A Dynamic Theory of Corporate Common Law

Job Market Paper

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Abstract

Courts are at the heart of a common law legal system. Along with their role as enforcers, they are regularly called to set legal rules to improve the efficiency of contractual outcomes. But how should courts carry out their rule-making role? In this paper we develop for the first time a model that precisely determines when and how forward-looking courts should set and reform legal rules. We explicitly take into account that the optimal rules most likely are not the same for all periods of time, courts can only rule at trials and their enforcement strategies determine the litigation strategies of the parties in conflict. First, we show that, in general, courts should not set those rules that the parties would have wanted before they signed the contract, but instead the rules which are optimally adapted to the states of nature most likely to occur before the next trial. Second, we show that courts should also not set the unconstrained first-best rules for society. As the contracting parties don't generate trials at the optimal frequency for society, first-best rules need to be adjusted to give incentives to partially correct this inefficiency. In addition, the model predicts that: 1) there always exists a distribution of the litigation expenses between the parties in conflict that generates an optimal frequency of trials in which case courts don't need to bias the rules; 2) if the total litigation expenses are above a certain threshold then trials take place too infrequently in which case courts bias the rules toward the interests of current litigants. Given this last result, we 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. or agencies as the S.E.C.

Keywords: Myopic Courts, Forward-Looking Courts, Optimal Enforcement Strategies, Optimal Frequency of Trials, Legal Rule, Legal Standard.

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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

In this paper we formulate a formal framework that determines the precise rule-making role of courts in a dynamic setting. Legal scholars and economists suggest that courts are called to set and reform rules (for example, they interpret statutes, decide new issues and overrule former precedents) in order to improve the efficiency of contracts in at least two ways: they must fill the gaps left by the contracting parties because it is expensive to write complete set of clauses, and they must constrain the behavior of the parties whenever inefficiencies such as abuses of power or collective action problems are possible (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) or strong defenders of its original text (originalists)[1]?

An extensive literature in Law and Economics[2] has suggested that, in their sentences at trials, courts should set the ex-ante most efficient rules for the disputing parties, that is, what the parties would have wanted to write before the dispute took place. In that context courts act myopically and set the most efficient rules given the current environment. In reality, however, the problem faced by a rational court is not static but dynamic. Unlike a myopic court a forward looking one has to take into account three considerations

[1] 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.

[2] The classical reference is Easterbrook and Fischel [1991]. Complementary analysis can be found in Baird and Jackson [1985] and Posner [2003].

when making a decision. First, as nature is in constant evolution, the best rule for one period of time may not be the best rule for future periods. Financial innovations, technological progress and even changes in the characteristics of the agents that are regulated will affect the efficiency of given rules. Second, unlike legislators, courts cannot modify common law whenever they want, they must wait for a trial to take place to reform a legal rule. Third, the court's rule-setting strategy will affect the incentives of future contracting parties to generate trials. Given these considerations, should forward-looking courts set the most efficient rules for the current parties in dispute?

In addition, due to the intrinsic connection between rules and trials we notice that a model that describes the rule-making role of courts in a dynamic setting provides a natural framework to determine whether society generates an efficient frequency of litigation.[3] The common belief among academics[4], legislators[5] and even the general public[6] 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, in reality, trials accomplish two other important roles: they reveal information that can increase the efficiency of future contracts[7] and they generate opportunities in which courts can set rules that will improve the quality of the law.[8] Taking into account these other roles of trials, it becomes unclear whether society faces too many or too few of trials.

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 and benevolent court facing agents that live for one period, which we take to be corporations. These 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 the acquirer (or the target) chooses to sue. 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)

[3] As we don't consider the option of settlement but until the end of the paper we will use the terms "trial" and "litigation" interchangeably.

[4] See, for example, Murphy, Shleifer and Vishny [1991].

[5] "To avoid the expense and delay of having a trial, judges encourage the litigants to try to reach an agreement resolving their dispute." (www.uscourts.gov/understand02/content_6_1.html).

[6] "The Most expensive disease in this country is hyperlexis, too many lawsuits chasing too few facts" (Editorial The Wall Street Journal 01/20/92).

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

[8] 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.

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) probablity generates an offer that will increase its value (an efficient offer).[9] As shown by Grossman and Hart [1980], an inefficient offer increases the probability that a corporation could be sold below its current value.[10] Higher defenses give the target more time to analyze the business opportunity, receive alternative offers or look for a friendly acquirer (a "white knight"). Finally, 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 (shareholders want to extract a monopoly rent.)[11]

The paper generates two main results. First, unless litigation takes place continuously, society is completely myopic, or the state of nature is constant, 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 nature 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

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

[10] 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.

[11] 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.

[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 dificult 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.

as leading precedents.[16]

Second, forward-looking courts should not set the rules that society would ideally like to have. 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]) in an analysis done in the context of tort law, the frequency of litigation is not optimal because the parties in dispute do not internalize the social costs of litigation[17] (we call this contemporaneous externality) and do not internalize the benefits that a judicial sentence brings to the whole society (we call this inter-temporal externality.) In an attempt to bring the frequency of litigation closer to the optimal level and in absence of alternative policy instruments courts must bias the rules in favor or against the preferences of current litigants.

This may explain why certain branches of the law seem to be biased in favor of the interests of one party over the other. For example, the American Bankruptcy Law is regarded as debtor friendly (see for example Skeel [2001]) while the current antitakeover and predatory pricing standards in the Delaware jurisdiction are considered too stringent (see for example Bebchuk and Ferrell [1999] and Posner [2001] respectively.)

In addition, the model identifies the conditions under which the frequency of litigation would be too high or too low from society's perspective. In particular, two predictions seem especially relevant. First, as in the case in which corporations don't face litigation expenses the aggregate externality (contemporaneous plus inter-temporal) is negative and in the case in which corporations face 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. This optimal distribution can be estimated empirically.

Second, we show that, contrary to intuition, the frequency with which trials take place is suboptimally low if the social costs of litigation (relative to the value of the corporation) are big enough. In this last 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. Then, society may want to litigate less frequently than corporations for low litigation expenses but society will prefer the opposite with certainty when these expenses are above a certain threshold.

The result opens a new angle in the debate whether judges should be activists or originalists (the debate

[16] *Moran* is the *stare decisis* (legal doctrine in which courts are supposed to follow binding precedents) 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.

[17] Plaintiffs don't internalize the costs inflicted upon the defendant or the public legal system when they file the suit.

has been revived in the last days with the nomination and confirmation of John Roberts as the successor of William Renhquist as chief justice of the Supreme Court. Several commentators have described Roberts as a conservative that "would not likely push the court to overturn previous decisions.")[18] 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 if trials take place more regularly. Consequently, it is possible that the optimum for society is that judges should be activists in certain branches of the law but originalists in others.

The result also suggests that the frequency of corporate, bankruptcy and antitrust litigation may be suboptimally low from society's point of view. The reason is that litigation is particularly expensive in all these branches of the law.

Given this last consideration, we conclude by analyzing two strategies that are commonly suggested by regulators in the context of shareholder litigation as ways of achieving an efficient frequency of trials. First, we consider if the hypothetical increment in the number of legal disputes generated by the addition of indeterminacy in the law is welfare-improving. As stated by Kamar [1998] "while some indeterminacy in corporate law may be inevitable, the degree of indeterminacy in Delaware law seems too high". We show that the pure addition of uncertainty to the law doesn't improve welfare because the kind of trials generated due to flexible but ambiguous regulation have the undesirable property of taking place whether the law needs to be improved or whether it does not.[19] 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. The reason of this is that the option of settlement gives the parties incentives to increase the frequency of trials when they are needed but the increment will be excessive if the cost of settlement is very low and will be negligible if the same cost is very high. The result suggests that vague standards such as the *Unocal-Revlon* proportionality test[20] are more effective in keeping legal rules up the 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

[18] 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.

[19] Nevertheless, we believe that our analysis underestimates the value of ambiguous but flexible rules because it does not consider that they allow the law to better adapt to new conditions in markets.

[20] 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.

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 they can initiate litigations when they are not needed.

The rest of the paper is organized as follows. In Section 2 we place the paper within the literature. In section 3 we provide an example of the mechanism driving the dynamics of the rule-setting process. In Section 4 we introduce the theoretical framework. In Section 5 we describe the problem faced by the court at each trial. In Section 6 we derive our main results. In Section 7 we test the robustness of the results and develop extensions. Finally, in Section 8 we conclude and mention avenues for future research.

2 Related Literature

A first attempt to model the rule-making role of courts in a dynamic setting has been made by Franks and Sussman [2005]. In their paper the authors analyze the evolution of the bankruptcy law as a mechanism for the standardization of default clauses[21] under a free-contracting regime. There, one-period lived corporations write a debt contract that determines the probability of liquidation of their assets in the case of bankruptcy. Corporations can either write a standard contract at zero cost or write a new contract paying a fixed cost (they may want to do this if the standard is not optimal.)[22] The role of the courts is summarized in an exogenously given probability of enforcement of the innovated contract (the standard contract is always enforced), if the innovation is enforced, it becomes the new standard. The main result of the paper is that there is under-innovation because corporations don't internalize other corporations' benefits when an inefficient standard is updated. In addition, the authors show that the standard has path-dependence and moves in cycles that under- and over-shoot the optimum. Although these results are appealing their validity seems restricted because they strongly rest on the assumption that the decisions of courts are not endogenously determined.[23]

Our formulation improves on Franks and Sussman in four key dimensions. First, we explicitly model the problem faced by a benevolent and infinitely-lived court when it decides what standard to enforce. The court

[21] 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.

[22] The optimal standard balances the benefit of giving incentives to managers to avoid bankruptcy with the cost of value-reducing liquidation.

[23] If there is complete information, nature doesn't evolve and lawmakers are benevolent (enforce the optimal standard for corporations) then the optimal standard is achieved in the first innovation.

does not only accept or reject an innovation, but also decides on the restrictiveness of the new standard.[24] Although studies in which parties have asymmetric information (as in Ayres and Gertner [1989], Bebchuk and Shavell [1991], Anderlini *et al* [2003] and Maskin [2005]) or in which judges are not benevolent (as in Usman [2002], Bond [2003], Shavell [2003] and Levy [2005]) have concluded that courts should not necessarily set the rules from the perspective of the best interests of the contracting parties, these analysis have been done in a static context. A line of research that goes some way towards a dynamic perspective, initiated by Landes and Posner [1976] and formalized by Priest [1977], Rubin [1977], Cooter and Kornhauser ([1979], [1980]) studies whether the legal rules generated by a common law system evolve efficiently but in this perspective the decision problem of the courts is not modeled.[25]

Second, we explicitly incorporate in our model the fact that nature is in permanent change. In order to do that, we assume that the optimal takeover defense (or the optimal probability that a tender offer faced by a target is rejected) changes through time. There are two reasons why the probability that the corporation could face an inefficient offer evolves through time. First, changes in markets like the degree of diversification in conglomerates can lead to different degrees of sub-valorization of corporations (see Shleifer and Vishny [1991]). Second, financial innovations like junk bonds, strategy innovations like hostile offers, or technological progress like internet can substantially change the quantity (level of activity) and the quality (type) of the offers faced by corporations (see Gilson and Black [1995]).

Third, we endogenously determine the periodicity with which contracting parties litigate and analyze whether that is excessive or insufficient from a social point of view. In the context of a static model of tort litigation Shavell ([1997], [1999]) compares the private and social incentives to generate suits (trials and/or settlements) when trials have a role in the improvement of the law. He concludes that the frequency with which litigation takes place can be either excessive[26] because the parties don't internalize the difference between the private and social costs of litigation or inadequate because they don't internalize the deterrence of future accidents induced by the judicial sentences. In his model, high social costs of litigation invariably imply an excessive level of litigation.

Fourth and final, unlike in the majority of the literature in which only the decisions of the court or

[24] In that sense our theory can be interpreted as an evolution either of mandatory or default rule (although courts make final decisions, corporations have the freedom to propose new rules).

