Dynamics of Collective Litigation

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Abstract

In collective litigations the outcome of the trial may depend on the number of litigants. In this paper, we study how collectives form and explore actions that the defendant can take to interfere in this process. We propose a dynamic model of litigation in which a defendant faces the arrival of plaintiffs over time and where the defendant is privately informed about the scope of the harm she has caused (e.g. how many consumers have been exposed to a defective product). We show that when all plaintiffs are strategic the defendant can completely avoid the formation of a collective. However, if some plaintiffs (exogenously) join the collective then strategic plaintiffs may also join. We compare the baseline, in which all settlements are public, to a setting where the privacy of settlements is endogenous. We show that use of private settlements can decrease expected payments for some plaintiffs but may increase payments to subsequent ones. Importantly, the defendant does not always gain from the availability of private settlements.

1 Introduction

Settlement negotiations between a defendant and a plaintiff do not occur in the vacuum. Their outcomes are used by third parties (e.g. other plaintiffs) as an input when designing their own litigation strategies. Previous settlements may directly affect the outcomes that can be expected from a trial. Additionally, they also allow other parties to learn about features of the environment.

As an example, consider an individual that is harmed after consuming a product. He, naturally, takes into account observed past behavior of the producer and other harmed consumers to decide whether to start a law suit, when to do it, and whether to do it alone or joining others. Likewise, whatever he chooses to do is likely to affect the information available as well as incentives of future harmed consumers. In this litigation setting, as in many others, it is natural to consider that the defendant is better informed than each individual plaintiff about the underlying environment. For instance, a firm has privilege knowledge about the safety measures taken during production, which determine the extend to which consumers are exposed to a possible harm. In such a case, the actions of the firm are used by interested parties to make inferences about its private information. This feature remains under-explored in the study of litigations in which more than one plaintiff may be involved.

A case that illustrates the main features of the litigation environment that we are studying is the Baxter dialysis crisis [Diermeier and Dickinson, 2012]. In the fall of 2001, more than 50 patients in seven countries died between few days of going through dialysis. Deaths did not occur all at once. It was rather a sequential process. As deaths occurred, health authorities (initially in Spain) discovered a connection between the cases: the same type of dialyzer (a filter used during a hemodialysis) was used in all diseased patients.

The manufacturer of the dialyzers (Baxter International) was the first one to find out the cause of the deaths: a fluid used to identify leaks remained in the dializers, evaporating during the treatment, and entering the patients' bloodstream. The manufacturer was better informed about the scope of the crisis. It had privilege knowledge about the number of patients that could have been exposed to the faulty dialyzers. In the aftermath of this crisis, the manufacturer settled with the families of all patients.

In this paper, we study the dynamics of settlement negotiations between a privately-informed defendant and several potential plaintiffs arriving over time. We focus on two main issues: how collectives form and the extend to which the defendant can affect this process. We present three main findings. First, the ability to settle with each individual plaintiff is a very effective tool for the defendant to avoid the formation of a collective. Second, if there is an endogenous chance of break down in negotiations with plaintiffs arriving late, then settlements with plaintiffs arriving early on can endogenously fail. In this setting, making an offer so low that the plaintiff is willing to reject it is the only way in which the defendant is able to credibly reveal her private information. Finally, we show that the availability of secret settlements may be harmful for the defendant.

We propose a model in which a defendant faces random arrival of plaintiffs over three periods. In each period, one plaintiff can arrive with some exogenous probability. The defendant is privately informed about the actual value of the probability of arrival, which the plaintiffs do not know. This probability can be interpreted as a safety characteristic of a product that determines, for example, the extend to which a population of consumers is exposed to a risk (e.g. a defective product).

The three periods in our model need not to be taken in a literal sense. The last period can be interpreted as a deadline prescribed by the court for plaintiffs' opt out choices. In that sense, the first period is meant to capture an initial phase in which there is no previous information that can influence plaintiff decisions, for instance because the defendant is a new firm in the market or because there is no precedent of an accident of the same kind. The second period intends to capture an intermediate stage in which information about the case may potentially exist but there is still room for the arrival of additional plaintiffs.

We assume that the outcome of a trial is affected by the number of litigants. This may be because trial costs can be divided among the litigants, because each additional litigant provides evidence that increases the chance of prevailing in the case, or because there are some administrative requirements about the minimal amount of plaintiffs being allowed to litigate collectively. In our model, plaintiffs' entry is endogenous, i.e., after arrival a plaintiff decides whether to file the case. If the case is filed, the defendant gets to make a settlement offer. We study two cases: one in which all settlements are publicly observed and one in which the defendant can settle secretly. Whenever an offer is rejected, the plaintiff can join a (potentially collective) lawsuit.

Plaintiffs can be of two types: strategic or behavioral. A plaintiff is *behavioral* if he strictly prefers to file the case and go to trial. A possible interpretation is that a fraction of plaintiffs are vengeful, benefit from the publicity given to the case, or otherwise derive utility from going to trial. Alternative, it can also be seen as a fraction of plaintiffs that over-estimate payments from going to court. A plaintiff is said to be *strategic* if his optimal choice depends on other plaintiffs' actions. On one hand, a strategic plaintiff arriving in the last period faces no uncertainty about payoff and bases his litigation strategy on the actions he has observed. On the other hand, in the first two periods a plaintiff's optimal choice depends on his beliefs about the probability of arrival of new litigants (as well as on the conjecture about the strategy of those that arrive).

There are two sources of externalities in our model. First, there is the payoff externality arising from the assumption that outcomes from trial depend on the number of litigants. Second, there also exist information externalities. When a plaintiff does not file the case or settles secretly other players do not observe the arrival. This affects beliefs and filing decisions of subsequent plaintiffs.

As a benchmark, we start our analysis in Section 3.1 assuming that the probability of arrival is commonly known. In this case, only behavioral plaintiffs go to trial. Strategic plaintiffs file the case whenever someone has already chosen to go to trial, or if the probability of arrival of a behavioral plaintiff is sufficiently high. If the case is filed, an strategic plaintiff always accepts the settlement offer. Equilibrium behavior of strategic plaintiffs resembles the equilibrium in divide-and-conquer strategies identified in the literature (Segal, 1999; Che and Spier, 2008). If the fraction of behavioral plaintiffs is low, the mere capability of the defendant of paying-off future plaintiffs is enough to prevent any filing from strategic plaintiffs.

In Section 3.2, we introduce asymmetric information and study the case in which all settlements are publicly observed. The equilibrium in divide-and-conquer strategies persists if there are not enough behavioral plaintiffs. However, if the fraction of behavioral plaintiff is above a certain threshold our predictions change. In the first two periods, negotiations with a strategic plaintiff look like a signaling game. In any separating equilibrium, the offer by a defendant facing high arrival rate is always accepted by an strategic plaintiff. On the other hand, in the showcase equilibrium, the offer by a defendant that faces low arrival rate is rejected with some positive probability. That is, the inability to settle with a fraction of plaintiffs gives rise to failed negotiations between a privately-informed defendant and strategic plaintiffs (who would have otherwise settled). The defendant facing low arrival trades-off the probability of an agreement for lower offers. Moreover, after observing a settlement, a plaintiff in the second period is relatively more incline to file the case than if offers were always accepted for both types of defendants.

In Section 3.3, we allow the defendant to hide the occurrence of a settlement (and the arrival of the plaintiff involved) from other players. We show that the availability of secret settlements does necessarily benefit the defendant. Privacy regimes are only meaningful in the first period. This is because plaintiff's choices in the last period do not depend on beliefs. In equilibrium, filing decision in the second period cannot depend on whether a settlement was observed in the first period. As a result, an strategic plaintiff's filing decision in the second period depends more closely on the prior belief than when all settlements are public. For a prior low (high) enough, an strategic plaintiff never (always) files in the second period. On the other hand, for intermediate priors filing decision in the second period depends on how often an strategic plaintiff rejects the offer in the first period. This gives raise to multiple equilibria, even when a unique outcome is selected in each negotiation.

As argued before, in the absence of behavioral plaintiffs our model has a unique equilibrium in which the defendant avoids the formation of a collective. This coincides with the equilibrium in divide-and-conquer strategies discussed by Che and Spier (2008) in an static context with complete information.[1] More broadly, this point has also been made in the literature in contracting with externalities (Segal, 1999 and 2003; Segal and Whinston, 2000). Besides considering the effects of exogenous breakdowns in the negotiations, we differ in that our focus is on a dynamic context with a privately-informed defendant.

This paper closely relates to the literature on litigation in dynamic environments. Some papers consider environments with symmetric information (Deffains and Langlais, 2011; Bernhardt and Lee, 2014) while others study private information on the side of the plaintiffs (Che, 1996; Daughety and Reinganum, 2011). For example, Daughety and Reinganum [2011] focus on privately-informed plaintiffs deciding on whether to file a case. The central trade-off for the plaintiffs is between acting early to motivate other plaintiffs to join and waiting to be more informed about the number of other plaintiffs. Private information on the defendant's side is a feature that, to the best of our knowledge, has not been explored.

[1] In addition to the static model with complete information, Che and Spier (2008) consider the following two extensions. First, they consider the case in which bilateral negotiations between the defendant and each plaintiff are sequential instead of simultaneous. Second, they allow for private information on the side of the plaintiffs. Divide-and-conquer strategies are used by the defendant in both extensions, although asymmetric information in the side of the plaintiff generates trials in equilibrium.

The effects of secret settlements have been studied in other environments. Daughety and Reinganum [2005] study a dynamic setting in which consumers choose whether to purchase a product taken into account their beliefs about the likelihood of being harmed by the product. The availability of secret settlements between the firm and harmed consumers results in a privately-informed firm, which gives prices a signaling role. This asymmetric information may reduce demand, making preferable for the firm to commit to only settling publicly. We complement this analysis by focusing on a way in which the secret settlements can influence the litigation itself.

Our paper belongs to the broader literature on collective action in a dynamic environment. A wide array of collective action models have been firstly studied by [Olson, 1965]. Recently, the interest in the dynamics of collective action is mostly related to collective investment with a particular focus on crowdfounding [Alaei et al., 2016]. Two papers are particularly related. Liu [2018] presents a dynamic setting with both, payoffs and information externalities. Investors choose whether and when to invest in a project. Each investor receives a private signal about the probability of success of the project. An investor can enter the project early baring the risk that the project does not receive enough support, but revealing her optimistic view of the prospects of the project. On the other hand, the investor can also wait to observe whether her peers support the project before committing herself. The main difference with our setting is that we consider a party (the defendant) that intervenes (through settlement offers) in the formation of the collective.

In Deb et al. [2019], buyers decide whether purchase a product in a crowdfunding campaign. Buyers face an opportunity cost of purchasing the product and waiting until the the campaign success. Thus, buyers only but if the probability of success is high enough. The arrival rate of buyers is commonly known in their model. Similar to our setting, their model considers players (donors) that intervenes in the actions of buyers (through donations). However, while the objective of donors is to maximize the probability of success of the campaign, the objective of the defendant in our context is to minimize the probability of the collective litigation occurring.

