expenses are larger than a certain threshold then corporations litigate with a frequency that is too low from the social point of view. The reason is that while corporations consider a direct cost of fc when society decides if it wants to generate a new trial it considers a marginal cost of litigation of $\frac{1-\delta}{1-\delta^\tau}c$. Hence, in the case that $f > \frac{1-\delta}{1-\delta^\tau}$ we have that an increment in the aggregate cost of litigation has a bigger impact in the incentives faced by a single corporation than the ones faced by society. It is true that when τ is small (small values of c), the former inequality is never satisfied, but when τ becomes large enough (large values of c) the inequality becomes $f > 1 - \delta$ which very likely may be satisfied.[64] That

---

[64] The value of f tends to be closer to 0.5 while the value of δ tends to be closer to 1.

is, as it is formalized in the next proposition, although for low values of c the frequency of litigation may be too high, when the total litigation expenses are high enough this same frequency is too low with certainty.[65]

Proposition 5 *(Bound of the social costs of litigation) If $p^* = \frac{1}{2}$ and $f > 1 - \delta$ there exists $\overline{c}$ such that for all $c > \overline{c}$ litigation is too infrequent and courts bias the standards in favor of the interests of current litigants.*

Proof: See Appendix A.

Proposition 5 not only is counterintuitive because it suggests that society faces an excess (a lack) of trials in branches of the law in which litigation is relatively inexpensive (expensive) but it is also counterintuitive because it contrasts with Shavell's result that excessive litigation is more likely when c is large. Shavell doesn't retrieve our result because in his framework c doesn't appear in the inter-temporal externality.

4.4.3 Activists or originalists judges?

On a different angle, the model predicts that the a priori probability that a judge will reform a standard at a trial (an activist judge in contraposition to an originalist judge who preserves the old standard) depends on the frequency of litigation. The smaller that frequency, the stronger the information decay process and consequently the higher the probability that the standard has become obsolete. That is, courts should be active reformers of rules in branches of the law in which litigation is expensive but strong defenders of current rules in branches in which is inexpensive. The message is clear: a "one size fits all" policy is not in the best interest of society.

5   Robustness and Extensions

In this Section we briefly comment on the robustness of the results. After that and given the conclusion that the frequency of trials may be too low in branches of the law in which litigation is expensive, we use our model to determine if two strategies suggested by legal academics as possible ways of increasing the frequency of shareholder litigation are socially desirable. We finish by considering whether society would be better off if judges were setting contingent instead of rigid rules.

5.1   Robustness of the Results

In assumption 1 we imposed that the probability with which corporations make a wrong decision due to the regulation is uniformly distributed. One may think that this is the reason why the first best standards

---

[65] Although the result is derived for in the symmetric model, we believe that it should hold for the asymmetric model as well.

don't track the environment. This is not the case: the majority of distributions imply that the $\tau-$periods return functions are not maximized by corner solutions.[66] In addition, even if the first best standards tracked the environment, the difference between the social and private incentives to litigate would prevent the enforcement of the first best standards. In assumption 2 we imposed that agents cannot learn outside trials. In reality agents learn from the markets. If every period corporations were able to discover the true state of the environment with a fixed probability then whenever a business opportunity takes place the cycle with the current standard would be broken and a new one initiated. Under these conditions, the model still have a cut-off solution but the interpretation of τ_n is different. This parameter becomes the periodicity with which the standard s_n is litigated conditional on that the agents have not learned the true state of the environment before.[67] Regardless of this new interpretation the main results (propositions 1-3) are preserved. In assumption 3 we imposed that a business opportunity is not required to trigger a trial. In reality, many trials take place in the middle of a takeover battle. If we add this condition to our model[68] then τ_n becomes the periodicity with which corporations *attempt* to reform the standard. As an attempt is not enough to generate a trial, there would be a period of random length in which the old standard is preserved until a new trial takes place. Regardless that, our main results are also preserved. Finally, in assumption 4 we imposed that the court commits to its strategy. When the court does not commit to its strategy then (1) has a multiplicity of PBEs but all of them preserve the property that the court bias the standards towards (against) the interests of corporations when the aggregate externality is negative (positive). The only difference is that a non-committed court sets standards that are closer to the first best levels than a committed court. The reason is that a non-commited court doesn't take into account the welfare effects of

---

[66] For a general distribution $F(x), F'(x) > 0$, the standards that maximize the $\tau-$periods return functions satisfy the following expression

$$\frac{(s_n^{FB} - \theta_L)F'((s_n^{FB} - \theta_L)^2)}{(\theta_H - s_n^{FB})F'((\theta_H - s_n^{FB})^2)} = \frac{\sum_{t=1}^{\tau_n}\delta^{t-1}(1 - p_n(t))}{\sum_{t=1}^{\tau_n}\delta^{t-1}p_n(t)} = H_n(\tau_n), n \in \{L, H\}$$

It is easy to verify that only special cases as $F'(x) = \sqrt{x}$ define corner solutions.

[67] With this small twist, the system of Bellman equations becomes

$$\upsilon_n = r_n + \left[z\sum_{i=1}^{\tau_n}((1 - zb)\delta)^{i-1}\left[p_n(i)\upsilon_L + (1 - p_n(i))(\upsilon_H - cb)\right]\right]$$
$$+\delta^{\tau_n}\left[p_n(\tau_n + 1)\upsilon_L + (1 - p_n(\tau_n + 1))\upsilon_H - c\right]$$

with $r_n = (1 - z)\sum_{i=1}^{\tau_n}((1 - zb)\delta)^{i-1}V(s_n, p_n(i))$ and z the probability that a corporation learns from a business opportunity faced by another corporation.

[68] The value function becomes

$$\upsilon_n = r_n - \delta^{\tau_n}\left[\begin{array}{c}(1 - b)\sum_{i=0}^{\infty}((1 - b)\delta)^iW+ \\ b\sum_{i=0}^{\infty}((1 - b)\delta)^i\left[p_n(\tau_L + 1 + i)\upsilon_L + (1 - p_n(\tau_L + 1 + i))\upsilon_H - c\right]\end{array}\right]$$

where r_n is as in our basic framework.

a new standard on the cycles in which the alternative standard is in place.[69]

5.2 Law indeterminacy and the possibility of settlement

As mentioned by Kamar (1998), there are two reasons why legislators and courts could be interested in keeping a certain degree of uncertainty in Delaware Corporate Law.[70] First, broader and flexible instead of bright-line and narrow rules adapt better to the constant changes in the environment (corporations and also courts have more discretion to interpret the rule.)[71] For example, as described by Yablon (1989), Delaware courts have clearly stated what kind of Poison Pills are legal[72] but they have not clearly stated when managers should redeem[73] them. Given that flexibility corporations would be able to condition the redemption of the Pill on the type of business opportunity they face. Second, uncertain rules are more likely to generate litigation because the parties may interpret them differently. This increment in litigation would be desirable because courts would have more opportunities to verify the efficiency of the standards.

It is important to notice that uncertainty generates trials of different characteristics than the ones we have studied so far (we call the first ones random while the second ones strategic.) While random trials take place with an exogenously given probability (proportional to the degree of uncertainty in the law) strategic

---

[69] A court that deviates one period solves

$$\max_{s_L} \left\{ r(s_L, \tau_L) - \delta_L c + \delta_L \left[p_L v_L(\widehat{s}_L, \widehat{s}_H) + (1 - p_L) v_H(\widehat{s}_L, \widehat{s}_H) \right] | \widehat{s}_L, \widehat{s}_H \right\}$$

and

$$\max_{s_H} \left\{ r(s_H, \tau_H) - \delta_H c + \delta_H \left[p_H v_L(\widehat{s}_L, \widehat{s}_H) + (1 - p_H) v_H(\widehat{s}_L, \widehat{s}_H) \right] | \widehat{s}_L, \widehat{s}_H \right\}$$

from where the system of F.O.C. that defines the non-coorperative solution $(\widehat{s}_L, \widehat{s}_H)$ is

$$\frac{\partial v_L}{\partial s_L} + \frac{\partial v_L}{\partial \tau_L} \frac{\partial \tau_L}{\partial s_L} = 0$$

$$\frac{\partial v_H}{\partial s_H} + \frac{\partial v_H}{\partial \tau_H} \frac{\partial \tau_H}{\partial s_H} = 0$$

The only difference between this system and the one that defines the cooperative solution (s_L^{SB}, s_H^{SB})

$$\frac{\partial v_L}{\partial s_L} + \frac{\partial v_L}{\partial \tau_L} \frac{\partial \tau_L}{\partial s_L} + \frac{\partial v_L}{\partial \tau_H} \frac{\partial \tau_H}{\partial s_L} = 0$$

$$\frac{\partial v_H}{\partial s_H} + \frac{\partial v_H}{\partial \tau_H} \frac{\partial \tau_H}{\partial s_H} + \frac{\partial v_H}{\partial \tau_L} \frac{\partial \tau_L}{\partial s_H} = 0$$

is that the cross-derivatives disappear. Consequently, in the first case, the bias of the standards is smaller than in the second.

[70] His analysis is framed in the broader question of desirability of interstate competition in providing corporate law. He suggests that Delaware can enhance his advantages over other states (more than halve of the Fortune 500 corporations are incorporated in its jurisdiction) by developing indeterminate and judge-oriented law.

[71] In addition, general rules are cheaper to write. However the literature (as in Ayres and Gertner [1989] and more recently Mahoney and Sanchirico [2005]) has emphasized that custom-tailored rules permit the regulator to make a more efficient use of the information owned by the parties in dispute.

[72] In addition to *Moran,* in 1998 *the* Delaware courts sentenced did not enforce the use of the dead-hand (pill that can only be redeemed by the directors that adopted it or by their designated successors) and no-hand (pill that can only be redeemed by the directors that adopted it or by their designated successors only after 6 months they assumed their jobs) verisons of the Pill in *Carmody* (723 A.2d 1180, 1998) and *Mento*r (728 A.2d 25, 1998) respectively.

[73] The pill becomes void.

trials take place with a probability endogenously determined.[74] Here, we concentrate on the second role of uncertainty in the law and ask whether society is better with or without the existence of random trials.[75] In Appendix C we show that society will prefer not to have random trials at all because they have two undesirable effects: 1. they take place whether the law needs to be improved or not; 2. they reduce the frequency with which strategic trials take place. However a numerical example suggests that if the litigating parties have the option to settle their disputes and that option is neither too expensive nor too cheap, society could prefer a non-zero level of ambiguity in the law. The cost of settlement cannot be too low otherwise the parties at dispute will always prefer to settle their disputes and it cannot be too high otherwise they will always prefer trials.

5.3 The Role of Agencies

Almost every major breakdown in corporate America that took place in the last century was followed by a period of high regulatory activity (enforcement or enactment of new rules). Skeel (2005) documents that states adjusted their bodies of regulation in response to the railroad failure of 1873, the Congress enacted the Securities and Exchange Acts of 1933-34 in response to the depression of the 30's and the Sarbanes-Oxley Act in response to the Enron and WorldCom scandals of 2001. But should regulators only react after a major crisis takes place? In this part of the paper we analyze the capacity of agencies such as the Security and Exchange Commission or public prosecutors such as the New York General Attorney's Office to correct the inefficient frequency of trials through the external generation of litigation. In appendix D we show that if the agency is worse informed than corporations about the environment or the characteristics of the same corporations[76] its intervention will bias the frequency of litigation toward excess whether that is needed or not. The reason is that while the agency is able to generate trials it is not able to prevent them from taking place. If the frequency of litigation is suboptimally high then an agency cannot do anything and legislators should use other corrective methods as imposing taxes or giving incentives to the parties to settle.[77] If the frequency of trial is suboptimally low, the agency can help correct the inefficiency but it can also make it

---

[74]In order to verify that this distinction among trials is real we identified in Westlaw (online legal database that among other services provides all the sentences of judicial cases (civil and criminal) taken place in U.S. jurisdictions since 1800 to the present) all the judicial trials related to the use of the Pill that have been litigated in the jurisdiction of Delaware. We found a total of 120 cases between 1985 and 2004. Among the 31 published opinions (listed in appendix B) that make direct reference to the Pill (we leave aside 76 unpublished opinions and 13 opinions that make indirect references to the pill) we distinguished 9 strategic trials, 18 random (9 redemptions plus 3 conditional redemptions against 6 keep in place) and 4 that belong to other categories. That shows us that indeterminacy is a relevant source of litigation.

[75]Consequently, our results may underestimate the social value of indeterminacy.

[76]Although it is true that the Division of Enforcement of the S.E.C. is permanently commited to conduce investigations in order to determine when a violation has been made, it is a fact that it will have restricted access to information owned by the corporation

[77]See Shavell (1997) for other suggestions.

worse. At the end, the desirability of the intervention of these type of agencies will be a function of the quality of their information.

5.4 Rigid or contingent standards?

A last point that we wanted to discuss is: why don't forward-looking courts set contingent (rules that are a function of t) instead of rigid rules? the answer is: it depends on the costs that the parties have to pay to enforce the rule adjustments between periods, we will call them adjustment costs. What is an example of adjustment costs in practice? In the case of the *Unocal-Revlon* proportionality test mentioned in the introduction, all the costs incurred by companies to determine which actions managers can use to resist a takeover offer and not be deemed violations of their fiduciary duties in the context of the current environment. It is obvious that if there are no adjustment costs then contingent rules dominate rigid rules. To see that, suppose that the optimal rigid rules s_n generate trials every τ_n periods then if courts set the following contingent rules

$$s_n^{cont}(t) = \begin{cases} s_n \text{ if } t = 1 \\ p_n(t)\theta_L + (1 - p_n(t))\theta_H \text{ if } t \in (1, \tau_n) \\ s_n \text{ if } t = \tau_n \end{cases}$$

trials still are generated every τ_n periods and the utilities of the first and last corporations in a cycle are the same as with rigid rules, nevertheless the utilities of the corporations in the other periods within the cycle are higher with contingent rules as $V(s, p_n(t))$ is maximum when $s = p_n(t)\theta_L + (1 - p_n(t))\theta_H$.[78]

But now, if any rule change induces an adjustment cost $a_n > 0$, it is clear that there exists values $\bar{a}_n > 0$ such that for any $a \leq \bar{a}_n$ courts set contingent standards but for any $a_n > \bar{a}_n$ they prefer to set rigid standards. To see that, notice that the bigger are the adjustment costs the smaller is the number of adjustments that courts will induce. When a_n has became large enough, courts will only induce one adjustment, at the second period, that is courts will solve problem (1) with two variations: 1) $s_n(1) = \theta_n$ and 2) the τ_n-period return function is $r_n = V(\theta_n, p_n(1)) + \sum_{t=2}^{\tau_n} \delta^{t-1}V(s_n, p_n(t)) - \delta a_n$. Hence if $v_n(s_n^{cont}(t, a_n), \tau_n(a_n))$ are the optimal values of current and future corporations when courts set contingent standards according to 1) and 2), cut-off values $\bar{a}_n$ are defined by

$$v_n(s_n^{cont}(t, \bar{a}_n), \tau_n(\bar{a}_n)) = v_n(s_n, \tau_n)$$

---

[78] In the case that rigid rules optimally generate trials every one or two periods then rigid and contingent rules generate the same aggregate utility.

where the last expression are the optimal values of current and future corporations when courts set rigid standards.[79]

6 Conclusions

In this paper we developed a theoretical framework that describes when and how courts should reform legal rules. We determined the infinite horizon problem faced by a benevolent court that has to enforce a standard rule each time that faces a trial, taking into account that the environment evolves and that the parties rationally decide when to generate a trial. We showed that a forward-looking court should not set the rules that the parties at dispute would have wanted before they signed the contract but the rules that are optimal for the period of time that will take place until a new trial takes place. In addition, we showed that because a court cannot reform a rule whenever it wants and the private incentives to generate litigation differ from the social ones, the rules will be biassed in favor or against the interests of current litigants. Finally, we also showed that if the litigation costs are big enough the frequency of litigation becomes insufficient and courts set standards that are more favorable to the interests of current litigants than what society would ideally like to have.

Our model opens the door for several avenues of future research. At the empirical level, work is needed to determine whether courts are better described as myopic or forward-looking agents;[80] in which branches of the law the externality associated to the generation of trials is positive; and whether the sensitivity analysis predicted by the model is accurate. At the theoretical level work is needed to understand the role of legislators as a different source of legislation;[81] to determine the way in which courts should react to transitory shocks in the state of the environment; to determine the optimal combination of general and specific rules; and to determine the optimal level of courts' activism. The sooner we are able to understand the rule-making role of courts in all its complexity the sooner we will be able to provide society with an efficient law.