[25] Common law would evolve efficiently because inefficient rules are litigated more frequently than efficient ones. The analysis is mainly focused in the technical conditions under which exogenously given strategies of enforcement assure convergence to the most efficient rules. More recent research has shown that this result is not robust if judges maximize personal utilities, are biased, or face personal costs for overruling precedents (Miceli and Cosgel [1993], Harnay and Marciano [2003] and Gennaioli and Shleifer [2005]). Similarly the result is not preserved if judges take into account the productive externalities of their sentences (Chu [2003]).

[26] He suggests that this will be the case in litigation related to car accidents and product liability.

the decisions of the contracting parties are modeled (see for example Fon and Parisi [2003]), in our paper we determine both decisions endogenously. The resulting mechanism[27] of strategic interactions between corporations and the court determines the evolution of the anti-takeover standard. As this mechanism is at the core of our model in the next Section we explain it in more detail through an example.

3 The Mechanism

Suppose that in any given period a corporation can receive an inefficient offer with a high (H) or low (L) probability. Then, the expected value of a corporation is high if the standard matches the state of nature because if nature is high the corporation benefits from a high probability of rejecting an inefficient offer but if it is low it benefits from a high probability of accepting an efficient offer. The standard can only be reformed by rulings of the court at trials which we assume take place every T periods. Then we notice the following three facts. First, holding T fixed, at a trial, a corporation would like to set a standard equal to L or H while the court would like to set a "weighted" combination between L and H. A benevolent court internalizes that the standard will be fixed for T periods while the state of nature may be switching between L and H.

Second, holding the standard fixed, the court and corporations want a different T. The objective of the court is to maximize the value of current and future corporations. A priori, it is not clear if the court wants a lower or a higher T than a corporation. If the aggregate effect of the contemporaneous and inter-temporal externalities is positive, then society will want to have trials more frequently than corporations, but if the aggregate effect is negative, the opposite will be true.

Third, the closer is the standard to the true state of nature, the quicker a corporation will want to respond to a likely change in nature by generating a trial because the higher will be the payoff for having the right standard.

If we put the facts together we realize that a court that has to set a new standard faces the following trade-off. It wants to set an optimal "weighted" average for the T periods in which it will be fixed, but if it sets this value it will generate a frequency of litigation that is not socially desirable. If the aggregate effect of the externality is positive, then the court biases the "weighted" average closer to the true state of nature in order to increase the frequency of trials, but if the aggregate externality is negative then it does the opposite

[27] Although not completely accurate, we refer to the core logic behind the model as a mechanism instead of a repeated game. We don't use the second alternative for two reasons. First, the court commits to its strategy. Second, the court does not decide every period.

in order to decrease the frequency of trials.

4 Theoretical Framework

We model the decisions of an infinitely lived court and an infinite sequence of one-period lived corporations[28] in discrete time, both indexed by t on the natural line.[29] For clarity of exposition we explain each of its components separately.

4.1 Corporations, State of Nature and the Standard

All corporations are identical. Each of them has an initial value of W and faces a business opportunity (for example a takeover or a merger offer) with probability b.[30] We characterize the opportunity as the random price $P(t)$ uniformly distributed in $[0,1]$ at which a raider offers to buy the corporation.[31] The corporation has to accept or reject the offer. Although at first view it seems that this decision should be made by the board of directors and managers with different degrees of involvement of shareholders, in reality the decision is strongly determined by the set of rules enacted by legislators (statutes) and courts (case law) that are usually written into the charters of the corporation.[32] In order to model the role of these rules we define $s(t) \in [0,1]$ as the probability that an offer is rejected if the decision is completely determined by the regulation. We assume that if $P(t) < s(t)$ then the corporation rejects the offer with certainty but if $P(t) \geq s(t)$ then it accepts it with certainty. We call $s(t)$ the legal standard.

As in general, only some business opportunities are profitable for targets we assume that nature can have two states $\theta(t) \in \{\theta_L, \theta_H\}$ with $\theta_H > \theta_L$ such that, conditional on the offer being accepted, if $P(t) < \theta(t)$ the target decreases its value (an inefficient offer) while if $P(t) \geq \theta(t)$ the target increases its value (an efficient offer). 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

[28] The expected life of a corporation is much shorter than the one of a legal system (corporations are disolved, merged or bought among other options while a legal system will be present along with the existence of a country). We believe that our qualitative (although not quantitative) results are preserved if corporations are modeled as long-lived agents.

[29] 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.

[30] In reality, this probability is endogenously determined by the legal framework as in Schnitzer [1991].

[31] 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]).

[32] 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.

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.) As mentioned before, there are two reasons why the probability that corporations may face inefficient offers can be different through time. First, changes in markets may generate or eliminate rent opportunities.[33] Second, financial innovations,[34] technological progress[35] and also changes in the characteristics of corporations may alter the level of activity and the type of offers faced by targets.[36] We model the evolution of nature as a two states Markov process with transition probabilities

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

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

In order to capture the fact that the level of regulation does not completely determine the decision of the corporation we assume that the standard can induce the corporation to make a wrong decision (accept an inefficient business opportunity or reject an efficient one) with probability $F((s(t)-\theta(t))^2)$ where $F:[0,1]\to[0,1]$ and $F'>0$. This expression penalizes in the same way too stringent ($s(t)>\theta(t)$) or too soft standards ($s(t)<\theta(t)$). Given that the literature doesn't know *exactly* how much the regulation affects the final decision, which is captured by the shape of the function F, we prioritize tractability of our model and assume that

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

Within this framework the expected value of corporation t turns to be an increasing function on how well

[33] For example, 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. An alternative theory is that the diversification strategy of the '60s was a mistake that the '80s tried to correct.

[34] For example, the development of the high yield bonds market in the second halve of the '80s considerably increased the level of takeovers activity (Gilson and Black [1995] report that the total acquisition activity, measured as percentage of real GNP, increased from 1.4 in 1980 to 5 in 1985 and kept this level until 1989 with 5.3 but it droped in 1990 to 2.6) and extended the use of particular types of takeovers like the leveraged buyouts (as described by Gilson and Black (chapter 11), in a leveraged buyout a company with no prior operating history, formed solely to conduct the acquisition (a shell company) acquires (or offers to) the target mostly with borrowed funds. After the operation is completed, very commonly, the acquirer bust-ups divisions of the target in order to pay the debt.)

[35] For example, the innovation of computers and internet considerably increased the speed with which tender offers can take place and reduced the time in which shareholders have to make a decision. Among other things a similar logic attempting to provide shareholders enough time to make a decision lead the congress to enact the Williams Act in 1968.

[36] For example, hostile and two-tier tender offers increase the probability that a raider will extract the rents generated in the acquisition by forcing the shareholders to sell at a low price.

the law tracks the state of nature

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

where it is implicit that the value of a corporation that makes the wrong decision when it faces a business opportunity goes to 0 while the value of a corporation that makes the right decision increases due to a takeover-premium captured by the parameter $\alpha > 1$.[37] This parameter has no relevance in our qualitative results.

4.2 Information Process and Litigation Strategies

Corporations 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 state of nature from the decisions of former corporations facing business opportunities, at this point we restrict the sources of information only to trials.

Assumption 2: All agents learn the true state of nature at trials which are the only source of information.

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

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

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

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, nature 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.[38] That is, at time t, the

[37] In the case of takeovers Black and Grundfest [1988] suggest that this premium can range between 1.3 and 1.5.

[38] 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

probability that the state of nature 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 nature. 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 state of nature.

At some point in time a corporation may attempt a reform of the standard by writing a new rule in the charter.[39] In our framework, that innovation generates a trial with certainty. There are two reasons why this is an accurate description of reality. First, there are strong conflicts of interest between the target and the raider (or potential raider.) One or the other side may challenge a change in the standard because that reduces its capacity to obtain the acquisition rent. Second, there are strong conflicts of interest among the corporate constituents.[40] Managers, minority shareholders and outsiders want to set a “tougher” standard 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.[41] That happened in *Revlon.*[42] Minority Shareholders do the same because a takeover would dilute their positions. That happened in *Weinberger.*[43] And creditors see a takeover as a threat because the corporation can be driven to financial distress or bankruptcy. That happened in *Nabisco.*[44]

finance.

[39] Evidently the concept of the reform of the standard is much broader than the idea of writting a new rule. For example, an old standard can be modified by the introduction of new strategies. That was the case when corporations started using no-shop aggrements, looking for white knigths or calling for the expert advice of banks at the moment of determining the fairness of an offer.

[40] Kraakman and Hansman [2004] state that corporate law has two main objectives. First, it establishes and supports the structure of the coporate form. Second, it attempts to control the conflicts of interest among corporate constituents.

[41] Many times the second reason is more important than the first one. That was well depicted in the personification of the CEO of Nabisco RJR Ross Johnson in “Barbarians at the Gates”, both the book and the movie.

[42] 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).

[43] 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).

[44] 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

Although in reality legal disputes happen both before the target faces the offer (as in *Moran*) and during the time it is taking place (as in *Lynch*)[45], at this point we assume that only the first option is possible

Assumption 3: Trials take place before corporations face a business opportunity

We denote the litigation strategy $l(p_n(t), s(t)) = l_n(t) : [0,1]^2 \longrightarrow \{0,1\}$ in which $l_n(t) = 1$ means a trial while $l_n(t) = 0$ means no trial

4.3 Trials, the Court and Enforcement Strategies

The aggregate cost of litigation (the social cost of litigation) is $c < W$. This cost includes the litigation expenses of both parties at dispute (unlike in the British legal system in which the losing party pays the totality of the litigation expenses in the American legal system each party pays its own) and the costs of using the legal system. The litigation cost faced by a corporation (the private cost of litigation) is fc, with $f \leq 1$. Notice that our formulation applies to litigations among corporations as well as among corporate constituents.

We explicitly model the three roles of trials. First, at a trial, the true state of nature is revealed to all agents (reveal information). Second, at a trial, courts resolve the disputes of shareholders by deciding if the standard will be preserved or reformed (resolve disputes). And third, at a trial, the court can set or reform a precedent that will rule the affairs of future corporations (improve the law).

Finally, in our model, there is a unique[46] and time-consistent court that acts as a central planner. That is, although the court could behave in alternative ways that are discussed later in the paper, at this point we assume that

Assumption 4: The court commits to the strategy that maximizes the value of all corporations at $t = 1$.

More specifically, whenever the court is called to resolve a dispute (at a trial) it has to decide if the current standard will be preserved or modified. We call this decision the enforcement strategy $s(\theta(t)) = s_n$:

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.

[45] 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).

[46] In reality there is a multiplicity of judges. 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. Judges are supposed to follow the precedents established by judges strictly above in the hierarchy, nevertheless there are many exceptions in which they have considerable discretion to decide when precedents are binding or what is the content of a statute.

$\{\theta_L, \theta_H\} \longrightarrow [0,1]$.

4.4 Dynamics of the System and Timing of Actions

Our problem is stationary and not path dependent.[47] 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 nature that will be revealed at the next trial. We define the periodicity $\tau_n \geq 1$, as the number of periods in which the system has standard s_n[48] or equivalently, the number of corporations that don't innovate in their charters (and consequently don't generate a trial) 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. A deterministic length of a cycle is the result of some of our assumptions. In Section 7 we describe systems in which this length is random. Although the interpretation of τ_n changes our main results are preserved. Finally we explicitly write the timing of the actions that takes place every period.

1. Nature realizes $\theta(t)$. Not observed by the agents.
2. Agents adjust their beliefs: $p(t-1) \rightarrow p(t)$.
3. Corporation t, facing standard $s(t-1)$ and having beliefs $p(t)$, decides $i(t)$.
4. If $l(t) = 1$ then a trial takes place, a cost fc is paid by corporation t, $p(t)$ becomes 1 or 0 and the Court decides $s(t)$.
5. If $l(t) = 0$ then a trial doesn't take place, agents adjust their beliefs as in point 2 and $s(t) = s(t-1)$.
6. A business opportunity takes place or not, the payments of the game are realized and discounted at the beginning of the period.