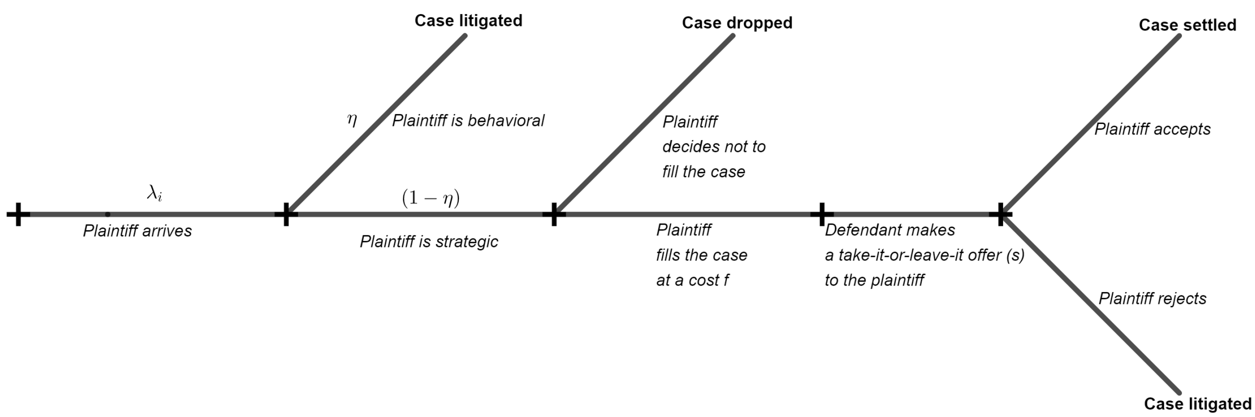
The rest of the paper continues as follows: Section 2 introduces the model, Section 3 presents the analysis and main results. Finally, Section 4 concludes.

2 Model

In case of the commonly studied individual ligation, the outcome of the trial depends mostly on the merit of the case. However, the outcome of a collective litigation depends also on the number of litigants. Firstly, some amount of plaintiffs needs to be reached, in order to file a collective case. Secondly, each new plaintiff may provide some useful evidence and increases the chance of prevailing in the case.

We propose a simple dynamic model of collective litigation. We model the collective litigation as a four-period sequential game between *a defendant* and three potential *plaintiffs*. In period $t = 0$ there is an accident with a random scope (i). The accident has a high scope ($i = H$) with a commonly-known probability μ and a low scope ($i = L$) with probability $1 - \mu$. We suppose

Figure 1: Sequence of events in periods 1-3



that the plaintiff does not observe the scope of the harm, but the defendant does. Therefore, through the paper we refer to the scope of the harm as the characteristic of the defendant. That is, we call a defendant who is liable for an accident with a high (low) scope simply as a high-type (low-type) defendant. In each following period ($t = 1, 2, 3$), with probability λ_i one plaintiff suffers a harm. λ_H is assumed to be larger than λ_L, that is, an accident of high scope is more likely to result in a harm. After arrival the plaintiff decides whether to file the case or not. Filing the case results in a cost f for the plaintiff.[2]

After the case is filed, the plaintiff is approached by the defendant, who makes a take-it-or-leave-it settlement offer (S_t). The offer consists of two variables: the monetary transfer ($s_t \in \mathbb{R}$) and the secrecy regime ($\zeta_t \in \{0, 1\}$, where $\zeta_t = 0$ denotes a secret settlement). After receiving the offer, the plaintiff makes a decision (a_t) on whether to accept it ($a_t = 1$) and settle the case, or to reject it ($a_t = 0$) and litigate the case.

Moreover, we assume that with probability η the plaintiff is *behavioral*. A behavioral plaintiff can be seen as either vengeful or pro-social. He always files the case and rejects any settlement.[3] In contrast, with probability $1 - \eta$ the plaintiff is *strategic* and takes the decisions in order to maximize his expected payoff.

The sequence of events within each period t, for $t = 1, 2, 3$, is presented on Figure 1.

The outcome of the litigation depends on the amount of participants that litigate. We focus on the simplest situation, in which there is a minimal amount of litigants required for the

[2] This cost can be interpreted not only as an administrative cost, but also as an opportunity cost. If the plaintiff decides to file a collective litigation case, he at least temporarily gives up the opportunity to litigate the case individually.

[3] Although the model requires some exogenous probability of settlement failure, the qualitative results do not depend on the particular assumption made. It can be simply assumed that there is some exogenous probability η that the settlement negotiation fails, for example, because the defendant failed to identify the plaintiff.

collective litigation to be successful. The closest collective litigation form to this scenario is a class action, when some amount of representative plaintiffs must be gathered to file the case.[4] When the litigation is successful, the defendant is forced to transfer the compensation $w > f$ to each of the participants. Otherwise, the collective litigation fails and no transfers are realized.[5] We focus on the most interesting scenario, in which the minimal amount of participants is set to 2.[6] We assume that $\lambda_H w > f > \lambda_L w$, that is, if the scope of accident is known to be low the second period plaintiff would never start a collective litigation, but he may consider it if the scope of the harm is high. Overall, the payoff of the defendant is given by $-\big(\sum_t a_t s_t + \mathbb{1}_{k>1} k w\big)$ and the payoff of the period t plaintiff is given by $a_t s_t + (1-a_t)\mathbb{1}_{k>1} w$, where $\mathbb{1}_{k>1}$ is the indicator function taking value of 1 if there is more than 1 litigant at the end of the game, and 0 otherwise.

Unlike the defendant, the plaintiff does not observe the scope of an accident. Instead, he forms a belief about the probability of each state of the world using the Bayes' rule. We denote the probability that the plaintiff arriving in period t and observing some history h_t assigns to the scope of the harm being high by μ_{t,h_t}. We assume that h_t is a pair of two variables: the number of previous litigants (k_t) and the of public settlements by period t (n_t). In other words, we suppose that a plaintiff does not observe the terms of previous settlements, but only a number of publicly settled cases. The plaintiff also updates his beliefs after receiving an offer from the defendant. We denote by $\mu_{t,h_t}(S_t)$ the probability that the t-th period plaintiff gives to the scope of the harm being high after observing a history h_t and an offer S_t.

We solve the game by backwards induction, looking for Perfect Bayesian Equilibria (PBE) satisfying the D1 criterion [Banks and Sobel, 1987]. That is, we look for a strategy profile for all the strategic plaintiffs and the defendant of each type and the beliefs of the plaintiffs, such that the players are sequentially rational and their beliefs follow the Bayes' rule whenever possible. Moreover, we require that when the plaintiffs observe some action of the defendant that has a 0 probability on the equilibrium path, that is, they cannot use the Bayes rule, they believe that it comes from a defendant type who is "more likely" to profit on this action compared to her equilibrium payoff. In practice, the D1 criterion selects the separating equilibrium with the least probability of litigation.

3 Analysis

Before analyzing the fully-fledged model we consider two simpler scenarios. Firstly, we study the game under symmetric information. Secondly, we consider a situation when the information is asymmetric, but all the settlements are public. Only then we move to the most complex case, when secret settlements are allowed.

[4] In the model we allow for the plaintiffs to settle the case even after a minimal amount of the representative plaintiffs has been already reached, which corresponds to an opt-in rule. In the United States an opt-out rule is used instead, that is, once the class action case is filed subsequent plaintiffs are automatically participating in the litigation. However, in terms of payoffs, the choice of participation rule is irrelevant in our model.

[5] The model is easily extendable for the case in which the payoff from the litigation is described by a strictly increasing sequence w_k. However, whether the negotiation at some period t with history h_t result in a separating or a pooling equilibrium depends on the particular choice of the sequence.

[6] If $k = 1$ the model is a simple sequence of ultimatum games. If $k = 3$ only the decision of the first period plaintiff is relevant, hence there is no incentive to manipulate the information for the defendant.

3.1 Symmetric information model

We start the analysis by considering a symmetric information scenario, in which both the plaintiffs and the defendant observe the scope of the harm and hence the probability of arrival (λ) of future plaintiffs.

Clearly, independently of the period analyzed, a strategic plaintiff always files the case if there already is at least one other litigant. He realizes that the case will be certainly successful if he joins the litigation, and the costs of filing the case will be covered. After the case is filed, the negotiation between the plaintiff and the defendant is a simple ultimatum bargaining game. The defendant proposes a settlement transfer equal to w, which is always accepted in the equilibrium.[7] Since the scope of the harm is known, the selected secrecy regime is irrelevant.

If a strategic plaintiff does not observe any past litigants, he files the case only if the proportion of behavioral plaintiffs is sufficiently high. He realizes that if he litigates any future strategic plaintiff will necessarily settle the case; hence the collective litigation can be successful only if at least one behavioral plaintiff arrives. We denote this probability by ρ_t. Naturally $\rho_3 = 0$, and $\rho_t = \lambda\eta + (1 - \lambda\eta)\rho_{t+1}$ for $t < 3$. Once the case is filed, the negotiation is a simple ultimatum bargaining game. The defendant proposes a settlement offer which exactly covers the expected payoff of the plaintiff, that is, $\rho_t w$, and the case is settled in the equilibrium.

The equilibrium of the symmetric information model is summarized in Proposition 1.

Proposition 1. *If $k_t > 0$ a strategic plaintiff files the case independently of the period. After a case is filed, the defendant makes an offer $s_{t,k=1} = w$, which is always accepted by the strategic plaintiff.*
If $k_t = 0$ a strategic plaintiff files the case if and only if $\rho_t \geq \frac{f}{w}$.

Proposition 1 shows that when the information is symmetric the litigation is completely driven by the behavioral plaintiffs. Importantly, it implies that if all the plaintiffs are strategic (that is $\eta = 0$) no case is ever filed independently of how high are λ and w. Each plaintiff realizes that even if he files the case and decides to litigate, future plaintiffs will free-ride on his decision by settling the case. Hence, it is always optimal to drop the case. Moreover, if η is low the probability of successful collective litigation is small. Hence, a strategic plaintiff never files the case unless there are previous litigants. The cut-off values for η are provided in Corollary 1.

Corollary 1. *If $\eta < \frac{1-\sqrt{1-\frac{f}{w}}}{\lambda}$, then no strategic plaintiff files the case unless $k_t > 0$.*
If $\eta \in [\frac{1-\sqrt{1-\frac{f}{w}}}{\lambda}, \frac{f}{w\lambda})$, then a first-period strategic plaintiff always files the case, but a second-period strategic plaintiff files the case only if $k_2 = 1$.
If $\eta > \frac{f}{w\lambda}$ then a strategic plaintiff in periods 1 and 2 always files the case.

It is worth observing that in standard individual litigation models the settlement can be seen as a positive outcome. It allows the plaintiff to be compensated for the harm by the

[7] To be precise, if $k_3 = 2$ there are two possible outcomes of the sub-game in the final period. One in which the final plaintiff settles the case, and one in which he litigates the case. Since they result in the same payoffs for all the players, we ignore the latter possibility.

defendant without incurring litigation costs for both parties and the state. However, in the context of collective litigation this assertion is not necessarily correct. Indeed, if all the plaintiffs were represented by a single lawyer who negotiates settlement terms on their behalf (as it may happen in class action), it could be socially beneficial to settle the case. But, in our model, the defendant settles the case with each plaintiff separately and is capable of preventing collective litigation. In fact, the mere capability of the defendant of paying-off future plaintiffs is enough to prevent any case from being filed.[8]

3.2 Asymmetric information with public settlements

Before we introduce the possibility of manipulating the information, we study a simpler case in which the information is asymmetric, but all the settlements are public. We focus on the scenario in which $\eta \geq \frac{f}{\lambda_H w}$, that is, we assume that there exist beliefs sufficiently high for a strategic plaintiff to file the case even if no previous litigants are observed. We denote the difference between arrival rates by $\Delta\lambda \equiv \lambda_H - \lambda_L$. Moreover, to ensure uniqueness of the equilibrium we assume that $1 - \lambda_L > \lambda_H$.[9]

Some results from the model with symmetric information still hold. Particularly, in period 3 there is no uncertainty about future arrivals, hence, a strategic plaintiff files the case only if $k_3 > 0$ and settles it for a transfer of w. Similarly, if a strategic plaintiff arriving in period 2 observes a past litigant, that is, $k_2 = 1$, he does not face any uncertainty about his payoff. Hence, he always files the case and settles it for a transfer w.

