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Asymmetric Reimbursement and Contingent Fees in Environmental Conflicts: Observable vs. Unobservable Contracts

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Abstract: We investigate the impact of observability of contracts between a plaintiff and his attorney on both the efficiency of the environmental conflict and the fairness of the resulting outcome from the environmental conflict. By including two specific game-theoretic models (an observable-contract game and an unobservable-contract game), we find two key results: (i) The unobservability of a contract may increase inefficiency of the environmental conflict in terms of legal efforts; however, (ii) the unobservability of a contract may increase the fairness of the outcome in terms of the plaintiff's probability of winning the contest.

Keywords: asymmetric reimbursement; contingent fee; inefficiency; fairness; Tullock-type contests; unobservable and observable contracts

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1. Introduction

1.1. Background Information

Federal environmental laws in the United States, including the Clean Air Act and the Clean Water Act, encourage citizens to act like "private attorney generals" and to sue a firm for its actions leading to pollution in violation of the federal law [1]. Along these lines, contest theory has explored environmental conflicts with asymmetric reimbursement between citizens' groups and firms [1–7]. The asymmetric reimbursement principle means that if a firm (a defendant) loses, the firm must then compensate the citizens' group (the plaintiff in a lawsuit brought against the firm) for the remuneration paid to the plaintiff's attorney, but if the defendant wins, no compensation is received from the plaintiff.[1]

Much of this literature [1–5] assumes a situation in which a plaintiff and a defendant directly file a lawsuit. These papers assume direct representation, which is a restrictive assumption since it is common for parties to hire lawyers in litigation. In consideration of this, Refs. [6,7] extend papers [1–5] by assuming that the attorney who is hired by a plaintiff and a defendant who has in-house legal advice file a lawsuit. However, the model in [6,7] of environmental conflicts with asymmetric reimbursement can be extended in two key aspects. First, they assume information about the delegation contract between a plaintiff and his attorney is disclosed. However, information about delegation contracts between the parties in the United States is protected [8,9]. The private information of the plaintiff and the attorney affects not only their strategic actions but also the defendant's, thereby affecting the outcomes of litigation, such as who prevails at trial and how much the attorney's fees and legal efforts become during trial. Second, they assume a losing defendant reimburses the attorney's effort to the attorney. The assumptions of the studies do not match what is often done in real-world situations. This paper extends the environmental contests of [6,7] and the legal contests in [9] to the specific case where a losing defendant reimburses the attorneys' fees that the plaintiff pays to his attorney[2]. This altered assumption accounts for lawsuits in which an exception is made to civil cases in the United States, lawsuits which would otherwise be governed by the American rule. It is obvious that the strategic actions of the plaintiff, the defendant, and the attorney change depending on whether information on delegate contracts between a plaintiff and his attorney is observable or unobservable, and who gets awarded the attorney's fees.

We investigate the outcomes of environmental conflicts by considering both asymmetric reimbursement and the unobservability of delegation contracts within a single model. In detail, this paper aims to answer the following questions. First, does the unobservability of a delegation contract increase the attorney's legal efforts and fees? Second, does the unobservability induce further reflection of objective merits in the plaintiff's probability of winning? The first question is related to economic efficiency, which is achieved by an environmental conflict, since legal costs such as the attorney's fees and legal efforts are social costs [1,10–12]. This is due to the fact that legal costs would not have occurred if the parties in the lawsuit reached an agreement. The increase in the inefficiency means that the application of asymmetric reimbursement to environmental conflicts in terms of social costs is not desirable. The second is related to the fairness achieved by the litigation. The increase in fairness means that the application of asymmetric reimbursement to the conflicts is desirable in terms of the plaintiff's probability of winning the contest.

To do so, we examine two Tullock-type environmental conflicts in which a plaintiff employs an attorney who works on his behalf, and a defendant employs an attorney who provides in-house legal advice. The plaintiff's attorney works for a contingent-fee basis.[3]

We first examine an environmental conflict—called the unobservable-contract game—in which the defendant cannot witness the delegation contract between the plaintiff and his attorney. In the unobservable-contract game, when the plaintiff determines the contingent fee to be paid to his attorney, he has the defendant not know the amount of the fee. Then, the attorney and the defendant compete with each other by expending their efforts simultaneously. The winner is determined through a Tullock-type lottery. The winning plaintiff pays compensation to his attorney pursuant to the delegation contract and receives reimbursement for the attorney's fee from the defendant.