[47] This may seem a major limitation in a model of common law in which judges are oblied to follow precedents. Nevertheless, as Atiyah and Summers [1987] point out, there is an even deeper principle of common law that preceds path dependence: substantivity. The American common law legal system is commited to use socio-economic 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 an attribute of the law only if that proves to be up to date. Under this considerations, our model can be interpretetd 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. Finally, a modification of our model that directly generates path dependence is the addition of a cost of adjustment of the standard.

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

5 The Problem faced by the Court

A benevolent, forward-looking and time-consistent court maximizes the expected value of current and future corporations. That is, it solves

$$\max_{s_n} E_{\widetilde{\tau}(z)} \sum_{z=1}^{\infty} \delta^{\widetilde{\tau}(z)-1} \left\{ \begin{array}{c} p(\widetilde{\tau}(z)) \left[\sum_{t=1}^{\tau_L} \delta^{t-1} V(s_L, p_L(t)) - \delta^{\tau_L} c\right] + \\ (1 - p(\widetilde{\tau}(z))) \left[\sum_{t=1}^{\tau_H} \delta^{t-1} V(s_H, p_H(t)) - \delta^{\tau_H} c\right] \end{array} \mid n \in \{L, H\} \right\} \tag{1}$$

with

$$\widetilde{\tau}(z) = \sum_{i=1}^{z} \tau(i) \quad \text{and} \quad \tau(z) = \begin{cases} \tau_L & \text{if} \quad \theta(\widetilde{\tau}(z-1)) = \theta_L \quad \text{and} \quad z > 1 \\ \tau_H & \text{if} \quad \theta(\widetilde{\tau}(z-1)) = \theta_H \quad \text{and} \quad z > 1 \end{cases} \tag{2}$$

s.t.:

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

$$\tau_L = \arg\min_{\tau \in \mathbb{N}} \{(1 - p_L(\tau + 1)) (V(s_H, 0) - V(s_L, 0)) \geq fc\} \tag{4}$$

$$s_L, s_H \in [0, 1]\,; \tau_L, \tau_H \geq 1; \tau(1) = 1; p(1) \in \{1, 0\} \text{ given} \tag{5}$$

The objective function tells us that, at a trial in which the true state of nature is revealed to be $n \in \{H, L\}$, the court chooses the standard s_n that will optimally regulate corporations affairs for τ_n periods knowing that the standard s_{-n} will optimally regulate corporations affairs for τ_{-n} periods. The solution defines a Nash equilibrium (indeed a perfect Bayesian equilibrium (PBE) when δ is big enough).[49] The uncertainty of the problem is given by the timing $\{\widetilde{\tau}(z)\}$ 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 nature revealed at the next trial (and consequently what will be the next standard). In (1) we distinguish between $p(t)$ and $p_n(t)$. The first term refers to the beliefs of agents at periods in which trials take place while the second term refers to the beliefs of agents during the periods within a cycle. Inequalities (3) and (4) are the incentive constraints faced by corporations when they decide to generate a trial or not. Both standards are present in each of the restrictions. Notice that because the litigation strategy determines the values of τ_H and τ_L we can omit $l_n(t)$. Finally, as an initial condition, we assume that a trial takes place at $t = 1$ with certainty $\widetilde{\tau}(1) = \tau(1) = 1$.

We don't progress much if we try to solve (1) directly. That is why we rewrite it as a dynamic pro-

[49] 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.

graming problem (DDP) in which 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 determined by $p_n(\tau_n + 1) = \Pr[\theta(z+1) = \theta_L \mid \theta(z) = \theta_n]$ 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}. The DPP defines the following system of Bellman equations

$$\upsilon_L = r(s_L, \tau_L) - \delta^{\tau_L} c + \delta^{\tau_L} \left[p_L(\tau_L + 1)\upsilon_L + (1 - p_L(\tau_L + 1))\upsilon_H\right] \tag{6}$$

$$\upsilon_H = r(s_H, \tau_H) - \delta^{\tau_H} c + \delta^{\tau_H} \left[p_H(\tau_H + 1)\upsilon_L + (1 - p_H(\tau_H + 1))\upsilon_H\right] \tag{7}$$

which implies closed form expressions for the expected value of corporations when a trial takes place

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

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

with $\delta_L \equiv \delta^{\tau_L}; \delta_H \equiv \delta^{\tau_H}; p_L \equiv p_L(\tau_L + 1)$ and $p_H \equiv p_H(\tau_H + 1)$. Then, at each trial the court faces the following problem

$$\max_{s_n} \upsilon_n \tag{8}$$

s.t.:

$$\tau_H = \arg\min_{\tau \in \mathbb{N}} \left\{ (1 - \Lambda^\tau) \left((s_H - \theta_L)^2 - (s_L - \theta_L)^2 \right) \geq \frac{fc}{\alpha b W p^*} \right\} \tag{9}$$

$$\tau_L = \arg\min_{\tau \in \mathbb{N}} \left\{ (1 - \Lambda^\tau) \left((\theta_H - s_L)^2 - (\theta_H - s_H)^2 \right) \geq \frac{fc}{\alpha b W (1 - p^*)} \right\} \tag{10}$$

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

In which we have rewritten (3) and (4) as (9) and (10). We end this section establishing a technical result that will prove useful later in the characterization of the solution of (8).

Lemma 1 *υ_n is quasi-concave in τ_n and strictly concave in s_n.*

As with all the mathematical results we prove the lemma in the appendix A.

6 Main Results

In this section we present our main results. First, we show that unlike myopic courts (a court that only cares about the value of current corporations) a forward-looking court does not want to set standards that are optimal for current times but the ones that are optimal for the period of time in which they will rule the affairs of corporations. Second, we show that a forward-looking court does not want to set the standards that society would ideally like to have but it wants to set standards that are biassed towards or against the interests of current litigants. As the court cannot generate trials and the incentives to generate trials for corporations are not the same for society (an externality is present), if the court enforced the first best standards then trials would be generated with an inefficient periodicity. We show that if the externality is positive (society wants a higher frequency of litigation than corporations) then the court sets standards that are closer to the interests of corporations than what society would ideally like to have. If the externality is negative then the court relaxes the first best standards in the opposite direction. Third, we show that, conditional on that the fraction of the litigation costs paid by the corporation and the discount factor are big enough, if the litigation costs are larger than a certain bound then corporations generates trials with a frequency that is too low from the social point of view. In that case, we have certainty that the court would bias the standards in favor of the interests of current litigants.

We solve (8) in three steps. First, we determine the solution of a legal system in which the court is myopic ($\delta = 0$).[50] After this, in a second step we determine the standard and frequency of trials that a central planer would like to impose to the society, that is we determine the first best common law legal system. Finally we solve (8) distinguishing that only the court can enforce the standards while corporations decide when to generate trials. As the solution will turn to be an intermediate case between the myopic and the first best models we will refer to it as the second best solution.

6.1 Myopic Courts

A myopic court[51] adjudicates cases as if it 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. If $\Pi = \{q_0, q_1, \delta, \alpha, b, W, f\}$ is a set of fixed parameters then we have that

Proposition 2 *(Myopic Court) When the court is myopic* ($\delta = 0$) *the unique PBE of (8) is the one in*

[50] 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".

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

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

A myopic court sets standards that perfectly track the state of nature 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 the court wasn't benevolent or didn't act completely informed then the standards would not track nature any more.[52] In addition, 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 (the standard changes according to the state of nature discovered at the trial). That is, myopic judges are activists.[53]

Trials are initiated by the first corporation which incentive constraint becomes active. From the definition of $\tau_n^M(c;\Pi)$ we have that the frequency of litigation increases with the expected value of the corporation ($\alpha b W$) but decreases with the cost of litigation (c). In addition, the longer nature 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). Less obvious we notice that, depending on the cost of litigation, the system has three possible dynamics. For low costs ($c < \min\{c_L^M(\Pi), c_H^M(\Pi)\}$) both standards generate litigation with finite frequency. For intermediate costs ($c \in \left[\min\{c_L^M(\Pi), c_H^M(\Pi)\}, \max\{c_L^M(\Pi), c_H^M(\Pi)\}\right]$), one of the standards becomes an absorbing state, that is, it is never litigated and for high costs ($c > \max\{c_L^M(\Pi), c_H^M(\Pi)\}$) corporations never generate trials. Figure 1 shows the regions in which these dynamics take place.

[52] 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 $s_H^M(e) = e\theta_L + (1-e)\theta_H$.

[53] If judges were originalists, the central role in the reform of the standard would be assumed by legislators.

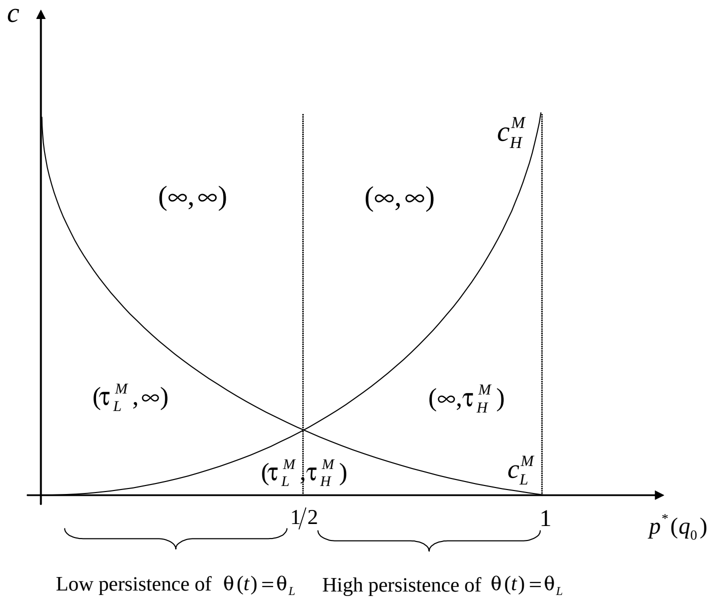


Figure 1. Possible Dynamics in the Myopic Judges model

However, efficiency minded courts are forward looking agents ($\delta > 0$) who take into account the future implications of their adjudications. We show next that there are three essential differences between the considerations made by a forward looking and a myopic court when they have to set a standard. First, a forward looking court internalizes that a new precedent will not only rule the affairs of the current corporations but also of the future ones (the standard will be fixed during a period of time in which nature evolves). Second, it internalizes that for almost any cost of litigation and standard, corporations don't want to generate an optimal frequency of litigation (corporations don't realize that the improvement of the standard generates benefits for the whole society nor that they don't pay the totality of the litigation expenses) and third it internalizes that its enforcement strategy will affect the litigation strategies of corporations.

6.2 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 nature 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 first best common law legal system.

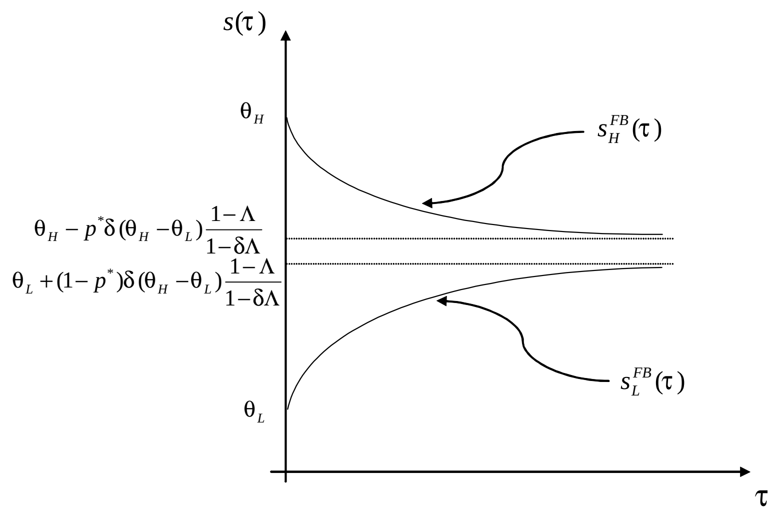
6.2.1 First Best Standards

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 the corporations during the τ_n periods in which the standard will be in place (the $\tau-$periods return functions). That is

$$s_H^{FB}(\tau_H) = (p^* - A_H(\tau_H))\,\theta_L + (1 - p^* + A_H(\tau_H))\,\theta_H \tag{11}$$

$$s_L^{FB}(\tau_L) = (p^* + A_L(\tau_L))\,\theta_L + (1 - p^* - A_L(\tau_L))\,\theta_H \tag{12}$$

with $A_H(\tau_H) = p^* \frac{1-\delta}{1-\delta\Lambda}\frac{1-(\delta\Lambda)^{\tau_H}}{1-\delta^{\tau_H}}$ and $A_L(\tau_L) = (1-p^*)\frac{1-\delta}{1-\delta\Lambda}\frac{1-(\delta\Lambda)^{\tau_L}}{1-\delta^{\tau_L}}$. A central planner doesn't want to set standards that track nature anymore. Given that they will regulate the affairs of corporations for τ_n periods the optimum is to set combinations of both states of nature. Figure 2 shows (11) and (12).



