WHY ARE LAWYERS NICE OR NASTY?
INSIGHTS FROM AGENT-BASED MODELING

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All substantive areas of law, with no exception, have a common concern for the processes by which legal disputes get resolved. Naturally, the success of any particular litigation strategy in a legal dispute depends on several factors, such as procedural costs, the judges’ accuracy and, most importantly, the litigation strategy followed by the counterpart. Previous work within the legal scholarship has focused on the outcomes of the litigation process and their concordance with the merits of the claims presented by the parties.

In contrast, in this paper, we adopt a dynamic view of the legal system as a whole. In order to do this, we propose an evolutionary point of view. That is, we assume that the most successful litigation strategies at a certain time are more likely to be followed in the future, so the prevalence of different strategies in the system will generally change over time. Importantly, this change in the frequency of litigation strategies in the legal system will, in turn, affect the relative success of each litigation strategy, thus creating a double feedback loop between prevalence and success of litigation strategies, which we aim to explore. Furthermore, we will compare the results drawn from our model with the ones proposed by the empirical literature on the topic.

Thus, the main purpose of this paper is to offer a novel approach to study legal disputes, looking at the whole litigation system as a single entity that evolves through time. In particular, we focus on cases of medical liability, and use agent-based simulation to provide a dynamic view of how various factors affect the type of litigation strategies that are successful and prevail in a certain judicial context.

Keywords: Agent-based simulation; litigation strategies; medical liability; concordant outcomes; judicial framework.

1. Introduction

Conflict is inevitable in a society like ours, both in disputes and in deals. Therefore, understanding the litigation process is becoming increasingly important, as the number of trials in court and the size of the awards have augmented drastically.
in the last few decades. Traditional hard-bargaining tactics are widespread within legal practice and as a result, too often negotiations fall apart, cases do not settle, agreements are not complied with, justice is delayed and its enforcement confronts persistent obstacles. Hence, for the past three decades, we have been facing a crisis of confidence in the legal systems capacity to cope with the increasing amount of cases in its courts. According to [4], we can trace the origins of the problem back to the 1960s, “(which) were characterized by considerable strife and conflict. An apparent legacy of those times was a lessened tolerance for grievances and a greater tendency to turn them into lawsuits. […] One factor was the waning role of some of society’s traditional mediating institutions, the family, the church and the community. […] The net result was an increased volume of legal claims, many of which had not been previously recognized. Courts began to find themselves inundated with new filings, triggering cries of alarm from the judicial administration establishment. At the same time, judicial congestion, with its concomitant delay, led to claims of denial of access to justice.”

Solutions were necessary. Thus, we can trace the first analysis of legal disputes back to the late seventies, when the issue started to be tackled not merely through descriptive arguments, but also through formal modeling. A core article in that line of research is [5], which mentions how “the inability of legal theory to provide sufficient guidance for American courts that were increasingly involved with policy questions” provided a vacant niche that the economic analysis of law filled rapidly. This new perspective was meant to provide policy-makers with “a behavioral theory to predict responses to changes in law and to evaluate these responses systematically according to a normative standard.” Economic theory was, by nature, considered a branch of Science that could meet both the requirements of such formal and normative standards and enrich them with behavioral theory concepts. At the time, only two possible responses were proposed as alternative solutions: one was a “demand for more judges and more courtrooms”; another “a search for alternatives to the courts” [4].

While seeking for more adequate responses to the problem, and trying to understand the internal mechanisms that govern litigation strategies within, economics game theory soon became the instinctive tool to analyze and model bargaining in legal disputes. However, mostly due to some of the main assumptions that traditional game theory imposes — such as common knowledge of rationality — the limitations of this analytical device promptly became manifest. The predictions of models constructed under traditional game theory hypotheses are certainly insightful for the analysis of the strategic behavior of the litigants and the equilibrium attained, but they are nevertheless insufficient to address issues regarding the

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*An illustration of this fact is given by [5], who point out that, between 1975 and 1985, civil cases tried in federal courts tripled, and an 11 billion dollar judgment against Texaco forced one of America’s largest corporations to file for reorganization through bankruptcy, where the related costs of litigation were known to be large, although difficult to quantify.*
dynamics of the process, or the changes that result from the individuals’ adaptations to an actively changing environment.

The subject of this paper is precisely to offer a fresh and dynamic look at legal litigation. This novel approach to study legal disputes would be characterized by looking at the whole litigation system as a single entity that evolves through time. Therefore, it takes into account those litigant strategies that tend to prevail among legal practitioners and incorporates that knowledge to: first, prevent non-meritorious cases — i.e. those that have no legitimate basis — from reaching the courtroom; second, to promote settlement in those cases where parties can achieve a satisfactory solution by means of (alternative) mediation without necessarily involving judicial assessment; and third, to design a judicial process as effective as possible for those conflicts where none of the previous is possible and/or desirable.

In particular, we propose to focus on the study of the mechanisms governing legal litigations in different judicial contexts by means of agent-based simulation. Our analysis aims to show how contextual variables may affect lawyers’ adoption of different argumentation strategies. This approach has, in our view, both explanatory and normative value: understanding how various factors affect the success and prevalence of different argumentation strategies in a judicial system can help us anticipate the impact that different policies might have in regards to the structure of the judicial process, both on legal operators’ attitudes and on the general efficiency of the legal system.

The rest of the paper is structured as follows: in Sec. 2, we give a closer view of our framework of analysis, placing it in relation with some of the existent literature, and state our two main research questions; in Sec. 3, we present an agent-based model designed to investigate the question explained above; in Sec. 4, we present and discuss several simulation results, which are complemented with some mathematical insights derived from the fact that our agent-based model can be usefully seen as a time-homogeneous Markov chain; finally, Sec. 5 summarizes our conclusions and gives an outline proposal for future lines of work.