However, if no past litigants are observed in early periods, the results from the symmetric information model no longer hold. Consider a strategic plaintiff who arrives in period 1 or 2. He realizes that even if he decides to litigate, a strategic plaintiff in the future will always settle the case. Therefore, the litigation can be successful only if a behavioral plaintiff arrives. Similarly to subsection 3.1 we denote the probability of arrival of at least one behavioral plaintiff in the future periods conditional on the state of the world i, by ρ_t^i, where $\rho_3^i = 0$, and $\rho_t^i = \lambda_i\eta + (1 - \lambda_i\eta)\rho_{t+1}^i$ for $t < 3$. The difference between these probabilities in each state of the world is denoted by $\Delta\rho_t \equiv \rho_t^H - \rho_t^L$. Since the probability of arrival of a new behavioral plaintiff is higher when the scope of the accident is large than when the scope is low, the case is filed only when he assigns sufficiently large probability to the scope of the harm being high.

When the case is filed the defendant would like to achieve a settlement with a high probability at a low offer. Naturally, the offers a strategic plaintiff is willing to accept depend on his belief about the state of the world. In particular, if the plaintiff believes that the scope of the harm is low, he is willing to accept relatively small offers. As a result, the defendant always has an incentive to pretend that scope of the harm is low. However, in the equilibrium, a plaintiff can recognize the scope of the harm based on the offer made by the defendant. Since when the scope of the harm is low the defendant does not expect many future litigants to arrive, her expected cost of failing in achieving a settlement is small compared to the defendant of a high type.

[8] This problem is discussed more in details in Che and Spier [2008].

[9] This condition ensures that the marginal cost for the defendant of an additional plaintiff joining the litigation is always higher when the scope of harm is high than when it is low. If this assumption is violated, for some choices of η no separating equilibrium exists, but there are multiple pooling equilibria satisfying the D1 criterion.

Hence, she is more willing to risk a rejection of her offer. To be precise, in the equilibrium the defendant of each type makes an offer exactly compensating the expected payoff of the plaintiff in the realized state of the world. The plaintiff always accepts the offer coming from the high-type defendant, but he rejects the offer coming from the low-type defendant with some positive probability.

The outcome of the litigation strongly depends on the plaintiff's prior μ. A strategic plaintiff can anticipate the outcome of the negotiation, he realizes that he will be always compensated for his expected payoff under litigation. Hence, if a strategic plaintiff does not hold a strong belief that the scope of the harm is high, he will decide to drop the case, unless there are previous litigants. In order to simplify the exposition we describe the decision of the strategic plaintiff in terms of the likelihood ratio l_{t,h_t}:

$$l_{t,h_t} \equiv \frac{\mu_{t,h_t}}{1-\mu_{t,h_t}}. \tag{1}$$

To be precise, a strategic plaintiff arriving in period $t < 3$ and observing some history $h_t = (0, n_t)$ files the case only if the likelihood ratio of his beliefs is above a threshold $\check{l}_t$:

$$\check{l}_t \equiv \frac{\frac{f}{w} - \rho_t^L}{\rho_t^H - \frac{f}{w}}. \tag{2}$$

The numerator of (2) represents the expected payoff of the plaintiff if the scope of the harm is low, and the denominator the expected payoff of the plaintiff if the scope of the harm is high. Note that, $\check{l}_1$ can be negative for some parametrizations of the model, but $\check{l}_2$ is always positive. That is, it can be that the first period plaintiff files the case independently of his beliefs, but the second period plaintiff always decides to do so only if he assigns a sufficiently high probability to the scope of the harm being high.

Since the plaintiff arriving in the first period can face only one history, that is, his own arrival, it is easy to see that he will always decide to file the case if and only if the likelihood ratio of the prior ($l \equiv \frac{\mu}{1-\mu}$) is above a threshold $\hat{l}$:

$$\hat{l} \equiv \frac{\lambda_L}{\lambda_H}\check{l}_1. \tag{3}$$

However, the second-period strategic plaintiff's decision may depend on the history. Naturally, if the prior value is sufficiently low, the second-period strategic plaintiff will always decide to drop the case unless $k_2 = 1$. To be precise, if a second-period strategic plaintiff finds it unlikely that the scope of the harm is high even after observing an arrival in period 1, he never starts a litigation. In other words, if l is below a threshold $\underline{l}$ the second-period strategic plaintiff never files the case, unless $k = 1$, for:

$$\underline{l} \equiv \frac{\lambda_L^2}{\lambda_H^2}\check{l}_2. \tag{4}$$

Analogously, if the prior is sufficiently high, the second-period plaintiff always files the case. To be precise, the prior must be high enough for the plaintiff to believe that the case is worth litigation, even if he observes only his own arrival. In other words, if the likelihood ratio of the prior is above a threshold $\bar{l}$, the second period plaintiff always files the case, for:

$$\bar{l} \equiv \frac{\lambda_L(1-\lambda_L)}{\lambda_H(1-\lambda_H)}\check{l}_1. \tag{5}$$

Note that $\bar{l} > \hat{l}$, that is, if the second-period plaintiff always files the case, then a first-period plaintiff also always files the case. However the relation between $\underline{l}$ and $\hat{l}$ depends on the particulars of the model. If λ_L is sufficiently close to λ_H, then $\underline{l} > \hat{l}$. That is, there exists a range of priors for which the first-period plaintiff always files the case, but a second period-plaintiff never does. It happens whenever information about the scope is less relevant than the amount of periods during which a behavioral plaintiff may arrive. Whenever λ_H and λ_L are far apart $\underline{l} < \hat{l}$. Naturally, in this situation the second-period plaintiff may observe $h_2 = (0,0)$ even when a plaintiff in the first period arrived, but decided not file the case. Hence, the beliefs of the second-plaintiff observing a history $h_2 = (0,0)$ are higher if $l < \underline{l}$, than if $l \geq \underline{l}$. However, they are never high enough for the strategic plaintiff in the second period to start a litigation.

The prior influences not only the decision of a strategic plaintiff to file the case, but also the probability of the settlement negotiation failing. In particular, the probability of rejecting the low offer in the first period depends on the prior level. It happens because in any PBE satisfying the D1 criterion, the probability of rejection of a low offer is just high enough to ensure that the defendant of a high type prefers certain settlement at the high offer to risking litigation and making a low offer. When the prior is low, the threat of litigation is more efficient in the first period, since without a past litigant a second-period plaintiff does not file the case. Hence, the probability of rejection of the low offer is smaller. To be precise, we denote by $\underline{p}_{1,0}$ the probability of rejecting the low offer in the first period, which makes the defendant of the high type indifferent between making the high and low-offer when the second-period strategic plaintiff never starts the litigation:

$$\underline{p}_{1,0} \equiv \frac{\Delta\rho_1}{\Delta\rho_1 + 2\lambda_H(1-\lambda_H\eta)}. \tag{6}$$

Analogous probability, when the second-period strategic plaintiff always files the case is denoted by $\bar{p}_{1,0}$:

$$\bar{p}_{1,0} \equiv \frac{\Delta\rho_1}{\Delta\rho_1 + 2\lambda_H(1-\lambda_H\eta) - \lambda_H^2\eta(1-\eta)}. \tag{7}$$

The equilibrium is described in details in Proposition 2.

Proposition 2. *In any PBE equilibrium satisfying the D1 criterion, when only public settlements are available and $k_t > 0$, a strategic plaintiff files the case independently of the period. After the case is filed, the defendant makes an offer $s_{t,k=1} = w$, which is always accepted by the strategic plaintiff.*
If $k_t = 0$:

(i) a strategic plaintiff arriving in period 3 never files the case,

(ii) a strategic plaintiff arriving in period $t = 1,2$ files the case if and only if $l_{t,h_t} \geq \check{l}_t$. After the case is filed the defendant makes an offer $s^i_{t,0} = \rho^i_t w$. The offer $s^H_{t,0}$ is always accepted by the strategic plaintiff, but the offer $s^L_{t,0}$ is rejected with probability $p_{t,0}$, where $p_{2,0} = \frac{\Delta\rho_2}{\Delta\rho_2+\lambda_H}$; $p_{1,0} = \underline{p}_{1,0}$, if $l \geq \bar{l}$, and $p_{1,0} = \bar{p}_{1,0}$ otherwise.

3.3 Asymmetric information with endogenous secrecy regime

In this subsection we allow for the secrecy regime to be endogenously determined. That is, while making an offer the defendant chooses not only a transfer size (s_t) but also decides whether the potential settlement will be public (ζ_t).

Allowing for private settlements does not influence the decision of the plaintiff in the final period, since he does not face any uncertainty about the payoff. Hence, a strategic plaintiff in period 3 files the case if and only if at least one previous litigant is observed, and always settles it at w. Since the decision of the plaintiff in the final period is independent from the scope of the harm, but depends only on the number of litigants, the choice of secrecy regime in period 2 is irrelevant. From the perspective of the defendant it is irrelevant if the settlement is private or public, it is only relevant that it is reached.

However, the decision on the privacy regime in the initial period plays an important role. Te strategic plaintiff in period 2 starts the litigation only if he assigns sufficiently high probability to the scope of the harm being high. Hence, the defendant profits when the scope of the harm appears to be low.

Naturally, the choice of the privacy regime matters only for some range of prior beliefs. If the prior is very low ($l < \underline{l}$), the second-period strategic plaintiff never start the litigation. Analogously, if the prior is sufficiently high ($l \geq \bar{l}$), the second-period plaintiff always files the case. However, in-between these extremes there is a potential for influencing the decision of the second-period plaintiff through the secrecy regime.

Yet, in the equilibrium, any attempt to change the behavior of the second-period plaintiff must fail. In other words, if the secrecy regime is endogenous, the decision of the second period plaintiff must be independent from observing a previous settlement (that is, it must independent from the realization of n_2). To illustrate why this must be the case, suppose that the strategic plaintiff in the second period starts the litigation if and only if he observes a previous arrival. Naturally, the high-type defendant would then always settle the case privately, in order to limit future litigation. On the contrary, the low-type defendant would always make a public settlement offer. Since she faces a low probability of any subsequent plaintiff arriving, the possibility of the case being filed in the second period is not very costly for her. Therefore, she would prefer to signal her type to the first-period plaintiff and ensure a certain settlement through choosing a public settlement. However, if only the low-type defendant settles the case publicly in the first period, the second-period plaintiff would never file the case after observing $n_2 = 1$.

Since a second-period plaintiff never conditions his decision on observing a settlement in a previous period, his behavior depends on the prior belief even more than in the model with only public settlements available. If he holds a prior high enough, he will always file the case in the second period. We refer to this type of an equilibrium as a *high litigation equilibrium*. On the contrary, if the prior is low, the second-period strategic plaintiff never starts the litigation. We refer to this type of an equilibrium as a *low litigation equilibrium*. The prior threshold above which the second-period plaintiff always files the case depends on the first-period negotiation process itself. In particular, it is influenced by the probability with which the first-period strategic plaintiff rejects the low offer. The higher is this probability the less likely it is that the defendant manages to achieve a settlement when the scope of the harm is low. Hence, the second-period plaintiff holds a stronger belief that lack of litigants results from a successful settlement with a high-type defendant and is more willing to start the litigation. To be precise, if the probability of rejecting the low offer during the first-period negotiation is p, then the second-period strategic plaintiff always files the case if and only if $l \geq \tilde{l}(p)$, and never starts the litigation otherwise, for

$$\tilde{l}(p) \equiv \check{l}_2 \frac{\lambda_L\big(1-\lambda_L\eta - p\lambda_L(1-\eta)\big)}{\lambda_H\big(1-\lambda_H\eta\big)}. \tag{8}$$

The equilibrium is described in details in Proposition 3.