The higher the frequencies of litigation, the smaller the social discount factor or the higher the persistence of nature the closer the first best standards to the true states of nature. The intuition is direct. The longer the time in which a standard is in place, the higher the discounted value of future corporations or the more likely that nature will evolve the more relevant is that the standard is a good regulator for the future states of nature (or for the state of nature that was not revealed at the trial). In particular, each of these relations define an extreme case in which a forward-looking court sets the same standards (for both states) that a myopic judge. That happens when: i) trials take place every period; ii) judges are extremely impatient or

iii) nature doesn't evolve. The next proposition formalizes these considerations

Proposition 3 *(In general, first best standards don't track nature) 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 nature at the corresponding state* (p^* *in the case of* θ_L *and* $1 - p^*$ *in the case of* θ_H) *or the lower the social discount factor* (δ) *the closer the first best standards to the myopic standards.*

The main message behind proposition 3 is that, in general, society does not want courts to resolve disputes in the best interest of the litigating parties. It is important to notice that, although we derived this result in the context of corporate law, it can be easily replicated in the contexts of other branches of the law (like bankruptcy or antitrust.) For example, it is easy to argue that the intervention of bankruptcy courts to block the liquidation of the distressed nineteenth-century US railroads in order to protect other private economic activities in *Wabash Railway Company*[54] was rather a myopic instead of a forward-looking decision because the courts did not take into account that they were setting a standard that, applied to future and broader cases, was too "debtor friendly". In addition, the result does not only apply to case law but statutory law as well. Like courts, legislative agencies should take into account dynamic considerations when they enact new rules. Speed limits are a simple example. If we assume that the essential trade-off to decide a new limit is to reduce the length of a trip without jeopardizing the safety of the passengers and we notice that with time, *ceteris paribus*, technology should be able to reduce the likelihood of an accident (for example the quality of highways and the safety of automobiles will probably rise), then proposition 3 suggests that a legislator should set a speed limit that is higher than the optimum for current times.

6.2.2 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. Then, 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 corporations would want to have them? In their decisions to initiate trials, corporations don't take into account two externalities. First, a sentence of the court that improves the law not only benefits current corporations but future ones. We call this externality "inter-temporal". Second, the costs paid by a single corporation don't cover the totality of the expenses generated in a litigation. We call this externality "contemporaneous". In addition, the inter-temporal externality can

[54] Wabash, St. L. & P. Ry. Co. v. Central Trust Co. of New York and others, Circuit Court, N.D. Ohio, W.D. June, 1884 (Federal Reporter, 22).

be decomposed in a cost and value effect. The first one refers to the change in the litigation costs paid by future corporations because a trial takes place this period instead of the next one while the second one refers to the change in the value of future corporations due to the same reason.

First we show that the inter-temporal externality is always positive. 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.

The optimal value of all corporations can be expressed as follows[55]

$$\upsilon(s_n, p_n) = \upsilon_n(p) = \max \left\{ V(s_n, p) + \delta \upsilon_n(p^+), \left[\begin{array}{c} pV(s_L, 1) + (1-p)V(s_H, 0) - c \\ +\delta\left(p\upsilon_L(q_1) + (1-p)\upsilon_H(q_0)\right) \end{array} \right] \right\} \tag{13}$$

That is, at every period a court decides if it is more efficient to preserve the current standard or generate a trial to verify whether the standard should be modified. The functions in (13) 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

$$(1-\overline{p})\left(V(s_H, 0) - V(s_L, 0)\right) = fc + (1-f)c + \underbrace{\delta\left[\upsilon_L(\overline{p}^+) - \left(\overline{p}\upsilon_L(q_1) + (1-\overline{p})\upsilon_H(q_0)\right)\right]}_{\Sigma_L} \tag{14}$$

and

$$\underline{p}(V(s_L, 1) - V(s_H, 1)) = fc + (1-f)c + \underbrace{\delta\left[\upsilon_H(\underline{p}^+) - \left(\underline{p}\upsilon_L(q_1) + (1-\underline{p})\upsilon_H(q_0)\right)\right]}_{\Sigma_H} \tag{15}$$

We notice that the difference in the problems faced by a single corporation and the society when they have to reform the standard s_n is given by $E_n(c, \Pi) = (1-f)c + \Sigma_n$ (compare (14) and (15) with (3) and (4)). The first expression corresponds to the contemporaneous externality while the second one to the inter-temporal externality. Then, we are able to show that[56]

Lemma 4 *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 $\Sigma_n \leq 0$.*

[55] Problem (1) can be writen as a dynamic programming problem slightly different from DPP in which the state variables are the beliefs of the agents and the current standard, the control variable is the innovation i_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.

[56] The result is not conditional on $s_L \leq \frac{\theta_L + \theta_H}{2} \leq s_H$. We impose this relation to take into account that we are not restricting p^*. We already saw in proposition 3 that the standard is determined by the stationary probability. If we don't impose this restriction we can generate shapes of the value function that will never be optimal.

The formal proof of the lemma rests on the fact that $v_n(p)$ are convex functions.[57] As usual, the details can be found in the 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 $v(\tau) = \frac{r(\tau)-\delta^\tau c}{1-\delta^\tau}$). Then, we can rewrite (14) as[58]

$$(1-p(\tau))\left(V(s_H,0)-V(s_L,0)\right) < fc+(1-f)c-\delta c+\sum_{i=2}^{\tau}\delta^{i-1}\left(V(s_L,p_L(i))-V(s_L,p_L(i+1))\right)$$

the period before an innovation takes place and as

$$(1-p(\tau+1))\left(V(s_H,0)-V(s_L,0)\right) > fc+(1-f)c\underbrace{-\delta c}_{CE(c)}+\underbrace{\sum_{i=2}^{\tau+1}\delta^{i-1}\left(V(s_L,p_L(i))-V(s_L,p_L(i+1))\right)}_{VE(W)}$$

the period in which it does. We notice that $\Sigma_L = CE(c) + VE(W)$ where the first expression corresponds to the cost effect while the second one corresponds to the value effect of the inter-temporal externality. The first effect tells us that if a trial takes place today instead of tomorrow then future corporations save the cost of the first trial in the cycle, while the second effect tells us that if an innovation takes place today instead of tomorrow then future corporations don't increase their value as much as if the update of the law would have taken place in the next period. 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! The importance of lemma 4 is that it tells us that, at the optimum, the inter-temporal externality is always positive (society wants to have more trials than corporations). Nevertheless, there is a second externality, this time negative, that a single corporation doesn't internalize at the moment it decides whether to generate a trial or not, that is, the cost faced by the other litigating party $(1-f)c$. A priory it is not clear which of these externalities dominates. The next proposition, summarizes these considerations

Proposition 5 *(Inefficient frequency of trials) For any standards s_L and s_H such that $s_L \leq \frac{\theta_L+\theta_H}{2} \leq s_H$*

[57] The formal proof of the Lemma requires to show existence and uniqueness of (13). The analysis closely follows Harris and Holmstrom [1987]. The novelty which makes our problem more challenging is that the function

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

can be discontinuous at p^*.

[58] The analysis for (15) is equivalent.

and cost of litigation $c > 0$ if $E_n(c, \Pi) < (>) 0$ 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 result to the end of the Section. At this point, it is direct to notice that if the private and social costs of litigation are the same then unambiguously the society wants a higher frequency of litigation than corporations.

Corollary 6 *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.*

6.2.3 Optimal Common Law Legal System

A central planer decides the optimal standard and the optimal frequency of litigation for each state of nature

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

$$s_L, s_H \in [0,1]\,; \tau_L, \tau_H \in \mathbb{N}$$

Although now the standards are functions of the frequencies of litigation, the solution of (16) is already characterized in the former analysis and summarized in the next proposition

Proposition 7 *(First Best) When a central planer is able to generate trials and enforce standards, the unique solution of (16) is the one in which the standards are $s_H^{FB}(\tau_H^{FB})$ and $s_L^{FB}(\tau_L^{FB})$ with τ_L^{FB} and τ_H^{FB} implicitly defined by the system*

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

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 exist costs of litigation $\{c_L^{FB}(\Pi), c_H^{FB}(\Pi)\}$ beyond which a central planer would prefer not to litigate because it is too expensive. 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. In addition, as in the myopic model, the frequency with which one standard is litigated decreases with the cost of litigation (proportional to the value of a corporation) and decreases with the persistence of nature at the corresponding state. These results are summarized in the next corollaries

Corollary 8 *If $c_n^c(\Pi)$ 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 $E_n(c_n^{FB}(\Pi), \Pi) < 0$ then there exists a range of costs $c : \left(c_n^c(\Pi), c_n^{FB}(\Pi)\right)$ in which society wants to have trials but corporations don't and if $E_n(c_n^{FB}(\Pi), \Pi) > 0$ then there exists a range of costs $c : \left(c_n^{FB}(\Pi), c_n^c(\Pi)\right)$ in which society doesn't want trials but corporations will generate them.*

Corollary 9 *The frequency with which a standard is litigated decreases with c, increases with αbW, is inversely related to the time in which nature is at the corresponding state and is inversely related to the expected value of all corporations when the court enforces this standard.*

In this part of the paper we determined the enforcement and litigation strategies that a central planer would like to impose in society. However, in reality corporations and not courts initiate trials. Given the differences between the private and social incentives to generate litigation, should courts set the first best standards? If not, what standards should they set?

6.3 Forward-looking Courts

Forward looking courts face a fundamental trade off in their role as rule makers. 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 incentives to increase or decrease the frequency of litigation.

Next, we show that if the aggregate externality associated with the generation of trials is positive then, in order to encourage litigation, a forward-looking and time consistent court sets rules that are closer to the preferences of corporations than the first-best rules. If the externality is negative then it acts in the opposite way. Notice first that if we take into account the integer constraints then the second best periodicities of litigation are defined by

$$\tau_H^{SB}(s_L, s_H) = \left\lfloor \frac{\ln[1 - \frac{fc}{\alpha bWp^*(s_H - s_L)(s_H + s_L - 2\theta_L)}]}{\ln \Lambda} \right\rfloor + 1 \tag{17}$$

$$\tau_L^{SB}(s_L, s_H) = \left\lfloor \frac{\ln[1 - \frac{fc}{\alpha bW(1-p^*)(s_H - s_L)(2\theta_H - (s_H + s_L))}]}{\ln \Lambda} \right\rfloor + 1 \tag{18}$$

which means that they satisfy the following property

Lemma 10 *For any standards $s_L, s_H \in [\theta_L, \theta_H]$ the periodicities of litigation τ_H^{SB} and τ_L^{SB} are decreasing functions in s_H and increasing functions in s_L. In particular, both expressions achieve their minimum values when $s_L = \theta_L$ and $s_H = \theta_H$.*

The Lemma tells us that for any cost of litigation, the frequency of trials decreases with the distance between the standard and the state of nature.[59] The reason is that the closer the value of the standard to the true state of nature the higher the expected value of a corporation when nature is at this state and the lower the expected value when nature is at the opposite state.