---

[79] In addition, it can be argued that contingent standards generate more litigation that rigid standards. There are two reasons to believe that. First, due to the redistributive effects of a standard change, the harmed party will challenge the adjustment and with that generate a trial. Second, if contingent standards generate higher utilities than rigid standards, future corporations will have more incentives to attempt a change. To see this last point, suppose that contingent rules are $s_n^{cont}(t) = p_n(t)\theta_L + (1 - p_n(t))\theta_H$ then in the context of the symmetric model we have that trials are generated when

$$\alpha b W p (1 - p)(\theta_H - \theta_L)^2 = fc \tag{25}$$

while for any other rigid rules trials are generated when $\alpha b W (1 - \overline{p})(s_H - s_L)(\theta_H - \theta_L) = fc$ in the case that the standard is s_L and $\alpha b W \underline{p}(s_H - s_L)(\theta_H - \theta_L) = fc$ in the case that the standard is s_H. Because $s_H - s_L < \theta_H - \theta_L$ it is simple to verify that $\overline{p}$ is smaller than the largest root defined by (25) while $\underline{p}$ is smaller than the smallest root defined by (25). That means that $s_n^{cont}(t)$ generates more trials than any rigid rule. In particular, it suggests that if litigation expenses are high enough society ends better off with a rigid rule than with contingent rules $s_n^{cont}(t)$.

[80] We need a proxy that meassures the degree in which intertemporal considerations are present in judicial senteces.

[81] A source that has its own cost of reform and uses information of a different quality.

References

[1] Abreu, Pearce and Stacchetti (1990) "Toward a Theory of Discounted Repeated Games with Imperfect Monitoring", *Econometrica* **58**, 1041-1064.

[2] Anderlini, L., L. Felli and A. Postlewaite (2003) "Should Courts Always Enforce What Contracting Parties Write?", working paper, University of Pennsylvania.

[3] Anderlini, L., L. Felli and A. Riboni (2007) "Statute or Case Law?", working paper, University of Rochester.

[4] Atiyah, P.S. and R. Summers (1987) *Form and Substance in Anglo-American Law*, Oxford University Press.

[5] Ayres, I. and R. Gertner (1989) "Filling Gaps in Incomplete Contracts: An Economic Theory of Default Rules", *Yale Law Journal* **99**, 87-130.

[6] Baird, D. and Th. Jackson (1985) "Fraudulent Conveyance Law and Its Proper Domain", *Vanderbilt Law Review* **38**, 829-856.

[7] Bebchuk, L.A. (1988) "Suing Solely to Extract a Settlement Offer", *Journal of Legal Studies* **17**, 437-450.

[8] Bebchuk, L. and A. Ferrell (1999) "Federalism and Corporate Law: The Race to Protect managers from Takeovers", Columbia Law Review **99**, 1168-1199.

[9] Bebchuk, L. and A. Hamdani (2002) "Optimal Defaults for Corporate Law Evolution", *Northwestern University Law Review* **98**,2, 489-520.

[10] Bebchuk, L. and S. Shavell (1991) "Information and the Scope of Liability for Breach of Contract: The Rule of Hadley V. Baxendale", *Journal of Law, Economics and Organization* **7**, 284-312.

[11] Becht, M., P. Bolton and A. Roell (2003) "Corporate Governance and Control", Handbook of the Economics of Finance, Chapter 1, Volume 1A.

[12] Bertsekas, D. (1995) *Dynamic Programming and Optimal Control,* Belmont, Mass.: Athena Scientific.

[13] Black, B. (1991) *Black's Law Dictionary*, West Publishing Co., Sixth Edition.

[14] Black, B. and J. Grundfest (1988) "Shareholder Gains form Takeovers and Restructurings between 1981 and 1986", *Journal of Applied Corporate Finance* **5**, 1, 5-15.

[15] Bond, Ph. (2003) "Contracting in the Presence of Judicial Agency", working paper, Northwestern University.

[16] Bonomo, M. and C. Carvalho (2004) "Endogenous Time-Dependent Rules and Inflation Inertia", *Journal of Money, Credit and Banking* **36**, 6, 1015-1067.

[17] Cooter, R., L. Kornhauser and D. Lane (1979) "Liability Rules, Limited Information and the Role of Precedent", *The Bell Journal of Economics* **10**, 1, 366-373.

[18] Cooter, R. and L. Kornhauser (1980) "Can Litigation improve the Law without the Help of Judges", *Journal of Legal Studies* **9**, 1, 139-163.

[19] Chu, C.Y. Cyrus (2003) "Precedent Externality, Network Effect, and the Possible Inefficiency of the Evolution of Laws", *European Journal of Law and Economics* **16**, 2, 187-198.

[20] Easterbrook, F. and D. Fischel (1991) *The Economic Structure of Corporate Law*, Harvard University Press.

[21] Johnson S., R. La Porta, F. Lopez de Silanes and A. Schleifer (2000) "Tunneling", *American Economic Review* **90**, 2, 22-27.

[22] Fon V. and Parisi F. (2003) "Litigation and the evolution of legal remedies: a dynamic model", *Public Choice* **116**, 419-433.

[23] Franks, J. and O. Sussman (2005) "Financial Innovations and Corporate Bankruptcy", *Journal of Financial Intermediation* **14**, 3, 283-317.

[24] Fudenberg, Levine and Maskin (1994) "The Folk Theorem with Imperfect Public Information", *Econometrica* **62**, 997-1040.

[25] Gennaioli, N. and A. Shleifer (2005) "The Evolution of Precedent", working paper, University of Stockholm.

[26] Gilson, R. and B. Black (1995) *The Law and Finance of Corporate Acquisitions*, The Foundation Press, Inc., second edition.

[27] Grossman, S. and O. Hart (1980) "Takeover Bids, The Free-Rider Problem, and the Theory of the Corporation", *The Bell Journal of Economics* **11**, 1, 42-64.

[28] Harnay, S. and A. Marciano (2004) "Judicial Conformity versus dissidence: an economic analysis of judicial precedent", *International Review of Law and Economics* **23**, 405-20.

[29] Harris, M. (1987) *Dynamic Economic Analysis,* Oxford University Press.

[30] Harris, M. and B. Holmstrom (1987) "On the Duration of Agreements", *International Economic Review* **28,** 2, 389-406.

[31] Hayek F. (1973) *Law, Legislation and Liberty: Rules and Order*, The University of Chicago Press, first edition.

[32] Hua, X. and K. Spier (2005) "Information and Externalities in Sequential Litigation", *Journal of Institutional and Theoretical Economics* **161**, 2, 215-232.

[33] Kamar, E. (1998) "A Regulatory Competition Theory of Indeterminacy in Corporate Law", *Columbia Law Review* **98**, 1908-1962.

[34] Kraakman, R. and H. Hansmann (2004) "*The Anatomy of Corporate Law*", Oxford University Press.

[35] Landes, W. and R. Posner (1976) "Legal Precedent: A Theoretical and Empirical Analysis", *Journal of Law and Economics* **19**, 2, 249-307.

[36] Levy, G. (2005) "Careerist Judges", *Rand Journal of Economics* **36**, 2, 275-297.

[37] Mahoney, P. and C. Sanchirico (2005) "General and Specific Rules", *Journal of Institutional and Theoretical Economics* **161**, 2, 329-346.

[38] Matheson, J. and B. Olson (1991) "Shareholder Rights and Legislative Wrongs: Toward Balanced Takeover Legislation", *George Washington Law Review* **59**, 1425-1570.

[39] Maskin, E. (2005) "On the Rationale for Penalty Default Rules", working paper, Institute for Advanced Study and Princeton University.

[40] Miceli, T. and M. Cosgel (1994) "Reputation and judicial decision-making", *Journal of Economic Behavior and Organization* **23**, 31-51.

[41] Mitton, T. (2002) "A cross-firm analysis of the impact of corporate governance on the East Asian financial crisis", *Journal of Financial Economics* **64**, 2, 215-241.

[42] Murphy, K., A Shleifer and R. Vishny (1991) "The Allocation of Talent: Implications for Growth" *Quarterly Journal of Economics* **106**, 2, 503-30.

[43] Posner R. (2001) *Antitrust Law*, second edition, The University of Chicago Press.

[44] Posner R. (2003) *Economic Analysis of Law,* sixth edition, Boston, Little Brown.

[45] Priest, G. (1977) "The Common Law Process and the Selection of Efficient Rules", *Journal of Legal Studies* **6**, 1, 65-82.

[46] Reis, R. (2004) "Inattentive Consumers", NBER working paper 10883.

[47] Rubin, P. (1977) "Why Is the Common Law Efficient?", *Journal of Legal Studies* **6**, 1, 51-63.

[48] Scharfstein, D. (1988) "The Disciplinary Role of Takeovers", *Review of Economic Studies* **55**, 2, 185-199.

[49] Schnitzer, M. (1995) "Breach of trust in takeovers and the optimal corporate charter", *Journal of Industrial Economics* **43**, 3, 229-259.

[50] Shavell, S. (1997) "The Fundamental Divergence between the Private and the Social Motive to Use the Legal System", *Journal of Legal Studies* **26**, 2, 575-612.

[51] Shavell, S. (1999) "The Level of Litigation: Private Versus Social Optimality of Suit and of Settlement", *International Review of Law and Economics* **19**, 99-115.

[52] Shavell, S. (2003) "On The Writing and Interpretation of Contracts", working paper, Harvard University.

[53] Shleifer, A. and R. Vishny (1997) "A Survey of Corporate Governance", *Journal of Finance* **52**, 2, 737-783.

[54] Shleifer, A. and R. Vishny (1991) "Takeovers in the '60s and the '80s: Evidence and Implications", *Strategic Management Journal* **12**, Winter, 51-59.

[55] Skeel, D. (2001) *Debt's Dominion: A History of Bankruptcy Law in America.* Princeton University Press.

[56] Skeel, D. (2005) *Icarus in the Boardroom,* Oxford University Press.

[57] Thompson, R. and R. Thomas (2004) "The New Look of Shareholder Litigation: Acquisition Oriented Class-Actions" *Vanderbilt Law Review* **57**, 133-211.

[58] Usman, M. (2002) "Verifiability and Contract Enforcement: A Model with Judicial Moral Hazard", *Journal of Law Economics and Organization* **18**, 1, 67-94.

[59] Yablon, C. (1989) "Poison Pills and Litigation Uncertainty", *Duke Law Journal* **1989**, 1, 54-91.

Appendix

Appendix A: Mathematical Proofs

Proof of Lemma 1 We solve the three-stage game when the standard is s_L

Stage 3: P accepts the settlement offer S if and only if

$$(1 - \nu_2)V(s_H, p) + S > (1 - \nu_1)pU(s_L, \theta_L) + (1 - p)((1 - \nu_2)U(s_H, \theta_H) + h) - (1 - f)c$$

The left hand side is the utility of P if she accepts s_H as the new standard for the corporation. The right hand side is the utility of P if the court decides the new standard. If the new standard is s_H then D has to compensate P in the amount of her harm $h = (1 - \nu_1)U(s_L, \theta_H) - (1 - \nu_2)U(s_H, \theta_H)$.[82] Rearranging expressions, the constraint becomes

$$S > p\left[(1 - \nu_1)U(s_L, \theta_L) - (1 - \nu_2)U(s_H, \theta_L)\right] + (1 - p)h - (1 - f)c$$

By its side, D makes the settlement offer if and only if that satisfies

$$\nu_2 V(s_H, p) - S > \nu_1 pU(s_L, \theta_L) + (1 - p)\left(\nu_2 U(s_H, \theta_H) - h\right) - fc$$

The left hand side is the utility of D if P accepts s_H as the new standard for the corporation. The right hand side is the utility of D if the court decides the new standard. Consequently the constraint is equivalent to

$$S < p\left[\nu_2 U(s_H, \theta_L) - \nu_1 U(s_L, \theta_L)\right] + (1 - p)h + fc$$

which defines the set of all possible values of settlement as

$$S \in \left[\begin{array}{c} p[(1 - \nu_1)U(s_L, \theta_L) - (1 - \nu_2)U(s_H, \theta_L)] + (1 - p)h - (1 - f)c, \\ p\left[\nu_2 U(s_H, \theta_L) - \nu_1 U(s_L, \theta_L)\right] + (1 - p)h + fc \end{array} \right]$$

and that set exists if and only if

$$p < \frac{c}{U(s_L, \theta_L) - U(s_H, \theta_L)} = p^S$$

As the offer is take-it-or-leave-it D offers $S = p\left[(1 - \nu_1)U(s_L, \theta_L) - (1 - \nu_2)U(s_H, s_L)\right] + (1 - p)h - (1 - f)c$ if $p \leq p^S$ and $S = p\left[\nu_2 U(s_H, \theta_L) - \nu_1 U(s_L, \theta_L)\right] + (1 - p)h + fc$ otherwise. Clearly, only in the first case, P accepts it.

Stage 2: P decides to sue D when

$$(1 - \nu_1)pU(s_L, \theta_L) + (1 - p)\left[(1 - \nu_2)U(s_H, \theta_H) + h\right] - (1 - f)c > (1 - \nu_2)(pU(s_H, \theta_L) + (1 - p)U(s_H, \theta_H))$$

The left hand side is the utility of P if she decides to sue (which due to the value of the take-it-or-leave-it offer does not depend on whether the dispute is settled or goes to trial). The right hand side is the utility of P if she accepts the new standard. Consequently the constraint is equivalent to

$$p\left[(1 - \nu_1)U(s_L, \theta_L) - (1 - \nu_2)U(s_H, \theta_L)\right] + (1 - p)h > (1 - f)c$$

$$p > \frac{(1 - f)c - h}{(1 - \nu_1)U(s_L, \theta_L) - (1 - \nu_2)U(s_H, \theta_L) - h} = p^P$$

It is easy to verify that $p^S \geq p^P$ if and only if the following condition is true

$$c[(f - \nu_1)U(s_L, \theta_L) - (f - \nu_2)U(s_H, \theta_L) - h] \geq -h(U(s_L, \theta_L) - U(s_H, \theta_L)) \tag{26}$$

such that when $p^S \geq p^P$ we have that: if $p \geq p^S$ then P sues D and the parties don't settle, if $p^S > p > p^P$ then P sues and the parties settle and if $p^P \geq p$ then P accepts the change suggested by D. When $p^S < p^P$ we have that: if $p \geq p^P$ then P sues D and the parties don't settle, if $p^P > p$ then P accepts the suggested change without suing.

Stage 1: We analyze the cases in which (26) is true and false

If (26) is true then, if $p \geq p^S$ then D initiates a change when

$$\nu_1 pU(s_L, \theta_L) + (1 - p)\left(\nu_2 U(s_H, \theta_H) - h\right) - fc > \nu_1(pU(s_L, \theta_L) + (1 - p)U(s_L, \theta_H))$$

The left hand side is the utility of D if he decides to change the standard knowing that P will sue and there will be no settlement. The right hand side is the utility of D if he doesn't initiate a change. Consequently the constraint is equivalent to

$$p < \frac{\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H) - h - fc}{\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H) - h} = p_1^D$$

---

[82] We are aware that this expression can be negative which means that there are situations in which P must compensate D.

If $p^S > p > p^P$ then D initiates a change when

$$\nu_2 \left(pU(s_H, \theta_L) + (1-p)U(s_H, \theta_H)\right) - S > \nu_1 (pU(s_L, \theta_L) + (1-p)U(s_L, \theta_H))$$

The left hand side is the utility of D if he decides to change the standard knowing that P will sue and the parties settle. The right hand side is the utility of D if he doesn't initiate a change. Consequently, after replacing the value of S, the constraint becomes

$$\left\{ \begin{array}{c} \nu_2 \left(pU(s_H, \theta_L) + (1-p)U(s_H, \theta_H)\right) - (1-p)h + (1-f)c \\ -p\left[(1-\nu_1)U(s_L, \theta_L) - (1-\nu_2)U(s_H, s_L)\right] \end{array} \right\} > \nu_1 (pU(s_L, \theta_L) + (1-p)U(s_L, \theta_H))$$

or equivalently

$$p < \frac{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H)) - h + (1-f)c}{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H)) - (U(s_H, \theta_L) - U(s_L, \theta_L)) - h} = p_2^D$$

Finally if $p^P \geq p$ then D initiates a change when

$$\nu_2 V(s_H, p) > \nu_1 V(s_L, p)$$

as in this case we know that P accepts the change immediately. The constraint becomes

$$p < \frac{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H))}{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H)) - (\nu_2 U(s_H, \theta_L) - \nu_1 U(s_L, \theta_L))} = p_3^D$$

If (26) is false then, if $p \geq p^P$ then D initiates a change when $p < p_2^D$. In this case P sues and the parties settle. If $p < p^P$ then D initiates a change when $p < p_3^D$, in this case P accepts the change immediately.