Next, we examine another environmental conflict—called the observable-contract game—where the plaintiff decides on an appropriate contingent fee and, afterward, publicly announces the contract. The structure of the observable-contract game remains identical to the unobservable-contract game, except for the information about the delegation contract.

We find two key results by comparing the equilibria of the two environmental conflicts. First, the unobservability of the delegation contract may the lower economic efficiency by inducing a higher equilibrium contingent fee and a higher equilibrium total effort level than with observability of the contract. Second, the unobservability may increase the fairness achieved by the litigation by inducing the plaintiff's equilibrium winning probability to approach his objective.

In the next section, we briefly review the relevant literature related to this line of research. The framework of analysis is delineated in Section 2.1. Section 2.2 analyzes the unobservable-contract game. Section 2.3 analyzes the observable-contract game. Section 3 compares the equilibrium consequences of the two environmental conflicts. Finally, Section 4 offers our conclusions.

1.2. Related Literature

Tullock-type environmental conflicts with asymmetric reimbursement and without delegation are analyzed by [1–5]. Refs. [1,4] attempt to reconcile the effect of the two pre-commitments: The order of moves and changes to two exogenous parameters (i.e., the legal ability of each party and the portion of reimbursement). Through the effect, they examine economic efficiency on environmental conflicts. Ref. [4] shows, with endogenous timing, the plaintiff (the citizens' group) is a leader and the defendant (the firm) is a follower, which leads to the subgame perfect equilibrium. Furthermore, Ref. [4] finds that the combination 'Lead-Follow' is not necessarily efficient in regard to effort. This finding implies endogenous timing with legal efforts may be not a good assumption in environmental conflicts; however, the finding of Ref. [4] depends upon the assumption that the legal ability of the plaintiff is less than that of the defendant. Ref. [2] examines the efficiency consequences of a public–private environmental conflict, with and without asymmetric reimbursement rules. The conflict is over the probability of winning a fixed reward that is a private good for firms and a public good for citizens. Ref. [2] shows how a type of double free-riding exists: Only the hungriest citizen fights for the public good and all firms free-ride off the efforts of the others with an effort-independent sharing rule.

Over the past two decades, these Tullock-type contests have been extended in a variety of ways to apply to different situations. An original Tullock-type contest with asymmetric reimbursement and delegation is investigated by [6,7]. As aforementioned, Refs. [6,7] assume the defendant reimburses the plaintiff's attorney for its legal effort and the attorney receives reimbursement if the plaintiff wins at trial. There are some studies analyzing environmental conflicts, although not within the literature related to asymmetric reimbursement. Ref. [16] investigates the case in which a potential polluter, such as a firm, determines his profit level to reduce the cost of environmental conflicts. In the model, Ref. [16] considers a two-stage game: In stage one, the potential polluter determines the profit level, which is assumed to be a proxy variable for the "scale" of the project to be contested in stage two. These extensions of Tullock-type contests also include allowing for winner-reimbursement or loser-reimbursement in [17], finding that total spending in litigation is affected by altering the reimbursement rules. Ref. [10] investigates specific applications in Europe, providing support for not reimbursing contingent fees in these contests. A direct comparison between the English rule and the American rule is conducted in [18]. They find areas in which the English rule leads to better outcomes than the American rule, including a reduction in total litigation expenditures.

Ref. [9] examines a contest with delegation and without asymmetric reimbursement. They consider the two games, the unobservable- and the observable-contract games, and examine whether the observability of the delegation contract increases the expected payoff of the plaintiff. They find that the plaintiff favors the observable contract to the unobservable one, by comparing the equilibrium payoffs of the two games. Tullock-type contests with delegation have been studied, but they are not applied to environmental contests. Among them, studies analyzing delegation by unobservable contracts include [19,20]. Ref. [19] compares the equilibrium outcomes of the two games: contests with and without delegation. He shows that the unobservability of a delegation contract leads to consistent equilibrium outcomes in the two games. Ref. [20] considers a game in which only one of the two players have the option to delegate. Furthermore, they show the possibility that the unobservability of the contracts makes a player hire his delegate in the equilibrium.