2. Our Analytical Framework: Two Intertwined Layers

2.1. Litigation postures

We shall start from the very beginning. For simplicity’s sake, let us assume in our model that, when dealing with a case, a lawyer’s basic responsibility is to defend her client’s interests and furthermore, that each client in our model is choosing the lawyer that she considers can best defend her interests. Thus, we can treat a lawyer-client pair as a partnership where the two parts have their interests perfectly aligned. Admittedly, this might not always be the case; legal aid,\(^b\) for instance,

\(^b\)When a party cannot meet legal expenses in civil or criminal proceedings, most governments provide free legal advice and assistance, also called “pro bono”. In such situations, lawyers cannot easily refuse to defend their assigned client, even in cases where the lawyer herself may not be certain that she will have her client’s interests at heart.
could represent a case of potential misalignment between a lawyer and her client’s interest. Exceptions aside, we do believe that it is reasonably safe to assume that, in general, lawyers do defend their clients’ interests. Henceforth, we will thus treat the lawyer-client pair as a single agent.

Consequently, we can plausibly base our litigation model on the assumption that any lawyer involved in a case has a clear objective: to win the case when plausible and subsidiarily, in cases when the latter is not possible, to minimize her client’s loss. However, such a task is not an easy one in the current legal context. There are many loose ends in a legal case, especially in those concerning medical liability where both key factual statements to prove the parties’ arguments (i.e. the existence of harm and/or negligence) might entail subjectivity or even intentionality issues. In addition we shall note, as some authors emphasize (see for instance [22]), the importance of asymmetric information, both regarding the relevant facts for the process and their distribution beliefs about the possibility of victory. Closely related as well is the existence of asymmetry in the parties’ information about the legal costs, or the other party’s attitude towards risk.

As a result, in order to pursue her goal, a lawyer may follow a number of different litigation postures, depending on her perception and beliefs. For instance, in situations where winning the case may require holding an argument that is known by the lawyer to be false, different lawyers may adopt different strategies. Lawyers may also differ in their risk preferences to go to court: some lawyers are keen to reach agreements outside court, while others are less prone to do so. Undoubtedly, institutional context and the individual’s perception of it has a great impact on legal practitioners’ behavior, and hence, our first research question is: which litigation posture (i.e. strategy) will be more successful in a given judicial framework?

The latter is by no means a trivial question. Indeed, experimental and behavioral literature on context-dependant strategies has repeatedly argued against the existence of a single optimal strategy. In our concrete case, it is not difficult to

\(^{c}\) For example, harm can be a matter of pretending, whereas the incurrence in negligence during doctor’s performance is often to be found with certainty only during the process.

\(^{d}\) Although we do assume in our model that before trial each party’s information about the facts and beliefs about their winning probability are similar, we must take into account that such assumptions rule out some possibly frequent situations. As [22] points out, often “litigants’ information about trial outcomes is far from accurate and it is often decidedly unequal” because, for example, “one or the other party does not usually have very accurate information about trial outcomes and those in which one or the other party has substantially superior knowledge to the other.”

\(^{e}\) We do, however, include in our model a party’s ignorance about the counterpart’s tendencies, i.e. their strategic option regarding honesty about the facts and aggressivity.

\(^{f}\) The reader ought to understand here “her perception” as “her client’s perception” too, due to the above-mentioned lawyer-client identification assumption in our model.

\(^{g}\) See, for example, [10] who postulate bounded rationality as the key to understanding how real people make decisions. Among its features, they advance the so-called “priority heuristic” model for choices among risky options, or the “recognition heuristic” strategy, which values higher objects that can be recognized by the individual, over those that cannot, as a way to make inferences about a given environment.
sense that there is no unique strategy that will be most advantageous in every possible judicial environment. Which strategy performs best will depend on a number of factors such as the other party’s strategy, the costs deriving from the litigation process, or the judges’ abilities to tell truth from falsehood when presented with conflicting arguments. We will focus in some of these variables in our analysis.

2.2. “Trial and error”: False positives and false negatives

So far, we have examined litigation from the point of view of the individuals involved in the process. However, we shall also look at the issue from the systemic point of view. Indeed, the judicial system is frequently criticized because its outcomes do not match the real merits of the litigants, and cases involving medical liability are no exception. The system’s inaccuracy has been a constant issue of complaints and discomfort, not only among the parties involved and the legal practitioners representing them, but also among a wide part of the legal scholarship. As [28] point out, the medical liability system resembles a traffic officer who would “regularly [give] out more tickets to drivers who go through green lights than to those who go through red lights.”

The presumably high rates of discordant outcomes, in which the judicial system fails to match the compensation awards to the respective merits of the claims, have been subject of intense criticism from the medical and legal communities, and therefore largely debated in the political sphere, both in Europe and the United States. However, whether these strong claims do accurately represent reality is still in question. Some empirical studies, such as [24], provide us with a more nuanced picture of the situation. In their findings, the authors suggest that “in resolving malpractice claims, the tort system got it right’ about three quarters of the time” [24]; that is, approximately one in four not meritorious claims received compensation, whereas one in four claims that did not lack merit were denied payment. As the own authors mention in a previous article [23], assessing the level of inaccuracy of the judicial system that could be acceptable is an extremely difficult task. Litigation outcomes involve the evaluation of complex interaction processes including human error. Thus, those results “proved grist for both sides” [23]. On one hand, the medical community “lamented the costs of dealing with groundless litigation and focused on another of the study’s findings: one-third of claims that were brought lacked merit.” On the other hand, the community of legal practitioners “declared that the data showed there was much less frivolous litigation that many reformers have claimed and emphasized the finding that most non-meritorious claims did not receive payment.”