We identify

$$\widehat{c}_1 = \frac{1}{\frac{1}{U(s_L, \theta_L) - U(s_H, \theta_L)} + \frac{f}{U(s_H, \theta_H) - U(s_L, \theta_H)}}$$

as the litigation cost in which $p_1^D = p_2^D$,

$$\widehat{c}_2 = \frac{1}{\frac{f}{U(s_H, \theta_H) - U(s_L, \theta_H)} + \frac{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H))f}{(\nu_1 U(s_L, \theta_L) - \nu_2 U(s_H, \theta_L))(U(s_H, \theta_H) - U(s_L, \theta_H))}}$$

as the litigation cost in which $p_1^D = p_3^D$,

$$\widehat{c}_3 = \frac{(\nu_2 - \nu_1)(U(s_H, \theta_H)U(s_L, \theta_L) - U(s_H, \theta_L)U(s_L, \theta_H))}{(1-f)\left[\nu_2(U(s_H, \theta_H) - U(s_H, \theta_L)) + \nu_1(U(s_L, \theta_L) - U(s_L, \theta_H))\right]}$$

as the litigation cost in which $p_3^D = p_2^D$,

$$\widehat{c}_3^S = \frac{1}{\frac{1}{U(s_L, \theta_L) - U(s_H, \theta_L)} + \frac{\nu_1 U(s_L, \theta_L) - \nu_2 U(s_H, \theta_L)}{(\nu_2 U(s_H, \theta_H) - \nu_1 U(s_L, \theta_H))(U(s_L, \theta_L) - U(s_H, \theta_L))}}$$

as the litigation cost in which $p^S = p_3^D$,

$$\widehat{c}_1^P = \frac{(U(s_H, \theta_H) - U(s_L, \theta_H))((1-\nu_2)U(s_H, \theta_L) - (1-\nu_1)U(s_L, \theta_L))}{(1-f)U((s_H, \theta_H) - U(s_L, \theta_H)) + f((1-\nu_2)(U(s_H, \theta_H) - U(s_H, \theta_L)) - (1-\nu_1)(U(s_L, \theta_L) - U(s_L, \theta_H)))}$$

as the litigation cost in which $p^P = p_1^D$ and

$$\widehat{c}^{SP} = \frac{((1-\nu_2)U(s_H, \theta_H) - (1-\nu_1)U(s_L, \theta_H))(U(s_L, \theta_L) - U(s_H, \theta_L))}{[(f-\nu_1)U(s_L, \theta_L) - (f-\nu_2)U(s_H, \theta_L) - ((1-\nu_1)U(s_L, \theta_H) - (1-\nu_2)U(s_H, \theta_H))]}$$

as the litigation cost in which $p^P = p^S$.

Then, as the following properties hold: 1) $p_1^D(0) = 1$; 2) $p_1^D(\frac{U(s_H, \theta_H) - U(s_L, \theta_H)}{f}) = 0$; 3) $p_3^D \in [0, 1]$; 4) $p_2^D(0) > 0$; 5) $\frac{\partial p^S}{\partial c} > \frac{\partial p_2^D}{\partial c} > 0$; 6) $p_1^D \geq p^S$ if and only if $c < \widehat{c}_1$; 7) $p_2^D \geq p^S$ if and only if $c > \widehat{c}_1$; 8) $p^S(0) = 0$; 9) $p_2^D \geq p^P$ if and only if $c > \widehat{c}_3$; 10) $p_3^D \geq p^P$ if and only if $c < \widehat{c}_3$; 11) $p^P(0) < 0$; 12) $\frac{\partial p^P}{\partial c} > 0$ and 13) $p_3^D > p_2^D(0)$ there are only two possible order relations for $\widehat{c}_1, \widehat{c}_2, \widehat{c}_3, \widehat{c}^{SP}, \widehat{c}_3^S$ and $\widehat{c}_1^P$.

Case 1) $0 < \widehat{c}^{SP} < \widehat{c}_3 < \widehat{c}_1^P < \widehat{c}_3^S < \widehat{c}_1 < \widehat{c}_2$ which means that for all $c < \widehat{c}^{SP}$, $p_1^D > p_3^D > p_2^D > p^S > p^P$ for all $c \in [\widehat{c}^{SP}, \widehat{c}_3]$, $p_1^D > p_3^D > p_2^D > p^P > p^S$, for all $c \in [\widehat{c}_3, \widehat{c}_1^P]$, $p_1^D > p^P > p_2^D > p_3^D > p^S$, for all $c \in [\widehat{c}_1^P, \widehat{c}_3^S]$, $p^P > p_1^D > p_2^D > p_3^D > p^S$, for all $c \in [\widehat{c}_3^S, \widehat{c}_1]$, $p^P > p_1^D > p_2^D > p^S > p_3^D$, for all $c \in [\widehat{c}_1, \widehat{c}_2]$, $p^P > p^S > p_2^D > p_1^D > p_3^D$ and for all $c > \widehat{c}_2$, $p^P > p^S > p_2^D > p_3^D > p_1^D$. That is, if $c \leq \widehat{c}_1^P$ when p hits p_1^D, D initiates a change that is challenged by P, the parties don't settle and the court makes a decision. If $c > \widehat{c}_1^P$ when p hits p_3^D, D initiates a change which is accepted by P (there is no combination in which D initiates a change that is challenged by P and the parties settle their differences).

Case 2) $\widehat{c}_2 < \widehat{c}_1 < \widehat{c}_3^S < \widehat{c}_1^P < \widehat{c}_3 < \widehat{c}^{SP}$ which means that for all $c < \widehat{c}_2$, $p_1^D > p_3^D > p_2^D > p^S > p^P$ for all $c \in [\widehat{c}_2, \widehat{c}_1]$, $p_3^D > p_1^D > p_2^D > p^S > p^P$ for all $c \in [\widehat{c}_1, \widehat{c}_3^S]$, $p_3^D > p^S > p_2^D > p_1^D > p^P$, for all $c \in [\widehat{c}_3^S, \widehat{c}_1^P]$, $p^S > p_3^D > p_2^D > p_1^D > p^P$, for all $c \in [\widehat{c}_1^P, \widehat{c}_3]$, $p^S > p_3^D > p_2^D > p^P > p_1^D$ for all $c \in [\widehat{c}_3, \widehat{c}^{SP}]$, $p^S > p^P > p_2^D > p_3^D > p_1^D$ and for all $c > \widehat{c}^{SP}$ $p^P > p^S > p_2^D > p_3^D > p_1^D$. That is, if $c < \widehat{c}_1$ when p hits p_1^D, D initiates a change that is challenged by P, the parties don't settle and the court makes a decision. If $c \in [\widehat{c}_1, \widehat{c}_3]$ when p hits p_2^D, D initiates a change that is challenged by P and the parties settle their differences. If $c > \widehat{c}_3$ when p hits p_3^D, D initiates a change which is accepted by P.

We solve the three-stage game when the standard is s_H (the analysis is analogous as when the standard is s_L)

Stage 3: P accepts the settlement offer S if and only if

$$(1 - \nu_2)V(s_L, p) + S > p((1 - \nu_2)U(s_L, \theta_L) + h) + (1 - p)(1 - \nu_1)U(s_H, \theta_H) - (1 - f)c$$

The left hand side is the utility of P if she accepts s_L as the new standard for the corporation. The right hand side is the utility of P if the court decides the new standard. If the new standard is s_L then D has to compensate P in the amount of his harm $h = (1 - \nu_1)U(s_H, \theta_L) - (1 - \nu_2)U(s_L, \theta_L)$.[83] Rearranging expressions, the constraint becomes

$$S > (1 - p)\left[(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H)\right] + ph - (1 - f)c$$

By its side, D makes the settlement offer if and only if that satisfies

$$\nu_2 V(s_L, p) - S > p(\nu_2 U(s_L, \theta_L) - h) + (1 - p)\nu_1 U(s_H, \theta_H) - fc$$

The left hand side is the utility of D if P accepts s_L as the new standard for the corporation. The right hand side is the utility of D if the court decides the new standard. Consequently the constraint is equivalent to

$$S < (1 - p)\left[\nu_2 U(s_L, \theta_H) - \nu_1 U(s_H, \theta_H)\right] + ph + fc$$

which defines the set of all possible values of settlement as

$$S \in \left[\begin{array}{c} (1 - p)\left[(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H)\right] + ph - (1 - f)c, \\ (1 - p)\left[\nu_2 U(s_L, \theta_H) - \nu_1 U(s_H, \theta_H)\right] + ph + fc \end{array} \right]$$

and that set exists if and only if

$$p > 1 - \frac{c}{U(s_H, \theta_H) - U(s_L, \theta_H)} = p^S$$

As the offer is take-it-or-leave-it D offers $S = (1 - p)\left[(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H)\right] + ph - (1 - f)c$ if $p \geq p^S$ and $S = (1 - p)\left[\nu_2 U(s_L, \theta_H) - \nu_1 U(s_H, \theta_H)\right] + ph + fc$ otherwise. Clearly, only in the first case, P accepts it.

Stage 2: P decides to sue D when

$$p\left((1 - \nu_2)U(s_L, \theta_L) + h\right) + (1 - p)(1 - \nu_1)U(s_H, \theta_H) - (1 - f)c > (1 - \nu_2)(pU(s_L, \theta_L) + (1 - p)U(s_L, \theta_H))$$

The left hand side is the utility of P if she decides to sue (which due to the value of the take-it-or-leave-it offer does not depend on whether the dispute is settled or goes to trial). The right hand side is the utility of P if she accepts the new standard. Consequently the constraint is equivalent to

$$(1 - p)\left[(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H)\right] + ph > (1 - f)c$$

$$p < \frac{(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H) - (1 - f)c}{(1 - \nu_1)U(s_H, \theta_H) - (1 - \nu_2)U(s_L, \theta_H) - h} = p^P$$

It is easy to verify that $p^S \leq p^P$ if and only if the following condition is true

$$c[(f - \nu_1)U(s_H, \theta_H) - (f - \nu_2)U(s_L, \theta_H) - h] \leq -h(U(s_H, \theta_H) - U(s_L, \theta_H)) \tag{27}$$

such that when $p^P \geq p^S$ we have that: if $p \leq p^S$ then P sues D and the parties don't settle, if $p^P > p > p^S$ then P sues and the parties settle and if $p \geq p^P$ then P accepts the change suggested by D. When $p^S > p^P$ we have that: if $p \leq p^P$ then P sues D and the parties don't settle, if $p > p^P$ then P accepts the suggested change without suing.

Stage 1: We analyze the cases in which (27) is true and false

If (27) is true then, if $p \leq p^S$ then D initiates a change when

$$p\left(\nu_2 U(s_L, \theta_L) - h\right) + (1 - p)\nu_1 U(s_H, \theta_H) - fc > \nu_1(pU(s_H, \theta_L) + (1 - p)U(s_H, \theta_H))$$

The left hand side is the utility of D if he decides to change the standard knowing that P will sue and there will be no settlement. The right hand side is the utility of D if he doesn't initiate a change. Consequently the constraint is equivalent to

$$p > \frac{fc}{\nu_2 U(s_L, \theta_L) - \nu_1 U(s_H, \theta_L) - h} = p_1^D$$

---

[83] We are aware that this expression can be negative which means that there are situations in which P must compensate D.

if $p^S < p < p^P$ then D initiates a change when

$$\nu_2 \left(pU(s_L, \theta_L) + (1-p)U(s_L, \theta_H)\right) - S > \nu_1(pU(s_H, \theta_L) + (1-p)U(s_H, \theta_H))$$

The left hand side is the utility of D if he decides to change the standard knowing that P will sue and the parties settle. The right hand side is the utility of D if he doesn't initiate a change. Consequently, after replacing the value of S, the constraint becomes

$$\left\{ \begin{array}{c} \nu_2 \left(pU(s_L, \theta_L) + (1-p)U(s_L, \theta_H)\right) - ph + (1-f)c \\ -(1-p)\left[(1-\nu_1)U(s_H, \theta_H) - (1-\nu_2)U(s_L, \theta_H)\right] \end{array} \right\} > \nu_1(pU(s_H, \theta_L) + (1-p)U(s_H, \theta_H))$$

or equivalently

$$p > \frac{(U(s_H, \theta_H) - U(s_L, \theta_H)) - (1-f)c}{(\nu_2 U(s_L, \theta_L) - \nu_1 U(s_H, \theta_L)) + (U(s_H, \theta_H) - U(s_L, \theta_H)) - h} = p_2^D$$

Finally if $p^P \leq p$ then D initiates a change when

$$\nu_2 V(s_L, p) > \nu_1 V(s_H, p)$$

as in this case we know that P accepts the change immediately. The constraint becomes

$$p > \frac{(\nu_1 U(s_H, \theta_H) - \nu_2 U(s_L, \theta_H))}{\nu_2 \left(U(s_L, \theta_L) - U(s_L, \theta_H)\right) + \nu_1 \left(U(s_H, \theta_H) - U(s_H, \theta_L)\right)} = p_3^D$$

If (26) is false then, if $p \leq p^P$ then D initiates a change when $p > p_2^D$. In this case P sues and the parties settle. If $p > p^P$ then D initiates a change when $p > p_3^D$, in this case P accepts the change immediately.

We identify

$$\widehat{c}_1 = \frac{1}{\frac{1}{U(s_H, \theta_H) - U(s_L, \theta_H)} + \frac{f}{U(s_L, \theta_L) - U(s_H, \theta_L)}}$$

as the litigation cost in which $p_1^D = p_2^D$,

$$\widehat{c}_2 = \frac{1}{\frac{f}{U(s_L, \theta_L) - U(s_H, \theta_L)} + \frac{(\nu_2 U(s_L, \theta_L) - \nu_1 U(s_H, \theta_L))f}{(\nu_1 U(s_H, \theta_H) - \nu_2 U(s_L, \theta_H))(U(s_L, \theta_L) - U(s_H, \theta_L))}}$$

as the litigation cost in which $p_1^D = p_3^D$,

$$\widehat{c}_3 = \frac{(\nu_2 - \nu_1)(U(s_L, \theta_L)U(s_H, \theta_H) - U(s_L, \theta_H)U(s_H, \theta_L))}{(1-f)\left[\nu_2(U(s_L, \theta_L) - U(s_L, \theta_H)) + \nu_1(U(s_H, \theta_H) - U(s_H, \theta_L))\right]}$$

as the litigation cost in which $p_3^D = p_2^D$,

$$\widehat{c}_3^S = \frac{1}{\frac{1}{U(s_H, \theta_H) - U(s_L, \theta_H)} + \frac{\nu_1 U(s_H, \theta_H) - \nu_2 U(s_L, \theta_H)}{(\nu_2 U(s_L, \theta_L) - \nu_1 U(s_H, \theta_L))(U(s_H, \theta_H) - U(s_L, \theta_H))}}$$

as the litigation cost in which $p^S = p_3^D$,

$$\widehat{c}_1^P = \frac{(U(s_L, \theta_L) - U(s_H, \theta_L))((1-\nu_2)U(s_L, \theta_H) - (1-\nu_1)U(s_H, \theta_H))}{(1-f)U((s_L, \theta_L) - U(s_H, \theta_L)) + f((1-\nu_2)\left(U(s_L, \theta_L) - U(s_L, \theta_H)\right) - (1-\nu_1)(U(s_H, \theta_H) - U(s_H, \theta_L)))}$$

as the litigation cost in which $p^P = p_1^D$ and

$$\widehat{c}^{SP} = \frac{((1-\nu_2)U(s_L, \theta_L) - (1-\nu_1)U(s_H, \theta_L))\left(U(s_H, \theta_H) - U(s_L, \theta_H)\right)}{\left[(f-\nu_1)U(s_H, \theta_H) - (f-\nu_2)U(s_L, \theta_H) - ((1-\nu_1)U(s_H, \theta_L) - (1-\nu_2)U(s_L, \theta_L))\right]}$$

as the litigation cost in which $p^P = p^S$.

