The influence of present-biased plaintiffs' sophistication on endogenous timing and effort in litigation
– Preliminary Version –

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September 4, 2024

Abstract

This paper analyzes the influence of the present-biased plaintiff's sophistication on the outcome of endogenous timing and efforts in litigation. The plaintiff can choose to invest legal effort earlier than or at the same time as the defendant. We show that the timing of action depends on the degree of present bias and the merit of the case. When the degree of present bias is intermediate, the naive plaintiff is more likely to act early (late) than the sophisticated one when the case's merit is in favor of the defendant (plaintiff). In the settlement stage, the naive plaintiff demands a higher a settlement offer from the defendant than the sophisticated one, and therefore is more likely to go to trial.

Keywords: Litigation Contest; Settlement; Present Bias; Sophistication.
JEL classification: K41.

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1 Introduction

Litigation is a lengthy battle. Although in-court trials only last for 2-4 days depending on whether it is tried by jury or judge, the actual duration of a case, from the filing to the disposition, can go up to 755 days (Eisenberg and Clermont 1995). This delay not only adds to the agony of the victims as well as compromises their recovery, but is also influences the amount of efforts invested to pursue a case and thus the trial outcome in an adversarial legal system. The latter issue becomes more relevant when being seen against the backdrop of potential litigants' time preferences.

Time preferences are commonly represented by the exponential discounting model introduced by Samuelson (1937), which assumes a constant discount rate between two consecutive periods. However, data on intertemporal decision-making strongly suggest that immediate payoffs are special relative to future ones, such that the discount in payoffs one period from now is stronger than that between two consecutive periods in the future. The bias favoring the present features in Laibson (1997) and the applied works that follow, which add to the traditional setup a discount between the present and any point in time in the future (e.g., Frederick et al. 2002, DellaVigna 2009, O'Donoghue and Rabin 2015). This incorporation of present bias greatly improves the match between predictions and choice data. For example, Burks et al. (2012) emphasize that the model best predicts their data from a large-scale field experiment.

This paper studies the influence of the plaintiff's sophistication regarding her present bias on the endogenous timing and efforts in trial. The plaintiff can either be naive or sophisticated. While the latter anticipates how present bias affects her decision in the future, the former does not and thus is unaware of her self-control problem (O'Donoghue and Rabin 1999). We consider trial as a two-stage contest, where the defendant always moves late but the plaintiff can either choose to move early and act as a Stackelberg leader, or move late and exert effort simultaneously with the defendant. The probability of the plaintiff prevailing in trial depends on the relative amount of efforts exerted by each party and the merit of the case. The effort cost is immediate, while the judgment can only be collected an amount of time after the plaintiff wins the case.

We find that both the naive and sophisticated plaintiffs choose to move early when the degree of their present bias is weak. The reverse is true when they strongly discount future payoffs as both types of plaintiff prefer shifting the effort cost to the last stage of trial. When the degree of present bias is intermediate, the naive plaintiff is more likely to act early (late) than the sophisticated one when the case's merit is in favor of the defendant (plaintiff). In the settlement stage, the naive plaintiff demands a higher a settlement offer from the defendant than the sophisticated one, and therefore is more likely to go to trial.

Baumann and Friehe (2013) study a litigation contest timing game with perfect information. They find that the plaintiff will invest first (second) and the defendant second (first) for relatively low (high) levels of defendant fault. Park (2022) analyzes the timing of litigation in a perfect-information setting where a contingency fee compensates the plaintiff's lawyer and the defendant's lawyer is paid by the hour.