Our purpose in this paper, however, is not to make a normative claim regarding the level of accuracy the judicial system should achieve when assessing the merits of the causes alleged by the litigants. Our aim is to, by means of matching the results of our simulations to those of the existent empirical research, investigate
the potential of the application of agent-based modeling to legal issues of similar nature. In order to do that, we will focus on the ratio between concordant and discordant outcomes drawn by some of the existing literature; that is, the proportion of “false negatives” (where a non-meritorious claim receives compensation) and “false positives” (in which a case where negligence was involved remains unpaid) in relation with the fraction of cases where the outcome indeed matched the merit of the claims. Thus, our second research question is two-fold: do the results of our simulations match the findings of the existing empirical literature? and therefore, could agent-based modeling potentially provide legal scholarship with insights regarding the dynamics of the litigation process?

2.3. Scope of the paper: Is litigation as frivolous as they say?

In order to keep the model as intuitive as possible in this paper, we have limited the scope of our research to legal trials dealing with cases of medical liability. We consider that such cases constitute a straightforward example which can help the reader draw a better picture of the features of the model. More precisely, we consider the conflicts that may arise in a patient-doctor relationship, when there is disagreement on whether the doctor negligently damaged the patient and should therefore compensate him, or not.

Thus, as we explained in previous paragraphs, the main objective of this paper is to illustrate how agent-based modeling can provide us with useful insights to understand the dynamics of such judicial processes. Taking the above-mentioned framework into account, the dynamics of our agent-based model are based on an evolutionary approach: we assume that the more successful litigation attitudes tend to persist and spread over time in the population of lawyers by means of imitation. Using this approach, we investigate what kind of strategies will prevail and persist in a certain population under various different institutional conditions concerning the legal system. Institutional conditions are determined by specific instances of each of the environmental factors mentioned above, mainly the legal expenses and the judges’ ability to tell truth from falsehood. In addition, we contrast our results with the existing empirical research on the topic, focusing on the ratio of erroneous payment decisions (either due to payments made without merit, or to meritorious cases remaining unpaid) versus the concordant outcomes.

3. The Model

3.1. Overall view

As mentioned in the introduction, our contribution focuses on the study of the mechanisms that drive lawyers’ interaction in civil proceedings involving medical liability claims. To be more precise, the main area under discussion in medical
liability trials is whether the claim is meritorious; that is, whether the doctor negligently damaged the patient and the latter is therefore entitled to compensation, or not. Our proposal aims to model those interactions using an agent-based model programmed in Netlogo environment, by means of assimilating their litigation postures to strategies in the game theoretical sense. In such cases, the success of a certain litigation strategy will depend on several important factors.

First of all, it will depend on the strategy that the adversary is playing (which justifies modeling the legal interaction as a game). Second, the concrete factual circumstances of the case variant that is being brought into the courtroom will also have an important impact on the procedural outcome (i.e. is there objective harm? Is that harm consequence of the doctor’s negligence?). They will determine whether the factual propositions can be proved and defended as legal evidence in the process or not. Third, the legal context in which the litigation is taking place is essential in our framework. In particular, we ought to consider diverse contextual variables, such as the legal expenses cost structure for both parties involved in the procedure (i.e. the costs of participating in the proceedings and providing evidence, in relation with the value of the case), or the accuracy of the judges (namely their ability to recognize true factual propositions, given the evidence presented by the counterparts during the process). In other words, the best strategy to follow in a certain situation generally depends on a number of uncontrollable factors, external to the parties involved in the litigation.

Events in the model occur in discrete time-steps. Let us explain the basic functioning of the model in each time-step. At the beginning of each time-step, lawyers are randomly paired. One of the lawyers in the pair will defend the doctor, and the other lawyer will defend the patient. Each pair of lawyers is then assigned a random case (which may involve harm or not, and negligence or not). Lawyers then engage in legal litigation, and will act following their own particular strategy, taking into account similar experiences in the past. This legal interaction will result in a certain outcome (i.e. payoff) for the two lawyers involved in any particular case. Lawyers remember this experience and store information such as whether they defended the doctor or the patient, the case they had to deal with, the strategy they followed and, of course, the resulting outcome. Finally, there is a last stage where lawyers consider changing their strategy by means of imitation, if they observe that a randomly chosen peer obtained a better result. There is also a small probability that lawyers may choose to experiment with a new strategy. The following sections describe this sequence of events in greater detail.

Note that, for the sake of clarity, we adopt a fairly limited meaning of “success”: we consider success merely in terms of either maximizing the payoff obtained by a lawyer’s client, in those cases in which winning is feasible, or to minimize the monetary amount to pay, when the former is not possible.

Although in our model we talk about judges, when referring to the authority evaluating the merits of the evidence presented by the parties, the reader can also substitute the term “judge” by “jury”, or alternatively, if looking for a more neutral concept, for “fact finder”.

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3.2. Clients

Every round, our lawyers are assigned a client.\(^1\) Therefore, the same lawyer will act either on a Patient’s or a Doctor’s behalf, depending on the round. Lawyers advise Patients and Doctors on their litigation strategy, making the choices for them, and the clients’ gains and losses are also gains and losses for their lawyers. Thus, in the following sections, we shall speak of Patient and Doctor meaning the patient’s lawyers and the doctor’s lawyer.

Furthermore, even though both Patients and Doctors respond to the same type of strategies, these will result in slightly different litigation postures. This is due to the fact that we have modeled the judicial procedure as a sequential game, where, obviously, it is first for the Patient to decide whether she wants to go to court (i.e. demand her Doctor or not), and only later does the Doctor decide whether she will defend herself or not from her Patient’s claims.

3.3. Case variants

In our model, we assume that a lawyer working on medical liability cases can be assigned one of four possible types of cases, whose characterization is based on two basic Boolean parameters: (a) whether the Patient has suffered Harm (H) as a consequence of the operation or not, and (b) whether the Doctor has performed the medical procedure incurring in Negligence (N) or not. Hence, according to the existence or not of these two facts, there exist four different case variants:

(i) Harm–Negligence (H, N).
(ii) Harm–NoNegligence (H, ¬N).
(iii) NoHarm–Negligence (¬H, N).
(iv) NoHarm–NoNegligence (¬H, ¬N).