Although we cannot explicitly derive the solution of (8) we are able to show that it is unique. At first view it may seem that the problem has two Nash equilibria. One of low frequency of litigation and another of high frequency of litigation. Nevertheless there is a unique pair of standards that maximizes the expected value of all corporations. 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. As whenever the court set standards, through the incentive constraints, it 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 a court sets the frequency of litigations. Then, the Contract Mapping Theorem assures the existence of a unique solution. The next proposition formalizes the argument

Proposition 11 *(Second Best) When corporations generate trials and the time-consistent court enforces the standard, the unique solution of (8) is a NE in which standards are given by $s_n^{SB}(\tau_L^{SB}, \tau_H^{SB}) = \left\{ \arg\max_{s_n} \upsilon_n \left(\tau_L^{SB}, \tau_H^{SB}\right) \mid (s_n^{SB}, \tau_n^{SB}) \text{ satisfy (9) and (10)} \right\}$ and the periodicities of litigation τ_H^{SB} and τ_L^{SB} are implicitly defined by the system*

$$(\tau_H^{SB}, \tau_L^{SB}) = \arg\min_{\tau_L, \tau_H \in \mathbb{N}} \left\{ \begin{array}{l} \frac{\Delta \upsilon_L}{\Delta \tau_L} + \frac{\Delta \upsilon_L}{\Delta s_L^{SB}} \frac{\Delta s_L^{SB}}{\Delta \tau_L} + \frac{\Delta \upsilon_L}{\Delta \tau_H} \frac{\Delta \tau_H}{\Delta \tau_L} \geq 0 \\ \frac{\Delta \upsilon_H}{\Delta \tau_H} + \frac{\Delta \upsilon_H}{\Delta s_H^{SB}} \frac{\Delta s_H^{SB}}{\Delta \tau_H} + \frac{\Delta \upsilon_H}{\Delta \tau_L} \frac{\Delta \tau_L}{\Delta \tau_H} \geq 0 \end{array} \right\}$$

Notice that 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

[59] Hence, for any cost c, the standards set by myopic judges maximize the frequency of litigation.

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.

Given the uniqueness of the solution we only need to determine whether that is the one of high or low frequency of litigation. But that is direct from lemma 10. As it is shown in figures 3a and 3b, if the externality associated with the generation of a trial is positive then, in order to increase their frequency, the court sets standards that are closer to the states of nature than the first best rules (for example $s_1^{SB} < s^{FB}$ when the standard is L). If the externality is negative, the court sets standards that are further away from the states of nature (for example $s_2^{SB} > s^{FB}$ when the standard is L).

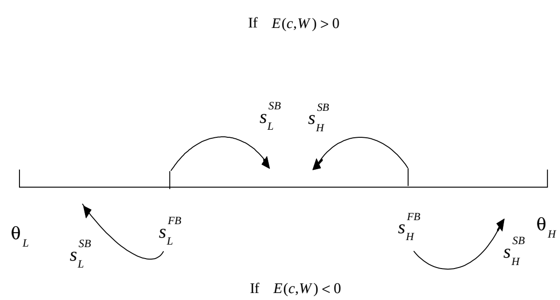


Figure 3a. How to set the second best standards

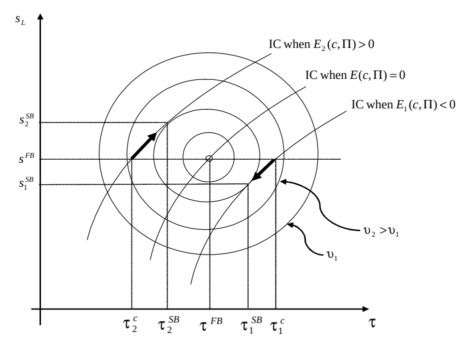


Figure 3b. How to set the second best standards (symmetric model)

It is true that society faces a cost when the court distorts the standards but unless the aggregate externality is zero, the first best standards are not the constrained optimum. Hence society will be better off if the standards are distorted. The question is in which direction. The answer is that the court prefers to distort the standards in order to decrease, and not increase, the inefficiency in the frequency of litigation. It follows directly that the second best frequencies of litigation are intermediate values between the first best frequencies and the frequencies that corporations would have wanted to generate if the first best standards had been enforced ($\tau_1^{SB} \in \left[\tau^{FB}, \tau_1^c\right]$ and $\tau_2^{SB} \in \left[\tau_2^c, \tau^{FB}\right]$). The next proposition formalizes the discussion

Proposition 12 *(The first best standards are biassed) In order to correct the suboptimal frequency with which trials are generated the court sets standards closer to (further away from) the interest of corporations than what society would ideally want to set if and only if* $E_n(c, \Pi) < (>) 0$.

6.4 Too many or too few trials?

The last proposition tells us 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 that case more likely to happen? It is easy to see that the contemporaneous externality decreases with f while the inter-temporal externality increases with δ. The bigger is the fraction of the total costs paid by the current corporation or the higher is the value of future corporations the more likely is that the frequency of trials will be too low from the social point of view. Interestingly, the fact that corporations 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 these last ones face the totality of the litigation expenses ($f = 1$) tell us that there always exists a cut-off value of 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. Formally

Proposition 13 *(Bound of the private costs of litigation) For all* (Π, c) *there exists* $\overline{f}_n \in [0,1]$ *such that* $E_n(c,\Pi) = 0$*. In particular, if* $p^* = \frac{1}{2}$ *then* $\overline{f}_L = \overline{f}_H = \min\left[\frac{\alpha bW(\theta_H-\theta_L)^2}{4c}\frac{1-\delta}{1-\delta\Lambda}\frac{1-(\delta\Lambda)^{\tau^{FB}}}{(1-\delta^{\tau^{FB}})(1-\Lambda^{\tau^{FB}})}, 1\right]$.

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 his analysis was developed in the static context of tort litigation and the subsidy or the tax that should be imposed cannot be estimated empirically because it depends on the effect that *effort* (made by the parties) will have in the deterrence of future accidents. Here we not only retrieve Shavell's result in a dynamic context but we provide estimable expressions for the expenses that should be paid by each party.

It is also easy to see that the private and social frequencies of litigation decrease with c. The less intuitive result is that, conditional on 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 they decide if they want to generate a new trial society considers a marginal cost of litigation of $(1-\delta)c$. Unlike a corporation that faces a one-shot game, the court decides whether society will be better off if trials take place every τ instead of $\tau + 1$ periods and takes into account that if a trial takes place today then society saves the cost of facing a trial tomorrow (δc). Hence, in the case that $f > 1 - \delta$ 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. 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. The result is formalized in the next proposition.

Proposition 14 *(Bound of the social costs of litigation) If $p^* = \frac{1}{2}$ and $f > 1 - \delta$ then there exists $\bar{c}$ such that for all $c > \bar{c}$ litigation is too infrequent and courts bias the standards in favor of the interests of current litigants.*

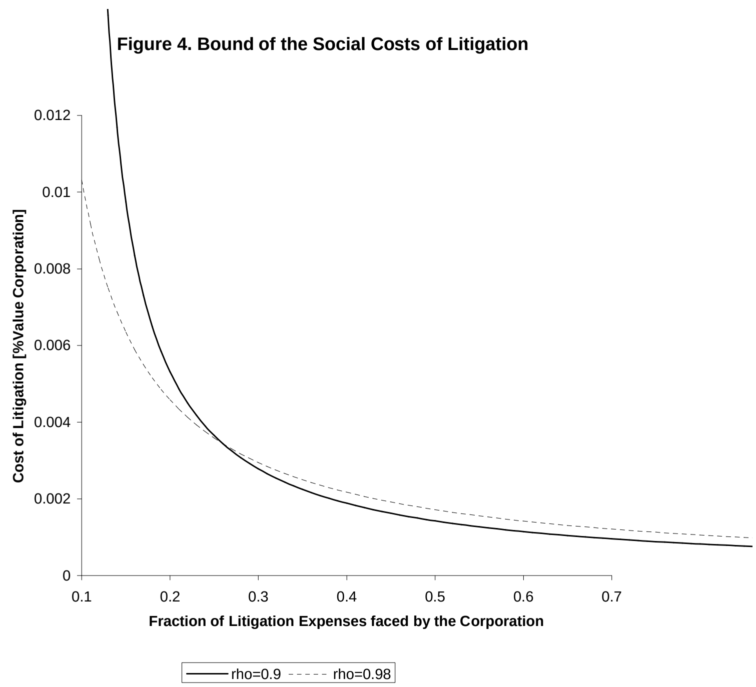
Proposition 14 not only is counterintuitive but also contrasts with Shavell [1999] in which a high cost of trial invariably increases the probability that litigation would be excessive. What is different in his model, compared to ours, is that the social cost of litigation does not have an inter-temporal effect in the externality generated by a new precedent.[60]

6.5 Calibrated Simulations

We end this Section presenting results of calibrated simulations that provide an estimation of the order of magnitude of the value of $\bar{c}$ and show the sensitivity of the second best standards with respect to the litigation expenses. We use data of Mergers and Acquisitions of corporations listed either in Nasdaq or NYSE that took place between 1978 and 2004 (in the appendix B we detail the way and sources in which we calibrate each of the parameters of the model). We calibrate nature as the probability with which an acquiring corporation was delisted from these markets due to financial distress within two years after the acquisition took place. After this we identify years in which this probability was either high ($\theta_H = 0.1$) or low ($\theta_H = 0.05$). We summarize our results in two graphs. In figure 4 we present the evolution of $\bar{c}$ as a

[60] Although the result is derived for the particular case of the symmetric model, we believe that it should hold for the general case.

function of the fraction of the litigation costs paid by the corporation f when δ takes the values 0.9 and 0.98.

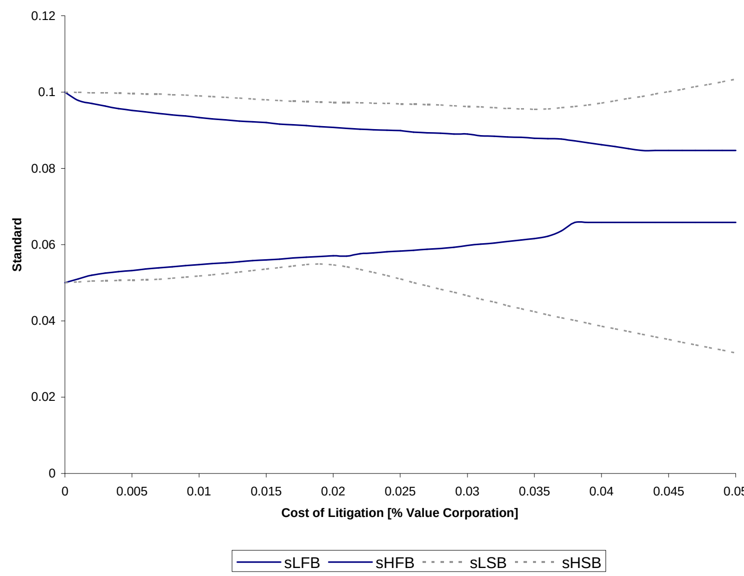


First we notice that unless the social cost of litigation is very low the inter-temporal externality dominates the contemporaneous one and consequently corporations generate too few trials. The value of $\overline{c}$ turns to move in the interval $[0.0007, 0.06]\,\%$. In particular, when $\delta = 0.9$ and $f = 0.5$ the bound is equal to 0.0016. We notice that the fact that $\overline{c}$ is small is robust to the value of δ.[61] In addition, figure 4 tells us that the bound decreases with the fraction of costs paid by the corporation (equivalently, $\overline{f}$ decreases with c, see

[61] We don't modify the value of δ more drastically in order to preserve $f + \delta > 1$.

figure 2B in the appendix).

Figure 5. First and Second Best Standards



In figure 5 we compare the evolution of the second best standards to the first best ones as functions of the litigation costs. Given the range of values of $\bar{c}$ we generate our simulations when $c \in [0, 0.05]$ (as percentage of the value of the corporation). The figure tells us that the second best standards are not monotonic in the cost of litigation. For small costs of litigation the second best standards get closer to the first best levels but for high costs of litigation they get closer to the true states of nature. The reason is that the difference in the frequency of trials desired by corporations and society increases with the cost of litigation (see figure 1B in the appendix.) Consequently, the bigger these costs the larger the required bias of the standards to give incentives to the corporations to litigate more frequently.