2 Model

A risk-neutral plaintiff files a lawsuit against a risk-neutral defendant. The litigation process starts with the settlement bargaining where the defendant makes a settlement offer to the plaintiff. A rejection of the offer is followed by trial, in which litigants exert effort to influence the probability of winning the judgment J. Following Hirschleifer and Osborne (2001), we assume the plaintiff's probability of prevailing in trial q to be:

$$q(e_p, e_d; \gamma) = \frac{\gamma e_p}{\gamma e_p + e_d} \tag{1}$$

where $e_p(e_d) \geq 0$ denotes the effort of the plaintiff (defendant).[1] The cost of exerting efforts is assumed to be linear in the effort level $c(e_i) = e_i$, $i = p, d$. The parameter $\gamma \in (0, 2)$ represents the case's objective merit/fault factor. The case is thus in favor of the plaintiff (defendant) when $\gamma > 1 (\gamma < 1)$. During trial, the plaintiff may move early and become the Stackelberg leader in the litigation contest; or, alternatively, she may move late and choose effort simultaneously with the defendant.[2] After winning the case in court, the judgment will not be available immediately, but only after a delay.

We assume that the plaintiff is present-biased such that she prefers receiving immediate rewards and shifting costs to the future. Her time preferences can be captured by the (β, δ) approach, where δ represents the standard exponential discounting and β the present bias (O'Donoghue and

[1] If both effort levels are zero, $q = 1/2$ applies.

[2] The sequential structure in litigation contest is also considered elsewhere in the literature (see, e.g., Farmer and Pecorino 1999, Guerra et al. 2019, Hirschleifer and Osborne 2001). In our model, we focus on the case where only the present-biased plaintiff can move first to accentuate the effect of time preference.

Rabin 1999, 2015). The parameter β is used to distinguish payoffs in the present from ones that lie in the future, no matter how far. Note that $\beta = 1$ corresponds to standard exponential discounting while $\beta < 1$ represents present bias. In order to focus on the effects of present bias, we set $\delta = 1$. The defendant is not present-biased but understands that the plaintiff is.

We distinguish between a naive and a sophisticated plaintiff. Early in the litigation process, the plaintiff may want to plan out what her future selves will behave in order to determine the best timing for exerting efforts. The sophisticated one anticipates that both her current as well as future selves are influenced by present bias. The naive one, however, believes that she will behave like a time-consistent agent in the future and thus is not aware of her self-control problem (O'Donoghue and Rabin 1999). When a new stage comes and the cost of effort becomes immediate, she may want to delay working on her case to shift the costs into the future. We further assume that in the plaintiff's contemplation, she believes the defendant shares her understanding of the litigants' best-response, regardless of her degree of sophistication (e.g., Hann and Hauck 2023).

We summarize the sequence of actions before proceeding to the analysis. The game consists of three main stages, with the trial stage can be divided into two sub-stages.

- In Stage 1, the defendant can make a settlement offer $\mathcal{O}$ to the plaintiff. The game ends if the plaintiff accepts and proceeds to trial if she rejects. If litigants reach trial, they enter a litigation contest.
- In Stage 2 and 3, trial ensues. The plaintiff considers whether to act or wait in Stage 2. If she acts, she chooses efforts before the defendant and becomes the Stackelberg leader. If she waits, she has to act in Stage 3 and choose effort simultaneously with the defendant.
- In stage 4, the plaintiff receives judgment J an amount of time after winning the case in court. The plaintiff discounts the expected judgment by β in Stages 1-3. Whereas the sophisticated plaintiff knows in Stage 1 that he will discount the expected judgment by β in later stages, the naive plaintiff thinks in Stage 1 that the discount by β applies only when comparing payoffs in Stage 1 to payoffs in later stages (but not between different stages in the future).

3 Analysis

We analyze the game using backward induction.

3.1 Stage 3: Late effort

The defendant always chooses effort in Stage 3, minimizing the expected costs

$$C(e_p, e_d; \gamma) = q(e_p, e_d; \gamma)J + e_d, \tag{2}$$

by implementing the effort level

$$e_d^*(e_p; \gamma) = \sqrt{\gamma J e_p} - \gamma e_p, \tag{3}$$

where γ is the fault factor. This is the defendant's best response to a given level of e_p, either the one observed after Stage 2 when the plaintiff moves early or the level anticipated in Stage 3 when she moves late. The optimal defendant effort rises at first in response to higher plaintiff effort but eventually falls off and changes with the fault factor in a way that depends on the plaintiff's effort level. For higher γ, the defendant's effort peaks at a lower level of e_p, and vice versa.