As mentioned before, each pair of lawyers is assigned a case variant randomly at every round. Also, note that for simplicity’s sake,\(^2\) we assume that both parties can truly assess the reality, that is, both know with certainty which case variant corresponds to what truly happened. However, as later demonstrated, the truthfulness of the facts matters independently of the existence of Harm and Negligence. The judicial assessment of these facts, as alleged by each party, determines the probability of such arguments being accepted as valid evidence in the trial.

\(^1\)Note that, as we explained in the introductory section, we assume that the lawyer’s interests are perfectly aligned with her client’s in every case.

\(^2\)As we mentioned in the introduction, the existence of harm might be relative in its grade, or even faked, and many times negligence can only be proved through the same judicial process. The reason why we do not take them into account in our analytical framework is because we believe that including such uncertainty factors in our model would not only increase the complexity exponentially, but also diminish its clarity and explanatory potential.
3.4. Strategies

We assume that lawyers are characterized by two features: aggressiveness and honesty. An honest lawyer only attacks or defends herself by providing arguments based on true, factual propositions (we assume that both parties know what really happened, i.e. which case variant is in litigation). Therefore, she will refuse to engage in any action that would require him to lie. On the contrary, a non-honest lawyer may use arguments based upon facts that are not true.

As far as aggressiveness is concerned, we can distinguish between two postures as well: aggressive and non-aggressive lawyers. A non-aggressive lawyer only attacks (when representing a Patient) or defends (when working for a Doctor) when she expects her gains to be higher than those of her counterpart. On the other hand, an aggressive lawyer always advances arguments, regardless of their cost. Expected gains are estimated by lawyers using their past experience; this is explained in detail in Sec. 3.7. By combining the two features, we obtain the following four litigation strategies, each one defining a lawyer’s type in a certain round:

(i) Honest and non-aggressive (HoNAg). The lawyer advances an argument whenever (1) the argument is right (it is based upon true factual propositions) and (2) it is cost-effective (its expected gains outweigh its expected costs).
(ii) Honest and aggressive (HoAg). The lawyer advances an argument whenever it is right, regardless of its cost.
(iii) Non-honest and non-aggressive (NHoNAg). The lawyer advances an argument whenever it is cost-effective, regardless of its rightness.
(iv) Non-honest and aggressive (NHoAg). The lawyer advances every argument available, regardless of its rightness and its cost.

Thus, for instance, an honest patient (regardless of her aggressiveness) would not take a case to court when she knows that there was no fault of the doctor, while an honest doctor would not provide arguments in a case where she knows that she negligently caused damage.

3.5. Procedural costs and value of the case

In our simulation, we assume that each party involved in legal proceedings has to support several procedural costs — namely related to the costs that initiating and taking part in the process involves, as well as the burden of proving the alleged evidence — that will be deduced from her final payoff. This payoff is modeled as a given percentage of the total initial claim that in our model is represented by a parameter, ValCase. The above-mentioned procedural costs are the following:

- Participation cost (PartCost). It represents a sunk cost that has to be paid in order to initiate the legal proceedings (i.e., for suing or resisting).
- Contested participation surcharge (ConPartSurch). This surcharge has to be paid in addition to the PartCost, in case the counterpart decides to take part in the
process too. It covers lawyer’s fees and other costs involved in replying to the arguments of the adversarial party. Thus, such cost ought to be taken into account always when computing Doctor’s procedural costs, while in the Patient’s case it will only be added in case the Doctor decides to defend herself.

- Evidence cost (EvCost). This cost has to be paid by a party for each factual proposition appearing within her arguments. EvCost for a factual proposition covers the expert or lawyer’s work required for building or presenting the evidence related to that proposition. Note that, in the case of the Patient, in order to win the case, she must prove both that there was Harm and that such Harm came as a consequence of the Doctor’s Negligence. The Doctor, however, will only need to prove evidence on the contrary on either one of the two facts.

- Contested evidence surcharge (ConEvSurch). This extra cost ought to be paid when the evidence provided on a factual proposition is contested through counter-evidence by the other party, namely by means of presenting evidence for the negation of such factual proposition. ConEvSurch covers matters such as contestation of the counterevidence or the cost of providing additional evidence, for instance.

Thus the procedural cost (ProcCost) to be sustained by a party Patient in a particular litigation history is given by the formula:

\[
ProcCost = Partcost + ContPartSurch + \text{num-evidence} \times \text{EvCost} + \text{num-evidence-of-counterpart} \times \text{ConEvSurch}
\]  
(1)

where:

- num-evidence is the number of factual propositions upon which the party provides evidence; therefore it can be equal to zero, one or two, depending on whether the party proves Harm, Negligence, neither or both of them.
- num-evidence-of-counterpart is the number of such factual propositions on which counterevidence is provided; obviously, it can also equal zero, one or two.

If we consider, for instance, a case where Patient sues and Doctor denies Harm, we would have that the Patient would have to pay:

\[
ProcCost = Partcost + ContPartSurch + 2 \times \text{EvCost} + 1 \times \text{ConEvSurch}
\]  
(2)

Whereas the Doctor’s costs would be:

\[
ProcCost = Partcost + ContPartSurch + 1 \times \text{EvCost} + 1 \times \text{ConEvSurch}
\]  
(3)
3.6. Judges’ accuracy

As previously mentioned, we assume both parties to have full knowledge of the nature of the case they have been assigned to. Namely, they know whether there was Harm and Negligence (this assumption could be relaxed to model situations where one or both parties are uncertain about the facts of the case but, for simplicity’s sake, we shall keep it here).

On the contrary, judges do not have such knowledge, and have to decide on the basis of the evidence and arguments provided by the parties. Henceforth, by considering that each proposition may be true or false, and uncontested (only evidence by the alleging party is provided) or contested (besides evidence for it, also evidence against is provided by the counterpart), we can specify the probability of a proposition being considered as true and therefore valid evidence, in all four possible cases. In order to do so, we introduce a function \( \text{PrAcc} \), defining the probability that the judge accepts a proposition \( \varphi \) according to the status of \( \varphi \), denoted as \( \text{Status}(\varphi) \). Though the (average) values for \( \text{PrAcc} \) should be established through empirical inquiry, we just make some general considerations that will serve as a basis for establishing reference values.