Proposition 3.

(a) If $l \leq \tilde{l}(\underline{p}_{1,0})$ there exists a PBE satisfying the D1 criterion called a low litigation equilibrium, in which:

(i) If $k_t > 0$ any strategic plaintiff always files the case. After the case is filed the defendant makes an offer with a monetary transfer $s_{t,k=1} = w$, which is always accepted by the plaintiff.

(ii) A strategic plaintiff arriving in the first period files the case if and only if $l \geq \check{l}_1$. After the case is filled, the defendant makes an offer with a transfer $s^i_{1,0} = \rho^i_1 w$. The offer $s^H_{1,0}$ is always accepted by the strategic plaintiff, and the offer $s^L_{1,0}$ is rejected with probability $\underline{p}_{1,0}$.

(iii) If $k_t = 0$, a strategic plaintiffs arriving in the second or third periods never files the case.

(b) If $l \geq \tilde{l}(\bar{p}_{1,0})$ there exists a PBE satisfying the D1 criterion called a high litigation equilibrium, in which:

(i) If $k_t > 0$ any strategic plaintiff always files the case. After the case is filed the defendant makes an offer with a monetary transfer $s_{t,k=1} = w$, which is always accepted by the plaintiff.

(ii) If $k_t = 0$ a strategic plaintiffs arriving in the first or second period always files the case. After the case is filled, the defendant makes an offer with a transfer $s^i_{t,0} = \rho^i_t w$. The offer $s^H_{t,0}$ is always accepted by the strategic plaintiff, and the offer $s^L_{t,0}$ is rejected with probability $p_{t,0}$, where $p_{1,0} = \bar{p}_{1,0}$, and $p_{2,0} = \frac{\Delta\rho_2}{\Delta\rho_2 + \lambda^H}$.

(iii) If $k_3 = 0$ a strategic plaintiff in the third period never files the case.

No other PBE satisfying the D1 criterion, in which the decision of a strategic plaintiff on whether to file the case is binary, exists.

The exact choice of secrecy regime cannot be pinned down in the equilibrium. To be precise, any pair of probabilities of making a public settlement offer by each type of the defendant in period 1 can be sustained as an element of some PBE satisfying the D1 criterion, as long as the decision of the second-period plaintiff is unaffected by the choice of the secrecy regime in the first period. Figure 2 presents a set of pairs of probabilities (q^H,q^L) of proposing a public settlements that can be an element of an equilibrium. In particular, a decision to always settle the case secretly can always be supported as an element of the equilibrium. It implies that introducing the possibility of settling the case privately is equivalent in terms of payoffs to allowing only secret settlements. This result is summarized in Corollary 2.

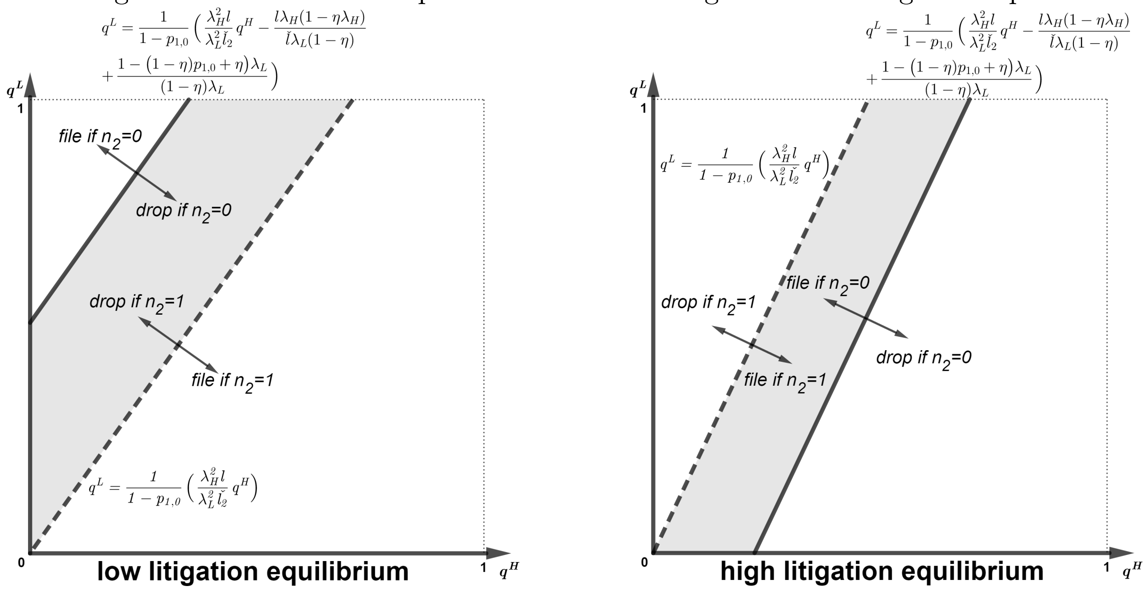
Corollary 2. *Any PBE satisfying the D1 criterion of the game with endogenous secrecy regime is payoff-equivalent to some PBE satisfying the D1 criterion of the game in which only secret settlements are available.*

Importantly, Corollary 2, does not state that only secret settlements have to be used on the equilibrium path. For example, there always exists an equilibrium in which the defendant of at least one type always settles the case publicly. Yet, if secret settlements are available observing history of past settlements never changes the decisions of the plaintiffs, and they behave as if all the settlements had been secret.

Note that $\tilde{l}(\bar{p}_{2,0}) < \tilde{l}(\underline{p}_{2,0})$, and there is a region of prior values for which the low- and high-litigation equilibra coexist. Naturally, on this region there also exist equilibria in which the second period strategic plaintiff starts the litigation with any probability. To simplify the analysis, we focus only on the equilibria in which the decision to file the case is binary. The multiplicity can be seen as an example of "self-fulfilling prophecy". Suppose that the agents during the first-period negotiation conjecture that a second-period plaintiff always files the case. Then the probability of rejecting a low offer must be high, in order to prevent the high-type defendant from making it. Hence, it becomes unlikely that the low-type defendant ensures a settlement in period 1, and the second-period plaintiff assigns larger probability to the scope of the harm being high whenever he observes no previous litigants (that is, $k_2 = 0$). As a result, he always files the case and the conjecture of the agents in the first period is correct. On the contrary, if the agents during the first-period negotiation believe that a second-period strategic plaintiff never starts the litigation, the probability of rejecting the low offer can be small. As a result the second-period plaintiff finds it likely that observing no litigants follows from the low-type defendant settling the case in the previous period. Hence, he indeed does not file the case.

Figure 2 presents the decision of a second-period strategic plaintiff as a function of probabilities with which the defendant of each type proposes a public settlement (q^H, q^L). The dashed line going through the origin represents the ratio of q^H and q^L for which a second period strate-

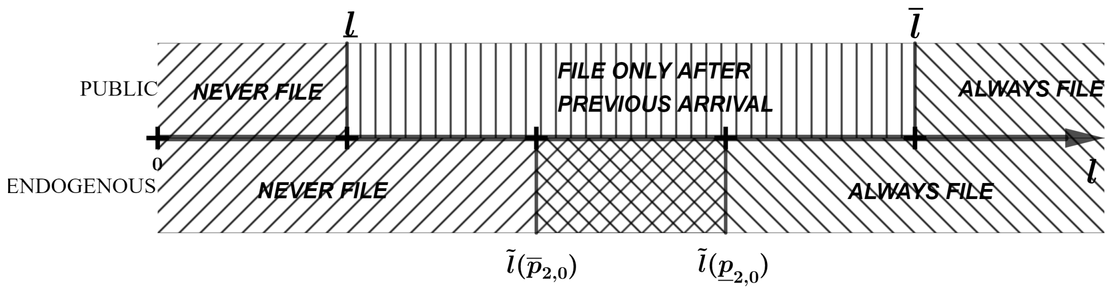
Figure 2: Probabilities of public settlement in high- and low litigation equilibria



gic plaintiff is indifferent between filing and dropping the case if a public settlement in the first period is observed. For all the combinations of q^H to q^L to the south-east of the dashed line the high-type defendant is relatively more likely to settle the case publicly than the low-type defendant and a second period plaintiff always files the case after observing a public settlement. The opposite is the case for points to the north-west of the dashed line. Analogously, the solid line represents the combinations of q^H and q^L for which a second period strategic plaintiff is indifferent between filing and dropping the case if he observes no previous arrival. Now, moving to the north-west would result in the plaintiff always filing the case upon observing no arrival, and moving to the north-east in always dropping the case in this situation. Since in the equilibrium the decision of a second period strategic plaintiff must be independent from realization of n_2, only the strategies represented by the shaded area in-between the solid and the dashed lines can be supported as a part of some equilibrium. When the solid line is above the dashed line (as on the left graph) there exist low-litigation equilibria. When the opposite is true (as on the right graph) there exist high-litigation equilibria.

Figure 3 presents the comparison of a second-period strategic plaintiff's decision in two versions of the model. The upper part of the figure represents the decision of a second-period strategic plaintiff when all the settlements are public, and the lower part of the figure represent this decision when the secret settlements are available. Naturally, if $l \le \max\{\hat{l}, \underline{l}\}$, (that is, the second-period strategic plaintiff never starts litigation even when all the settlements are public), or if $l \ge \bar{l}$ (that is, the second period plaintiff always files the case even when all the settlements are private), the equilibrium path and the payoffs of the players remain unchanged. However, in-between these extremes the outcome of the game changes. To be precise, in when all settlements are public a second-period strategic plaintiff conditions his decisions on the realization of n_2, whereas if private settlements are available he always takes the same decision. In particular, when $l < \tilde{l}(\bar{p}_{2,0})$ he never starts the litigation, and when $l > \tilde{l}(\underline{p}_{2,0})$ she always starts the litigation. For values of $l \in [\tilde{l}(\bar{p}_{2,0}), \tilde{l}(\underline{p}_{2,0})]$ both behaviors can be supported as a part of equilibrium path.The

Figure 3: Comparison of the decisions of the stratigic plaintiff in period 2 if $k_2 = 0$.



effect of availability of secret settlements on the payoffs of the player strongly differ between the low- and high-litigation equilibria. We begin by analyzing the first case.

In the low-litigation equilibrium, the defendant gains on introducing the possibility of settling the case. There is a direct effect of a strategic plaintiff in the second period never starting the litigation. Due to it, the defendant never has to pay the compensation to him or litigate against him. Moreover, there is also an indirect effect of the change in the behavior of a second-period plaintiff on the negotiation process in the first period. In particular, a first-period plaintiff accepts a low offer with a higher probability. Hence, the defendant gains also on limiting the probability of the litigation in the first period.

A plaintiff in the first period remains unaffected by introducing the possibility of settling the case secretly. However, a second-period plaintiff looses on it. Firstly, both a strategic and a behavioral plaintiff are less likely to face a previous litigant. Secondly, a strategic plaintiff has now less information to evaluate the scope of the harm. Thus, it happens more often that he drops the case even though the scope of the harm is high. Also a plaintiff in the final period of the game looses on introducing the possibility of settling the case secretly. Since the negotiation in the first period fails less often, and a second-period strategic plaintiff never even files the case, a plaintiff in the final period is less likely to face previous litigants and obtain a compensation from the defendant.