6.6 Commenting the Results

Our model provides a tractable framework that characterizes how courts should set standards in a dynamic setting. The model tells us that forward-looking courts should set the rules that are optimal for the expected time in which they will regulate the affairs of society. The model also uncovers a fundamental relation between dynamically optimal rules and the frequency with which trials take place. Taking into account that the social and private incentives to litigate are not the same and trials cannot be initiated when society needs them, in absence of alternative policy instruments courts should bias the first best rules towards the interests of current litigants whenever the frequency of trials is too low but against them whenever this same frequency is too high.

Additionally, the model generates three predictions related to the frequency of litigation. First, from an ex-ante point of view, legislators can always induce an efficient frequency of trials if they optimally distribute the litigating expenses among the parties. Second, contrary to the belief that judges should be either activists or originalists, the model predicts that they should adjust their level of activism to the frequency of litigation. 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 if that is inexpensive. Third, it is very likely that in branches of the law in which litigation is (relatively) inexpensive society faces an excess of trials, but in branches in which litigation is expensive it faces a lack of litigation!

Finally, we notice that we are able to retrieve the results derived by Franks and Sussman when we impose $f = 1$. Under this last condition, the frequency of trials is suboptimally low, when the costs of litigation are high enough the standards get locked-in for long periods of time, the second best standards over- and under-shoot the first best levels and we are able to explain why the law could be biased toward the interests of one of the parties in dispute (the one that was favored when courts set first precedents.)

7 Robustness and Extensions

In this section we briefly comment on the robustness of the results.[62] 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 show that the deliberate addition of indeterminacy to the law[63] with the intention to generate more legal disputes[64] decreases social welfare and we show that the capacity of agencies like the Securities and Exchange Commission to generate trials can bias the frequency of litigation toward excess.

[62] This analysis was developed in detail in a previous version of the current paper.
[63] For example through the enactment of ambiguous rules.
[64] Legal scholars (e.g. Bebchuk and Ferrell [1999]) consider that this is the case in Delaware Corporate Law.

7.1 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 don't track nature. This is not the case: the majority of distributions imply that the $\tau-$periods return functions are not maximized by corner solutions.[65] In addition, even if the first best standards track nature, the difference between the social and private incentives to generate trials would still imply that the first best standards will not be enforced. 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 nature 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 nature before.[66] Regardless of this new interpretation the main results (propositions 3 and 12 to 14) 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[67] 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

[65] 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.

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

$$\begin{aligned} v_n = r_n + &\left[z \sum_{i=1}^{\tau_n} ((1 - zb)\delta)^{i-1} \left[p_n(i) v_L + (1 - p_n(i)) (v_H - cb) \right] \right] \\ &+ \delta^{\tau_n} \left[p_n(\tau_n + 1) v_L + (1 - p_n(\tau_n + 1)) v_H - c \right] \end{aligned}$$

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.

[67] The value function becomes

$$v_n = r_n - \delta^{\tau_n} \left[\begin{array}{c} (1 - b) \sum_{i=0}^{\infty} ((1 - b)\delta)^i W + \\ b \sum_{i=0}^{\infty} ((1 - b)\delta)^i \left[p_n(\tau_L + 1 + i) v_L + (1 - p_n(\tau_L + 1 + i)) v_H - c \right] \end{array} \right]$$

where r_n is as in our basic framework.

standards that are closer to the first best levels than a committed court. The reason is that a non-commited court does not take into account the welfare effect that its decision to set a new standard will have in the cycles in which the alternative standard will be in place.[68]

7.2 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.[69] First, broader and flexible instead of bright-line and narrow rules adapt better to the constant changes in nature (corporations and also courts have more discretion to interpret the rule).[70] For example, as described by Yablon [1989], Delaware courts have clearly stated what kind of Poison Pills are legal[71] but they have not clearly stated when managers should redeem[72] them. Given that flexibility corporations would be able to condition the redemption of the Pill on the type of the business opportunity that is being offered. 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

[68] A court that deviates one period solves

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

and

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

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

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

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

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

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

[69] 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.

[70] 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.

[71] 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 *Mentor* (728 A.2d 25, 1998) respectively.

[72] The pill becomes void.

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 trials take place with a probability endogenously determined.[73] 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.[74] 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.[75]

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 approach 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 $\upsilon_n(p)$ becomes

$$\upsilon_n(p) = \max \left\{ \begin{array}{c} (1-\phi)(V(s_n, p) + \delta \upsilon_n(p^+)) + \phi \left[\begin{array}{c} (pV(s_L, 1) + (1-p)V(s_H, 0) - c \\ +\delta \left(p\upsilon_L(q_1) + (1-p)\upsilon_H(q_0) \right) \end{array} \right], \\ pV(s_L, 1) + (1-p)V(s_H, 0) - c + \delta \left(p\upsilon_L(q_1) + (1-p)\upsilon_H(q_0) \right) \end{array} \right\} \tag{19}$$

while the value function υ becomes[76]

$$\upsilon = \frac{r(\phi, \tau) - H(\phi, \delta, \tau)c}{1 - H(\phi, \delta, \tau)} \tag{20}$$

[73] 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 the appendix C) 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.

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

[75] 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.

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

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

and

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

with $r(\phi,\tau) = (1-\phi)\sum_{i=1}^{\tau}((1-\phi)\delta)^{i-1} V(s_n,p)$ 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, (19) 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 (20) 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 15 *(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 $\frac{\partial \tau^{SB}}{\partial \phi} > 0$.*

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 in the appendix D we show a numerical example in which for a certain (Π, c) it exists β such that society will prefer to have a strictly positive level of uncertainty.

7.3 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 scandals of Enron and WorldCom. 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. We show that if the agency is worse informed than corporations about nature or the characteristics of the same corporations[77] 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.[78] If the frequency of trial is suboptimally low, the agency can help correct the inefficiency but it can also make it worse. At the end, the desirability of the intervention of these type of agencies will be a function of the quality of their information.

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.[79] 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.[80] 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.

[77] 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

[78] See Shavell [1997] for other suggestions.

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

[80] 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.

8 Conclusions

In this paper we developed a theoretical framework that describes why, when and how courts should reform legal rules in a dynamic setting. 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 nature 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 then 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 many avenues of future research. At the empirical level, work is needed to determine whether courts are better described as myopic or forward-looking agents,[81] 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,[82] to determine the way in which courts should react to transitory shocks in the state of nature, the optimal combination of general and specific rules and the optimal degree with which courts should follow precedents. The sooner we are able to understand the rule-making role of courts in all its complexity the sooner we will be able to help them provide society with an efficient law.

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

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

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

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

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

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

[7] 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.

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

[9] Bertsekas, D. [1995] *Dynmic Programming and Optimal Control,* Belmont, Mass.: Athena Scientific.

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

[11] 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.

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

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

[14] 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.

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

[16] 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.

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

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

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

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

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

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

[23] 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.

[24] 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.

[25] Harris, M. [1987] *Dynamic Economic Analysis,* Oxford University Press.

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

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

[28] Kamar, E. [1998] "A Regulatory Compatition Theory of Indeterminacy in Corporate Law", *Columbia Law Review* **98**, 1908-1962.

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

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

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

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

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

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

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

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

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

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

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

[40] Reis, R. [2004] "Inattentive Consumers", NBER working paper 10883.

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

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

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

[44] 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.

[45] 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.

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

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

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

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

[50] Skeel, D. [2005] *Icarus in the Boardroom,* Oxford University Press.

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

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

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

Appendix

Appendix A: Mathematical Proofs

Proof of Lemma 1 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[83] 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.[84] 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 $\Psi(\tau) = (1 - (\delta\Lambda)^\tau)\ln\delta - (1-\delta^\tau)\Lambda^\tau \ln(\delta\Lambda) \leq 0, \forall\tau$ (as $\Psi(0) = 0$ and $\frac{\partial\Psi(\tau)}{\partial\tau} = \ln\Lambda\ln(\delta\Lambda)(\delta^\tau - 1)\Lambda^\tau \leq 0$). Then $\frac{\partial z_n}{\partial \tau_n} \geq 0 \Longleftrightarrow \tau_n \leq \widehat{\tau}_n$ in which $\widehat{\tau}_n$ is defined as follows[85]

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

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 it exists $\widetilde{\tau}_n > \widehat{\tau}_n$ such that $\frac{\partial^2 z_n}{\partial \tau_n^2} < 0, \forall\tau_n \leq \widetilde{\tau}_n$ 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 $r_n(\infty)$. 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,

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

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

[84] 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 $g(x_1) \geq g(x_0)$ and $\lambda \in [0,1]$ we have that: If $x_1 \geq x_0$ then directly $h(\lambda x_0 + (1-\lambda)x_1)u(\lambda x_0 + (1-\lambda)x_1) \geq h(x_0)u(x_0)$ and if $x_1 < x_0$ (as it exists x^* such that $h'(x)u(x) + h(x)u'(x) > 0 \Longleftrightarrow x < x^*$) 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 $y = \lambda x_0 + (1-\lambda)x_1$.

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

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 $\frac{\partial \upsilon_n}{\partial s_n} \geq 0 \Longleftrightarrow s_n \leq s_n^{FB}(\tau_n)$ 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 2 The problem faced by a myopic court is

$$\max_{s_n} \left[U(s_n, \theta_n)\right]$$

which is equivalent to

$$\max_{s_n} \left[\widetilde{W} - b\alpha W(s_n - \theta_n)^2\right] \Longrightarrow s_n^M = \theta_n$$

If we relax the integer constraint then the frequency of innovation when the standard is s_H is determined by

$$p_H(\tau+1)(V(s_L, 1) - V(s_H, 1)) = lc$$
$$p_H(\tau+1) b\alpha W((s_H^M - \theta_L)^2 - (s_L^M - \theta_L)^2) = lc$$
$$p^* b\alpha W(1 - \Lambda^\tau)(\theta_H - \theta_L)^2 = lc$$
$$\Longrightarrow \tau = \frac{\ln\left(1 - \frac{fc}{p^* b\alpha W(\theta_H - \theta_L)^2}\right)}{\ln \Lambda}$$

And if we take into account the integer constraint ($\lfloor x \rfloor$ is the maximum integer smaller than or equal to $x \in \mathbb{R}$) then

$$\tau_H^M = \left\lfloor \frac{\ln\left(1 - \frac{fc}{p^* b\alpha W(\theta_H - \theta_L)^2}\right)}{\ln \Lambda} \right\rfloor + 1$$

Proceeding in the same way for τ_L^M we get that

$$\tau_L^M = \left\lfloor \frac{\ln\left(1 - \frac{fc}{(1-p^*) b\alpha W(\theta_H - \theta_L)^2}\right)}{\ln \Lambda} \right\rfloor + 1$$

Notice that for any Π there exist costs of litigation beyond which innovations never take place, that is $\tau_n^M = \infty$. As $\lim\limits_{c \to c_n^M(\Pi)} \ln\left(1 - \frac{c}{c_n^M(\Pi)}\right) = -\infty$, it is clear that these limits are given by $c_L^M(\Pi)$ and $c_H^M(\Pi)$ ■.

Proof of Proposition 3 It is easy to see that

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

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 show that $A_L(\tau_L)$ and $A_H(\tau_H)$ are decreasing in τ_L and τ_H respectively which is equivalent to show that $(1 - (\delta\Lambda)^\tau) / (1 - \delta^\tau)$ is decreasing in

τ. We see that this is the case because

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

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 show 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

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

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 4 In order to show that when society wants a finite frequency of litigation the intertemporal externality is never negative we proceed in two steps. First we prove existence and uniqueness of (13) and then we prove that $\Sigma_n \leq 0$.

Existence and Uniqueness

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

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

in which $W_1(p) = \begin{cases} V(s_H,p) & \text{if} \quad p\in[0,p^{*}] \\ V(s_L,p) & \text{if} \quad p\in[p^{*},1]\end{cases}$ 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 $\upsilon(p)$ 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 [87] or Bertzekas [95]) 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 $\upsilon(p;s_L,s_H,c,\Pi)$ (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

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

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

- From (A1) it follows that $c-\delta\left[p^{*}\upsilon(q_1;c)+(1-p^{*})\upsilon(q_0;c)\right]$ 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 $\upsilon(1) > \upsilon(0) \Longleftrightarrow p^* > 1/2$.