Although these are not studies related to environmental conflicts, there are studies analyzing the economic inefficiency of contests based on rent dissipation using contest models: [21–24]. Several papers also study the role of sequential and/or simultaneous moves in a game [25–30]. This research investigate the impact of moving simultaneously versus sequentially [25–29], how ordering moves affects the equilibrium outcome [30], how sequential moves can lead to higher payoffs in the market [25], how investments in innovation are impacted by the movement in a game [29], how second movers can do better than first movers when switching to a sequential move game [30], how sharing information can alter a game's outcome [31], and how a contribution game is impacted by sequential moves [26–28]. These researchers find that firm profit can be increased by moving later in the game [25], innovation investments lead to higher profits for each player in sequential move games [29], how a second-mover advantage can occur [30], and how changing a game to sequential move can lead to different contributions in a contribution game [26–28]. However, the results are, in some circumstances, inconclusive as some researchers find total contributions in a contribution game are higher in sequential move games [26], while others find contributions are lower in sequential move games [27,28]. As with the Tullock-type contests, these previous studies have not investigated environmental conflicts, but specific economic market impacts and how contribution games are altered under various game theoretic conditions [25–30].

2. Results

2.1. Framework of Analysis

The theoretical models from [8,9], included two players, 1 (a plaintiff or a citizens' group) and 2 (a defendant or a firm), who compete in a lawsuit worth v. Delegate 1 (an attorney) represents player 1 in a Tullock-type environmental contest. Delegate 1 earns the contingent fee bv from player 1 if and only if player 1 wins v, where $0 < b < 1/2$. [4] Player 2 has in-house legal advice. Letting x_1 denote delegate 1's effort level and x_2 player 2's effort level, the probability of player 1 winning v is p_1. According to winner-takes-all, the probability that player 2 wins v is $p_2 = 1 - p_1$. Now, the Tullock-form litigation success function for player 1 is represented by

$$\begin{aligned} p_1(x_1, x_2) &= wx_1/(wx_1 + x_2) \text{ for } x_1 + x_2 > 0 \\ &= 1/2 \quad \text{ for } x_1 + x_2 = 0, \end{aligned}$$

where w is the objective merits of player 1. In the present model, we assume that w is the degree of fault of player 2: $w > 0$.[5] If $0 < w < 1$, the level of player 2 fault is greater than that of player 1; otherwise, vice versa. Without loss of generality, we assume that the prize is valued at $v = 1$. Then, delegate 1's expected payoff π_1 is:

$$\begin{aligned} \pi_1 &= p_1(b - x_1) + (1 - p_1)(-x_1) \\ &= p_1 b - x_1. \end{aligned} \tag{1}$$

We assume delegate 1 accepts the contract if $\pi_1 \geq 0$. Next, we consider the expected payoffs of each player. Player 1's expected payoff G_1 is given by:

$$G_1 = p_1[1 - (1 - a)b] \tag{2}$$

where $0 < a < 1$ represents the rate of reimbursement [1,6]. (2) says that if player 1 wins, he has to pay delegate 1 b, indicating he receives ab from player 2. Player 2's expected payoff G_2 is given by:

$$\begin{aligned} G_2 &= p_2(1 - x_2) + (1 - p_2)(-ab - x_2) \\ &= p_2(1 + ab) - ab - x_2. \end{aligned} \tag{3}$$

It is assumed the structure is common knowledge among players 1 and 2, and delegate 1.

2.2. The Unobservable-Contract Game

We solve the unobservable-contract game by viewing it as the following simultaneous-move game.[6] The game has two stages. In the first stage, player 1 determines the contingent-fee fraction b. In the second stage, delegate 1 and player 2 choose their effort levels, respectively—delegate 1 chooses x_1 with knowledge of b for him and without observing x_2, and player 2 chooses x_2 without observing b and x_1.

First, we derive best-response functions for delegate 1 and player 2 by considering delegate 1's decision on x_1 and player 2's decision on x_2, respectively. Then, we consider player 1's decision on b.