On the contrary, in the high-litigation equilibrium, the defendant would be better-off if he could commit to always settling the case publicly. Then, a second-period strategic plaintiff could always distinguish a history in which there was a previous arrival from a history in which no arrival happened, and he will file the case only in the first scenario. However, if the privacy regime is endogenous when the defendant faces a strategic plaintiff in the first period, it is tempting for her to settle the case privately. Hence, a plaintiff in the second period cannot distinguish between the histories with sufficient precision and he always files the case.

Similarly to the low-litigation equilibrium a first-period plaintiff is not affected by endogenizing the secrecy regime in high-litigation equilibrium, but a second-period strategic plaintiff loosing when secret settlements are allowed. He receives less information through observing the history, and more often files the case in the low state of the world. Interestingly, both a strategic and the behavioral plaintiff in the final period of the game are better-off when a secret

Table 1: Payoff changes after allowing for secret settlements

	Low-litigation	High-litigation
2nd period behavioral plaintiff	$-\Delta p_{1,0}\lambda_L(1-\eta)^2 w < 0$	0
2nd period strategic plaintiff	$-\mu\lambda_H(1-\eta)(\rho_H^2 w - f)$ $-(1-\mu)\lambda_L\Delta p_{1,0}(w-f)$ $+(1-\mu)\lambda_L(1-\eta)(1-\bar{p}_{1,0})(f-\rho_L^2 w) < 0$	$\mu(1-\lambda^H)(\rho_2^H w - f)$ $-(1-\mu)(1-\lambda_L)(f-\rho_2^L w) < 0$
3rd period behavioral plaintiff	$-\Big((\Delta p_{1,0}\lambda_L(1-\eta)(1-\lambda_L\eta)$ $+\big(\lambda_L(1-\eta)\big)^2(1-\bar{p}_{1,0})p_{2,0}\Big)w < 0$	$(1-\mu)(1-\lambda_L)\lambda_L p_{2,0} w > 0$
3rd period strategic plaintiff	$-\Big((\Delta p_{1,0}\lambda_L(1-\eta)(1-\lambda_L\eta)$ $+\big(\lambda_L(1-\eta)\big)^2(1-\bar{p}_{1,0})p_{2,0}\Big)(w-f) < 0$	$(1-\mu)(1-\lambda_L)\lambda_L(1-\eta)p_{2,0}(w-f) > 0$
defendant	$\mu\big(\lambda_H(1-\eta)\big)\rho_2^H w$ $+(1-\mu)\lambda_L(1-\eta)\Big(\Delta p_{1,0}(2\lambda_L(1+\eta)-(\lambda_L\eta)^2-\rho_1^L)$ $+(1-\bar{p}_{1,0})\lambda_L(1-\eta)\lambda_L(\eta+p_{2,0})\Big)w > 0$	$-\mu(1-\lambda_H)\lambda_H(1-\eta)\rho_2^H w$ $-(1-\mu)(1-\lambda_L)\lambda_L(1-\eta)(\rho_2^L w + p_{2,0}\lambda_L w) < 0$

settlements are allowed. Since a second-period plaintiff is more likely to file the case conditional on the scope of the harm being low, the negotiation in the second period fail more often and a plaintiff in the final period is more likely to face a previous litigant. The changes in *a priori* expected payoffs of the players are presented in Table 1. To simplify the expressions we denote the difference in the probability of rejection of the low offer in the first period in high- and low-litigation equilibria by $\Delta p_{1,0} \equiv \frac{\Delta\rho_1}{\Delta\rho_1+2\lambda_H(1-\lambda_H\eta)-\lambda_H\eta(1-\eta)} - \frac{\Delta\rho_1}{\Delta\rho_1+2\lambda_H(1-\lambda_H\eta)}$.

4 Conclusion

We study the dynamics of settlement negotiations between a privately-informed defendant and several potential plaintiffs arriving over time. We propose a model in which a defendant faces random arrival of plaintiffs over three periods. In each period, one plaintiff can arrive with some exogenous probability known to the defendant but not the plaintiffs. The outcome of the litigation depends on the amount of plaintiffs litigation, in particular, we assume that there is a minimal amount of plaintiffs required for the litigation to be successful. We suppose that there are two types of plaintiffs. A behavioral plaintiff always litigates, and a strategic plaintiff decides on whether to file the case, and then negotiates settlement with a defendant.

We show that if the fraction of behavioral plaintiffs is low, the mere capability of the defendant of paying-off future plaintiffs is enough to prevent any filing from strategic plaintiffs. However, if the fraction of behavioral plaintiffs is sufficiently high, the strategic plaintiffs will file the case. Moreover, pre-trial negotiations with strategic plaintiffs may fail, and the collective litigation can succeed. Additionally, we study the effects of private settlements in this context. We show that introducing a possibility of settling the case privately, is equivalent in terms of payoffs to only secret settlements being present. When the case can be settled privately, some plaintiffs receive less information and it becomes more difficult for them to learn about the scope of the harm. In particular, the plaintiffs do not change their decision on whether to file a case based on the history of past settlements. Importantly, the defendant gains on availability of private settlements when the plaintiffs hold a low prior about the arrival rate, but looses on it in the opposing scenario.

Several extensions are left for future research. First, it is relevant to verify the robustness of the model when there are more than 3 periods and the litigation payoff is strictly increasing in the amount of litigants. From our early results we conjecture that in this setting the late periods of the game the negotiations are more likely to fail. However, in the early periods of the game only pooling equilibria exist and the settlement can always be reached. On one hand, it suggests that the collective litigation is strongly driven by the behavior of the late plaintiffs. On the other hand, it implies that the effect of secret settlements is especially relevant in the early period, since the observed history influence both the decision on whether to file the case and the outcome of the negotiation. Second, in our analysis we ignore the role of attorneys. In fact, our model suggests that the attorneys may play much more relevant role in collective litigation than in individual litigation. In particular, apart from providing their services and expertise, they may limit the ability of the defendant to exploit the plaintiffs through sequential settlements by joining the cases and handling the negotiation on behalf of multiple litigants.

A Proofs

Proof of **Proposition 1**.

In the final period there is no uncertainty, and the negotiation, whenever the plaintiff files the case, is a simple ultimatum bargaining game. That is, if $k = 0$ an offer $s_3 = 0$ is made and accepted by a strategic plaintiff. If $k > 0$ an offer $s_3 = w$ is made an accepted by a strategic plaintiff. Since $0 < f < w$, the case is filed if and only if $k > 0$.
Using backwards induction, if $k_2 = 0$, the plaintiff in the second period expects a payoff of $\lambda\eta w$ from litigation. Hence, if the case is filed, in the equilibrium the defendant makes an offer $\lambda\eta w$ and a strategic plaintiff accepts it. What follows is that the strategic plaintiff files the case if and only if $\eta \geq \frac{f}{\lambda w}$, that is $\rho_2 \geq \frac{f}{w}$.
Analogs reasoning applies in period 1. ■

Proof of **Proposition 2**
Proposition 2 is proved by backward induction in lemmas 1 – 4.

Lemma 1. *In period 3 a strategic plaintiff files the case if and only if $k_3 > 0$. If he files the case, it is always settled for w.*

Since the game in the final period is a simple ultimatum bargaining game the proof is omitted.

Lemma 2. *In period 2, if $k_2 = 1$ a strategic plaintiff always files the case and settles it for w.*

Lemma 2 is the direct consequence of a fact that if there are two participants of the litigation the litigation is necessarily successful and yields a known payoff of w to the plaintiff.

Lemma 3. *In period 2, if $k_2 = 0$ in any PBE satisfying D1 criterion:*

(i) the defendant of type i makes an offer $s^i_{2,0} = \lambda_i \eta w$,

(ii) the plaintiff's beliefs satisfy $\mu(s^L_{2,0}) = 0$, and $\mu(s) = 1$ for any $s \in (s^L_{2,0}, s^H_{2,0}]$.

(iii) the plaintiff accepts any offer $s \geq s^H_{2,0}$, rejects any offer $s \in (-\infty, s^H_{2,0}) - \{s^L_{2,0}\}$, and rejects an offer $s^L_{2,0}$ with probability $p_{2,0} = \frac{\Delta\rho_2}{\Delta\rho_2 + \lambda_H}$.

Lemma 3 is proved in claims 1-3

Claim 1. *The described equilibrium is a PBE satisfying the D1 criterion.*

Proof. Simple inspection shows that the equilibrium is indeed a PBE: the plaintiff's beliefs are consistent, and the plaintiff is best responding to his beliefs. Given the response of the plaintiff, there is no profitable deviation for the defendant.
In order to show that the equilibrium satisfies the D1 criterion it is enough to prove that the high type is not deleted for any strategy $s \in (s^L_{2,0}, s^H_{2,0})$. That is, a plaintiff can assign a positive probability for the scope of harm being high if an offer $s \in (s^L_{2,0}, s^H_{2,0})$ is observed.

Take any such an offer s, then the high type is weakly better off making it if it is rejected with probability at most $p^H(s) \equiv \frac{p_{2,0}(w\lambda_H(1+\eta)-s^L_{2,0})-(s-s^L_{2,0})}{w(1+\lambda_H)(1+\eta)-s}$. The low type is strictly better off making this offer if it is rejected with probability at most $p^L(s) \equiv \frac{p_{2,0}(w\lambda_L(1+\eta)-s^L_{2,0})-(s-s^L_{2,0})}{w(1+\lambda_L)(1+\eta)-s}$. Since $p^H(s) \geq p^L(S)$ the equilibrium satisfies the D1 criterion. ■

Claim 2. *There is no PBE satisfying the D1 criterion in which the high-type defendant makes an offer $s < s^H_{2,0}$ with positive probability.*

Proof. Take some PBE in which some offer $s < s^H_{2,0}$ is made with a positive probability by the high-type defendant. Then, it must be the case that this offer is accepted with some positive probability $1 - p(s)$. Since it is always the best-response of the plaintiff to accept any offer $s > s^H_{2,0}$, otherwise the high-type defendant would have a profitable deviation of offering $s^H_{2,0} + \varepsilon$ and ensuring settlement. Since $p(s) < 1$ it must be the case that the plaintiff assigns a positive probability to s being made by the low-type defendant. Hence, in the equilibrium, the offer s has to indeed be made with a positive probability also by the low-type defendant.
Observe that there can exist only one such an offer. Suppose there are more, and denote any two of them by s_1 and s_2. Then it must be the case that both the high type and the low type must be indifferent in between making the offers, that is:

$$(1 - p(s_1,))s_{1,0} + p(s_1)w(1+\eta)\lambda_i = (1 - p(s_2))s_2 + p(s_2)w(1+\eta)\lambda_i \quad \text{for } i = H, L, \tag{9}$$

which yields a contradiction.
Take some offer $s' = s^L_{2,0} + \varepsilon$ which is not made on the equilibrium path. Then the high-type defendant is better off making the offer s' than under her equilibrium payoff if and only if it is rejected with probability at most $p^H(s') \equiv \frac{(1-p(s))s+p(s)(\lambda_H(1+\eta)w)-s'}{\lambda_H(1+\eta)w-s'}$. The low type is better off making the offer s' than under her equilibrium payoff if and only if it is rejected with probability at most $p^L(s') \equiv \frac{(1-p(s))s+p(s)(\lambda_L(1+\eta)w)-s'}{\lambda_L(1+\eta)w-s'}$. Since $p^L(s') < p^H(s')$, if the equilibrium satisfies the D1 criterion, then $\mu_{2,h_2}(s') = 0$. But then the offer s' is accepted by the plaintiff with probability 1 and the defendant has a profitable deviation. ■