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 $\upsilon(p)$ satisfies the following four properties.

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

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

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.

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

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

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

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

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

$$\upsilon(p) = \begin{cases} V(s_H, p) + \delta\upsilon(p^+) & \text{if} \quad p < \underline{p} \\ W_2(p) - c + \delta\left[p\upsilon(q_1) + (1-p)\upsilon(q_0)\right] & \text{if} \quad p \in \left[\underline{p}, p^*\right] \\ V(s_L, p) + \delta\upsilon(p^+) & \text{if} \quad p > p^* \end{cases} \tag{A5}$$

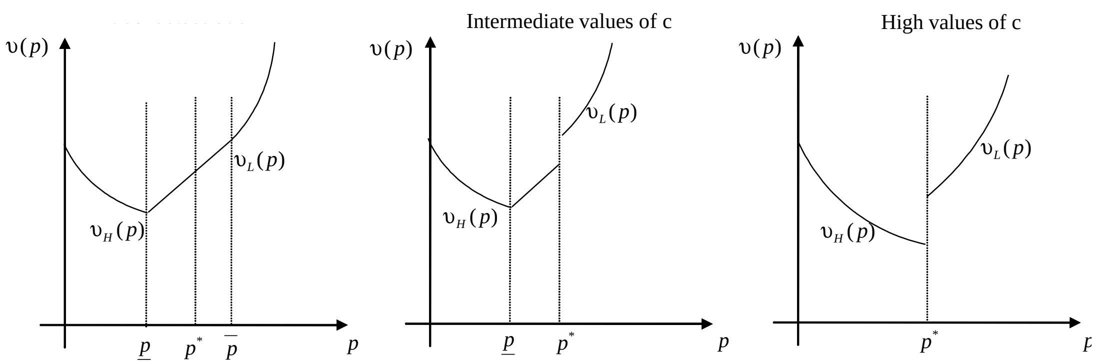
in which $\upsilon(p)$ is decreasing for all $p \leq \underline{p}$, increasing for all $p > \overline{p}$ and not necessarily continuous at p^*.

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

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

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 $p^* > 1/2$)



■.

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

This part follows directly from the former characterization of the value function $\upsilon(p)$. We assume that $p^* > 1/2$ (the analysis for $p^* < 1/2$ is symmetric) which implies that $c_L^{FB} < c_H^{FB}$. If $c < c_L^{FB}$ the value function $\upsilon(p)$ is continuous and convex from where by definition it is true that $\Sigma_L = \upsilon_L(\overline{p}q_1 + (1-\overline{p})q_0) - (\overline{p}\upsilon_L(q_1) + (1-\overline{p})\upsilon_H(q_0)) < 0$ and $\Sigma_H = \upsilon_H(\underline{p}q_1 + (1-\underline{p})q_0) - \left(\underline{p}\upsilon_L(q_1) + (1-\underline{p})\upsilon_H(q_0)\right) < 0$. If $c \in \left(c_L^{FB}, c_H^{FB}\right)$ 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

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

which is equal to

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

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

Proof of Proposition 5 As

$$\left(1 - \overline{p}^c\right)\left(V(s_H, 0) - V(s_L, 0)\right) = fc$$

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

while

$$\left(1 - \overline{p}^{FB}\right)\left(V(s_H, 0) - V(s_L, 0)\right) = fc + E_L(c, \Pi)$$

$$\underline{p}^{FB}(V(s_L,1)-V(s_H,1)) = fc + E_H(c,\Pi)$$

we have that

$$\overline{p}^c < \overline{p}^{FB} \Longleftrightarrow E_L(c,\Pi) < 0$$

$$\underline{p}^c > \underline{p}^{FB} \Longleftrightarrow E_H(c,\Pi) < 0$$

which means that society wants a higher frequency of litigation than corporations only if the aggregate externality is positive ■.

Proof of Corollary 6 The result follows from proposition 5 after we notice that when $f = 1$ the contemporaneous externality is 0 and $E_n(c,\Pi) = \Sigma_n \leq 0$ ■.

Proof of Proposition 7 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 υ 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

$$\upsilon_L = r(s_L^{FB}(\tau_L),\tau_L) - \delta_L c + \delta_L \left[p_L\upsilon_L + (1-p_L)\upsilon_H\right]$$

$$\upsilon_H = r(s_H^{FB}(\tau_H),\tau_H) - \delta_H c + \delta_H \left[p_H\upsilon_L + (1-p_H)\upsilon_H\right]$$

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

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

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

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

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

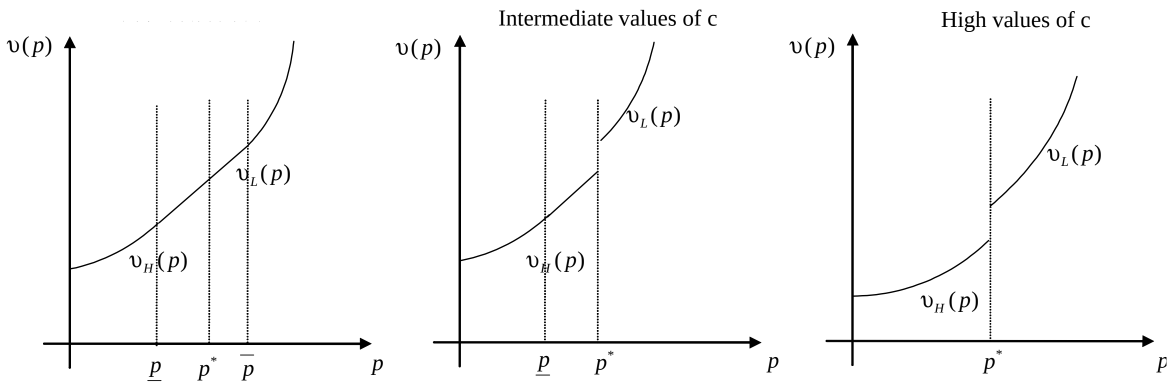
Uniqueness

As in Lemma 4, the uniqueness of $\upsilon(p)$ 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 4. 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 $W_2(p) + \delta\left[p\upsilon(q_1) + (1-p)\upsilon(q_0)\right]$ is increasing in p if and only if $p^* > 1/2$ that is because $\upsilon(1) > \upsilon(0) \Longleftrightarrow p^* > 1/2$ (see Lemma 4). Then, there exist bounds $\overline{p}^*$ and $\underline{p}^*$ such that for all $p^* > \overline{p}^*$ the function $\upsilon(p)$ 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 $\upsilon(p)$ can be decomposed in (A4)-(A6). The following graphs show the case $p^* > \overline{p}^*$.



■.

Proof of Corollary 8 From the conditions that define $\overline{p}$ and $\underline{p}$

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

and

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

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

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

Then, c_L^{FB} can be written as

$$lc_L^{FB} = lc_L^c - (1-l)c_L^{FB} + \delta\left[p^*\upsilon(q_1; c_L^{FB}) + (1-p^*)\upsilon(q_0; c_L^{FB}) - \upsilon(p^*; c_L^{FB})\right]$$
$$\Longrightarrow c_L^{FB} = c_L^c - \frac{E_L(c_L^{FB}, \Pi)}{f}$$

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 ■.

Proof of Corollary 9 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 $c/(\alpha bW)$. In order to prove that $p^* > \frac{1}{2} \Longleftrightarrow \tau_L^{FB} > \tau_H^{FB} \Longleftrightarrow \upsilon_L > \upsilon_H$ we proceed in two steps.

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

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

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

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: $\upsilon_L > \upsilon_H \Longrightarrow p^* > 1/2$ 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

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

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

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

The last equivalence implies that

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

but the right hand side is the same as

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

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

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

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 $p^* < 1/2 \Longleftrightarrow \tau_L^{FB} < \tau_H^{FB} \Longrightarrow A_H < A_L$ because under these conditions the left hand side is positive and the hand right side is negative $\blacksquare$.

Proof of Lemma 10 From (17) and (18) we notice that τ_H^{SB} is decreasing in $I = (s_H - s_L)(s_H + s_L - 2\theta_L)$ while τ_L^{SB} is decreasing in $II = (s_H - s_L)(2\theta_H - (s_H + s_L))$. Then, from $\frac{\partial I}{\partial s_H} = 2(s_H - \theta_L) > 0$ and $\frac{\partial I}{\partial s_L} = 2(\theta_L - s_L) < 0$ we conclude that τ_H^{SB} is decreasing with s_H and increasing with s_L. In particular, τ_H^{SB} is minimum when $s_H = \theta_H$ and $s_L = \theta_L$. The same logic is true for II this time with $\frac{\partial I}{\partial s_H} = 2(\theta_H - s_H) > 0$ and $\frac{\partial I}{\partial s_L} = 2(s_L - \theta_H) < 0$ $\blacksquare$.

Proof of Proposition 11 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.

$$\frac{\partial \upsilon_L}{\partial s_L} + \frac{\partial \upsilon_L}{\partial \tau_L}\frac{\partial \tau_L}{\partial s_L} + \frac{\partial \upsilon_L}{\partial \tau_H}\frac{\partial \tau_H}{\partial s_L} = 0 \tag{A9}$$

$$\frac{\partial \upsilon_H}{\partial s_H} + \frac{\partial \upsilon_H}{\partial \tau_L}\frac{\partial \tau_L}{\partial s_H} + \frac{\partial \upsilon_H}{\partial \tau_H}\frac{\partial \tau_H}{\partial s_H} = 0 \tag{A10}$$

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

$$I_L(\tau_L, \tau_H) = \{s_L, s_H \mid (3) \text{ and } (4) \text{ are satisfied}\}$$

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 1 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

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

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

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

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 $\overline{p}=p_L(\tau_L^{SB})$ 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 $\upsilon(p)$ 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

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

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

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

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

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

in which $\upsilon(p)$ is decreasing for all $p\le\underline{p}$ 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

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

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

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

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

in which $\upsilon(p)$ is decreasing for all $p\le p^*$, 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

$$(\tau_H^{SB},\tau_L^{SB})=\underset{\tau_L,\tau_H\in\mathbb{N}}{\arg\min}\left\{\begin{array}{l}\frac{\Delta\upsilon_L}{\Delta\tau_L}+\frac{\Delta\upsilon_L}{\Delta s_L^{SB}}\frac{\Delta s_L^{SB}}{\Delta\tau_L}+\frac{\Delta\upsilon_L}{\Delta\tau_H}\frac{\Delta\tau_H}{\Delta\tau_L}\ge 0\\ \frac{\Delta\upsilon_H}{\Delta\tau_H}+\frac{\Delta\upsilon_H}{\Delta s_H^{SB}}\frac{\Delta s_H^{SB}}{\Delta\tau_H}+\frac{\Delta\upsilon_H}{\Delta\tau_L}\frac{\Delta\tau_L}{\Delta\tau_H}\ge 0\end{array}\right\}$$

which completes the proof ■.

Proof of Proposition 12 In order to get some intuition we first show the result in the symmetric case. Then we solve the asymmetric one. Given proposition 11, 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

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

with

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

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

$$\frac{d\upsilon}{ds}=\frac{\partial\upsilon}{\partial s}+\frac{\partial\upsilon}{\partial\tau}\frac{\partial\tau}{\partial s}=0 \tag{A15}$$

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 $\upsilon(s,\tau)$ is concave in s and quasi-concave in τ. Then, we know that there exists s_s and s_τ such that $\frac{\partial\upsilon}{\partial s}<0$ if and only if $s>s_s$ and $\frac{\partial\upsilon}{\partial\tau}\big|_s<0$ if and only if $s>s_\tau$. In addition, it is clear that there exists $\overline{s}\in[\min(s_s,s_\tau),\max(s_s,s_\tau)]$ such that υ is increasing for all $s<\overline{s}$ but decreasing for $s>\overline{s}$. That is, $\overline{s}$ is the unique maximum of υ or equivalently, there exists $\overline{f}$ such that

i) $\frac{\partial\upsilon}{\partial s}\big|_{s^{SB}}=\frac{\partial\upsilon}{\partial\tau}\big|_{\tau^{SB}(s^{SB};\overline{f})}=0$. That is $s^{SB}=s^{FB}$ and $\tau^{SB}=\tau^{FB}$.
ii) $s_s>s_\tau$ if and only if $f>\overline{f}$.