Then, as the following properties hold: 1) $p_1^D(0) = 0$; 2) $p_2^D(\frac{U(s_H, \theta_H) - U(s_L, \theta_H)}{1-f}) = 0$; 3) $p_3^D < p_2^D(0) < p^P(0) < 1$; 4) $p_3^D \in [0, 1]$; 5) $p^S(U(s_H, \theta_H) - U(s_L, \theta_H)) = 0$; 6) $\frac{\partial p^S}{\partial c} < \frac{\partial p_2^D}{\partial c} < 0$; 7) $p_1^D \geq p^S$ if and only if $c > \widehat{c}_1$; 8) $p_2^D \geq p^S$ if and only if $c < \widehat{c}_1$; 9) $p^S(0) = 1$; 10) $p_2^D \geq p^P$ if and only if $c < \widehat{c}_3$; 11) $p_3^D \geq p^P$ if and only if $c > \widehat{c}_3$ and 12) $\frac{\partial p^P}{\partial c} < 0$ there are only two possible order relations for $\widehat{c}_1, \widehat{c}_2, \widehat{c}_3, \widehat{c}^{SP}, \widehat{c}_3^S$ and $\widehat{c}_1^P$.

Case 1) $\widehat{c}_3 < \widehat{c}_3^S < \widehat{c}_1^P < \widehat{c}_1 < \widehat{c}^{SP} < \widehat{c}_2$ which means that for all $c < \widehat{c}_3$, $p^S > p^P > p_2^D > p_3^D > p_1^D$ for all $c \in \left[\widehat{c}_3, \widehat{c}_3^S\right]$, $p^S > p_3^D > p_2^D > p^P > p_1^D$ for all $c \in \left[\widehat{c}_3^S, \widehat{c}_1^P\right]$, $p_3^D > p^S > p_2^D > p^P > p_1^D$, for all $c \in \left[\widehat{c}_1^P, \widehat{c}_1\right]$, $p_3^D > p^S > p_2^D > p_1^D > p^P$, for all $c \in \left[\widehat{c}_1, \widehat{c}^{SP}\right]$, $p_3^D > p_1^D > p_2^D > p^S > p^P$ for all $c \in \left[\widehat{c}^{SP}, \widehat{c}_2\right]$, $p_3^D > p_1^D > p_2^D > p^P > p^S$ and for all $c > \widehat{c}_2$ $p_1^D > p_3^D > p_2^D > p^P > p^S$. That is, if $c \leq \widehat{c}_1$ when p hits p_1^D, D initiates a change that is challenged by P, the parties don't settle and the court makes a decision. If $c > \widehat{c}_1^P$ when p hits p_3^D, D initiates a change which is accepted by P (there is no combination in which D initiates a change that is challenged by P and the parties settle their differences).

Case 2) $0 < \widehat{c}^{SP} < \widehat{c}_2 < \widehat{c}_1 < \widehat{c}_1^P < \widehat{c}_3^S < \widehat{c}_3$ which means that for all $c < \widehat{c}^{SP}$, $p^S > p^P > p_2^D > p_3^D > p_1^D$ for all $c \in \left[\widehat{c}^{SP}, \widehat{c}_2\right]$, $p^P > p^S > p_2^D > p_3^D > p_1^D$, for all $c \in [\widehat{c}_2, \widehat{c}_1]$, $p^P > p^S > p_2^D > p_1^D > p_3^D$, for all $c \in \left[\widehat{c}_1, \widehat{c}_1^P\right]$, $p^P > p_1^D > p_2^D > p^S > p_3^D$, for all $c \in \left[\widehat{c}_1^P, \widehat{c}_3^S\right]$, $p_1^D > p^P > p_2^D > p^S > p_3^D$, for all $c \in \left[\widehat{c}_3^S, \widehat{c}_3\right]$, $p_1^D > p^P > p_2^D > p_3^D > p^S$ and for all $c > \widehat{c}_3$, $p_1^D > p_3^D > p_2^D > p^P > p^S$. That is, if $c < \widehat{c}_1$ when p hits p_1^D, D initiates a change that is challenged by P, the parties don't settle and the court makes a decision. If $c \in [\widehat{c}_1, \widehat{c}_3]$ when p hits p_2^D, D initiates a change that is challenged by P and the parties settle their differences. If $c > \widehat{c}_3$ when p hits p_3^D, D initiates a change which is accepted by P ∎.

Proof of Lemma 2 First, we notice that υ_n can be rewritten as $\eta_n(\tau_L, \tau_H)z_L + (1 - \eta_n(\tau_L, \tau_H))z_H$ in which $z_n = \frac{r_n - \delta_n c}{1 - \delta_n}$ and $\eta_n(\tau_L, \tau_H) \in [0, 1]$. That is, the expected value of all corporations is a weighted combination of the value of basic cycles of length τ_n that we have denoted z_n. In order to show that υ_n is quasi-concave[84] with respect to τ_n it is enough to show that z_n is quasi-concave and $\eta_n \in [0, 1]$ is increasing with respect to the same variable.[85] First, we have that

$$\frac{\partial z_n}{\partial \tau_n} = \frac{\delta_n}{(1 - \delta_n)^2} \left[\Xi \Psi(\tau_n) - \ln \delta c\right]$$

in which $\Xi = \frac{\alpha b W (1 - p^*)}{(1 - \delta \Lambda)}(\theta_H - \theta_L)(\theta_H + \theta_L - 2s_L)$ and $\Psi(\tau) = (1 - (\delta \Lambda)^\tau) \ln \delta - (1 - \delta^\tau)\Lambda^\tau \ln(\delta \Lambda) \le 0, \forall \tau$ (as $\Psi(0) = 0$ and $\frac{\partial \Psi(\tau)}{\partial \tau} = \ln \Lambda \ln(\delta \Lambda)(\delta^\tau - 1)\Lambda^\tau \le 0$). Then $\frac{\partial z_n}{\partial \tau_n} \ge 0 \iff \tau_n \le \widehat{\tau}_n$ in which $\widehat{\tau}_n$ is defined as follows[86]

$$\Psi(\widehat{\tau}_n) = \frac{c}{\Xi \ln \delta}$$

In addition

$$\frac{\partial^2 z_n}{\partial \tau_n^2} = \left[\frac{\ln \delta \delta_n}{(1 - \delta_n)^2} + \frac{2 \ln \delta \delta_n}{(1 - \delta_n)^3}\right] \left[\Xi \Psi(\tau_n) - \ln \delta c\right] + \frac{\delta_n}{(1 - \delta_n)^2} \Xi \frac{\partial \Psi(\tau_n)}{\partial \tau_n}$$

which means that there exists $\widetilde{\tau}_n > \widehat{\tau}_n$ such that $\frac{\partial^2 z_n}{\partial \tau_n^2} < 0, \forall \tau_n \le \widetilde{\tau}_n$ and $\frac{\partial^2 z_n}{\partial \tau_n^2} > 0, \forall \tau_n > \widetilde{\tau}_n$. Then, z_n is concave up to $\widetilde{\tau}_n$, a point of inflexion after which z_n converges to $r_n(\infty)$, with r_n defined as in Section 3. Second, we have that

$$\frac{\partial \eta_L}{\partial \tau_L} = -\frac{\eta_L}{D}\left[\frac{\ln \delta (\delta_L)^2 (1 - p_L)}{(1 - \delta_L)} + \frac{\partial(\delta_L(1 - p_L))}{\partial \tau_L}\right] > 0$$

with $D = (1 - \delta_L p_L)(1 - \delta_H) + \delta_H p_H(1 - \delta_L)$ and $\frac{\partial(\delta_L(1 - p_L))}{\partial \tau_L} = (1 - p^*)\delta_L\left[\ln \delta - \Lambda_L \ln(\delta \Lambda)\right] < 0$. In addition,

$$\frac{\partial \eta_H}{\partial \tau_H} = \frac{\eta_H}{D}\left[\frac{\partial(\delta_H p_H)}{\partial \tau_H} - \frac{\ln \delta (\delta_H)^2 p_H}{(1 - \delta_H)}\right] > 0$$

with $\frac{\partial(\delta_H p_H)}{\partial \tau_H} = p^* \delta_H\left[\ln \delta - \Lambda_H \ln(\delta \Lambda)\right] < 0$. From where the quasi-concavity of υ_n follows. In order to show concavity of υ_n with respect to s_n we notice that

$$\frac{\partial \upsilon_n}{\partial s_n} = \eta_n \frac{\partial r_n}{\partial s_n} \frac{1}{1 - \delta_n}$$

$$= -2\alpha q V \sum_{t=1}^{\tau_n} \delta^{t-1} \left[p_n(t)(s_n - \theta_L) - (1 - p_n(t))(\theta_H - s_n)\right] \frac{\eta_n}{1 - \delta_n}$$

hence $\frac{\partial \upsilon_n}{\partial s_n} \ge 0 \iff s_n \le s_n^{FB}(\tau_n)$, with $s_n^{FB}(\tau_n)$ defined in Section 4 and $\frac{\partial^2 \upsilon_n}{\partial s_n^2} = -2\alpha q V \frac{\eta_n}{1 - \delta} < 0$ which is enough to have concavity ∎.

Proof of Proposition 1 It is easy to see that

$$s_H^{FB}(\tau_H) = \theta_H \text{ and } s_L^{FB}(\tau_L) = \theta_L \iff \frac{1 - \delta}{1 - \delta \Lambda}\frac{1 - (\delta \Lambda)^{\tau_H}}{1 - \delta^{\tau_H}} = \frac{1 - \delta}{1 - \delta \Lambda}\frac{1 - (\delta \Lambda)^{\tau_L}}{1 - \delta^{\tau_L}} = 1$$

and the last condition is satisfied if and only if $\delta = 0$ or $\tau_L = \tau_H = 1$ or $\Lambda = q_1 - q_0 = 1$. In order to show that $\partial s_H^{FB}(\tau_H)/\partial \tau_H < 0$ and $\partial s_L^{FB}(\tau_L)/\partial \tau_L > 0$ it is enough to prove that $A_L(\tau_L)$ and $A_H(\tau_H)$ are decreasing in τ_L and τ_H respectively which is

---

[84]$f(\cdot) : \mathbb{R} \longrightarrow \mathbb{R}$ is quasi-concave if for all $x, y \in \mathbb{R}$ such that $f(x) \ge f(y)$ and for all $\lambda \in [0, 1]$, $f(\lambda x + (1 - \lambda)y) \ge f(y)$.

[85]If $g(x) = h(x)u(x)$ in which $h(x) \in [0, 1]$ is continuous and increasing in x and $u(x)$ is cointinuous and quasi-concave in x then, for any $x_0, x_1 \in \mathbb{R}$ such that $g(x_1) \ge g(x_0)$ and $\lambda \in [0, 1]$ we have that: If $x_1 \ge x_0$ then directly $h(\lambda x_0 + (1 - \lambda)x_1)u(\lambda x_0 + (1 - \lambda)x_1) \ge h(x_0)u(x_0)$ and if $x_1 < x_0$ (as it exists x^* such that $h'(x)u(x) + h(x)u'(x) > 0 \iff x < x^*$) we have that for continuity of $h(x)$ and $u(x)$, $g(y) > g(x_0)$ for all $y \in [x_0, x_1]$, in particular when $y = \lambda x_0 + (1 - \lambda)x_1$.

[86]Notice that $\widehat{\tau}_n$ can be ∞ if $\theta_H + \theta_L < 2s_L$.

equivalent to show that $\left(1 - (\delta\Lambda)^\tau\right) / \left(1 - \delta^\tau\right)$ is decreasing in τ. We see that this is the case because

$$\frac{\partial}{\partial\tau} \frac{1 - (\delta\Lambda)^\tau}{1 - \delta^\tau} = \frac{\delta^\tau}{(1 - \delta^\tau)^2} \underbrace{\left[(1 - (\delta\Lambda)^\tau)\ln\delta - (1 - \delta^\tau)\Lambda^\tau\ln(\delta\Lambda)\right]}_{\Psi(\tau)} \leq 0$$

In order to show that $\partial s_H^{FB}(\tau_H)/\partial\delta < 0$ and $\partial s_L^{FB}(\tau_L)/\partial\delta > 0$ it is enough to prove that $\frac{1-\delta}{1-\delta\Lambda} \frac{1-(\delta\Lambda)^\tau}{1-\delta^\tau}$ is decreasing in τ and that is the case as

$$\frac{\partial}{\partial\tau} \frac{1 - \delta}{1 - \delta\Lambda} \frac{1 - (\delta\Lambda)^\tau}{1 - \delta^\tau} = \frac{1 - \delta}{1 - \delta\Lambda} \frac{\delta^\tau}{(1 - \delta^\tau)} \Psi(\tau) \leq 0$$

Finally, $\partial s_H^{FB}(\tau)/\partial p^* = \partial s_L^{FB}(\tau)/\partial p^* = p^*(1 - \frac{1-\delta}{1-\delta\Lambda} \frac{1-(\delta\Lambda)^\tau}{1-\delta^\tau})(\theta_L - \theta_H) < 0$ ∎.

Proof of Lemma 3 In order to show that when society wants a finite frequency of litigation the inter-temporal externality is never negative we proceed in two steps. First we prove existence and uniqueness of (10) and then we prove that $\Sigma_n \leq 0$.

Existence and Uniqueness

First, we define $\Pi = \{\alpha, b, W, q_0, q_1, \delta, \theta_H, \theta_L\}$. As a central planer who faces standards s_L and s_H the court chooses the timing of trials. In that case the optimal expected value of corporations when the court has beliefs p is given by

$$v(p) = \max\left\{W_1(p) + \delta v(p^+), W_2(p) - c + \delta\left[pv(q_1) + (1-p)v(q_0)\right]\right\} \tag{A0}$$

in which $W_1(p) = \begin{cases} V(s_H, p) & \text{if } p \in [0, p^*] \\ V(s_L, p) & \text{if } p \in [p^*, 1] \end{cases}$ and $W_2(p) = pV(s_L, 1) + (1-p)V(s_H, 0), \forall p$. In order to show that there exists a unique $v(p)$ satisfying (A0) we define the contracting mapping function T_Π as

$$(T_\Pi u)(p) = \max\left\{W_1(p) + \delta u(p^+), W_2(p) - c + \delta\left[pu(q_1) + (1-p)u(q_0)\right]\right\} \tag{A1}$$

and the (complete) space of continuous functions and continuous functions but for p^* mapping the unit interval into the reals as $S[0,1]$. Then, as T_Π maps $S[0,1]$ into itself, it is monotone ($u > v \implies T_\Pi u > T_\Pi v$) and for any constant λ satisfies $T_\Pi(u+\lambda) = T_\Pi(u) + \delta\lambda$, it is a contracting mapping of modulus δ. Consequently, the Contracting Mapping Theorem (see Harris [1987] or Bertzekas [1995]) assures that there exists a unique fixed point (unique function u) that solves (A1).

Next, we show by construction that there exist values of c that we denote $c_L^{FB}(s_L, s_H, \Pi)$ and $c_H^{FB}(s_L, s_H, \Pi)$ such that the function $v(p; s_L, s_H, c, \Pi)$ (the unique solution of (A1)) has different shapes if $c \leq \min\{c_L^{FB}(s_L, s_H, \Pi),$ $c_H^{FB}(s_L, s_H, \Pi)\}$ or $c \in \left[\min\{c_L^{FB}(s_L, s_H, \Pi), c_H^{FB}(s_L, s_H, \Pi)\}, \max\{c_L^{FB}(s_L, s_H, \Pi), c_H^{FB}(s_L, s_H, \Pi)\}\right]$ or $c \geq \max\{c_L^{FB}(s_L, s_H, \Pi),$ $c_H^{FB}(s_L, s_H, \Pi)\}$. In order to see that we notice the following points:

- If $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$ then $V(s_H, p)$ is decreasing in p while $V(s_L, p)$ is increasing in p.
- $W_2(p)$ is a constant for all values of p.
- $c_L^{FB}(s_L, s_H, \Pi)$ and $c_H^{FB}(s_L, s_H, \Pi)$ are implicitly defined by

$$c_L^{FB} - \delta\left[p^*v(q_1; c_L^{FB}) + (1-p^*)v(q_0; c_L^{FB})\right] = W_2(p^*) - \frac{V(s_L, p^*)}{1-\delta} \tag{A2}$$

$$c_H^{FB} - \delta\left[p^*v(q_1; c_H^{FB}) + (1-p^*)v(q_0; c_H^{FB})\right] = W_2(p^*) - \frac{V(s_H, p^*)}{1-\delta} \tag{A3}$$

- From (A1) it follows that $c - \delta\left[p^*v(q_1; c) + (1-p^*)v(q_0; c)\right]$ is not decreasing in c and $V(s_L, p^*) > V(s_H, p^*) \iff p^* > 1/2$ hence it is true that $c_L^{FB} < c_H^{FB} \iff p^* > 1/2$.
- It is direct from the asymmetry of the problem that $v(1) > v(0) \iff p^* > 1/2$.