If the plaintiff chooses to exert litigation effort in Stage 3, he will select effort to

$$\max_{e_p} \Pi_3 = \beta q(e_p, e_d; \gamma)J - e_p, \tag{4}$$

in response to the anticipated level e_d. This signifies that the plaintiff chooses effort according to the best-response function

$$e_p^*(e_d; \gamma) = \frac{\sqrt{\beta\gamma J e_d} - e_d}{\gamma}. \tag{5}$$

The (Stage 3, Stage 3) Equilibrium If the plaintiff and the defendant both choose effort in Stage 3, equilibrium efforts amount to

$$e_p^{33} = \frac{\beta^2 \gamma J}{(\beta\gamma + 1)^2} = \beta e_d^{33}. \tag{6}$$

The two effort levels are asymmetric because the plaintiff discounts the value of the judgment by the parameter β. For a given fault degree, more severe present bias (lower β) leads to lower effort exerted by the plaintiff in equilibrium. This influence of present bias also has a consequence on the plaintiff's probability of prevailing in trial

$$q(e_p^{33}, e_d^{33}; \gamma) = \frac{\beta\gamma}{\beta\gamma + 1}.$$

Dixit (1987) has considered strategic behavior in contests and termed the contestant as "favorite" when his winning probability is higher than one half, and "underdog" otherwise. The equilibrium winning probability shows that the plaintiff can be the underdog even when the merits are in her favor when her present bias is sufficiently strong.

Lemma 1 *P is the "underdog", that is, has a winning probability $q(e_p^{33}, e_d^{33}; \gamma) < 1/2$ when (i) $\gamma < 1$ or (ii) $\gamma \in [1, 2)$ but $\beta < 1/\gamma$, and the "favorite" when $\gamma \in [1, 2)$ and $\beta > 1/\gamma$.*

The plaintiff's expected payoff and the defendant's expected cost at this combination of effort levels amount to

$$\begin{aligned} \Pi^{33} =& \beta q(e_p^{33}, e_d^{33}; \gamma) J - e_p^{33} = \frac{\beta^3\gamma^2 J}{(\beta\gamma + 1)^2} \quad \text{and} \\ C^{33} =& q(e_p^{33}, e_d^{33}; \gamma) J + e_d^{33} = \frac{\beta\gamma J(\beta\gamma + 2)}{(\beta\gamma + 1)^2}. \end{aligned} \tag{7}$$

3.2 Stage 2: Early effort

We first describe the outcome if the plaintiff decides to exert effort in Stage 2 and then use this outcome to assess whether the plaintiff chooses to exert effort in Stage 2.

The (Stage 2, Stage 3) Equilibrium If the plaintiff chooses effort in Stage 2, he will anticipate $e_d^*(e_p)$ and

$$\max_{e_p} \Pi_2 = \beta q(e_p, e_d^*(e_p); \gamma) J - e_p = \beta\sqrt{\gamma J e_p} - e_p. \tag{8}$$

The privately optimal plaintiff effort results as

$$e_p^{23} = \frac{\beta^2\gamma J}{4}, \tag{9}$$

and induces the defendant's best response at the level

$$e_d^{23} = \frac{\beta\gamma J(2-\beta\gamma)}{4}. \tag{10}$$

It follows that the plaintiff's equilibrium winning probability in this case is $q(e_p^{23}, e_d^{23}; \gamma) = \beta\gamma/2$. Comparing to the case of simultaneous effort, we find that changing the timing cannot change the plaintiff's underdog/favorite status, as it all comes down to the comparison between $\beta\gamma$ and 1. We summarize how the equilibrium effort levels in the sequential-move timing compare to those in the simultaneous-move timing in:

Lemma 2 *(i) The plaintiff's equilibrium effort e_p^{23} is smaller (larger) than e_p^{33}, when she is the underdog (favorite). (ii) The defendant's equilibrium effort in the sequential structure, e_d^{23}, is smaller than in the simultaneous timing, e_d^{33}, unless $\beta\gamma = 1$ in which case they are symmetric. (iii) When the plaintiff is the underdog (favorite), her winning probability when moving early is smaller (larger) than that when moving late.*

Equilibrium effort levels in the scenario with sequential moves imply the following payoffs:

$$\Pi^{23} = \beta q(e_p^{23}, e_d^{23}; \gamma)J - e_P^{23} = \frac{\beta^2\gamma J}{4} \tag{11}$$

$$C^{23} = q(e_p^{23}, e_d^{23}; \gamma)J + e_d^{23} = \frac{\beta\gamma J(4-\beta\gamma)}{4}. \tag{12}$$

The actual payoff from acting as a Stackelberg leader is independent of whether the plaintiff is naive or sophisticated.[3] However, the anticipated payoff from playing the Cournot-Nash game instead is type-specific.

Plaintiff Chooses Whether to Move Early When deciding whether to exert effort in Stage 2 or 3, the *sophisticated* plaintiff prefers to move in Stage 2 when

$$\Pi^{23} = \beta q(e_p^{23}, e_d^{23}; \gamma)J - e_p^{23} > \beta \left(q(e_p^{33}, e_d^{33}; \gamma)J - e_p^{33}\right) = \frac{\beta^2\gamma J(1-(1-\gamma)\beta)}{(\beta\gamma+1)^2} \tag{13}$$

[3] In principle, the plaintiff could preempt the defendant in Stage 2 by investing so much that entering the litigation contest in Stage 3 costs the defendant J, making her indifferent between trial and paying J straightaway (e.g., Farmer and Pecorino 1999). Inserting $e_d^*(e_p)$ in $C(e_d, e_p; \gamma)$, and solving $C(e_d^*(e_p), e_p; \gamma)$ for e_p yields $\tilde{e}_P = J/\gamma$ as the plaintiff's preemptive effort investment and $\beta J - J/\gamma$ as the associated payoff. It turns out that $\Pi^{23} > \beta J - J/\gamma$, so we can disregard this preemptive strategy.

When moving early, the plaintiff incurs the effort cost momentarily and thus discounts only the expected judgment. In contrast, when considering moving late, the sophisticated one envisions the late-late equilibrium efforts taking into account her present bias, then treats the expected judgment and the effort cost as payoff consequences that lie in the future. The sophisticated plaintiff correctly anticipates that her Stage-3 self will have a present bias and thus discounts marginal benefits from the standpoint of the Stage-2 self when choosing litigation effort e_p^{33}. The sophisticated plaintiff prefers to exert effort in Stage 2 when

$$\beta > \frac{2\sqrt{\gamma^2 - \gamma + 1} + \gamma - 2}{\gamma^2} = \bar{\beta}_S(\gamma),$$

where $\bar{\beta}_S(\gamma) \in (0, 1)$ for $\gamma \in (0, 2)$, and $\bar{\beta}_S(Y) = 1$ at $\gamma = 1$.

Without complications from the present bias, the plaintiff would move early given that the defendant moves late (Baumann and Friehe 2013). The above condition shows that the circumstances in which the sophisticated plaintiff prefers to move early do not match the circumstances from the benchmark. The requirement for the present-bias parameter depends on the merits of the plaintiff's case. When the case is only slightly tilted in the favor of either litigant, very few levels of β are compatible with sequential effort.