In the following section we consider four different scenarios. In our baseline scenario, we assume that judges have cognitive capacities with regard to factual circumstances, that is, they are more likely to accept a factual proposition when it is true than when it is false, and when evidence for it is provided rather than the contrary. We use this baseline scenario as an illustration in this section. According to the above assumptions, the following table reflects the probability of judicial acceptance in each of the four possible situations:

<table>
<thead>
<tr>
<th>Table 1. Judge’s accuracy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>noCont</td>
</tr>
<tr>
<td>True</td>
</tr>
<tr>
<td>False</td>
</tr>
</tbody>
</table>

\( ^1 \)First, the probability of judicial acceptance of a true and uncontested proposition (\( \text{PrAcc}(\varphi) \) when \( \text{Status}(\varphi) = \text{True, no Cont} \)) must be very high. Second, the probability of judicial acceptance of a true and contested proposition (\( \text{PrAcc}(\varphi) \) when \( \text{Status}(\varphi) = \text{True, Cont} \)) must be lower than the probability of acceptance of a true and uncontested one (when \( \text{Status}(\varphi) = \text{True, no Cont} \)). However, it must still be higher than 0.5 (if we assume that sincere and insincere parties have the same capacity of providing evidence, and that judges have some cognitive capacity). Third, the probability of judicial acceptance of a false and uncontested proposition (\( \text{PrAcc}(\varphi) \) when \( \text{Status}(\varphi) = \text{False, no Cont} \)) depends on the possibility for the judge to get evidence not provided by the parties. When, as usually in private law, the judge does not have this possibility, the judge would tend to align with what is falsely indicated by the uncontested evidence provided by the lying party. Thus this probability too must be higher than 0.5. Fourth, the probability of judicial acceptance of a false and contested proposition (\( \text{PrAcc}(\varphi) \) when \( \text{Status}(\varphi) = \text{False, Cont} \)) must be lower than 0.5 (assuming that sincere and insincere parties have the same capacity of providing evidence, and that judges have some cognitive capacity).
Let us consider, for instance, a case variant where it is indeed true that the Patient has suffered harm and provided evidence for it. According to the previous table, two situations must be distinguished: (a) if the evidence for harm is uncontested (Doctor provides no evidence against Harm), with probability 1 the judge will be persuaded that there harm has been indeed caused to the Patient; while if (b) the evidence is contested (Doctor provides evidence against Harm), the chances that the judge will be convinced would decrease to 0.8.

3.7. Memory

Lawyers remember these experiences from each round and use this memory of past events to estimate future payoffs in situations that they perceive as similar. Two situations are perceived as similar by a lawyer if and only if the lawyer is (a) defending the same type of client (doctor or patient), (b) the case variant is the same (in terms of Harm and Negligence), (c) the lawyer is following the same strategy, and (d) the number of factual propositions upon which the relevant party provides evidence or counterevidence is also the same.

When facing any particular situation, a lawyer will look back at the five most recent times she experienced a similar situation in the past, and use the average of the payoffs she obtained in these five previous experiences as an estimate for the payoff she will obtain in the present situation.

3.8. Imitation and experimentation

Once every lawyer in the population has received her corresponding payoff, lawyers will consider changing their strategy for the next round. Each lawyer will look at another randomly selected peer with the same type of client and the same case variant. If and only if the payoff obtained by the peer was greater, then the imitating lawyer will adopt the same strategy as the peer. There is also a certain probability, namely Prob-experimentation, that each lawyer will adopt a randomly chosen strategy.

4. Results in Four Different Scenarios

4.1. Scenarios’ parameterization

This section presents some preliminary simulation results for four different scenarios. We are interested in exploring the impact of (a) procedural costs and of (b) judges’ ability to tell truth from falsehood on the evolution of lawyers’ strategies. Thus we define the following four scenarios: “Baseline”, “Gullible Judges”, “Barrier to Entry” and “Gullible Judges & Barrier to Entry.” The parametrization of each scenario is the following.

Note that even though in a certain round a given agent obviously cannot imitate and experiment at the same time, the probabilities of a lawyer imitating a peer or experimenting a new strategy are independent from each other.
Table 2. Parametrization of the four different scenarios.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>Gullible Judges</th>
<th>Barrier to Entry</th>
<th>Gullible Judges &amp; Barrier to Entry</th>
</tr>
</thead>
<tbody>
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<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
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<td>Initial-stratification</td>
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<td>random</td>
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<td>Case-generator</td>
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<td>random</td>
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<td>1</td>
<td>1</td>
</tr>
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<td>0.010</td>
<td>0.010</td>
<td>0.010</td>
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<td>5</td>
<td>5</td>
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<tr>
<td>True-no-cont</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>True-cont</td>
<td>0.8</td>
<td>0.5</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>False-no-cont</td>
<td>0.9</td>
<td>1</td>
<td>0.9</td>
<td>1</td>
</tr>
<tr>
<td>False-cont</td>
<td>0.2</td>
<td>0.5</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Part-cost</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Cont-part-cost</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ev-cost</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cont-ev-cost</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Val-Case</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

4.2. The model as a time-homogenous Markov chain

Before proceeding to the presentation of the simulation results, it is worth mentioning that the model presented here can be usefully seen as a time-homogeneous Markov chain [13]. The state of this system can be defined as the number of lawyers that follow each specific strategy at any given time. With this definition, the number of possible states is:

\[
\text{number of possible states} = \binom{4 + 200 - 1}{200}.
\]

It is easy to see that if the probability experiment is greater than 0, it is possible to go from any state to any other state in one single step. Consequently, the model is an irreducible and aperiodic time-homogeneous Markov chain, also called “ergodic” [13]. This means that the probability of finding the system in each of its states in the long run is strictly positive and independent of the initial conditions. It also means that such limited distribution over the state space of the system coincides with the system’s occupancy distribution, or the long-run fraction of the time that the system spends in each state. Given this, one can also state that the occupancy distribution of any statistic (i.e. the distribution of strategies in the population) is also independent of initial conditions.