At this point we impose that $p^* > 1/2$ (the case in which $p^* < 1/2$ is symmetric) and we use the former information to prove that $v(p)$ satisfies the following four properties.

Property 1: It exists $\underline{p}$ such that $v(p)$ is decreasing for all $p < \underline{p} \leq p^*$ and $v(p)$ is increasing for all $p \geq \underline{p}$.

We show that $T_\Pi u$ map functions of this characteristics into functions of the same characteristics. As the solution is unique, it has to have the same property. If $u(p)$ is such that is exists $\underline{p} \leq p^*$ such that $u(p)$ is decreasing for all $p < \underline{p}$ then we have that $W_1(p) + \delta u(p^+)$ is also decreasing when $p \leq \underline{p}$ and $W_2(p) - c + \delta\left[pu(q_1) + (1-p)u(q_0)\right] = pu(1) + (1-p)u(0) - c$ is increasing in p. In addition as $T_\Pi u(0) = \max\{u(0), u(0) - c\} = u(0)$ we have that $T_\Pi u(p)$ will be decreasing with certainty until $W_1(\widehat{p}) + \delta u(\widehat{p}^+) = \widehat{p}u(1) + (1-\widehat{p})u(0) - c$ where it is not necessarily the case that $\widehat{p} = \underline{p}$. Then we have that

$$T_\Pi u(p) = \begin{cases} W_1(p) + \delta u(p^+) & \text{if } p < \widehat{p} \\ pu(1) + (1-p)u(0) - c & \text{if } p \in [\widehat{p}, p^*] \\ \max\left\{W_1(p) + \delta u(p^+), pu(1) + (1-p)u(0) - c\right\} & \text{if } p > p^* \end{cases}$$

The proof ends by noticing that $T_\Pi u(p)$ is increasing in p when $p > p^*$ because $W_1(p) + \delta u(p^+)$ is increasing in this region.

44

Property 2: There exists $\overline{p} \geq p^*$ such that $\upsilon(p) = W_1(p) + \delta\upsilon(p^+)$ for all $p > \overline{p}$.

As with the proof of property 1 we have that $T_\Pi u(1) = \max\{u(1), u(1) - c\} = u(1)$. In addition $W_1(p) + \delta u(p^+)$ and $pu(1) + (1-p)u(0) - c$ are increasing functions in p when $p > p^*$. Then it follows that

$$T_\Pi u(p) = \begin{cases} pu(1) + (1-p)u(0) - c & \text{if} \quad p \in [p^*, \widetilde{p}] \\ W_1(p) + \delta u(p^+) & \text{if} \quad p > \widetilde{p} \end{cases}$$

in which it is not necessarily the case that $\widetilde{p} = \overline{p}$.

Property 3: If $c < c_L^{FB}$ then $\underline{p} < p^* < \overline{p}$, if $c \in \left[c_L^{FB}, c_H^{FB}\right]$ then $\underline{p} < p^* = \overline{p}$ and if $c > c_H^{FB}$ then $\underline{p} = p^* = \overline{p}$.

If $c < c_L^{FB}$ we just have to notice that (A2) implies $V(s_L, p^*) + \delta\upsilon(p^*) < p^*\upsilon(1) + (1-p^*)\upsilon(0) - c$ which means that $p^* < \overline{p}$ and as $c_L^{FB} < c_H^{FB}$ we have that (A3) implies $V(s_H, p^*) + \delta\upsilon(p^*) > p^*\upsilon(1) + (1-p^*)\upsilon(0) - c$ which means that $\underline{p} < p^*$. If $c \in \left[c_L^{FB}, c_H^{FB}\right]$ then (A2) implies $V(s_L, p^*) + \delta\upsilon_L(p^*) > p^*\upsilon(1) + (1-p^*)\upsilon(0) - c$ which means that $p^* \geq \overline{p}$ but still $V(s_H, p^*) + \delta\upsilon(p^*) > p^*\upsilon(1) + (1-p^*)\upsilon(0) - c$ which means $\underline{p} < p^*$ and finally if $c > c_H^{FB}$ then $\underline{p} \geq p^* \geq \overline{p}$.

Property 4: $\lim\limits_{\downarrow p^*}\upsilon(p) = \upsilon_L(p^*) \geq \upsilon_H(p^*) = \lim\limits_{\uparrow p^*}\upsilon(p)$

Directly we have that

$$\upsilon_L(p^*) > \upsilon_H(p^*) \iff V(s_L, p^*) > V(s_H, p^*) \iff p^* > 1/2$$

The former characterization tells us that, depending on the value of c, $\upsilon(p)$ has three possible shapes

1. If $c \leq c_L^{FB}$ then there exist $\underline{p}$ and $\overline{p}$ such that

$$\upsilon(p) = \begin{cases} V(s_H, p) + \delta\upsilon(p^+) & \text{if} \quad p < \underline{p} \\ W_2(p) - c + \delta\left[p\upsilon(q_1) + (1-p)\upsilon(q_0)\right] & \text{if} \quad p \in \left[\underline{p}, \overline{p}\right] \\ V(s_L, p) + \delta\upsilon(p^+) & \text{if} \quad p > \overline{p} \end{cases} \quad \text{(A4)}$$

in which $\upsilon(p)$ is decreasing for all $p \leq \underline{p}$ but increasing for all $p > \overline{p}$.

2. $c \in \left(c_L^{FB}, c_H^{FB}\right)$ then there exists $\underline{p}$ such that

$$\upsilon(p) = \begin{cases} V(s_H, p) + \delta\upsilon(p^+) & \text{if} \quad p < \underline{p} \\ W_2(p) - c + \delta\left[p\upsilon(q_1) + (1-p)\upsilon(q_0)\right] & \text{if} \quad p \in \left[\underline{p}, p^*\right] \\ V(s_L, p) + \delta\upsilon(p^+) & \text{if} \quad p > p^* \end{cases} \quad \text{(A5)}$$
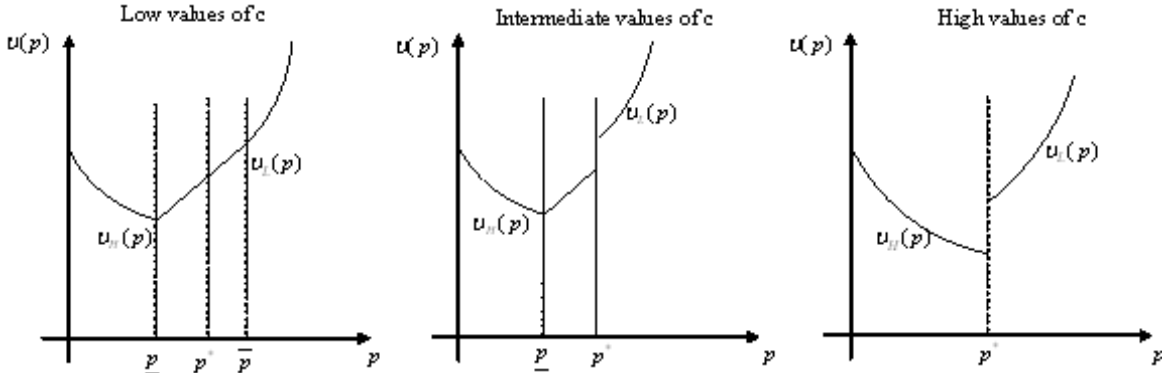
in which $\upsilon(p)$ is decreasing for all $p \leq \underline{p}$, increasing for all $p > \overline{p}$ and not necessarily continuous at p^*.

3. $c \geq c_H^{FB}$ then

$$\upsilon(p) = \begin{cases} V(s_H, p) + \delta\upsilon(p^+) & \text{if} \quad p \leq p^* \\ V(s_L, p) + \delta\upsilon(p^+) & \text{if} \quad p > p^* \end{cases} \quad \text{(A6)}$$

in which $\upsilon(p)$ is decreasing for all $p \leq p^*$, increasing for all $p > p^*$ and not necessarily continuous at p^*.

The next graphs summarize the possible shapes of $\upsilon(p)$ (always under the assumption $p^* > 1/2$)

■.

$\underline{\Sigma_n \leq 0 \text{ when } \tau_n^{FB}(s_H, s_L, c; \Pi) < \infty}$

This part follows directly from the former characterization of the value function $v(p)$. We assume that $p^* > 1/2$ (the analysis for $p^* < 1/2$ is analogous) which implies that $c_L^{FB} < c_H^{FB}$. If $c < c_L^{FB}$ the value function $v(p)$ is continuous and convex from where by definition it is true that $\Sigma_L = v_L(\bar{p}q_1 + (1-\bar{p})q_0) - (\bar{p}v_L(q_1) + (1-\bar{p})v_H(q_0)) < 0$ and $\Sigma_H = v_H(\underline{p}q_1 + (1-\underline{p})q_0) - (\underline{p}v_L(q_1) + (1-\underline{p})v_H(q_0)) < 0$. If $c \in (c_L^{FB}, c_H^{FB})$ then $\tau_L^{FB}(s_H, s_L, c; \Pi) = \infty$ but $\tau_H^{FB}(s_H, s_L, c; \Pi) < \infty$. Then, Σ_H can be rewritten as

$$\underline{p}v_L(q_1) + (1-\underline{p})v_H(q_0) - \left[\underline{p}^+ v_L(1) + (1-\underline{p}^+)v_H(0) - c \right]$$

which is equal to

$$\left[\underline{p}v_L(1) + (1-\underline{p})v_H(0) \right] - \left[\underline{p}^+ v_L(1) + (1-\underline{p}^+)v_H(0) \right] < 0$$

if trials don't take place every period and equal to 0 if they do. If $c \geq c_H^{FB}$ then $\tau_L^{FB}(s_H, s_L, c; \Pi) = \tau_H^{FB}(s_H, s_L, c; \Pi) = \infty$ ∎.

First Best Solution We proceed in two steps. First we derive the F.O.C. and then we show that they define a unique solution.

First Best Solution

We proceed in two steps. First we assume that the frequencies of litigation τ_L and τ_H are fixed and derive expressions for the first best standards, then we plug-in these expressions in v and derive the conditions that implicitly define the optimal solution. We know that the first best standards are given by $s_H^{FB}(\tau_H)$ and $s_L^{FB}(\tau_L)$. Then we plug these expressions in the value functions and obtain

$$v_L = r(s_L^{FB}(\tau_L), \tau_L) - \delta_L c + \delta_L [p_L v_L + (1-p_L)v_H]$$
$$v_H = r(s_H^{FB}(\tau_H), \tau_H) - \delta_H c + \delta_H [p_H v_L + (1-p_H)v_H]$$

If we differentiate these expressions with respect to τ_L and τ_H we get

$$\frac{\Delta v_L}{\Delta \tau_L} = \frac{(1 - \delta_H(1-p_H))}{D} \underbrace{\left\{ \frac{\Delta r_L}{\Delta \tau_L} + \frac{\Delta(\delta_L p_L)}{\Delta \tau_L}(v_L - v_H) + \frac{\Delta \delta_L}{\Delta \tau_L}(v_H - c) \right\}}_{\Theta_L}$$

$$\frac{\Delta v_L}{\Delta \tau_H} = \frac{\delta_L(1-p_L)}{D} \underbrace{\left\{ \frac{\Delta r_H}{\Delta \tau_H} + \frac{\Delta(\delta_H p_H)}{\Delta \tau_H}(v_L - v_H) + \frac{\Delta \delta_H}{\Delta \tau_H}(v_H - c) \right\}}_{\Theta_H}$$

and $\frac{\Delta v_H}{\Delta \tau_L} = \frac{\delta_H p_H}{D}\Theta_L; \frac{\Delta v_H}{\Delta \tau_H} = \frac{1 - \delta_L p_L}{D}\Theta_H$ which after taking into account the integer constraint define the first best frequencies of litigation as

$$(\tau_H^{FB}, \tau_L^{FB}) = \underset{\tau_L, \tau_H \in \mathbb{N}}{\arg\min} \left\{ \begin{matrix} \Theta_L(\tau_L, \tau_H) \geq 0 \\ \Theta_H(\tau_L, \tau_H) \geq 0 \end{matrix} \right\}$$

Uniqueness

As in lemma 3, the uniqueness of $v(p)$ is assured by the C.M.T. Whenever $s_L^{FB} \leq \frac{\theta_L + \theta_H}{2} \leq s_H^{FB}$ we retrieve the three same possible shapes of the function characterized in the solution of lemma 3. However, as now the standards are functions of the frequencies of litigation, the relation $s_L^{FB} \leq \frac{\theta_L + \theta_H}{2} \leq s_H^{FB}$ is not always satisfied. We show that for extreme values of p^* there still are three possible shapes of the value function but in all of them the function is always increasing or decreasing. From the definition of the first best standards we have that

$$s_L^{FB} \leq \frac{\theta_L + \theta_H}{2} \Leftrightarrow (\frac{1 - 2p^*}{2}) < A_L(\tau_L)$$

$$s_H^{FB} \geq \frac{\theta_L + \theta_H}{2} \Leftrightarrow (\frac{2p^* - 1}{2}) < A_H(\tau_H)$$

We immediately notice that if $p^* > 1/2$ then $s_L^{FB} \leq \frac{\theta_L + \theta_H}{2}$ and if $p^* < 1/2$ then $s_H^{FB} \geq \frac{\theta_L + \theta_H}{2}$. Recall that $V(s_H, p)$ is decreasing in p when $\frac{\theta_L + \theta_H}{2} \leq s_H$ while $V(s_L, p)$ is increasing in p when $s_L \leq \frac{\theta_L + \theta_H}{2}$. In the same way we have that $W_2(p) + \delta[pv(q_1) + (1-p)v(q_0)]$ is increasing in p if and only if $p^* > 1/2$ that is because $v(1) > v(0) \iff p^* > 1/2$ (see Lemma 4). Then, there exist bounds $\bar{p}^*$ and $\underline{p}^*$ such that for all $p^* > \bar{p}^*$ the function $v(p)$ is everywhere increasing while for all $p^* < \underline{p}^*$ it is everywhere decreasing. Regardless that we can apply the same logic as before to show that the shape of $v(p)$

can be decomposed in (A4)-(A6). The following graphs show the case $p^* > \overline{p}^*$.

■.
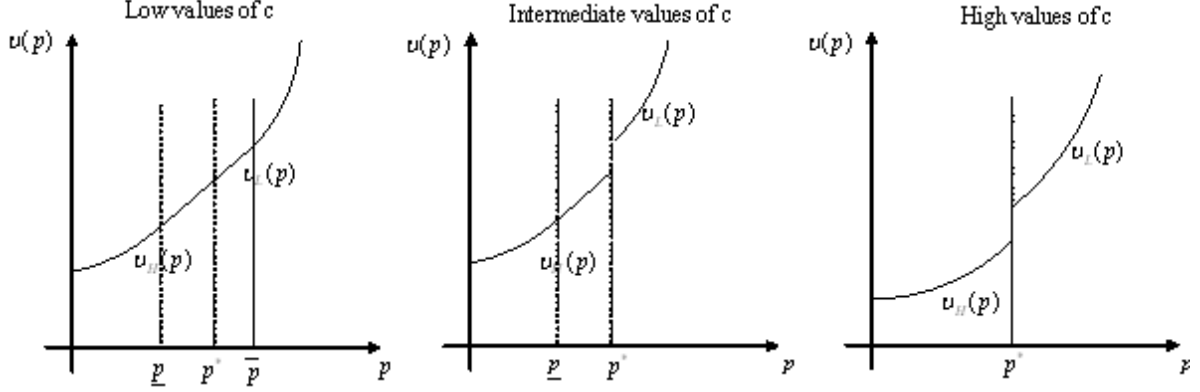
Corollary 2 *If c_n^c is the maximum cost that a corporation facing standard s_n is willing to pay to generate a trial then for any standards s_H and s_L such that $\theta_H > s_H > s_L > \theta_L$ if $E_n(c_n^{FB}) < 0$ then there exists a range of costs $\left(c_n^c, c_n^{FB}\right)$ in which society wants to have trials but corporations don't and if $E_n(c_n^{FB}) > 0$ then there exists a range of costs $\left(c_n^{FB}, c_n^c\right)$ in which society doesn't want trials but corporations will generate them.*

Proof of Corollary 2 From the conditions that define $\overline{p}$ and $\underline{p}$

$$(1 - \overline{p})\left(V(s_H, 0) - V(s_L, 0)\right) = fc + (1 - f)c + \delta\left[\overline{p}v_L(q_1) + (1 - \overline{p})v_H(q_0) - v_L(\overline{p}^+)\right]$$

and

$$\underline{p}(V(s_L, 1) - V(s_H, 1)) = fc + (1 - f)c + \delta\left[\underline{p}v_L(q_1) + (1 - \underline{p})v_H(q_0) - v_H(\underline{p}^+)\right]$$

we identify the maximum costs that corporations are willing to pay to have a trial as

$$c_L^c = \frac{(1 - p^*)\left(V(s_H, 0) - V(s_L, 0)\right)}{f}$$

and

$$c_H^c = \frac{p^*\left(V(s_L, 1) - V(s_H, 1)\right)}{f}$$

Then, c_L^{FB} can be written as

$$lc_L^{FB} = lc_L^c - (1 - l)c_L^{FB} + \delta\left[p^*v(q_1; c_L^{FB}) + (1 - p^*)v(q_0; c_L^{FB}) - v(p^*; c_L^{FB})\right]$$

$$\implies c_L^{FB} = c_L^c - \frac{E_L(c_L^{FB}, \Pi)}{f}$$

while in the same way c_H^{FB} can be written as

$$c_H^{FB} = c_H^c - \frac{E_H(c_H^{FB}, \Pi)}{f}$$

which means that if $E_n(c_n^{FB}, \Pi) < 0$ then $c_n^{FB} > c_n^c$ and for all $c \in \left[c_n^c, c_n^{FB}\right]$ society would want to have trials but corporations will not generate them. In the same way, if $E_n(c_n^{FB}, \Pi) > 0$ then $c_n^{FB} < c_n^c$ and for all $c \in \left[c_n^{FB}, c_n^c\right]$ society would prefer not to have trials but corporations will generate them ■.