Delegate 1 selects x_1 to maximize π_1 given in (1), taking b and x_2 as given. Solving for the maximization problem yields the first-order condition: $bwx_2/(wx_1 + x_2)^2 - 1 = 0$. Since the litigation success function is concave, the second-order condition is satisfied. From the first-order condition, delegate 1's best response function $x_1(b, x_2)$ is obtained:

$$x_1(b, x_2) = [-x_2 + (bwx_2)^{1/2}]/w. \tag{4}$$

Player 2 selects x_2 to maximize G_2 given in (3), taking x_1 as given. Solving for the maximization problem yields the first-order condition: $(ab + 1)wx_1/(wx_1 + x_2)^2 - 1 = 0$.[7] Then, player 2's best response function $x_2(x_1)$ is

$$x_2(x_1) = -\,wx_1 + [wx_1(ab + 1)]^{1/2}. \quad (5)$$

We now consider player 1's decision on b. Taking x_2 as given, player 1 selects b to maximize $G_1(x_1, x_2)$ given in (2), using backward induction about $x_1(c, x_2)$ for b. That is, player 1 seeks to maximize

$$G_1(b, x_2) = wx_1(b, x_2)[1 - (1 - a)b]/[wx_1(b, x_2) + x_2] \quad (6)$$

over b, taking x_2 as given. Solving for the first-order condition, we obtain

$$[1 - (1 - a)b]x_2 - 2(1 - a)b(bwx_2)^{1/2} = 0. \quad (7)$$

Then, we find the best response function for player 1, by solving (7) for b.

Finally, we find the equilibrium contingent-fee fraction (b^*) and the equilibrium effort levels, ($x_1{}^*$, $x_2{}^*$), for the game. Without loss of generality, let $x_1{}^* = \delta x_2{}^*$, where δ is a positive value to be solved for below. Then, we derive (8) and (9) by using (4) and (7):

$$x_2{}^* = b^*w/(1 + w\delta)^2 \quad (8)$$

$$[1 - (1 - a)b^*]x_2{}^* - 2(1 - a)b^*(b^*wx_2{}^*)^{1/2} = 0. \quad (9)$$

Next, making use of $x_1{}^* = \delta x_2{}^*$ and (8) and (9), we obtain b^*, $x_1{}^*$, and $x_2{}^*$:

$$x_1{}^* = w\delta/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)], \quad (10)$$

$$x_2{}^* = w/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)], \quad (11)$$

and

$$b^* = 1/[(1 - a)(1 + 2w\delta)]. \quad (12)$$

As the final step, we solve for δ, utilizing $x_1{}^* = \delta x_2{}^*$:

$$\delta = [(1 + 4w) - (1 + 8w(1 - a))^{1/2}]/[2w[(1 + 8w(1 - a))^{1/2} - 1 + 2a]], \quad (13)$$

where $\delta < 1$. Now, we report the above results in Lemma 1.

Lemma 1. *In the equilibrium of the game with unobservable contract,*

(i) *if* $0 < a < [-(3 + 2w) + [(1 + 2w)^2 + 16w)]^{1/2}]/2$,
- *(a)* *The delegation contract is* $b^* = 1/[(1 - a)(1 + 2w\delta)]$,
- *(b)* *Delegate* 1 *and player* 2 *expend* $x_1{}^* = w\delta/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)]$ *and* $x_2{}^* = w/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)]$.
- *(c)* *The probability of winning for player* 1 *is* $p_1{}^* = w\delta/(1 + w\delta)$.
- *(d)* *The expected payoff for delegate* 1 *is* $\pi_1{}^* = (wv)^2/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)]$.
- *(e)* *The expected payoffs for players are* $G_1{}^* = 2(w\delta)^2/[(1 + w\delta)(1 + 2w\delta)]$ *and* $G_2{}^* = [(1 + w\delta)[1 - a + (2 - 3a)w\delta] - w]/[(1 - a)(1 + w\delta)^2(1 + 2w\delta)]$.