As we specified in the introductory sections, one of the two focal points of this paper is characterizing the frequency distribution of the strategies in the population. In other words, we simply aim to answer the following question: how often is each strategy brought into play in the population (on average, a longtime), in each of the four scenarios proposed? Clearly, analytically calculating this occupancy
distribution is rather impractical, but it can be approximated by running the computer model, as illustrated in the next section.

4.3. Simulation results

In this section, we report simulation results for each of the scenarios. Figure 1 shows the evolution of the relative frequency of strategies in one representative run for each of the four possible scenarios. While the first one is designed to provide the reader with a more intuitive picture of the situation, the second provides the exact figures resulting from our agent-based model.

After conducting several tests (see [13] for details), we came to the conclusion that gathering data in between time-steps 10001 and 11000 was sufficient to characterize the occupancy distribution over strategies for each of the four scenarios. Thus, Table 3 below reports the average values for the fraction of the main strategies.

![Figure 1. Frequency distribution of the four strategies (Honest and Non Aggressive, Honest and Aggressive, Non Honest and Non Aggressive, Non Honest and Aggressive) in the four different simulation scenarios.](image)

Table 3. Cumulative strategy frequency.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>HoNAg (%)</th>
<th>HoAg (%)</th>
<th>NHoNag (%)</th>
<th>NhoAg (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>90.80</td>
<td>4.92</td>
<td>2.93</td>
<td>1.33</td>
</tr>
<tr>
<td></td>
<td>(0.96)</td>
<td>(0.83)</td>
<td>(0.38)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Gullible Judges</td>
<td>89.82</td>
<td>2.81</td>
<td>5.99</td>
<td>1.39</td>
</tr>
<tr>
<td></td>
<td>(1.45)</td>
<td>(0.29)</td>
<td>(1.36)</td>
<td>(0.14)</td>
</tr>
<tr>
<td>Barrier to Entry</td>
<td>15.16</td>
<td>79.50</td>
<td>3.85</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>(5.24)</td>
<td>(5.48)</td>
<td>(0.62)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>Gullible Judges &amp; Barrier to Entry</td>
<td>83.84</td>
<td>3.92</td>
<td>9.89</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>(3.59)</td>
<td>(0.55)</td>
<td>(3.44)</td>
<td>(0.33)</td>
</tr>
</tbody>
</table>

*The values in the table represent the average results along the simulations, and the corresponding number in parenthesis denote the standard deviation.

Each reported value in this table and in the following charts corresponds to the average between stages 10001 and 11000 and has been calculated over 200 simulated runs of the process, with random initial conditions.
between stages (10001) and (11000) for each of the four different scenarios. Each reported value has been calculated over 200 simulated runs of the process, with random initial conditions. The values in brackets show the standard deviation of the averages across runs.

These preliminary results show an interesting and unexpected phenomenon: departing from baseline conditions, judges’ ability to tell truth from falsehood does not seem to have a significant effect on the adoption of different strategies in the population of lawyers depicted in our model. However, the picture is completely different when studying a system with an existing barrier to entry for the judicial procedure. It seems that barriers to entry, on their own, dramatically change the composition of strategies being used by lawyers, favoring Honest and Aggressive behaviors over Honest and Not Aggressive. Having said that, the effect is only observable if judges have some ability to tell truth from falsehood. If, using our informal terminology, judges are “gullible,” imposing the payment of a relatively high lump sum on the parties to start the procedure does not seem to make a significant difference.

However, we believe it is more than reasonable to assume that, through the examination of the evidence presented by the litigants, judges can achieve an accurate enough assessment of the merit of the claim. Accepting the previous assumption as plausible, there is a positive effect of the imposition of a barrier to entry. The adjudication system leads us in the direction of a question of vital importance in the existent literature: the effects of different reforms in the frequency and average amount of payments in civil proceedings dealing with medical injury. This issue has been largely studied with sometimes ambiguous, sometimes controversial results. Proponents of the reforms argue that they will lead to a decrease in the amount of litigation by reducing the incentive of plaintiffs to sue, while their opponents argue that it will diminish the protection for the patients, since the penalty for medical malpractice will not be high enough to act as a deterrent anymore.

A recent study by [1] explores the eventual effects of a wide range of possible reforms. However, although his findings account for statistically different effects mainly for two of the reforms studied, he only grasps the superficial reasons why these effects occur. As [15] points out in his review of Avraham’s study, “it would be useful to probe why the different reforms had different effects, though that may become complicated by the interaction between the effects of multiple reforms operating simultaneously.” In our opinion, this vacant niche in the empirical literature could be filled by the use of agent-based models, such as the one proposed here, where we can assess not only the effects of each individual reform in the adjudication

\[\text{It does, however, have a significant effect on the proportion of cases won by Doctors, as the reader will be able to appreciate along the following paragraphs.}\]

\[\text{We qualify the effects as “positive” because the barrier increases the frequency of Honest strategies in the population; that is, a higher proportion of the claims that reach the courtroom is based on true facts, reducing therefore the quota of “frivolous” claims.}\]
system (see, e.g. “gullible judges” and “barrier to entry”), but also the results derived from their interaction. Hence, although our model is by no means complete, it does represent a step forward in the inquiries about such policy-related issues.

Changes in the relative success and prevalence of different argumentation strategies in each of the scenarios have wider implications. For instance, another unsolved, yet basic, question in the litigation literature concerns the frequency of plaintiff victory at trial, and how cases that go to trial relate to settled cases. [19] advanced a model in which there is a tendency for plaintiffs to prevail at trial with probability 50 percent. However, their hypothesis was tested later on by [22] with differing results. By relaxing [19]’s assumption of symmetric information, [22] claims that it does not seem appropriate to regard 50 percent plaintiff victories as a central tendency, either in theory or in comparison with real data. On the contrary, his claim is that, for the cases that go to trial, plaintiff victory occurs with any probability.