A *naive* plaintiff does not anticipate that her effort choice in Stage 3 will be affected by present bias. She believes that her Stage-3 self has $\beta = 1$ and envisions

$$e_{pn}^{33} = \frac{\gamma J}{(\gamma + 1)^2} = e_{dn}^{33}$$

as equilibrium litigation efforts when both litigants choose late. Thus, she prefers to move in Stage 2 when

$$\Pi^{23} = \beta q(e_p^{23}, e_d^{23}; \gamma)J - e_p^{23} > \beta \left(q(e_{pn}^{33}, e_{dn}^{33}; \gamma)J - e_{pn}^{33}\right) = \beta J \frac{\gamma^2}{(\gamma + 1)^2}, \tag{14}$$

which holds as long as

$$\beta > \frac{4\gamma}{(\gamma + 1)^2} = \bar{\beta}_N(\gamma).$$

We have that $\bar{\beta}_N(\gamma) \in (0, 1)$ for $\gamma \in (0, 2)$, and $\bar{\beta}_N(\gamma) = 1$ at $\gamma = 1$.

We find that the present bias must be sufficiently weak (demonstrated by a sufficiently high level of β) for both plaintiff types to allow for early effort. When comparing the respective thresholds, we find that

$$\bar{\beta}_S(\gamma) \begin{Bmatrix} > \\ < \end{Bmatrix} \bar{\beta}_N(\gamma) \text{ when } \gamma \begin{Bmatrix} < \\ > \end{Bmatrix} 1.$$

We summarize in:

Proposition 1 *(1) If $\beta < \min\{\bar{\beta}_S; \bar{\beta}_N\}$, both plaintiff types exert effort in Stage 3. (2) If $\beta > \max\{\bar{\beta}_S; \bar{\beta}_N\}$, both plaintiff types exert effort in Stage 2. (3i) If $\gamma < 1$ and $\beta \in (\bar{\beta}_N, \bar{\beta}_S)$, the naive plaintiff exerts effort in Stage 2 and the sophisticated plaintiff exerts effort in Stage 3. (3ii) If $\gamma > 1$ and $\beta \in (\bar{\beta}_S, \bar{\beta}_N)$, the sophisticated plaintiff exerts effort in Stage 2 and the naive plaintiff exerts effort in Stage 3.*

When the plaintiff strongly discounts future payoff consequences, she prefers to shift the effort cost to Stage 3 independent of her sophistication. In contrast, when her present bias is weak, the plaintiff exerts effort in Stage 2, no matter whether she is sophisticated or naive. It is interesting to note that the naive plaintiff may move earlier than the sophisticated when the case is in the defendant's favor, despite that the sophisticated is aware of her self-control problem. It comes from the fact that the former mistakenly anticipates much higher equilibrium efforts from both litigants in Stage 3 than the latter does. When the case is in the defendant's favor, the naive plaintiff expects that higher defendant's effort could outweigh the increase in her own effort and thus moving late can result in her disadvantage.

3.3 Stage 1: Settlement

This section highlights the difference in settlement behavior between the naive and the sophisticated plaintiff. We first discuss what each type of plaintiff plans to do at the settlement stage, then derive the lowest settlement offer that the plaintiff accepts depending on her degree of sophistication.

Naive plaintiff In Stage 1, the naive plaintiff believes that she will choose effort in Stages 2 or 3 without the influence of the present bias that affects her decision-making in Stage 1. This means that the naive plaintiff anticipates an early effort level that differs from e_p^{23}, which makes the analysis involving the critical level $\bar{\beta}_N$ irrelevant for deriving the minimum offer to the naive plaintiff.

For the scenario in which effort is chosen early, the naive plaintiff in Stage 1 plans to maximize

$$\Pi_{2N} = q(e_p, e_d^*(e_p); \gamma)J - e_p = \sqrt{\gamma J e_P} - e_P \tag{15}$$

by the implementation of

$$e_{pn}^{23} = \frac{\gamma J}{4} = \frac{e_d^{23}}{\beta^2} \tag{16}$$

in Stage 2, anticipating the defendant's best response at the level

$$e_{dn}^{23} = \frac{\gamma J(2-\gamma)}{4} = e_d^{23} \frac{2-\gamma}{\beta(2-\beta\gamma)}. \tag{17}$$

The effort levels are positive because $\gamma \in (0, 2)$.