(ii) *if* $[-(3 + 2w) + [(1 + 2w)^2 + 16w)]^{1/2}]/2 \le a < 1$,
- *(a)* *The delegation contract is* $b^* = 1/2$,
- *(b)* *Delegate* 1 *and player* 2 *expend* $x_1{}^* = (2 + a)w/[2(2 + a + w)^2]$ *and* $x_2{}^* = (2 + a)^2w/[2(2 + a + w)^2]$.
- *(c)* *The probability of winning for player* 1 *is* $p_1{}^* = w/(2 + a + w)$.
- *(d)* *The expected payoff for delegate* 1 *is* $\pi_1{}^* = w^2/[2(2 + a + w)^2]$.
- *(e)* *The expected payoffs for players are* $G_1{}^* = (1 + a)w/[2(2 + a + w)]$ *and* $G_2{}^* = [8 + [12 - (2 + w)^2]a + 2(1 - w)a^2]/[2(2 + a + w)^2]$.

Lemma 1 shows that the difference in the equilibrium contingent fee depends on the combination of the rate of reimbursement and the objective merits of player 1. For example, if a is less than $[-(3 + 2w) + [(1 + 2w)^2 + 16w)]^{1/2}]/2$, then b^* is less than one half; otherwise, $b^* = 1/2$. Specifically, (ii) of Lemma 1 says if $w \leq 1$, then $b^* = 1/2$. This implies that if player 1's objective merit is less than player 2's, then player 1 pays half of the reward to delegate 1.

2.3. The Observable-Contract Game

The observable-contract game is the same as the unobservable-contract game, with the exception that when choosing his effort level, player 2 knows the level of contingent fee. The game also has two stages. In the first stage, player 1 determines the contingent-fee fraction b. In the second stage, delegate 1 and player 2 choose their effort levels, respectively—delegate 1 chooses x_1 with knowledge of b for him and without observing x_2 and player 2 chooses x_2 with knowledge of b and without observing x_1. Working backwards, this study solves for a subgame-perfect equilibrium of the two-stage game.

Delegate 1's maximization problem arises in the second stage—delegate 1 solves (1) with respect to x_1. The maximization problem derives delegate 1's best-response function:

$$x_1(b) = b^2w(1 + ab)/[1 + b(a + w)^2]. \quad (14)$$

At the same stage in the game, player 2 solves (3) with respect to x_2. Then, we find the best-response function for player 2:

$$x_2(b) = bw(1 + ab)^2/[1 + b(a + w)^2]. \quad (15)$$

Next, consider the first stage—player 1's decision on b is executed. Using (2), (14), and (15), we obtain

$$G_1(b) = bw[1 - (1 - a)b]/[1 + b(a + w)]. \quad (16)$$

Player 1 seeks to maximize (16) with respect to b. Then, this solves:

$$b^{**} = [-(1 - a) + [(1 - a)(1 + w)]^{1/2}]/[(1 - a)(a + w)]. \quad (17)$$

Finally, we solve for the equilibrium contingent-fee fraction (b^{**}) and the equilibrium effort levels, (${x_1}^{**}$, ${x_2}^{**}$), for the observable-contract game. Let ${x_1}^{**} = \theta {x_2}^{**}$, where θ is a positive parameter. Then, using (14), (15), and (17), we derive

$$b^{**} = \theta/(1 - a\theta), \quad (18)$$

$${x_1}^{**} = \theta^2 w/[(1 - a\theta)(1 + w\theta)^2], \quad (19)$$

$${x_2}^{**} = \theta w/[(1 - a\theta)(1 + w\theta)^2]. \quad (20)$$

A final step solves for θ, using ${x_1}^* = \theta {x_2}^*$:

$$\theta = [-(1 + a) + [(1 + a)(1 + 2a + w)]^{1/2}]/[(1 + aw) + a[(1 + a)(1 + 2a + w)]^{1/2}], \quad (21)$$

where $\theta < 1$. Now summarizing the above results, we report

Lemma 2. *In the equilibrium of the game with observable contract,*

(i) *if* $a < [-(3 + w) + [(1 + w)(9 + w)]^{1/2}]/2$,
  (a) *The delegation contract is* $b^{**} = \theta/(1 - a\theta)$,
  (b) *Delegate 1 and player 2 expend* ${x_1}^{**} = \theta^2 w/[(1 - a\theta)(1 + w\theta)^2]$ *and* ${x_2}^{**} = \theta w/[(1 - a\theta)(1 + w\theta)^2]$.
  (c) *The probability of winning for player 1 is* ${p_1}^{**} = w\theta/(1 + w\theta)$.
  (d) *The expected payoff for delegate 1 is* ${\pi_1}^{**} = w^2\theta^3/[(1 - a\theta)(1 + w\theta)^2]$.