Against the vagueness of these propositions, posterior articles have given a more nuanced view on the subject, by rigorously compiling evidence from medical malpractice claims filed. Furthermore, together with the ratio of plaintiff-defendant victories, an important focal point in the debate around the adjudication system is the frequency of outcomes which do not match the merits of the case. As we pointed out in the introduction, results from a previous paper by [24] had revealed that some of the critics of the accuracy of adjudication were not justified, as only about one in four outcomes were discordant with the actual merits of the case. However, in their next article, [23], develop a further comparison between their results and those extracted from relevant existent empirical literature.

Departing from those data, we have compiled and analyzed them in various ways, in order to provide a more realistic picture of the courtroom reality, in which we could frame the results from our model. This can be appreciated in Figs 2 and 3, which report the average number of cases in which the verdict does not reflect the merits of the litigants. As we can see, the results of our model suggest that approximately two-thirds of the claims (67.56%) filed obtained a verdict concordant with the merits of the case, whereas the other third (32.44%) reflected a poor evaluation of the evidence by the judge.

As we can extrapolate from the figures presented in this section, none of the results obtained in any of our four scenarios corresponds with the 50 percent assumption drew by [19]. In addition — even though, as we explained in the preface, we do introduce a simplifying assumption regarding the parties’ capacity of truly assessing the existence of both Harm and Negligence —, the fruits of our simulation seem to match extremely close those resulting from the examination of the literature presented by [23]. However, we must note that (c.f. central column in Fig. 2) our model did not provide the parties with the possibility of
settlement outside the courtroom. There is a similar option for the Doctor, who can desist in proving her innocence, decide not to defend herself and just proceed to pay the compensation claimed by the Patient. This could be assimilated to a settlement.

On the contrary, there is no such equivalent on the Patient’s side. As a result, the proportions in the findings are significantly different, as the data in the central column depicts. We could nevertheless expect that part of the cases (in our data, approximately 23%) in which the Patient decides not to sue the Doctor, would be a side-effect of the impossibility to settle and the monetary risks that this implies. Therefore, we can reasonably suppose that, if settlement is introduced,

Fig. 2. Comparison between the results from our model (both including and excluding those cases where the plaintiff did not file a claim) and those extracted from empirical literature.

aNote that in the first bar, those cases where the plaintiff did not file a claim are included, whereas in the second bar they are excluded and drawn explicitly.

bSee the tables in Appendices A, B and C for exact frequency figures.

Fig. 3. Comparison between the results from our model and those extracted from a selection of relevant empirical literature.
there will be a shift that will approximate our results again in the empirical
data. However, this is work that remains to be done in future extensions of this
article.

Moreover, we can say that our results are concordant with those extracted
from the empirical literature employed, not only in general terms (i.e. in over-
all ratio of concordant-discordant results), but also in the detailed composition of
those outcomes. That is, the average proportion of meritorious claims that have
received compensation (23.81%), unpaid non-meritorious claims (43.75%), false
positives (31.99%) and false negatives (0.45%) approximates the correspondent
values found in empirical evidence studied (28.23%, 38.24%, 25.82% and 7.70%,
respectively).

Furthermore, following this discussion on the influence of judges’ valuation
of the facts, we should mention [9], which concludes that judges exercising discretion
in finding facts in a trial lead to a setting of damages unpredictable from true
facts, not only raising the incidence of litigation, but also encouraging litigants
to take extreme positions in court. Indeed, we do appreciate very different results in
both scenarios involving judicial discretion, with defendants’ successful rate ranging
from a minimum nine percent to more than half. However, no augmentation in the
frequency of extreme positions — the term “extreme” would resemble our model’s
Aggressive and/or Non-Honest strategies — is observed.

One suspects, however, that litigants’ strategies should also follow different
paths, depending on the magnitude of legal expenses. As we have argued exten-
sively throughout the article, this question is a main focal point of the literature on
litigation. However, most formal legal models are mainly static and, though they are
able to reflect some implications of procedural costs variance, they generally give
little or no consideration to the evolution over time of such consequences. Inspired
by P. Rubin’s Why is The Common Law Efficient? article’s spirit, but borrowing
some tools of evolutionary analysis from biology, in 1981, [26] developed one of the
few legal models involving dynamism. [26] evaluates the impact that rule efficiency
has on litigation, and concludes that plaintiffs and defendants adopt strategies that
result in a high rate of litigation when legal rules are inefficient and a low rate of
litigation when they are efficient.

This conclusion matches the results of our simulation,\textsuperscript{P} where the percentage
of cases that are resolved in a courtroom increases substantially when the legal
expenses are augmented. Indeed, the percentage of cases that go to trial is almost
34 percent higher in the case where legal expenses are incremented, rising from
36.42% to 48.72%.\textsuperscript{P}

\textsuperscript{P}Note that we should consider the baseline case as representative of an efficient-rule-based system;
in contrast with the scenario in which a barrier of entry is imposed, increasing the cost that parties
ought to bare once they enter the process.

\textsuperscript{q}In Tables A.1, A.2, and A.3 of the Appendices A, B and C respectively, the reader can find a
detailed overview of the figures from which the latter results are drawn.
5. Conclusions and Future Work

This paper proposes a novel approach to study legal interactions. In particular, it illustrates how agent-based modeling can provide insightful explanations that help us understand the dynamics of litigation in civil proceedings. Our agent-based model studies the mechanisms that govern the adoption of diverse litigation attitudes, and their interplay with given parameters in a certain judicial environment. More concretely, our analysis intends to extrapolate the influence of variances in some of the factors that determine adjudication (such as judicial accuracy, or legal expenses) on the evolution and prevalence of certain strategies in lawyers dealing with cases of medical malpractice.