In order to see that, we explicitly define

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

Then, (A14) implies that when $f>\overline{f}$ it is true that $\tau(s^{SB};f)>\tau(s^{SB};\overline{f})$. That means that $\frac{\partial\upsilon}{\partial s}\big|_{s^{SB}}>0$ and $\frac{\partial\upsilon}{\partial\tau}\big|_{\tau^{SB}(s^{SB};f)}<0$. 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 $f<\overline{f}$ then $\frac{\partial\upsilon}{\partial s}\big|_{s^{SB}}<0$ and $\frac{\partial\upsilon}{\partial\tau}\big|_{\tau^{SB}(s^{SB};f)}<0$ 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 $E(c,\Pi)>0\Longleftrightarrow f<\overline{f}$.

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

i) $\frac{\partial\upsilon_n}{\partial s_n}\Big|_{s_n^{SB}}=\frac{\partial\upsilon_n}{\partial\tau_L}\Big|_{\tau^{SB}(s_n^{SB};\overline{f}_n)}=\frac{\partial\upsilon_n}{\partial\tau_H}\Big|_{\tau^{SB}(s_n^{SB};\overline{f}_n)}=0$. 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 $f_n>\overline{f}_n$.

This time

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

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

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 13 The existence of $\overline{f}_n$ was proven in the proposition 12. 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 $\overline{f}_n \in [0,1]$ at which $\Sigma_n = 0$. Notice that in general $\overline{f}_L \neq \overline{f}_H$.

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

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

which after using (11)-(12) 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 14 Given proposition 12 we just need to show that it exists $\overline{c}$ such that for all $c > \overline{c}$ 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

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

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 $c > \overline{c} = \frac{1-\Lambda}{1-\delta\Lambda}\delta\Lambda\frac{\alpha bW(\theta_H-\theta_L)(s_H-s_L)p^*}{f+\delta-1}$ it is true that $\tau^{FB} < \tau^c$ ■.

Proof of Proposition 15 First we prove that $\frac{\partial \upsilon}{\partial \phi} = \frac{1}{1-H}\left[\frac{\partial r}{\partial \phi} + \upsilon\frac{\partial H}{\partial \phi}\right] < 0$. We proceed in three steps. First we show that $\upsilon(\tau;\phi)$ is still quasi-concave in τ. Second we show that $\upsilon(\tau = 1; \phi = 0) < \upsilon(\tau = 1; \phi)$ and third we show that $\upsilon(\tau^{SB};\phi)$ is decreasing in ϕ.

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

$$\upsilon(\tau;\phi) = \frac{\sum_{i=1}^{\tau}\delta'^{i-1}V' - \delta'^{\tau}c'}{(1-A)(1-\delta')} \tag{A18}$$

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 (A18)

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

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

and the last relation is obviously always true.

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

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

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

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

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

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

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

also as

$$\frac{\partial^2 r}{\partial\phi\partial\tau} = \left(\frac{1-b}{1-\delta}W + \left(\frac{1}{1-\delta} - \frac{\left[(s_L-\theta_L)^2 + (\theta_H - s_L)^2\right]}{2}\right)b\alpha W\right)Z(\phi)$$
$$-\frac{\left[(\theta_H - s_L)^2 - (s_L-\theta_L)^2\right]}{2}b\alpha W\frac{\partial Z(\phi)}{\partial \phi} > 0$$

because

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

and

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

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

Appendix B: Data Used in the Calibrated Simulations

- $W = 100$: Normalization variable.
- $\delta = 0.95$: The literature assumes that this parameter belongs to the interval $[0.9, 0.95]$.
- $\alpha = 1.5$: Black and Grundfest [1988] document that the premiums obtained by targets in takeovers are in the range of $[1.3, 1.5]$.

- $f = 0.5$: Thompson and Thomas [2004] document that in shareholders litigation the parties usually split the expenses.

  In order to calculate $b, \theta(t), q_0$ and q_1 we identified the corporations that, conditional on being listed in the NYSE and NASDAQ between the years 1978 and 2004, received a takeover or merger offer (regardless that it was accepted or rejected). In addition, we determined the cases in which the raider experienced financial distress within two years after the acquisition took place

Year	Listed Firms	Offers	Mergers	Delistings
1978	4056	4	0	0
1979	4108	3	1	0
1980	4464	16	1	0
1981	4918	86	38	3
1982	4790	241	40	0
1983	5451	463	30	0
1984	5140	832	49	3
1985	5677	638	47	6
1986	5992	819	90	6
1987	6353	1639	91	8
1988	6132	1456	123	11
1989	6013	1854	84	2
1990	5906	1663	70	4
1991	5979	1096	59	2
1992	6202	1205	89	4
1993	6972	1339	104	6
1994	7472	1989	177	11
1995	7787	2123	210	11
1996	8463	2559	262	15
1997	8534	2197	296	16
1998	8182	2781	352	23
1999	7854	2395	353	24
2000	7596	1801	344	23
2001	6907	1309	264	12
2002	7242	925	147	3
2003	8345	913	140	2
2004	8890	876	168	2

sources: S.D.C. and C.R.S.P.

- $b = 0.21$: Number of offers divided by the number of listed firms (average for the period 1978-2004).

- $\theta(t)$: Probability that a corporation will be delisted presumably due to financial distress (codes 400-499, 552, 560, 561, 572, 574, 582, 584 or 585) within two years after it acquired another corporation. We determined $\theta_L = 0.05$ and $\theta_H = 0.1$.

- $q_0 = 0.38$ and $q_1 = 0.8$: Transition probabilities describing the change of $\theta(t)$ estimated as follows

$$(q_0, q_1) = \arg\max \left[(q_1)^{N_1} (1 - q_1)^{N_2} (q_0)^{N_3} (1 - q_0)^{N_4} \right]$$

  where N_1 is the number of years in which $\theta(t) = \theta(t+1) = \theta_L$; N_2 is the number of years in which $\theta(t) = \theta_L$ and $\theta(t+1) = \theta_H$; N_3 is the number of years in which $\theta(t) = \theta(t+1) = \theta_H$ and N_4 is the number of years in which $\theta(t) = \theta_H$ and $\theta(t+1) = \theta_L$.

The next two graphs summarize the results of the simulations not captured by the figures 4 and 5. Figure 1B shows that the ratio between the frequencies of litigations desired by the society and the corporations increases with the cost of litigation. Figure 2B shows that the fraction of the litigation expenses paid by the corporation beyond which the inter-temporal externality dominates the contemporaneous decreases with the cost of litigation.

Figure 1B. Ratio of Frequencies (High Standard)

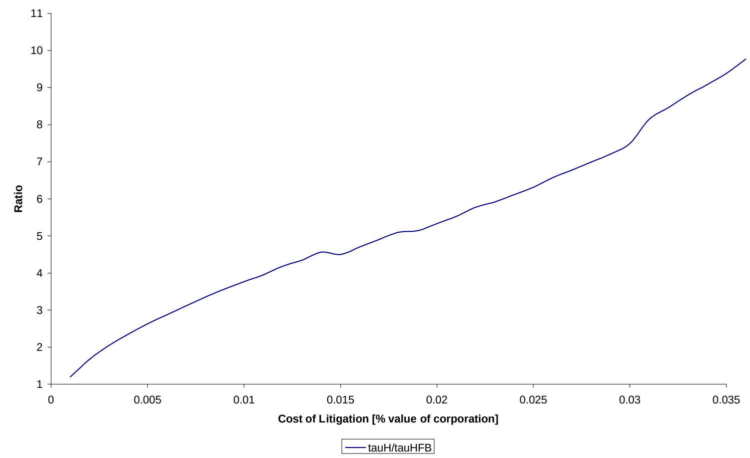
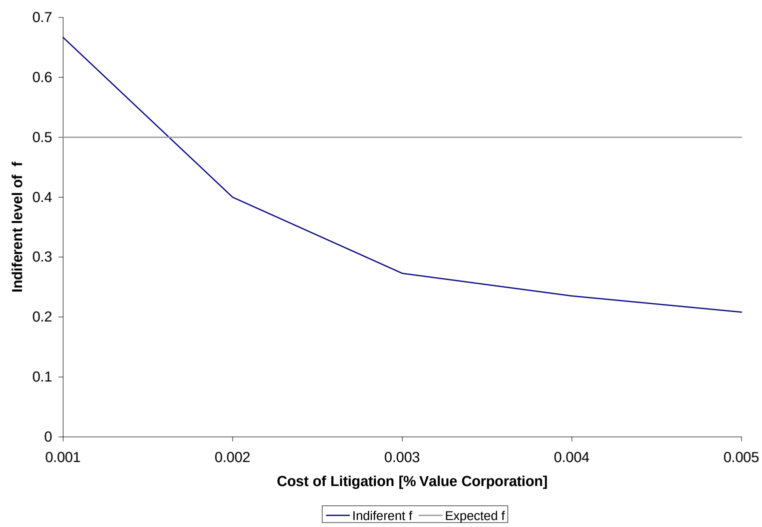


Figure 2B. Bound of the Private Costs of Litigation



Appendix C: 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 D: Numerical example in which $\phi^*(\beta) > 0$

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

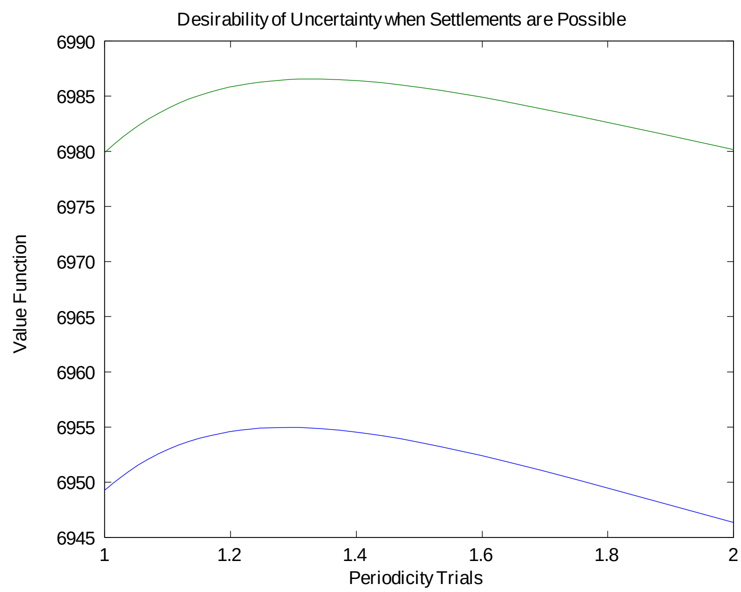
$$\upsilon(\tau) = \frac{r_r + r_s - [H'(\phi,\delta,\tau) + (1-\beta)\delta^{\tau_s}(1-\phi)^{\tau_s-\tau_r}]\, c}{1 - H'(\phi,\delta,\tau)}$$

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 $H'(\phi,\delta,\tau) = \delta^{\tau_r}\left[\phi\left(\frac{1-(\delta(1-\phi))^{\tau_s-\tau_r}}{1-\delta(1-\phi)}\right) + (\delta(1-\phi))^{\tau_s-\tau_r}\right]$. 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 $\theta_L = 0.\bar{3}$; $\theta_H = 0.\bar{6}$; $q_1 = 0.9$; $q_0 = 0.1$; $W = 100$; $\alpha = 2$; $b = 0.4$; $\delta = 0.98$; $c = 1$; $\beta = 0.001$.



The optimal value of $\upsilon(\tau;\phi = 0)$ is $6954,86$ while the optimal value of $\upsilon(\tau;\phi = 0.005)$ is $6986,03$.