Claim 3. *The described equilibrium is the unique PBE satisfying D1 criterion.*

Proof. A consequence of Claim 2 is that the high type always makes an offer $s^H_{2,0}$ in any PBE satisfying D1. Moreover, since the unique best response of a plaintiff is to always accept any offer $s > s^H_{2,0}$, the offer $s^H_{2,0}$ must also always be accepted on the equilibrium path. Otherwise the defendant of a high type would have a profitable deviation of making an offer $s^H_{2,0} + \varepsilon$.
Observe that the low type cannot make any offer $s \in (s^L_{2,0}, s^H_{2,0})$ on the equilibrium path. Otherwise, the equilibrium beliefs of the plaintiff would be $\mu_{2,h_2}(s) = 0$ and it would be always accepted. Hence the high-type defendant would have a profitable deviation of making an offer s. Any offer $s > s^H_{2,0}$ cannot be an element of the equilibrium path, since the defendant would have a profitable deviation of making an $s - \varepsilon > s^H_{2,0}$. An equilibrium in which the low-type defendant makes an offer $s^H_{2,0}$ cannot satisfy the D1 criterion. The proof follows exactly the proof of Claim 2 and is omitted.
Take some separating equilibrium in which the high-type defendant makes an offer $s^H_{2,0}$ and the low type makes an offer $s^L_{2,0}$. Observe that there cannot exist an equilibrium in which the

offer $s^L_{2,0}$ is rejected with probability smaller than $p_{2,0}$, since the high-type defendant would have a profitable deviation of making the offer $s^L_{2,0}$. Hence, take some equilibrium in which the offer $s^L_{2,0}$ is rejected with some probability $p > p_{2,0}$, and consider some offer $s = s^L_{2,0} + \varepsilon$. The defendant of the low type is better off making an offer s than under her equilibrium payoff if it is rejected with probability at most $p^L(s) \equiv \frac{p\lambda_L(1+\eta)w+(1-p)s^L_{2,0}-s}{\lambda_L(1+\eta)w-s}$. The defendant of the high type is better off making an offer s than under her equilibrium payoff it is rejected with probability at most $p^H(s) \equiv \frac{s^H_{2,0}-s}{\lambda_H(1+\eta)w-s} = \frac{p_{2,0}\lambda_L(1+\eta)w+(1-p_{2,0})s^L_{2,0}-s}{\lambda_H(1+\eta)w-s}$. Hence, $\lim_{s\to s^L_{2,0}} p^H(s) = p_{2,0}$ and $\lim_{s\to s^L_{2,0}} p^L(s) = p$. Thus, there exists s small enough such that $p^L(s) < p^H(s)$. Therefore $\mu_{2,h_2}(s) = 0$ and the offer s is always accepted by the plaintiff. Hence, the defendant has a profitable deviation of making the offer s.
Note that the proof applies also for any equilibrium in which the low-type defendant makes an offer $s < s^L_{2,0}$. ∎

Lemma 4. *In period 1 in any equilibrium satisfying the D1 criterion:*

(i) the defendant of type i makes an offer $s^i_{1,0} = \rho^i_1 w$,

(ii) the plaintiff's beliefs satisfy $\mu(s^L_{1,0}) = 0$, and $\mu(s) = 1$ for any $s \in (s^L_{2,0}, s^H_{2,0}]$,

(iii) the plaintiff accepts any offer $s \geq s^H$, rejects any offer $s \in (-\infty, s^H_{2,0}) - \{s^L_{2,0}\}$, and rejects an offer $s^L_{2,0}$ with probability $p_{1,0} = \frac{\Delta\rho_1}{\Delta\rho_1+2\lambda_H(1-\lambda_H\eta)}$, if $\mu \geq \underline{l}$, and $p_{1,0} = \frac{\Delta\rho_1}{\Delta\rho_1+2\lambda_H(1-\lambda_H\eta)-\lambda_H^2\eta(1-\eta)}$ otherwise.

We establish the existence of the equilibrium in claims 4 and 5. Observe that in the described equilibrium the defendant of each type makes an offer exactly compensating the expected payoff of a first-period plaintiff conditional on the realized state of the world, and the high type is exactly indifferent between making an offer $s^H_{1,0}$ and $s^L_{1,0}$. Hence, the proof that the described equilibrium is the unique equilibrium satisfying the D1 criterion exactly follows claims 2 and 3. Therefore, it is omitted.

Claim 4. *The continuation value of the game for the defendant of type i, given that there is $k \in \{0, 1\}$ plaintiffs litigating by the end of period 1 and a plaintiff in period 1 filed the case is given by $-\kappa^i_k(\mu)$ such that:*

$$\kappa^i_k(\mu) \equiv \begin{cases} \left[2(1+\eta) - \lambda_i\eta^2\right]\lambda_i w & \text{if } k = 1 \\ \lambda_i^2\eta(1+\eta)w & \text{if } k = 0 \text{ and } \mu < \underline{l} \\ \lambda_i^2\eta w\left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta+\lambda_H}\mathbb{1}_{\lambda_i=\lambda_L}\right] & \text{if } k = 0 \text{ and } \mu > \underline{l} \end{cases} \tag{10}$$

Proof. Following lemmas 1 and 2, observe that if $k_1 = 1$ then a strategic plaintiff files the case in periods 2 and 3 at settles it at w and a behavioral plaintiff always litigates the case. Hence, the continuation value of the game for the defendant is given by: $-\left[2(1+\eta) - \lambda_i\eta^2\right]\lambda_i w$.
If $k = 0$ there are two cases. Either the plaintiff in the second period files the case, or he does not. If he does not file the case the litigation is driven fully by the behavioral plaintiff. Hence, the continuation value of the game is given by: $-\lambda_i^2\eta(1+\eta)w$.

If the plaintiff in the second period files the case, then, following Lemma 3, conditional on the arrival of the plaintiff, in the second period the defendant makes an offer exactly compensating the expected payoff of the plaintiff conditional on the scope of the harm. Moreover, the offer made by the low type defendant is rejected with positive probability $p_{2,0}$. Hence, the continuation value of the game is given by: $-\lambda_i^2 \eta w \left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta+\lambda_H} \mathbb{1}_{\lambda_i=\lambda_L}\right]$.
To finish the proof recall that a strategic plaintiff in the second period files the case conditional on $k_2 = 0$ if and only if $l_{2,h_2} \geq \check{l}_2$. The beliefs of the plaintiff in period 2 if $h_2 = (0,1)$ are given by $l_{2,h_2} = l\frac{\lambda_H^2}{\lambda_L^2}$. Hence $l_{2,h_2=(0,1)} \geq \check{l}_2$ if and only if $l \geq \underline{l}$. ■

Claim 5. *The described equilibrium is a PBE satisfying D1 criterion.*

Proof. We start by analyzing the case when $\mu < \frac{\frac{f}{w} - \rho_2^L}{\Delta\rho_2}$. We firstly show that the proposed strategy profile can be indeed sustained as a PBE.
Set the following interim belief profile $\mu_{1,h_1}(s) = \mathbb{1}_{s \neq s_{1,0}^L}$.

A strategic plaintiff accepts an offer $s_{1,0}^i$ from type i if

$$s_{1,0}^i \geq [\lambda_i \eta + (1-\lambda_i)\lambda_i \eta]\, w = (2-\lambda_i)\,\lambda_i \eta w$$

Thus, the unique best response for the plaintiff is to reject the offer whenever $s_{1,0} \in (s_{1,0}^L, s_{1,0}^H)$. Also note that for $s_{1,0} \in \{s_{1,0}^L, s_{1,0}^H\}$ the plaintiff is indifferent between accepting or rejecting the offer. Hence, the plaintiff has no profitable deviation.

Note that $p_{1,0}$ is such that the high-type defendant is indifferent between offering $s_{1,0}^L$ or $s_{1,0}^H$:

$$p_{1,0}\left[\left[2(1+\eta) - \lambda_H \eta^2\right]\lambda_H w\right] + (1-p_{1,0})\left[s_{1,0}^L + \lambda_H^2 \eta(1+\eta)w\right] = s_{1,0}^H + \lambda_H^2 \eta(1+\eta)w$$

$$\iff p_{1,0}\left[2(1+\eta)\lambda_H w - \lambda_H^2 \eta^2 w - s_{1,0}^L - \lambda_H^2 \eta(1+\eta)w\right] = s_{1,0}^H - s_{1,0}^L$$

Using $s_{1,0}^i = (2-\lambda_i)\lambda_i \eta w$ we get

$$p_{1,0}\left[2(1+\eta)\lambda_H w - \lambda_H^2 \eta^2 w - (2-\lambda_L)\lambda_L \eta w - \lambda_H^2 \eta(1+\eta)w\right] = (2-\lambda_H-\lambda_L)\Delta\lambda\eta w$$

$$\iff p_{1,0} = \frac{(2-\lambda_H-\lambda_L)\Delta\lambda\eta}{2\lambda_H\left(1-\eta^2\lambda_H\right) + (2-\lambda_H-\lambda_L)\Delta\lambda\eta} \in (0,1)$$

Any other offer is either rejected or higher than the equilibrium offer. Hence, she does not have a profitable deviation.

Finally, we show that the low-type defendant does not have a profitable deviation either.

We have that in the proposed equilibrium the payoff for the low-type defendant equals to:

$$-p_{1,0}\left[\left[2(1+\eta) - \lambda_L \eta^2\right]\lambda_L w\right] - (1-p_{1,0})\left[(2-\lambda_L)\lambda_L \eta w + \lambda_L^2 \eta(1+\eta)w\right]$$

$$= -2p_{1,0} w \lambda_L (1-\lambda_L \eta^2) - w\lambda_L \eta(2+\lambda_L \eta)$$

.

A deviation to any $s_{1,0} \in (s^L_{1,0}, s^H_{1,0})$ delivers expected payoffs equal to $-\left[2(1+\eta) - \lambda_L \eta^2\right] \lambda_L w$. Note that

$$-2p_{1,0} w \lambda_L (1 - \lambda_L \eta^2) - w\lambda_L \eta(2 + \lambda_L \eta) > -\left[2(1+\eta) - \lambda_L \eta^2\right] \lambda_L w$$
$$\iff p_{1,0} < \frac{1 - \lambda_L \eta^2}{1 - \lambda_L \eta^2} = 1$$

which always holds.

Let $g(\lambda_i)$ be the expected gain for type λ_i from offering $s^H_{1,0}$ instead of $s^L_{1,0}$, taking $(s^L_{1,0}, s^H_{1,0}, p_{1,0})$ as given:

$$g(\lambda_i) = -s^H_{1,0} - \lambda_i^2 \eta(1+\eta) w + p_{1,0}\left[2(1+\eta) - \lambda_i \eta^2\right]\lambda_i w + (1 - p_{1,0})\left[s^L_{1,0} + \lambda_i^2 \eta(1+\eta) w\right]$$

We already argued that $g(\lambda_H) = 0$, hence $g(\lambda_L) = g(\lambda_L) - g(\lambda_H)$. As a result

$$\begin{aligned} g(\lambda_L) &= -s^H_{1,0} - \lambda_L^2 \eta(1+\eta) w + p_{1,0}\left[2(1+\eta) - \lambda_L \eta^2\right]\lambda_L w + (1 - p_{1,0})\left[s^L_{1,0} + \lambda_L^2 \eta(1+\eta) w\right] && (11)\\ &\quad + s^H_{1,0} + \lambda_H^2 \eta(1+\eta) w - p_{1,0}\left[2(1+\eta) - \lambda_H \eta^2\right]\lambda_H w - (1 - p_{1,0})\left[s^L_{1,0} + \lambda_H^2 \eta(1+\eta) w\right] && (12)\\ &= w p_{1,0} \Delta\lambda \left[\eta(\lambda_H + \lambda_L)(2\eta + 1) - 2(1+\eta)\right] && (13) \end{aligned}$$

Therefore, $g(\lambda_L) \leq 0$ if and only if $(\lambda_L + \lambda_H)/2 \leq (1+\eta)/(2\eta^2 + \eta)$, which is implied by $1 - \lambda_L > \lambda_H$ for any choice of η.