In the model presented, the chances of success of a litigation posture are determined by the case variant, the merit that its concrete factual propositions entitle, the strategy adopted by both parties involved (i.e. their argumentative and probatory activities) and the assessment capacity of the judges. Furthermore, our agent-based simulation is analyzed in four particular sample scenarios, with two different cost structures — starting from the baseline scenario, modified by incrementing the costs of participating in the process, by imposing a barrier to entry the procedure — and two diverse levels of judges' capacity to assess the merit of the evidence provided by the parties — that is, one where judges can with a high probability discern true from false facts, and another where, if a fact is counter-proved, they are equally likely to assess it as true or not.

In our introduction, we proposed to focus on two main research questions: which litigation posture (i.e. strategy) will be more successful in a given judicial framework? and the two-fold question, do the results of our simulations match the findings of the existing empirical literature? and therefore, could agent-based modeling potentially provide the legal scholarship with insights regarding the dynamics of the litigation process? We believe that — given the results of our simulation and their comparison to the empirical findings drawn by recent literature — we can confidently say that the evolutionary framework which is provided by agent-based simulation enables us to take a further step in the analysis of the dynamics within courtroom interactions.

Furthermore, by showing to what extent contextual variables may impact the adoption of certain argumentation strategies in a population of heterogeneous lawyers, and how different postures may evolve and eventually become prevalent over time, we can better understand why different reforms on the adjudication environment may produce different effects. Hence, further developments of bottom-up models such as the one described in this paper could help in anticipating the impact of new policies. Such foreseen impacts could lead us to enhance the design of policy instruments, and therefore attain more desirable effects on the attitudes of legal operators and on the general efficiency of the legal system.

Though in this paper we have only considered one possible change in the cost structure of the proceedings, other changes may be considered, such as increasing
or decreasing costs in a different way, making the losing party bear all the pro-
cedural costs, adding a penalty in addition to the costs upon the losing party, 
increasing or decreasing the accuracy of the judges, etc. In addition, different 
attitudes to risk and loss could also impact on agents’ choices. Another possi-
ble change could be, as we mentioned, introducing the option of settlement; in 
such case, a way of managing the corresponding negotiation space should also be 
considered.

Moreover, the pattern proposed here could also be developed by relaxing our 
knowledge assumptions about the lawyers, namely, that they are aware of the vari-
ant of the case they are dealing with, that is, whether harm and negligence have 
occurred. In addition, we could construct communities of agents, operating within 
a social network, in which lawyers could share their memory with other lawyers 
in their same group, as if they were part of a law firm. Hence, we consider that 
our dynamic analysis, while still being very preliminary, could lead to interesting 
results and, more importantly, we believe that the ideas presented in this paper 
may pave the way for future developments where law and agent-based simulation 
interact.

Acknowledgments

We would like to thank Philippe Reyniers, Tiago de Freitas and Abhijit Sengupta 
for their useful comments and their support, as well as two anonymous referees.
Appendix A. Empirical Literature Results

Table A.1. Extract from relevant empirical literature results.

<table>
<thead>
<tr>
<th>Study</th>
<th>Meritorious</th>
<th>Non-meritorious</th>
<th>Dubious</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percentage (%)</td>
<td>Paid (%)</td>
<td>Total paid (%)</td>
</tr>
<tr>
<td>Studdert et al. (2006)</td>
<td>63</td>
<td>73</td>
<td>45.99</td>
</tr>
<tr>
<td>Cheney et al. (1989)</td>
<td>54</td>
<td>90</td>
<td>48.60</td>
</tr>
<tr>
<td>Taragin et al. (1992)</td>
<td>25</td>
<td>91</td>
<td>22.75</td>
</tr>
<tr>
<td>Farber and White (1994)</td>
<td>35</td>
<td>66</td>
<td>23.10</td>
</tr>
<tr>
<td>Brennan (1996)</td>
<td>20</td>
<td>56</td>
<td>11.20</td>
</tr>
<tr>
<td>Phillips et al. (2004)</td>
<td>23</td>
<td>86</td>
<td>19.78</td>
</tr>
</tbody>
</table>

Note: Self-elaborated table, with the data extracted from [23]. In the latter, the authors make a substantive literature review on the empirical research dealing with the jury's verdict accuracy in adjudicating cases involving eventual medical malpractice.

aIn the cited study, claims' files were evaluated by impartial and qualified reviewers. Confidence scale and cutoff point were adapted from instruments used in previous studies of medical injury (among them, the authors cite [27]).

Cases were considered as “dubious” if either the evidence that the adverse outcome resulted from negligence of the doctor was not clearly stated, or the own adverse outcome could or could not be a consequence of the latter.
### Appendix B. Simulation Results

<table>
<thead>
<tr>
<th></th>
<th>Total (%)</th>
<th>Meritorious claims paid (%)</th>
<th>Non-meritorious claims unpaid (%)</th>
<th>Concordant outcomes (%)</th>
<th>False negatives (%)</th>
<th>False positives (%)</th>
<th>Discordant outcomes (%)</th>
</tr>
</thead>
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<tr>
<td>Settlement</td>
<td>61.15</td>
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<td>37.67</td>
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<td>Adjudication</td>
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<td>Total</td>
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<td>43.75</td>
<td>67.56</td>
<td>0.45</td>
<td>31.99</td>
<td>32.44</td>
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</table>

### Appendix C. Empirical Literature Summary

<table>
<thead>
<tr>
<th></th>
<th>Total (%)</th>
<th>Meritorious claims paid (%)</th>
<th>Non-meritorious claims unpaid (%)</th>
<th>Concordant outcomes (%)</th>
<th>False negatives (%)</th>
<th>False positives (%)</th>
<th>Discordant outcomes (%)</th>
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</thead>
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<tr>
<td>Settlement &amp; Adjudication</td>
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<td>66.52</td>
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