(e) *The expected payoffs for players are*
$G_1^{**} = (1-\theta)w\theta/[(1-a\theta)(1+w\theta)]$ *and*
$G_2^{**} = [1-a\theta(1+w\theta)^2]/[(1-a\theta)(1+w\theta)^2]$.

(ii) *if* $[-(3+w)+[(1+w)(9+w)]^{1/2}]/2 \leq a < 1$,

(a) *The delegation contract is* $b^{**} = 1/2$,
(b) *Delegate* 1 *and player* 2 *expend*
$x_1^{**} = (2+a)w/[2(2+a+w)^2]$ *and* $x_2^{**} = (2+a)^2w/[2(2+a+w)^2]$.
(c) *The probability of winning for player* 1 *is* $p_1^{**} = w/(2+a+w)$.
(d) *The expected payoff for delegate* 1 *is*
$\pi_1^{**} = w^2/[2(2+a+w)^2]$.
(e) *The expected payoffs for players are*
$G_1^{**} = (1+a)w/[2(2+a+w)]$ *and*
$G_2^{**} = [8+[12-(2+w)^2]a+2(1-w)a^2]/[2(2+a+w)^2]$.

Lemma 2 also says that the difference in the equilibrium contingent fee depends on the combination of the rate of reimbursement and the objective merits of player 1. Unlike Lemma 1, Lemma 2 indicates that, even if the objective merits of player 1 are less than one, the equilibrium contingent fee may be less than one half. This implies that the unobservability of the contingent fee may incur more equilibrium contingent fee. This will be explained in detail in Section 3.

3. Discussion

We next examine: (i) whether the unobservability contract increases the equilibrium contingent fee and the equilibrium total effort level and (ii) whether the unobservability contract induces player 1′s probability of winning to approach his objective merit. First, we begin with an analysis of (i). Using Lemmas 1 and 2, we compare b^* with b^{**} in the two environmental conflicts. Further, considering the bounded reimbursement rate ($b \leq 1/2$), we obtain: if $0 < \theta < 1/(2+a)$, then $b^* > b^{**}$; and if $1/(2+a) \leq \theta < 1$, then $b^* = b^{**} = 1/2$. It is obvious that if $b^* > b^{**}$, then $x_1^* + x_2^* > x_1^{**} + x_2^{**}$; and if $b^* = b^{**}$, then $x_1^* + x_2^* = x_1^{**} + x_2^{**}$.[8]

Proposition 1. *The unobservability contract does not decrease the equilibrium contingent fee, nor the equilibrium total effort level.*

Proposition 1 focuses on the economic efficiency achieved in the model's results in the environmental conflict. The increase in the equilibrium total effort level implies a decrease in economic efficiency. Hence, the unobservability contract may reduce the economic efficiency of the environmental conflict with asymmetric reimbursement. If the contingent fee is disclosed, the intensity of the environmental conflicts will be reduced, and the plaintiff will sign a lower level of contingent-fee contract in consideration of this.[9] We can find similar results from [9] and [25]. Refs. [9,25] also showed that the equilibrium expenditures when the private information is disclosed are smaller than when the disclosure is not made.