Then, we show that if $\mu \geq \frac{\frac{f}{w} - \rho_2^L}{\Delta \rho_2}$ the described strategy profile is an element of a PBE.

Set the belief profile to $\mu_1(s) = \mathbb{1}_{s \neq s^L_{1,0}}$. The plaintiff is indifferent between accepting or rejecting equilibrium offers. For any offer $s_{1,0} \in (s^L_{1,0}, s^H_{1,0})$ the plaintiff strictly prefers to reject. Hence, there is no profitable deviation for the plaintiff.

We choose $p_{1,0}$ such that the high-type defendant is indifferent between offering $s^H_{1,0}$ and $s^L_{1,0}$:

$$p_{1,0}\left[2(1+\eta) - \lambda_H \eta^2\right]\lambda_H w + (1 - p_{1,0})\left[s^L_{1,0} + 2\lambda_H^2 \eta w\right] = s^H_1 + 2\lambda_H^2 \eta w$$

$$\iff p_{1,0}\left[\left[2 + (2 - \lambda_H)\eta - \lambda_H \eta(1+\eta)\right]\lambda_H w - s^L_{1,0}\right] = s^H_1 - s^L_{1,0}.$$

Using $s^i_{1,0} = (2 - \lambda_i)\lambda_i \eta w$ we get

$$p_{1,0} = \frac{s^H_1 - s^L_{1,0}}{\left[2 - \lambda_H \eta(1+\eta)\right]\lambda_H w + s^H_{1,0} - s^L_{1,0}} = \frac{(2 - \lambda_H - \lambda_L)\Delta\lambda\eta}{\lambda_H\left[2 - \eta\lambda_H(1+\eta)\right] + (2 - \lambda_H - \lambda_L)\Delta\lambda\eta}.$$

Finally, we check that the low-type defendant has no incentive to deviate. As in the previous part of the proof let $g(\lambda_i)$ be the expected gain for type λ_i of offering $s^H_{1,0}$ instead of $s^L_{1,0}$, taking $(s^L_{1,0}, s^H_{1,0}, p_{1,0})$ as given.

$$\begin{aligned} g(\lambda_i) &= -s^H_{1,0} - \lambda_i^2 \eta w\left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta + \lambda_H} I[\lambda_i = \lambda_L]\right] \\ &\quad + p_{1,0}\left[2(1+\eta) - \lambda_i \eta^2\right]\lambda_i w + (1 - p_{1,0})\left[s^L_{1,0} + \lambda_i^2 \eta w\left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta + \lambda_H} I[\lambda_i = \lambda_L]\right]\right]. \end{aligned}$$

Since $g(\lambda_H) = 0$, we can write $g(\lambda_L) = g(\lambda_L) - g(\lambda_H)$ to get the following expression:

$$\begin{aligned} g(\lambda_L) &= -s^H_{1,0} - \lambda_L^2 \eta w \left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta + \lambda_H}\right] \\ &+ p_{1,0}\left[2(1+\eta) - \lambda_L\eta^2\right]\lambda_L w + (1-p_{1,0})\left[s^L_{1,0} + \lambda_L^2\eta w\left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta + \lambda_H}\right]\right] \\ &+ s^H_{1,0} + 2\lambda_H^2\eta w - p_{1,0}\left[2(1+\eta) - \lambda_H\eta^2\right]\lambda_H w - (1-p_{1,0})\left[s^L_{1,0} + 2\lambda_H^2\eta w\right] \\ &= p_{1,0} w \Delta\lambda\left[-2(1+\eta) - \lambda_L^2\eta\frac{1-\eta}{\Delta\lambda\eta + \lambda_H} + (\lambda_H + \lambda_L)(2\eta + \eta^2)\right]. \end{aligned}$$

Therefore, $g(\lambda_L) \leq 0$ if and only if

$$\frac{\lambda_H + \lambda_L}{2} \leq \frac{1+\eta}{2\eta + \eta^2} + \frac{\lambda_L^2(1-\eta)}{2(2+\eta)(\Delta\lambda\eta + \lambda_H)}, \tag{14}$$

$$\tag{15}$$

which is implied by $1 - \lambda_L > \lambda_H$ for any choice of η.

To finish the proof, we show that the proposed equilibrium satisfies the D1 criterion. To prove it, it is enough to show that the high-type defendant is not eliminated for any strategy $s \in (s^L_{1,0}, s^H_{2,0})$ under the D1 criterion.

Take any such an offer. Then the defendant of type i is better-off making the offer s rather than under her equilibrium payoff if and only if the offer s is rejected at most with probability $p^i(s) \equiv p_{1,0} - \frac{s - s^L_{1,0}}{\kappa^i_1 - \kappa^i_0 - s_L}$.

Recall that the low type never has profitable deviation of proposing $s^H_{1,0}$, and the high type never has a profitable deviation of proposing $s^L_{2,0}$. Hence, it is always the case that $\kappa^H_1 - \kappa^H_0 > \kappa^L_1 - \kappa^L_0$. Hence $p^H(s) > p^L(s)$ and the defendant of the high type is not eliminated for strategies $s \in (s^L_{1,0}, s^H_{2,0})$. ∎

Proof of Proposition 3 Proposition 3 is proved in lemmas 5 – 7. The proof includes only the analysis of the negotiation in period 1 and the decision on filing the case in period 3, as other subgames follow exactly the proof of Proposition 2.

Lemma 5. *In any equilibrium satisfying the D1-criterion during the negotiation in the first period:*

(i) the defendant makes an offer including a transfer $s^i_{1,0} = \rho^i_1 w$.

(ii) A pair of probabilities (q^H, q^L) *with which the i-type defendant makes a public settlement offer can be supported as a part of some equilibrium if and only if the decision of the second period plaintiff is independent from observing a public settlement.*

(ii) The plaintiff always accepts the offer with a transfer $s^H_{1,0}$, *and rejects the offer with a transfer* $s^L_{1,0}$ *with some positive probability.*

Lemma 5 is proved in claims 6 – 10.

Claim 6. *In any PBE satisfying the D1 criterion during the first-period negotiation the defendant of a high type makes an offer* $s^H_{1,0}$.

Proof. Firstly, observe that a strategic plaintiff always accepts any offer including a transfer $s > s^H_{1,0}$ independently of the secrecy regime proposed. Hence, no offer $s > s^H_{1,0}$ can be made in the equilibrium.

Take some candidate equilibrium in which the high type makes the offer $S = (s, \zeta)$ where $s < s^H_{1,0}$. Then it must be the case that this offer is not rejected with probability 1, but only with some probability p. Hence, the low type must make an offer S with positive probability. Following the proof of Claim 2, recall that, for a given ζ, there exists at most one such an offer.

Then take some offer $S' = (s', \zeta)$, which is not made on the equilibrium path, with $s' = s^L_{1,0} + \varepsilon$ and ζ that is used in the offer S. Recall from Claim 4 the values of the continuation game for the defendant κ^i_k. Observe that if the second-period plaintiff files the case after observing history $h_2 = (0, \zeta)$, then $\kappa^i_0 = \lambda^2_i \eta w \left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta + \lambda_H} \mathbb{1}_{\lambda_i = \lambda_L}\right]$, and otherwise $\kappa^i_0 = \lambda^2_i \eta(1+\eta)w$. Moreover κ^i_1 remains unchanged.

Hence, the i-type defendant is better-off making an offer S' if it is rejected with probability at most $p^i(S') \equiv \frac{p(\kappa^i_1 - \kappa^i_0 - s) - s' + s)}{\kappa^i_1 - \kappa^i_0 - s'}$. Recall form the proof of Claim 5 that $\kappa^H_1 - \kappa^H_0 > \kappa^L_1 - \kappa^L_0$. Hence, $p^H(S') < p^L(S')$, and if the equilibrium satisfies the D1 criterion $\mu_{1,h_1}(S') = 0$. Therefore, the offer S' is always accepted by the plaintiff, and the defendant has a profitable deviation of making the offer S'. ■

Claim 7. *In any PBE satisfying the D1 criterion during the first-period negotiation the defendant of a low type makes an offer* $s^L_{1,0}$.

Proof. Claim 6 implies that there does not exist an equilibrium in which the low-type defendant makes an offer with a transfer $s > s^L_{1,0}$. If $s \in (s^L_{1,0}, s^H_{1,0})$ in a candidate equilibrium, then the offer made by the low type is always accepted and the high type has a profitable deviation of making an offer s. If $s \geq s^H_{1,0}$ then the proof of Claim 6 applies, and there exists some offer S' with a transfer $s' = s^L_{1,0} + \varepsilon$, which is always accepted by the plaintiff. Thus, the defendant has a profitable deviation of making the offer S'.
Suppose there exists an equilibrium, in which some offer $s < s^L_{1,0}$ is made by the defendant of the low type. Then, it is always rejected by the plaintiff. Consider some offer S' with a transfer $s' = s^L_{1,0} + \varepsilon$. Then the plaintiff of the low type is better-off making this offer than under her equilibrium payoff if it is accepted with any positive probability. The plaintiff of the high type is better-off making the offer S' only if it is accepted with a probability higher than some threshold. Hence, if the equilibrium satisfies the D1 criterion, $\mu_{1,h_1}(S') = 0$, and the offer S' is always accepted. Therefore the defendant has a profitable deviation of making an offer S'. ■

Claim 8. *There does not exist a PBE satisfying the D1 criterion, in which the second-period plaintiff files the case upon observing* $h_2 = (0,0)$ *but not upon observing* $h_2 = (0,1)$.

Proof. Take any such candidate equilibrium. Then, it must that the high-type defendant settles the case secretly with some positive probability. Hence, the high-type defendant has a profitable deviation of proposing a public settlement with probability 1. ∎

Claim 9. *There does not exist a PBE satisfying the D1 criterion, in which the case is settled publicly with some positive probability and the second-period plaintiff files the case upon observing* $h_2 = (0, 1)$*, but not upon observing* $h_2 = (0, 0)$*.*

Proof. Take any such an equilibrium. Then, it must be that the high type proposes a public settlement with some positive probability. Hence, she has a profitable deviation of proposing a secret settlement with probability 1. ∎

Claim 10. *There does not exist a PBE satisfying the D1 criterion, in which the second-period plaintiff files the case upon observing* $h_2 = (0, 1)$*, but not* $h_2 = (0, 0)$*.*

Proof. Claim 9 proves the case when the case is settled publicly with some positive probability. Suppose there exists an equilibrium in which the case is always settled secretly in the first period, and the second-period strategic plaintiff files the case if he observes $h_2 = (0, 1)$, but not $h_2 = (0, 0)$.
Observe that in any such an equilibrium, the low offer during the first-period negotiation must be rejected with some probability $p \geq \underline{p}_{1,0} = \frac{\Delta\rho_1}{\Delta\rho_1 + 2\lambda_H(1-\lambda_H\eta) - \lambda_H\eta(1-\eta)}$.
Denote by $-\kappa_0^i(\zeta)$ the value of the continuation game for the defendant of type i, if the case in period 1 is settled at a privacy regime ζ. Following the proof of Claim 4 $\kappa_0^i(0) = \lambda_i^2\eta(1+\eta)w$, and $\kappa_0^i(1) = \lambda_i^2\eta w\left[2 + \frac{\Delta\lambda(1-\eta)}{\Delta\lambda\eta+\lambda_H}\mathbb{1}_{\lambda_i=\lambda_L}\right]$.