Corollary 3 *The frequency with which a standard is litigated decreases with c, increases with αbW, is inversely related to the time in which the environment is at the corresponding state and is inversely related to the expected value of all corporations when the court enforces this standard.*

Proof of Corollary 3 The sensitivity of τ_H^{FB} and τ_L^{FB} with respect to c and αbW is preserved under the symmetric model (τ_H and τ_L behave in the same way). In this case, the optimal frequency of trials is implicitly defined by

$$\frac{\alpha bW(\theta_H - \theta_L)^2}{2(1 - \delta\Lambda)}A(\tau^{FB})\Psi(\tau^{FB}) - c\ln\delta = 0$$

The function $A(\tau)\Psi(\tau)$ is strictly concave in τ with $A(0)\Psi(0) = 0$ and $\lim_{\tau \longrightarrow \infty} |A(\tau)\Psi(\tau)| > 0$. Although each $c/(\alpha bW)$ may define two possible solutions, τ_1^{FB} and τ_2^{FB} with $\tau_1^{FB} < \tau_{\max}^{FB} < \tau_2^{FB}$ ($\tau_{\max}^{FB} = \arg\max_\tau A(\tau)\Psi(\tau)$) it is easy to verify (through

the second order conditions) that τ_1^{FB} defines a maximum while τ_2^{FB} defines a minimum hence τ^{FB} is increasing in $c/(\alpha b W)$. In order to prove that $p^* > \frac{1}{2} \iff \tau_L^{FB} > \tau_H^{FB} \iff \upsilon_L > \upsilon_H$ we proceed in two steps.

Step 1: $p^* > 1/2 \iff \tau_L^{FB} > \tau_H^{FB}$ We write the value functions as

$$\upsilon_L = \underbrace{\frac{(1-\delta_H(1-p_H))\,(1-\delta_L)}{D}}_{\eta_L(\tau_L,\tau_H)}\underbrace{\left[\frac{r_L - \delta_L c}{1-\delta_L}\right]}_{z_L(\tau_L)} + \underbrace{\frac{\delta_L(1-p_L)\,(1-\delta_H)}{D}}_{1-\eta_L(\tau_L,\tau_H)}\underbrace{\left[\frac{r_H - \delta_H c}{1-\delta_H}\right]}_{z_H(\tau_H)}$$

$$= \eta_L(\tau_L,\tau_H)(z_L(\tau_L) - z_H(\tau_H)) + z_H(\tau_H)$$

$$\upsilon_H = \underbrace{\frac{\delta_H p_H\,(1-\delta_L)}{D}}_{1-\eta_H(\tau_L,\tau_H)}\underbrace{\left[\frac{r_L - \delta_L c}{1-\delta_L}\right]}_{z_L(\tau_L)} + \underbrace{\frac{(1-\delta_L p_L)\,(1-\delta_H)}{D}}_{\eta_H(\tau_L,\tau_H)}\underbrace{\left[\frac{r_H - \delta_H c}{1-\delta_H}\right]}_{z_H(\tau_H)}$$

$$= \eta_H(\tau_L,\tau_H)(z_H(\tau_H) - z_L(\tau_L)) + z_L(\tau_L)$$

Then, without lost of generality we relax the integer constraint and write the FOC of (16)

$$\frac{\partial \upsilon_L}{\partial \tau_L} = \frac{\partial \eta_L(\tau_L,\tau_H)}{\partial \tau_L}(z_L(\tau_L) - z_H(\tau_H)) + \eta_L(\tau_L,\tau_H)\frac{\partial z_L(\tau_L)}{\partial \tau_L} = 0 \tag{A7}$$

$$\frac{\partial \upsilon_H}{\partial \tau_H} = \frac{\partial \eta_H(\tau_L,\tau_H)}{\partial \tau_H}(z_H(\tau_H) - z_L(\tau_L)) + \eta_H(\tau_L,\tau_H)\frac{\partial z_H(\tau_H)}{\partial \tau_H} = 0 \tag{A8}$$

If $\widehat{\tau}_L$ and $\widehat{\tau}_H$ are the frequencies that maximize $z_L(\tau_L)$ and $z_H(\tau_H)$ respectively then if $p^* > 1/2$ we have that for any $s_H > s_L$

$$\widehat{\tau}_L > \widehat{\tau}_H$$

and

$$z_L(\widehat{\tau}_L) > z_H(\widehat{\tau}_H)$$

obviously (A7) and (A8) are not satisfied, even more we have that

$$\frac{\partial \eta_L(\widehat{\tau}_L,\widehat{\tau}_H)}{\partial \tau_L}(z_L(\widehat{\tau}_L) - z_H(\widehat{\tau}_H)) > 0$$

and

$$\frac{\partial \eta_H(\widehat{\tau}_L,\widehat{\tau}_H)}{\partial \tau_H}(z_H(\widehat{\tau}_H) - z_L(\widehat{\tau}_L)) < 0$$

which means that $\tau_L^{FB} > \widehat{\tau}_L > \widehat{\tau}_H > \tau_H^{FB}$. If $p^* < 1/2$, then the same logic implies that $\tau_L^{FB} < \widehat{\tau}_L < \widehat{\tau}_H < \tau_H^{FB}$.

Step 2: $\upsilon_L > \upsilon_H \implies p^* > 1/2$ Rewriting (14) and (15) we have that

$$V(s_L^{FB}(\tau_L), p_L(\tau_L + 1)) + \delta(p_L(\tau_L + 2) - p_L(\tau_L + 1))(\upsilon_L - \upsilon_H) + (\delta - 1)(\upsilon_H - c) = 0$$

$$V(s_H^{FB}(\tau_H), p_H(\tau_H + 1)) + \delta(p_H(\tau_H + 2) - p_H(\tau_H + 1))(\upsilon_L - \upsilon_H) + (\delta - 1)(\upsilon_H - c) = 0$$

which implies that

$$V(s_L^{FB}(\tau_L), p_L(\tau_L + 1)) - V(s_H^{FB}(\tau_H), p_H(\tau_H + 1)) =$$
$$[\delta(p_H(\tau_H + 2) - p_L(\tau_L + 2)) + (p_L(\tau_L + 1) - p_H(\tau_H + 1))](\upsilon_L - \upsilon_H)$$

but as $\delta(p_H(\tau_H + 2) - p_L(\tau_L + 2)) + (p_L(\tau_L + 1) - p_H(\tau_H + 1)) > 0$ for all τ_L and τ_H then

$$V(s_L^{FB}(\tau_L^{FB}), p_L(\tau_L^{FB} + 1)) > V(s_H^{FB}(\tau_H^{FB}), p_H(\tau_H^{FB} + 1)) \iff \upsilon_L > \upsilon_H$$

The last equivalence implies that

$$\upsilon_L > \upsilon_H \implies V(s_L^{FB}(\tau_L^{FB}), p_L(\tau_L^{FB} + 1)) > V(s_H^{FB}(\tau_H^{FB}), p_H(\tau_H^{FB} + 1))$$

but the right hand side is the same as

$$p_L(\tau_L^{FB} + 1)(s_L - \theta_L)^2 + (1 - p_L(\tau_L^{FB} + 1))(s_L - \theta_H)^2 <$$
$$p_H(\tau_H^{FB} + 1)(s_H - \theta_L)^2 + (1 - p_H(\tau_H^{FB} + 1))(\theta_H - s_H)^2$$

If we use $s_L - \theta_L = (1 - p^* - A_L(\tau_L))(\theta_H - \theta_L)$; $\theta_H - s_L = (p^* + A_L(\tau_L))(\theta_H - \theta_L)$; $s_H - \theta_L = (1 - p^* + A_H(\tau_H))(\theta_H - \theta_L)$ and $\theta_H - s_H = (p^* - A_H(\tau_H))(\theta_H - \theta_L)$ then the inequality becomes

$$p_L(1 - p^* - A_L)^2 + (1 - p_L)(p^* + A_L)^2 < p_H(1 - p^* + A_L)^2 + (1 - p_H)(p^* - A_H)^2$$

48

which after some algebra is equivalent to

$$(p_L - p_H)(1 - 2p^*) < (A_H)^2 - (A_L)^2 + 2A_L(p^* - p_L) + 2A_H(p_H - p^*)$$

and this relation is not satisfied if $p^* < 1/2 \iff \tau_L^{FB} < \tau_H^{FB} \implies A_H < A_L$ because under these conditions the left hand side is positive and the hand right side is negative $\blacksquare$.

Second Best Solution The proof proceeds in four steps. First we show that a mapping one to one is possible between the standards and the frequencies of litigation. That means that when the court sets the standards it determines the frequencies of litigation. This property implies that the solution of the problem in which the court chooses the standards (defined by the pair of reaction functions) is the same of the problem in which the court chooses the frequencies of litigation (defined by the pair of Bellman equations). Then in a second step we use the C.M.T. to prove uniqueness of the solution. In the next the two steps we show that the possible shapes of the optimal value function are the same found in the first best solution.

Step 1: One to one mapping between s_n and τ_n. Before jumping to the problem with the integer constraint we analyze the case in which this constraint is relaxed and provide some intuition of why this mapping is possible.

When $\tau_n \in \mathbb{R}$ the incentive

$$\max_{s_n} \upsilon_n(s_n, s_{-n}, \tau_H(s_n, s_{-n}), \tau_L(s_n, s_{-n}))$$

which defines the following F.O.C.

$$\frac{\partial \upsilon_L}{\partial s_L} + \frac{\partial \upsilon_L}{\partial \tau_L}\frac{\partial \tau_L}{\partial s_L} + \frac{\partial \upsilon_L}{\partial \tau_H}\frac{\partial \tau_H}{\partial s_L} = 0 \qquad (A9)$$

$$\frac{\partial \upsilon_H}{\partial s_H} + \frac{\partial \upsilon_H}{\partial \tau_L}\frac{\partial \tau_L}{\partial s_H} + \frac{\partial \upsilon_H}{\partial \tau_H}\frac{\partial \tau_H}{\partial s_H} = 0 \qquad (A10)$$

constraints bind at the equilibrium and define τ_H and τ_L as functions of s_H and s_L. But then we notice that we can retrieve the same F.O.C. if the court decides τ_H or τ_L instead of s_L (of course the court cannot choose s_H). For example when the court chooses τ_n it faces the following problem

$$\max_{\tau_n} \upsilon_n(s_n(\tau_n, \tau_{-n}), s_{-n}, \tau_n, \tau_{-n}(\tau_n, s_{-n}))$$

which defines the following F.O.C.

$$\frac{\partial \upsilon_L}{\partial \tau_L} + \frac{\partial \upsilon_L}{\partial s_L}\frac{\partial s_L}{\partial \tau_L} + \frac{\partial \upsilon_L}{\partial \tau_H}\frac{\partial \tau_H}{\partial \tau_L} = 0$$

$$\frac{\partial \upsilon_H}{\partial \tau_H} + \frac{\partial \upsilon_H}{\partial s_H}\frac{\partial s_H}{\partial \tau_H} + \frac{\partial \upsilon_H}{\partial \tau_L}\frac{\partial \tau_L}{\partial \tau_H} = 0$$

and after multiplying by $\frac{\partial \tau_L}{\partial s_L}$ the first equation and by $\frac{\partial \tau_H}{\partial s_H}$ the second one we retrieve the original system. As conclusion, we get the same solution whether the court chooses the standards or the frequencies of litigation.

When $\tau_n \in \mathbb{N}$ we need to take into account that the incentive constraints not necessarily bind at the equilibrium. Nevertheless we can still establish a one to one mapping if we notice that due to the concavity of υ_n courts choose a unique s_n for any given τ_n. Formally

$$I_L(\tau_L, \tau_H) = \{s_L, s_H \mid (2) \text{ and } (3) \text{ are satisfied}\}$$

and

$$s_n^{SB}(\tau_L, \tau_H) = \left\{ \arg\max_{s_n} \upsilon_n(\tau_L, \tau_H) \mid s_n \in I_L(\tau_L, \tau_H) \right\}$$

Then directly from lemma 2 we know that each pair of (τ_L, τ_H) defines a unique pair of $\left(s_L^{SB}, s_H^{SB}\right)$.

Step 2: Uniqueness of the solution. As the second best standards are functions of the frequencies of innovation we can plug $s_n^{SB}(\tau_L^{SB}, \tau_H^{SB})$ into the value functions as follows

$$\upsilon_n(p) = \max \left\{ V(s_n^{SB}, p) + \delta \upsilon_H(p^+), \begin{bmatrix} pV(s_L^{SB}, 1) + (1-p)V(s_H^{SB}, 0) - c \\ + \delta\left(p\upsilon_L(q_1) + (1-p)\upsilon_H(q_0)\right) \end{bmatrix} \right\}$$

Then, we can apply the C.M.T. over

$$\upsilon(p) = \begin{cases} \upsilon_H(p) & \text{if} & p \in [0, p^*] \\ \upsilon_L(p) & \text{if} & p \in [p^*, 1] \end{cases}$$

to show that it has a unique solution. This time both frequencies of innovation are determined simultaneously by

$$(1 - \bar{p})\left(V(s_H^{SB}(\tau_L^{SB}, \tau_H^{SB}), 0) - V(s_L^{SB}(\tau_L^{SB}, \tau_H^{SB}), 0)\right) = c + \delta\left[\bar{p}\upsilon_L(q_1) + (1 - \bar{p})\upsilon_H(q_0) - \upsilon_L(\bar{p}^+)\right]$$

and

$$\underline{p}(V(s_L^{SB}(\tau_L^{SB}, \tau_H^{SB}), 1) - V(s_H^{SB}(\tau_L^{SB}, \tau_H^{SB}), 1)) = c + \delta\left[\underline{p}\upsilon_L(q_1) + (1 - \underline{p})\upsilon_H(q_0) - \upsilon_H(\underline{p}^+)\right]$$

in which $\bar{p} = p_L(\tau_L^{SB})$ and $\underline{p} = p_H(\tau_H^{SB})$.

Step 3: Properties of the second best standards. The second best standards have the following properties

Property 1: $s_H^{SB}(\tau_L^{SB}, \tau_H^{SB}) > s_L^{SB}(\tau_L^{SB}, \tau_H^{SB})$ for all τ_L^{SB} and τ_H^{SB}.

Property 2: $p^* > 1/2 \iff \Gamma(\tau_L^{SB}, \tau_H^{SB}) > 1 \iff s_H + s_L \in [2\theta_L, \theta_L + \theta_H] \implies s_L < \frac{\theta_H + \theta_L}{2}$ and $p^* < 1/2 \iff$
$\Gamma(\tau_L^{SB}, \tau_H^{SB}) < 1 \iff s_H + s_L > \theta_L + \theta_H \implies s_H > \frac{\theta_H + \theta_L}{2}$. In which $\Gamma(\tau_L, \tau_H) = \frac{p^*}{1-p^*} \frac{1 - \Lambda^{\tau_H}}{1 - \Lambda^{\tau_L}}$.