Next, we examine (ii). The Tullock-form litigation success function for player 1 enables the investigation of normative criteria representing fairness. Consider that the resulting effort level of the attorney is that of the defendant: $x_1 = x_2$. Then, the winning probability of the plaintiff is $w/(1+w)$. The equilibrium winning probability for the plaintiff being close to $w/(1+w)$ makes the fairness of the contest higher [10–12]. For example, when $w = 1.2$, if the game is fair, the probability that player 1 wins should be 54.5%. Using Lemmas 1 and 2, we obtain that $w/(1+w) - p_1^* = w(1-\delta)/[(1+w)(1+w\delta)] > 0$ and $w/(1+w) - p_1^{**} = w(1-\theta)/[(1+w)(1+w\theta)] > 0$. With a smaller gap, a fairer outcome is reached in this environmental conflict. That is, if $p_1^* > p_1^{**}$ or $\delta > \theta$, then the unobservability contract increases the fairness of the outcome, and vice versa. Using (13) and (21), we obtain that if $0 < \theta < 1/(2+a)$, then $\delta > \theta$; and if $1/(2+a) \leq \theta < 1$, then $\delta = \theta$.

Proposition 2. *The unobservability contract may induce player 1's equilibrium probability of winning to approach his objective merits.*

Proposition 2 relates to the fairness achieved by this environmental conflict. The greater the probability of winning for player 1 reflects the objective merits for player 1, the fairer the outcome of the conflict.

4. Conclusions

Unlike the environmental conflict literature on asymmetric reimbursement, we allow that: (i) a plaintiff and his attorney may agree not to disclose information on the delegation contract, and (ii) reimbursement is awarded for attorney's fees. This model is more applicable to certain real-world cases, including civil cases in the United States in which exemptions are given, than models in previous research. The purpose of this research has been to examine if the unobservability of a delegation contract increases the attorney's fees and legal efforts, and whether the unobservability induces further reflection of objective merits in the plaintiff's winning probability. The novelty of this paper is that it analyses the efficiency and fairness achieved by environmental conflict with asymmetric reimbursement in one model.

To this aim, we studied an unobservable-contract game and an observable-contract game sequentially. Further, solving the games, we obtained the outcomes of the two games—the equilibrium attorney's fees, the equilibrium attorney's effort level, the equilibrium defendant's effort level, and the equilibrium expected payoffs for the attorney, the plaintiff, and the defendant. Furthermore, we compared the equilibrium consequences of these environmental conflicts. Then, we discovered two interesting results. The unobservability of the delegation contract increases the inefficiency of the environmental conflict in terms of legal efforts. However, the unobservability increases the fairness achieved by these environmental conflicts in terms of the plaintiff's winning probability.

It Is difficult to find empirical evidence of efficiency and fairness with the unobservability of a delegation contract in actual environmental conflicts since data on whether the plaintiff disclosed information on the contract cannot be obtained. However, while reviewing previous studies, it is possible to compare the efficiency and fairness of the contract unobservability to those with observability. For example, [9] reported that total legal efforts are lower in legal contests with the unobservability of delegation contract with no-reimbursement. It implies the economic inefficiency occurs in the unobservability with reimbursement. Ref. [9] also reported the winning probabilities of the plaintiff in the unobservable and observable contracts. Our model can also be used to compare the fairness of the unobservable-contract game with that of the observable-contract game. We find that fairness with the unobservability of contracting is higher than that with the observability of contracting. In sum, we find that unobservability with reimbursement increases economic inefficiency compared to unobservability without reimbursement.

Based on the limitations of this paper, a broader understanding of environmental conflicts can be provided by the following extensions. First, we did not consider the efficiency and fairness in settlement of environmental conflicts, but focused on those in trial. When considering settlement, unobservability may prevent the case from going to trial with higher litigants' legal expenditures (higher plaintiffs' contingent fees and defendants' legal efforts). This may imply that unobservability, considering settlement, makes the inefficiency lower. Second, endogenous timing can be considered in environmental conflicts (see [4]). For example, the plaintiff's lawyer may first present the defendant's fault as evidence, or the defendant may plead himself first. The broad expansion could present new results in environmental conflicts. Finally, we do not consider the potential impact of asymmetric information in our model. It is possible for one player to have an informational advantage in the game. However, the role of disclosures and a regulator eliciting information from a regulated entity does not fully fit with the case we explore in this research dealing with citizen suits. These extensions would provide additional information for cases beyond this current research.

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Notes

1 In the United States, only the remuneration paid by the citizens to the attorney is subject to asymmetric reimbursement, excluding office costs such as postage and fact-finding costs of various documents. Ref. [1] describes it as follows. "*Reimbursement could include repaying the cost for discovery, investigation, court costs, and support staffs, but generally is only awarded for attorney's fees*".