Consider an offer $S' = (s' = s_{1,0}^L + \varepsilon, \zeta = 1)$. Then, the high-type defendant is better-off making the offer S' than under her equilibrium pay-off if it is rejected with probability at most $p^H \equiv \frac{s_{1,0}^H - s' - (\kappa_0^H(1) - \kappa_0^H(1))}{\kappa_1^H - \kappa_0^H(1) - s'}$. And the low-type defendant is better-off making the offer S' than under her equilibrium if it is rejected with probability at most $p^L \equiv \frac{p(\kappa_1^L - \kappa_0^L(0) - s_{1,0}^L) - (\kappa_0^L(1) + s' - \kappa_0^L(0) - s_{2,0}^L)}{\kappa_L^1 - \kappa_0^1(1) - s'}$.

We claim that for ε small enough it must be the case that $p^H < p^L$ and $p^L > 0$. Observe that p^L is increasing in p, hence take the smallest possible $p = \underline{p}_{1,0}$. Knowing that if $p = \underline{p}_{1,0}$, the defendant of a high type is indifferent between making an offer $S = (s_{1,0}^H, 0)$ and $S = (s_{1,0}^L, 0)$, we can restate the expression for p^i where $i = H, L$ in the following way:

$$\underline{p}_{1,0}\kappa_1^i + (1 - \underline{p}_{1,0})(\kappa_0^i(0) + s_{1,0}^L) = p^i\kappa_1^i + (1 - p^i)(s' + \kappa_0^i(0)) + (1 - p^i)(\kappa_0^i(1) - \kappa_0^i(0)). \quad (16)$$

Hence, if $\kappa_0^H(1) - \kappa_0^H(0) > \kappa_0^L(1) - \kappa_0^L(0)$, there exists an offer s' sufficiently close to $s_{1,0}^L$ for which indeed p^L is strictly smaller than p^H. Substituting for κ_k^i's and simplifying we obtain:

$$\lambda_H^2\eta > \lambda_L^2\eta + \lambda_L^2 p_{2,0}. \quad (17)$$

Observe that $p_{2,0}$ is bounded form above by $\frac{\Delta\lambda}{\Delta\lambda+\lambda_H}$. Therefore, a sufficient condition for (17) is given by:

$$\Delta\lambda[\lambda_L + \lambda_H]\eta + \lambda_H[\lambda_L + \lambda_H]\eta > \lambda_L^2. \quad (18)$$

Using the assumption that $\lambda_L < \frac{f}{w}$ and $\lambda_H \eta > \frac{f}{w}$, and therefore $\lambda_L < \lambda_H \eta$, it must be the case that $\kappa_0^H(1) - \kappa_0^H(0) > \kappa_0^L(1) - \kappa_0^L(0)$.

Observe that the RHS of (16) is continuously increasing in p^i and s'. Hence, to show that $p^L > 0$ for some s' sufficiently close to $s_{1,0}^L$, it is enough to prove that if $s' = s_{1,0}^L$ and $p^L = 0$, then the RHS of (16) is strictly larger than the LHS of (16). In other words:

$$\Delta\rho_1 \lambda_L [2(1-\lambda_l \eta) - \lambda_l \eta(1-\eta)(\eta + p_{2,0})] > \lambda_H (2(1-\lambda_H \eta) - \lambda_H \eta(1-\eta))(\kappa_0^L(1) - \kappa_0^L(0)). \quad (19)$$

Note that $2(1-\lambda_L \eta) - \lambda_L \eta(1-\eta)(\eta + p_{2,0}) > 2(1-\lambda_H \eta) - \lambda_H \eta(1-\eta)$.

Hence, it is enough to prove that:

$$\Delta\rho_1 > \lambda_H \lambda_L (1-\eta)(\eta + p_{2,0}). \quad (20)$$

Using the assumption that $(1-\lambda_L > \lambda_H)$, we can show that $\Delta\rho$ is bound from below by $\eta\Delta\lambda(2-\eta)$. Moreover, since $\lambda_L < \lambda_H \eta$, it must be the case that $\Delta\lambda > (1-\eta)\lambda_H$ and $\eta > \frac{\lambda_L}{\lambda_H}$. Naturally, $p_{2,0} < 1$. Hence, a sufficient condition for $p^L > 0$ is given by:

$$2 - \eta \geq \lambda_H (1+\eta), \quad (21)$$

which is always satisfied.

Thus, if the equilibrium satisfies the D1 criterion, there exists an offer $S' = (s' > s_{2,0}^L, \zeta = 1)$ such that $\mu(S') = 0$. This offer is always accepted by the plaintiff and (by the fact that $p^L > 0$) the defendant of a low type has a profitable deviation of making the offer S'. ■

Lemma 6. *If the probability of rejection of the offer $s_{1,0}^L$ during the first-period negotiation is given by p, then in any PBE equilibrium satisfying the D1 criterion in which the decision on filing the case is taken in pure strategies, the second-period strategic plaintiff files the case upon observing $k_2 = 0$ if and only if $l \geq \tilde{l}(p) \equiv \check{l}_2 \frac{\lambda_L(1-\eta\lambda_L - p\lambda_L(1-\eta))}{\lambda_H(1-\eta\lambda_H)}$. Otherwise, there exists an equilibrium in which the second-period plaintiff always files the case.*

Proof. Following Lemma 5 it must be that a decision of a second-period plaintiff is independent from the realization of n_2.
Denote by q^i the probability with which the defendant of type i proposes a public settlement in period 1. Then, if an equilibrium in which the second-period plaintiff never starts the litigation exists, there must exist a pair $(q^H, q^L) \in [0,1]^2$ satisfying the following two conditions:

$$\check{l}_2 \leq l \frac{\lambda_H \Big(\lambda_H (1-\eta)(1-q^H) + 1 - \lambda_H\Big)}{\lambda_L \Big((1-\eta)(1-p)(1-q^L) + 1 - \lambda_L\Big)}, \quad (22)$$

$$\check{l}_2 \leq l \frac{\lambda_H \lambda_H (1-\eta) q^H}{\lambda_L \lambda_L (1-\eta)(1-p) q^L}. \quad (23)$$

Condition (22) ensures that a second-period strategic plaintiff does not file the case if he observes $h_2 = (0,0)$, condition (23) ensures that a second-period strategic plaintiff does not file the case

if he observes $h_2 = (0,1)$.
Rearranging the conditions we obtain:

$$q^L \geq \frac{1}{1-p}\Big(\frac{l}{\check{l}_2}\frac{\lambda_H^2}{\lambda_L^2}q^H - \frac{l\lambda_H}{\check{l}_2\lambda_L}\frac{(1-\eta\lambda_H)}{\lambda_L(1-\eta)} + \frac{1-\big((1-\eta)p+\eta\big)\lambda_L}{\lambda_L(1-\eta)}\Big), \tag{24}$$

$$q^L \leq \frac{1}{1-p}\frac{l}{\check{l}_2}\frac{\lambda_H^2}{\lambda_L^2}q^H. \tag{25}$$

From (24) and (25) we get that the set of $(q^H, q^L) \in [0,1]^2$ satisfying (22) and (23) is non-empty if and only if:

$$\frac{1-\big((1-\eta)p+\eta\big)\lambda_L}{\lambda_L(1-\eta)} \leq \frac{l\lambda_H}{\check{l}_2\lambda_L}\frac{(1-\eta\lambda_H)}{\lambda_L(1-\eta)}. \tag{26}$$

Solving (26) for l the following condition is obtained:

$$l \leq \check{l}_2\frac{\lambda_L\big(1-\lambda_L\eta - p\lambda_L(1-\eta)\big)}{\lambda_H(1-\lambda_H\eta)} = \tilde{l}(p). \tag{27}$$

Hence the equilibrium, in which a second-period strategic plaintiff never starts the litigation exists if and only if $l \leq \tilde{l}(p)$.
The proof that the equilibrium in which a second-period plaintiff always files the case exists if and only if $l > \tilde{l}(p)$ follows exactly the same steps, and requires only reversing the direction of inequalities. ∎

Lemma 7. *If $l \leq \tilde{l}(\underline{p}_{1,0})$ then there exists a PBE satisfying the D1-criterion, in which the second-period strategic plaintiff never starts the litigation, and the probability of rejecting the offer $s^L_{1,0}$ during the first period negotiation is given by $\underline{p}_{1,0}$.*
If $l \geq \tilde{l}(\bar{p}_{1,0})$ then there exists a PBE satisfying the D1-criterion, in which the second-period plaintiff always files the case, and the probability of rejecting the offer $s^L_{1,0}$ during the first period negotiation is given by $\bar{p}_{1,0}$.
No other PBE satisfying the D1 criterion, in which the decision on filing the case is taken in pure strategies exists.

Proof. Observe that $\bar{p}_{1,0}$ is probability of rejecting the low offer during the first-period negotiation which makes the high-type defendant exactly indifferent between making the offer $s^L_{1,0}$ and $s^H_{1,0}$, conditional on the second-period plaintiff always filing the case.
The proof that if a second-period plaintiff always files the case, then in any PBE satisfying the D1-criterion during the first-period negotiation the low offer is rejected with probability $\bar{p}_{1,0}$ follows the proof of Proposition 2. Hence, the existence condition is a corollary of Lemma 6.
Analogous reasoning applies for the equilibrium in which a second-period strategic plaintiff never starts the litigation. ∎

References

Saeed Alaei, Azarakhsh Malekian, and Mohamed Mostagir. dynamic model of crowdfunding. Working paper, Ross School of Business, 2016.

Jeffrey S Banks and Joel Sobel. Equilibrium selection in signaling games. *Econometrica: Journal of the Econometric Society*, pages 647–661, 1987.

Dan Bernhardt and Frances Zhiyun X Lee. Trial incentives in sequential litigation. *American Law and Economics Review*, 17(1):214–244, 2014.

Yeon-Koo Che. Equilibrium formation of class action suits. *Journal of Public Economics*, 62 (3):339–361, 1996.

Yeon-Koo Che and Kathryn E Spier. Exploiting plaintiffs through settlement: divide and conquer. *Journal of Institutional and Theoretical Economics JITE*, 164(1):4–23, 2008.

Andrew F Daughety and Jennifer F Reinganum. Secrecy and safety. *American Economic Review*, 95(4):1074–1091, 2005.

Andrew F Daughety and Jennifer F Reinganum. A dynamic model of lawsuit joinder and settlement. *The RAND Journal of Economics*, 42(3):471–494, 2011.

Joyee Deb, Aniko Oery, and Kevin R Williams. Aiming for the goal: Contribution dynamics of crowdfunding. Working Paper 25881, National Bureau of Economic Research, 2019.

Bruno Deffains and Eric Langlais. Informational externalities and settlements in mass tort litigations. *European Journal of Law and Economics*, 32(2):241–262, 2011.

Daniel Diermeier and Stacy Dickinson. Baxter dialysis crisis. Case study, Kellogg School of Management, 2012.

Shannon Liu. A theory of collective investment with application to venture funding. Working paper, 2018.

Mancur Olson. The logic of collective action. *Harvard Univ. Pr*, 1965.

Ilya Segal. Contracting with externalities. *The Quarterly Journal of Economics*, 114(2):337–388, 1999.

Ilya Segal. Coordination and discrimination in contracting with externalities: Divide and conquer? *Journal of Economic Theory*, 113(2):147–181, 2003.

Ilya R Segal and Michael D Whinston. Naked exclusion: comment. *American Economic Review*, 90(1):296–309, 2000.