The plaintiff prefers to move early in a setup without discounting given that the defendant moves late (Baumann and Friehe 2013). As a result, we have

$$\beta \left(q(e_{pn}^{23}, e_{dn}^{23}; \gamma)J - e_{pn}^{23} \right) > \beta \left(q(e_{pn}^{33}, e_{dn}^{33}; \gamma)J - e_{pn}^{23} \right). \tag{18}$$

This means that the naive plaintiff anticipates that she will always move early, i.e., in Stage 2. Our previous analysis shows that this plan may not realize, as the present bias may later tempt her into procrastinating. With this plan, the naive plaintiff only accepts offer $\mathcal{O}$ such that

$$\mathcal{O} \geq \beta \left(q(e_{pn}^{23}, e_{dn}^{23}; \gamma)J - e_{pn}^{23} \right) = \frac{\beta\gamma J}{4} = \mathcal{O}_N. \tag{19}$$

The defendant understands that the naive plaintiff will not stick to this plan. Depending on the plaintiff's present bias, the defendant may end up in the early-late or the late-late equilibrium and incur an expected cost of C^{23} or C^{33} respectively. However, we find that the defendant is always better off settling with the plaintiff by offering $\mathcal{O}_N$, regardless of the expected cost that may realize. Mathematically, we have

$$C^{23} - \mathcal{O}_N = \frac{\beta\gamma J(3-\beta\gamma)}{4} > 0,$$

and

$$C^{33} - \mathcal{O}_N = \frac{\beta\gamma J\left[4(2+\beta\gamma) - (\beta\gamma+1)^2\right]}{4(\beta\gamma+1)^2} > 0,$$

due to our assumption that $\gamma < 2$.

Sophisticated plaintiff The sophisticated plaintiff understands how and when her later selves choose effort. Accordingly, the defendant must distinguish the parameter combinations when considering which settlement offer would be accepted by the sophisticated plaintiff.

If $\beta > \bar{\beta}_S$, the sophisticated plaintiff chooses effort in Stage 2. She foresees that (e_p^{23}, e_d^{23}) will result and accepts any offer

$$\mathcal{O} \geq \beta \left(q(e_p^{23}, e_d^{23}; \gamma)J - e_p^{23} \right) = \frac{\beta^2 \gamma J(2-\beta)}{4} = \mathcal{O}_S^{23}. \tag{20}$$

The expected cost of the defendant in this case amounts to $q(e_p^{23}, e_d^{23}; \gamma)J + e_d^{23}$, and thus exceed the plaintiff's critical settlement offer.

If $\beta < \bar{\beta}_S$, the sophisticated plaintiff chooses effort in Stage 3. She foresees that (e_p^{33}, e_d^{33}) will result and accepts any offer

$$\mathcal{O} \geq \beta \left(q(e_p^{33}, e_d^{33}; \gamma)J - e_p^{33} \right) = \frac{\beta^2 \gamma J(1-(1-\gamma)\beta)}{(\beta\gamma+1)^2} = \mathcal{O}_S^{33}. \tag{21}$$

The expected cost of the defendant in this case amounts to $q(e_p^{33}, e_d^{33}; \gamma)J + e_d^{33}$, and thus exceed the plaintiff's critical settlement offer.

Proposition 2 *Settling with the naive plaintiff is more expensive than settling with the sophisticated one:*

$$\mathcal{O}_N = \max\{\mathcal{O}_N; \mathcal{O}_S^{23}; \mathcal{O}_S^{33}\}. \tag{22}$$

The naive is not aware of her self-control problem and thus is more optimistic about the trial outcome compared to the sophisticated. Not only does she fail to anticipate the correct timing of her action, but she also overestimates the level of effort she will exert. As a result, the likelihood of rejecting a given offer from the defendant decreases in the degree of sophistication. If this degree is the plaintiff's private information, we expect that the naive is more likely to go to trial than the sophisticated one.

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