Property 3: $s_H^{SB}(\tau_L^{SB}, \tau_H^{SB})$ first decreases and then increases with c, $s_L^{SB}(\tau_L^{SB}, \tau_H^{SB})$ first increases and then decreases with c. Under moderate assumptions we have that $\max\left\{s_L^{SB}(\tau_L^{SB}, \tau_H^{SB})\right\} < \frac{\theta_L + \theta_H}{2}$ and $\min\left\{s_H^{SB}(\tau_L^{SB}, \tau_H^{SB})\right\} > \frac{\theta_L + \theta_H}{2}$

Step 4: Possible shapes of the value function. Given properties 1-3, we have that $V(s_H, p)$ is always decreasing in p, $V(s_L, p)$ and $W_2(p)$ are always increasing in p. Then the value function $v(p)$ has the three same possible shapes identified in Lemma 4. That is, there exist $c_L^{SB}(\Pi)$ and $c_H^{SB}(\Pi)$ defined by

$$c_L^{SB} - \delta\left[p^* v(q_1; c_L^{SB}) + (1 - p^*) v(q_0; c_L^{SB})\right] = W_2(p^*) - \frac{V(s_L^{SB}, p^*)}{1 - \delta}$$

$$c_H^{SB} - \delta\left[p^* v(q_1; c_H^{SB}) + (1 - p^*) v(q_0; c_H^{SB})\right] = W_2(p^*) - \frac{V(s_H^{SB}, p^*)}{1 - \delta}$$

such that, if $p^* > 1/2$

1. If $c \leq c_L^{SB}$ then there exist $\underline{p}$ and $\overline{p}$ such that

$$v(p) = \begin{cases} V(s_H^{SB}, p) + \delta v(p^+) & \text{if} \quad p < \underline{p} \\ W_2(p) - c + \delta\left[p v(q_1) + (1-p) v(q_0)\right] & \text{if} \quad p \in \left[\underline{p}, \overline{p}\right] \\ V(s_L^{SB}, p) + \delta v(p^+) & \text{if} \quad p > \overline{p} \end{cases}$$

in which $v(p)$ is decreasing for all $p \leq \underline{p}$ but increasing for all $p > \overline{p}$.

2. $c \in \left(c_L^{SB}, c_H^{SB}\right)$ then it exists $\underline{p}$ such that

$$v(p) = \begin{cases} V(s_H^{SB}, p) + \delta v(p^+) & \text{if} \quad p < \underline{p} \\ W_2(p) - c + \delta\left[p v(q_1) + (1-p) v(q_0)\right] & \text{if} \quad p \in \left[\underline{p}, p^*\right] \\ V(s_L^{SB}, p) + \delta v(p^+) & \text{if} \quad p > p^* \end{cases}$$

in which $v(p)$ is decreasing for all $p \leq \underline{p}$, increasing for all $p > \overline{p}$ and not necessarily continuous at p^*.

3. $c \geq c_H^{SB}$ then

$$v(p) = \begin{cases} V(s_H^{SB}, p) + \delta v(p^+) & \text{if} \quad p \leq p^* \\ V(s_L^{SB}, p) + \delta v(p^+) & \text{if} \quad p > p^* \end{cases}$$

in which $v(p)$ is decreasing for all $p \leq p^*$, increasing for all $p > p^*$ and not necessarily continuous at p^*.

Finally, the F.O.C. conditions (for the problem with the integer constraint) that define the second best frequencies of innovation are the same as with the first best solution, with the exception that now we must take into account that s_L is a function of τ_L. That is

$$(\tau_H^{SB}, \tau_L^{SB}) = \underset{\tau_L, \tau_H \in \mathbb{N}}{\arg\min} \left\{ \begin{matrix} \frac{\Delta r_L}{\Delta \tau_L} + \frac{\Delta r_L}{\Delta s_L}\frac{\Delta s_L}{\Delta \tau_L} + \frac{\Delta(\delta_L p_L)}{\Delta \tau_L}(v_L - v_H) + \frac{\Delta \delta_L}{\Delta \tau_L}(v_H - c) \geq 0 \\ \frac{\Delta r_H}{\Delta \tau_H} + \frac{\Delta r_H}{\Delta s_H}\frac{\Delta s_H}{\Delta \tau_H} + \frac{\Delta(\delta_H p_H)}{\Delta \tau_H}(v_L - v_H) + \frac{\Delta \delta_H}{\Delta \tau_H}(v_H - c) \geq 0 \end{matrix} \right\}$$

which completes the proof ∎.

Proof of Proposition 3 In order to get some intuition we first show the result in the symmetric case. Then we solve the asymmetric one. Without lost of generality we relax the integer constraint.

Symmetric case: A court that sets s_L (the analysis is equivalent if the court picks s_H instead) faces the following problem

$$\max_{s_L}\left[v(s_L, \tau(s_L)) = \frac{r(s_L, \tau(s_L)) - \delta^{\tau(s_L)} c}{1 - \delta^{\tau(s_L)}}\right] \tag{A13}$$

with

$$\tau(s_L; f) = \frac{\ln\left[1 - \frac{fc}{\alpha b W p^* (\theta_H - \theta_L)(\theta_H + \theta_L - 2s_L)}\right]}{\ln \Lambda} \tag{A14}$$

>From where the F.O.C. of (A13) is given by

$$\frac{dv}{ds} = \frac{\partial v}{\partial s} + \frac{\partial v}{\partial \tau}\frac{\partial \tau}{\partial s} = 0 \tag{A15}$$

First, it is easy to see that $\tau(s_L)$ is strictly increasing and convex in s_L. In addition, from lemma 1 we know that $v(s,\tau)$ is concave in s and quasi-concave in τ. Then, we know that there exists s_s and s_τ such that $\frac{\partial v}{\partial s} < 0$ if and only if $s > s_s$ and $\frac{\partial v}{\partial \tau}\big|_s < 0$ if and only if $s > s_\tau$. In addition, it is clear that there exists $\bar{s} \in [\min(s_s, s_\tau), \max(s_s, s_\tau)]$ such that v is increasing for all $s < \bar{s}$ but decreasing for $s > \bar{s}$. That is, $\bar{s}$ is the unique maximum of v or equivalently, there exists $\bar{f}$ such that

   i) $\frac{\partial v}{\partial s}\big|_{s^{SB}} = \frac{\partial v}{\partial \tau}\big|_{\tau^{SB}(s^{SB};\bar{f})} = 0$. That is $s^{SB} = s^{FB}$ and $\tau^{SB} = \tau^{FB}$.

   ii) $s_s > s_\tau$ if and only if $f > \bar{f}$.

In order to see that, we explicitly define

$$\bar{f} = \frac{\alpha bW p^*(1 - \Lambda^{\tau^{FB}})(\theta_H - \theta_L)(\theta_H + \theta_L - 2s^{FB})}{c}$$

Then, (A14) implies that when $f > \bar{f}$ it is true that $\tau(s^{SB}; f) > \tau(s^{SB}; \bar{f})$. That means that $\frac{\partial v}{\partial s}\big|_{s^{SB}} > 0$ and $\frac{\partial v}{\partial \tau}\big|_{\tau^{SB}(s^{SB};f)} < 0$. Hence, it is not only true that $s_s > s_\tau$ but also that at the unique solution of (A15) the following relations hold: $s^{SB} < s^{FB}$ and $\tau^{SB} > \tau^{FB}$. The same logic tells us that when $f < \bar{f}$ then $\frac{\partial v}{\partial s}\big|_{s^{SB}} < 0$ and $\frac{\partial v}{\partial \tau}\big|_{\tau^{SB}(s^{SB};f)} < 0$ and at the unique solution of (A15) the following relations hold: $s^{SB} > s^{FB}$ and $\tau^{SB} < \tau^{FB}$. The proof ends by noticing that $E(c, \Pi) > 0 \iff f < \bar{f}$.

<u>Asymmetric case</u>: we use the same logic of the symmetric case but this time we have to distinguish two possible values of $\bar{f}$, one for each state of the environment. This time the F.O.C. are given by (A9) and (A10). As before, there exists $\bar{f}_L$ and $\bar{f}_H$ such that

   i) $\frac{\partial v_n}{\partial s_n}\big|_{s_n^{SB}} = \frac{\partial v_n}{\partial \tau_L}\big|_{\tau^{SB}(s_n^{SB};\bar{f}_n)} = \frac{\partial v_n}{\partial \tau_H}\big|_{\tau^{SB}(s_n^{SB};\bar{f}_n)} = 0$. That is $s_n^{SB} = s_n^{FB}$ and $\tau_n^{SB} = \tau_n^{FB}$.

   ii) $s_n^{SB} < s_n^{FB}$ and $\tau_n^{SB} > \tau_n^{FB}$ if and only if $f_n > \bar{f}_n$.

This time

$$\bar{f}_L = \frac{\alpha bW(1 - p^*)(1 - \Lambda^{\tau_L^{FB}})(s_H^{FB} - s_L^{FB})(2\theta_H - (s_H^{FB} + \theta_L^{FB}))}{c}$$

$$\bar{f}_H = \frac{\alpha bW p^*(1 - \Lambda^{\tau_H^{FB}})(s_H^{FB} - s_L^{FB})(s_H^{FB} + s_L^{FB} - 2\theta_L)}{c}$$

where it is not necessarily the case that they are the same. Hence, we conclude that if $E_n(c, \Pi) > 0$ then $s_n^{SB} > s_n^{FB}$ and $\tau_n^{SB} < \tau_n^{FB}$ while if $E_n(c, \Pi) < 0$ then $s_n^{SB} < s_n^{FB}$ and $\tau_n^{SB} > \tau_n^{FB}$ ∎.

Proof of Proposition 4 The existence of $\bar{f}_n$ was proven in the proposition 3. Alternatively we can reason as follows: corollary 6 tells us that when $f_n = 1$ it is true that $\Sigma_n \leq 0$ while when $f_n = 0$ it is true that $\Sigma_n \geq 0$ because society cannot litigate more frequently than every period. Then, by continuity we know that there exists $\bar{f}_n \in [0, 1]$ at which $\Sigma_n = 0$. Notice that in general $\bar{f}_L \neq \bar{f}_H$.

In addition, when $p^* = \frac{1}{2}$ it is true that $\bar{f}_L = \bar{f}_H = \bar{f}$ will be given by

$$(1 - \Lambda^{\tau^{FB}}) = \frac{\bar{f}c}{\alpha bW(\theta_H - \theta_L)(s_H^{FB} - s_L^{FB})p^*}$$

which after using (8)-(9) and noticing that because of the integer constraint when c is low enough such that $\tau^{FB} = 1$ and $\Sigma_n = 0$ then $E_n(c, \Pi) = 0$ if and only if $f = 1$ gives us the expression of the proposition ∎.

Proof of Proposition 5 Given proposition 3 we just need to show that it exists $\bar{c}$ such that for all $c > \bar{c}$ a central planner would like to litigate with a frequency that is higher than the one corporations would freely generate. Corporations decide to litigate when

$$(1 - \Lambda^{\tau^c}) = \frac{fc}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*} \tag{A16}$$

By their side, a central planer decides to litigate when

$$(1 - \Lambda^{\tau^{FB}}) = \frac{(1 - \delta)c}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*} + \frac{1 - \Lambda}{1 - \delta\Lambda}(\delta\Lambda - (\delta\Lambda)^{\tau^{FB}})$$

which can be rewritten as

$$(1 - \Lambda^{\tau^{FB}}) + \frac{1 - \Lambda}{1 - \delta\Lambda}(\delta\Lambda)^{\tau^{FB}} = \frac{(1 - \delta)c}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*} + \frac{1 - \Lambda}{1 - \delta\Lambda}\delta\Lambda \qquad (A17)$$

hence if the right hand side of (A17) is lower than the right hand side of (A16) the result follows. We have that

$$\frac{(1 - \delta)c}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*} + \frac{1 - \Lambda}{1 - \delta\Lambda}\delta\Lambda < \frac{fc}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*}$$

which is equivalent to

$$\frac{(1 - \delta - f)c}{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*} < -\frac{1 - \Lambda}{1 - \delta\Lambda}\delta\Lambda$$

then, as by assumption $\delta + f > 1$ we have that for all $c > \bar{c} = \frac{1 - \Lambda}{1 - \delta\Lambda}\delta\Lambda\frac{\alpha bW(\theta_H - \theta_L)(s_H - s_L)p^*}{f + \delta - 1}$ it is true that $\tau^{FB} < \tau^c$ ■.

Appendix B: Poison Pill Cases in the Jurisdiction of Delaware

Table 1: Published opinions with direct reference to the use of Poison Pills

Year	Case	Sentence
1985	*Moran vs Household* (S)	The use of flip-over Poison Pills is legal (i^+)
1985	*Unocal vs Mesa* (S)	The use of back-end Poison Pills is Legal (i^+)
1985	*Revlon vs MacAndrews* (S)	The use of flip-in Poison Pills is Legal (i^+)
1988	*Robert Bass vs Evans* (R)	Conditional redemption of the Pill (cr)
1988	*City Capital vs Interco* (R)	Court required redemption of the Pill (r^+)
1988	*Grand Metropolitan vs Pillsbury* (R)	Court required redemption of the Pill (r^+)
1989	Mills Acquisition vs Macmillan (R)	Supreme court affirms sentence in *Bass*
1989	*Shamrock Holdings vs Polaroid* (R)	Appropriate to keep the Pill in place (r^-)
1989	*In re Holly Farms Shs. Litigation* (R)	Appropriate to keep the Pill in place (r^-)
1989	*Paramount vs Time* (R)	Appropriate to keep the Pill in place (r^-)
1989	*Barkan vs Amsted* (R)	Appropriate to keep the Pill in place (r^-)
1991	*In re MCA, Inc.* (R)	Conditional redemption of the Pill (cr)
1993	*In re Sea-Land vs Simmons* (S)	Appropriate adoption of the Pill (i)
1993	*QVC Network vs Paramount* (R)	Court required redemption of the Pill (r^+)
1995	*Unitrin vs American General* (S)	Appropriate adoption of the Pill (i)
1998	*Carmody vs Toll* (S)	The use of dead-hand Poison Pills is Illegal (i^-)
1998	*In re First Interstate Bancorp* (R)	Court required redemption of the Pill (r^+)
1998	*Mentor vs Quickturn* (S)	The use of no-hand Poison Pills is Illegal (i^-)
1998	Quickturn vs Shapiro (S)	Supreme court affirms sentence in *Mentor*
1999	*In re Lukens* (R)	Appropriate redemption of the Pill (r^+)
2000	*In re Gaylord* (S)	Appropriate adoption of the Pill (i)
2000	*Chesapeake vs Shore* (R)	Appropriate to keep the Pill in place (r^-)
2000	*In re MCA Inc.* (R)	Appropriate redemption of the Pill (r^+)
2001	*Account vs Hilton* (S)	Appropriate adoption of the Pill (i)
2001	*In re MCA vs Matsushita* (R)	Appropriate redemption of the Pill (r^+)
2003	*MM Companies vs Liquid* (R)	Appropriate redemption of the Pill (r^+)
2004	*Hollinger Intern. vs Black* (R)	Appropriate to keep the Pill in place (r^-)

(S): Strategic trial; (R): Random trial; (i^+): successful innovation; (i): allowed adoption; (i^-): unsuccessful innovation; (r^+): redeem the pill; (r^-): don't redeem the pill; (cr): conditional redemption of the pill

Appendix C: Law Indeterminacy

As we are interested in determining if indeterminacy is an effective tool to be used in the case of a suboptimal frequency of trials we assume that $f = 1$ and that $p^* = \frac{1}{2}$. That is, there are no contemporaneous externalities and the model is symmetric. In order to model the presence of uncertainty in the simplest possible way we assume that in the case of no innovation a trial can take place with a fixed probability ϕ. In order to keep both kinds of trial comparable we assume that a business opportunity is not required to trigger a trial. Under these conditions, the value function $v_n(p)$ becomes

$$v_n(p) = \max \left\{ \begin{array}{c} (1-\phi)(V(s_n, p) + \delta v_n(p^+)) + \phi \left[\begin{array}{c} (pV(s_L, 1) + (1-p)V(s_H, 0) - c \\ + \delta \left(pv_L(q_1) + (1-p)v_H(q_0) \right) \end{array} \right], \\ pV(s_L, 1) + (1-p)V(s_H, 0) - c + \delta \left(pv_L(q_1) + (1-p)v_H(q_0) \right) \end{array} \right\} \tag{A18}$$

while the value function v becomes[87]

$$v = \frac{r(\phi, \tau) - H(\phi, \delta, \tau)c}{1 - H(\phi, \delta, \tau)} \tag{A19}$$

with $r(\phi, \tau) = (1-\phi) \sum_{i=1}^{\tau} \left((1-\phi)\delta \right)^{i-1} V(s_n, p)$ and $H(\phi, \delta, \tau) = \left[\phi \left(\frac{1-(\delta(1-\phi))^{\tau}}{1-\delta(1-\phi)} \right) + (\delta(1-\phi))^{\tau} \right]$ in which $\frac{\partial H}{\partial \phi} > 0$, $\frac{\partial H}{\partial \tau} < 0$

and $\frac{\partial^2 H}{\partial \phi \partial \tau} > 0$. First, (A18) tells us that the addition of uncertainty has no direct effect in the incentives faced by corporations to generate trials (you can verify from the FOC that ϕ cancels out). Nevertheless, the addition of uncertainty do have an indirect effect. As (A19) tells us, the expected value of corporations is a function of ϕ. The higher its value the smaller the $\tau-$periods return function and the higher the "perceived" discount factor $H(\phi, \delta, \tau)$. The next proposition tells us that

Proposition 6 *(Indeterminacy in the law) If random trials take place with probability ϕ then the periodicity of strategic trials and social welfare are decreasing functions in ϕ. That is $\frac{\partial v}{\partial \phi} = \frac{1}{1-H} \left[\frac{\partial r}{\partial \phi} + v \frac{\partial H}{\partial \phi} \right] < 0$ and $\frac{\partial \tau^{SB}}{\partial \phi} > 0$.*

Proof of Proposition 6 First we prove that $\frac{\partial v}{\partial \phi} = \frac{1}{1-H} \left[\frac{\partial r}{\partial \phi} + v \frac{\partial H}{\partial \phi} \right] < 0$. We proceed in three steps. First we show that $v(\tau; \phi)$ is still quasi-concave in τ. Second we show that $v(\tau = 1; \phi = 0) < v(\tau = 1; \phi)$ and third we show that $v(\tau^{SB}; \phi)$ is decreasing in ϕ.

Step 1: We can rewrite $v(\tau; \phi)$ in the following way

$$v(\tau; \phi) = \frac{\sum_{i=1}^{\tau} \delta'^{i-1} V' - \delta'^{\tau} c'}{(1-A)(1-\delta')} \tag{A20}$$

in which $\delta' = (1-\phi)\delta$, $V' = (1-\phi)V(s_n, p)$, $c' = \frac{(1-\phi)(1-\delta)}{1-\delta(1-\phi)}c$ and $A = \frac{\phi}{1-\delta(1-\phi)}$. Then it is direct that Lemma 1 also applies to (A20)

Step 2: We have that $v(\tau = 1; \phi) = \frac{(1-\phi)V(s_L, 1) - (\phi + \delta(1-\phi))}{1 - (\phi + \delta(1-\phi))}$ and $v(\tau = 1; \phi = 0) = \frac{V(s_L, 1) - \delta}{1-\delta}$ from where

$$v(\tau = 1; \phi = 0) < v(\tau = 1; \phi) \iff \phi(1 - \delta) > 0$$

and the last relation is obviously always true.

Step 3: Given steps 1 and 2 we know that $v(\tau; \phi)$ can only have the next two possible shapes 1) $v(\tau; \phi) > v(\tau; 0)$ and 2), it exists $\bar{\tau}$ such that for all $\tau < \bar{\tau}$ then $v(\tau; \phi) > v(\tau; 0)$ and for all $\tau > \bar{\tau}$ then $v(\tau; \phi) < v(\tau; 0)$. We show that $\bar{\tau}$ is defined by the following relation

$$c = \frac{\delta(1-\Lambda)\alpha bW(\theta_H - \theta_L)^2}{(1-\delta)(1-\delta\Lambda)(1-\delta\Lambda(1-\phi))}$$

Now we prove that $\frac{\partial \tau^{SB}}{\partial \phi} > 0$. We know that

$$\frac{\partial v}{\partial \tau} = \frac{(1-H)\frac{\partial r}{\partial \tau} + \frac{\partial H}{\partial \tau}(r-c)}{(1-H)^2} = \frac{1}{1-H}\left(\frac{\partial r}{\partial \tau} + v\frac{\partial H}{\partial \tau} \right) = 0$$

$$\implies \frac{\partial \tau}{\partial \phi} = \frac{-\left[\frac{\partial^2 r}{\partial \phi \partial \tau} + \frac{\partial v}{\partial \phi}\frac{\partial H}{\partial \tau} + v\frac{\partial^2 H}{\partial \phi \partial \tau} \right]}{\left[\frac{\partial^2 r}{\partial \tau^2} + v\frac{\partial^2 H}{\partial \tau^2} \right]}$$

---

[87]We are assuming that c is big enough such that $\tau^{SB} > 1$. That allows us to write

$$v_L(1) = V(s_L, 1) + \delta v_L(q_1) - \phi c$$

and

$$v_H(0) = V(s_H, 0) + \delta v_H(q_0) - \phi c$$

we already know that $\frac{\partial H}{\partial \tau} < 0$ and $\frac{\partial^2 H}{\partial \phi \partial \tau} > 0$. In addition, as v is concave in τ we know that

$$\frac{\partial^2 v}{\partial \tau^2} = \frac{\frac{\partial^2 r}{\partial \tau^2} + v \frac{\partial^2 H}{\partial \tau^2}}{(1-H)} \leq 0$$

also as

$$\frac{\partial^2 r}{\partial \phi \partial \tau} = \left(\frac{1-b}{1-\delta} W + \left(\frac{1}{1-\delta} - \frac{[(s_L - \theta_L)^2 + (\theta_H - s_L)^2]}{2} \right) b \alpha W \right) Z(\phi)$$

$$- \frac{[(\theta_H - s_L)^2 - (s_L - \theta_L)^2]}{2} b \alpha W \frac{\partial Z(\phi)}{\partial \phi} > 0$$

because

$$Z(\phi) = \delta(\delta(1-\phi))^{\tau-1} [1 - \tau \ln(\delta(1-\phi))]$$

and

$$\frac{\partial Z(\phi)}{\partial \phi} = \delta(\delta(1-\phi))^{\tau-2} [1 + \tau(\tau-1) \ln(\delta(1-\phi))]$$

>From where it follows that $\frac{\partial \tau}{\partial \phi} \geq 0$ ■.

As courts internalize that there is a new source of trials that does not directly affect the incentives of corporations to generate trials, adjust the standards in order to induce corporations to generate less strategic trials. In addition, as the courts internalize that random trials are trials of "bad quality" they would prefer not to have them at all, that is, if society could choose a level of uncertainty in the law that would be zero.

Finally, if the parties have the option to settle their disputes, that is, to pay a cost βc with $\beta \in [0,1]$ in order to avoid the randomly generated dispute (in this case the original standard is preserved) then random trials take place with frequency τ_r defined by $(1 - \Lambda^{\tau_r})(\theta_H + \theta_L - 2s_L)(\theta_H - \theta_L) = \frac{2(1-\beta)c}{\alpha W b}$ while strategic trials take place with frequency τ_s defined by $(1 - \Lambda^{\tau_s})(\theta_H + \theta_L - 2s_L)(\theta_H - \theta_L) = \frac{2c}{\alpha W b}$. As a result, conditional on a random dispute being generated, random trials take place with a higher frequency than strategic trials if and only if $\beta > 0$ and this difference is increasing in β. Society is interested in increasing the frequency of trials nevertheless the higher is the cost of settlement the higher the cost that the parties will have to pay if a random dispute takes place before τ_r. Although a priory it is not clear which effect dominates, next we show through a numerical example that for a certain set of parameters there exists β such that society will prefer to have a strictly positive level of uncertainty.

The next graphs show the comparative evolution of $v(\tau)$ when $\phi = 0$ and $\phi = 0.005$. In which

$$v(\tau) = \frac{r_r + r_s - \left[H'(\phi, \delta, \tau) + (1-\beta)\delta^{\tau_s}(1-\phi)^{\tau_s - \tau_r} \right] c}{1 - H'(\phi, \delta, \tau)}$$

with $r_r = (1-\phi) \sum_{i=1}^{\tau_r} \delta^{i-1} V(s, p(i))$, $r_s = (1-\phi) \sum_{i=\tau_r+1}^{\tau_s} ((1-\phi)\delta)^{i-1} V(s, p(i))$ and $H'(\phi, \delta, \tau) = \delta^{\tau_r} \left[\begin{matrix} \phi \left(\frac{1 - (\delta(1-\phi))^{\tau_s - \tau_r}}{1 - \delta(1-\phi)} \right) + \\ + (\delta(1-\phi))^{\tau_s - \tau_r} \end{matrix} \right]$.
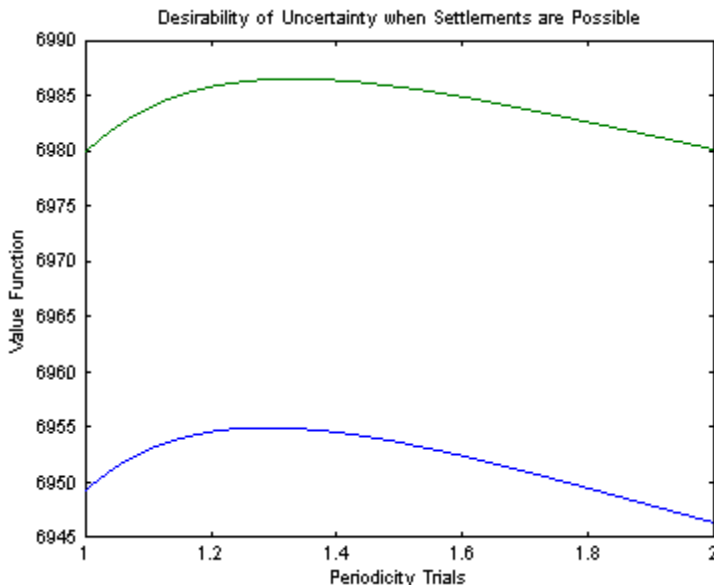
In addition, τ_s and τ_r are defined by

$$(1 - \Lambda^{\tau_s})(\theta_H + \theta_L - 2s_L)(\theta_H - \theta_L) = \frac{2c}{\alpha W b}$$

$$(1 - \Lambda^{\tau_r})(\theta_H + \theta_L - 2s_L)(\theta_H - \theta_L) = \frac{2(1-\beta)c}{\alpha W b}$$

respectively. We assume that the rest of the parameters have the following values $\theta_L = 0.\overline{3}$; $\theta_H = 0.\overline{6}$; $q_1 = 0.9$; $q_0 = 0.1$;

$W = 100;\ \alpha = 2;\ b = 0.4;\ \delta = 0.98;\ c = 1;\ \beta = 0.001.$

The optimal value of $\upsilon(\tau; \phi = 0)$ is $6954, 86$ while the optimal value of $\upsilon(\tau; \phi = 0.005)$ is $6986, 03$ which means that society is better off with random trials than without them.

Appendix D: The Role of Agencies

In order to capture the information disadvantage of the agency we assume that it only knows the expected value of the corporation $E[W]$ (the same analysis is valid for α or b). Suppose that $E[W] > W$, then the agency would want to generate more trials than a fully informed central planner.[88] Then, if $E_n(c, W) > 0$ society would want to reduce the frequency of trials generated by corporations but in this case the frequency either will not change because the informational distortion $(E[W] \neq W)$ is not enough to compensate the aggregate negative externality or will increase because the distortion moves in the wrong direction. On the other side, if $E_n(c, W) < 0$ then the agency would want to generate a frequency of trials higher than the informed central planer, in that case the agency will generate a suboptimally high frequency of litigation. Suppose instead that $E[W] < W$ then the agency would want to generate less trials than a fully informed central planer. If $E_n(c, W) > 0$, then the agency would like to correct the inefficiency by generating less trials but it will not be able to do it because it cannot stop corporations from generating trials. Finally if $E_n(c, W) < 0$ the frequency of litigation would increase but without achieving the first best.[89] As a result, the agency can only induce an increment in the frequency of litigation and its intervention will be socially desirable only if the informational disadvantage (bias) is not too big.

---

[88] The higher the corporations value the higher the first best frequency of trials.

[89] A similar result is derived if we assume that every period the agency doesn't have infomation about nature and believes that every period it is at state H or L with the same probability. In that case $\Lambda = 0$ and $p^* = \frac{1}{2}$. It is not difficult to show that in the symmetric model $\tau^{FB}(\Lambda)$ is increasing in Λ because the less persistant is nature the more frequently the standard needs to be updated. As this analysis is independent of the sign of the aggregate externality we conclude that the agency will attempt an innovation more frequently than what an informed central planer would like.
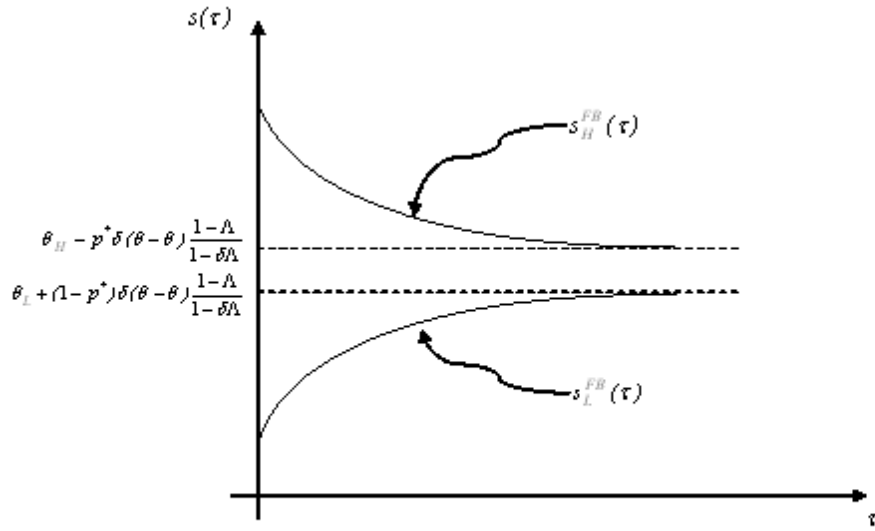
Figures

$$\theta_H - p^* \delta (\theta - \theta) \frac{1 - \Lambda}{1 - \delta \Lambda}$$

$$\theta_L + (1 - p^*) \delta (\theta - \theta) \frac{1 - \Lambda}{1 - \delta \Lambda}$$

$s_H^{FB}(\tau)$

$s_L^{FB}(\tau)$

$s(\tau)$

τ

Figure 1: How to set First Best Standards (symmetric case)

$s(\tau)$

θ_H

$$\theta_H - p^* \delta (\theta_H - \theta_L) \frac{1 - \Lambda}{1 - \delta \Lambda}$$

$$\theta_L + (1 - p^*) \delta (\theta_H - \theta_L) \frac{1 - \Lambda}{1 - \delta \Lambda}$$
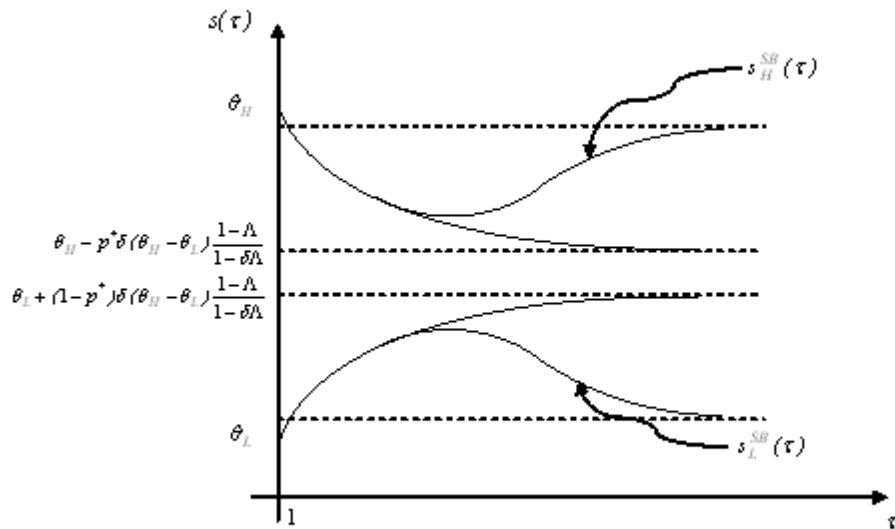
θ_L

$s_H^{SB}(\tau)$

$s_L^{SB}(\tau)$

1

τ

Figure 2: How to set Second Best Standards (symmetric case)

56