2 This paper is narrowly focused on a specific application of contract theory, environmental contests, instead of being broader in nature by creating a unified theory of contracts.

3 There are various reasons why plaintiffs hire lawyers under contingent fee [9,13–16]. In most civil cases, defendants are corporations, such as insurance companies, while plaintiffs are individuals. Accordingly, plaintiffs with less litigation experience have a greater incentive to prevent moral hazard of their attorneys than defendants and are more prone to be confronted with liquidity constraints than defendants. This is also why it is relatively easy for the plaintiffs to bring into line the contingent fee formula at an assured percentage of the compensation for damage, unlike the defendants [14]. On the other hand, it is common for the defendants to have in-house legal resources to invest in civil disputes, unlike the plaintiffs.

4 In the United States, the maximum feasible percentage the client can give the attorney is often dictated by legal restrictions on the contingent fee (which prohibit fees exceeding 50 percent).

5 As [4] mentioned, player 2 has more information about the case than player 1. Thus, Ref. [4] assumes that w is less than 1. This study assumes that the asymmetry of information is resolved by player 1 hiring delegate 1. Accordingly, this study considers w as player 2's degree of fault. Thus, w can be greater than 1.

6 See [8] for a detailed description of how the delegation contests can be solved with unobservable contracts.

7 The second-order condition is satisfied with $\partial^2 G_2/\partial x_2^2 = (\partial^2 p_2/\partial x_2^2)\,(1 + ab) < 0$.

8 Note that $x_1 + x_2 = bw(ab + 1)[1 + (a + 1)b]/[1 + (a + w)^2 b]$. Further, $\partial(x_1 + x_2)/\partial b = [1 + 2a(a + 1)(a + w)^2 b^3 + (2a^3 + 4(w + 1)a^2 + (2w^2 + 2w + 3)a + w^2)b^2 + 2(2a + 1)b]w/[1 + (a + w)^2 b]^2 > 0$ for $0 < \theta < 1/(2 + a)$, which implies that the total efforts are increasing in b. Considering $\partial(x_1 + x_2)/\partial b$ and $b^* > b^{**}$ for $0 < \theta < 1/(2 + a)$, this study obtains that if for $0 < \theta < 1/(2 + a)$, then $x_1^* + x_2^* > x_1^{**} + x_2^{**}$.

9 Furthermore, the equilibrium contingent fees in the two games increase in a, which makes the equilibrium total effort levels increase: $\partial b^*/\partial a > 0$, $\partial b^{**}/\partial a > 0$, $\partial(x_1^* + x_2^*)/\partial a > 0$, and $\partial(x_1^{**} + x_2^{**})/\partial a > 0$ for $0 < \theta < 1/(2 + a)$. This study uses Maple, a computer program, for comparative static analysis.

References

1. Baik, K.H.; Shogren, J.F. Environmental Conflicts with Reimbursement of Citizen Suits. *J. Environ. Econ. Manag.* **1994**, *27*, 1–20. [CrossRef]
2. Park, S.-H.; Shogren, J.F. Public-Private Environmental Conflicts. In *Risk and Uncertainty in Environmental and Natural Resource Economics*; Wessler, J., Weikard, H.-P., Weaver, R.D., Eds.; Cheltenham: Edward Elgar, UK, 2004; pp. 161–192.
3. Cherry, T.L.; Cotton, S.J. Environmental Conflicts with Reimbursement: Experimental Evidence. *Econ. Bull.* **2012**, *32*, 3224–3232.
4. Chassé, R.M. Strategic Behavior in Environmental Contests with Asymmetric Ability and Reimbursement. *Int. Rev. Law Econ.* **2019**, *58*, 115–126. [CrossRef]
5. Park, S.-H.; Settle, C. Internalizing Environmental Damages and Endogenous Reimbursement in Environmental Conflicts: A Game-theoretic Analysis. *Int. Rev. Econ.* **2022**, *69*, 547–569. [CrossRef]

6. Park, S.-H. Asymmetric Reimbursement System in an Environmental Conflict. *Appl. Econ. Lett.* **2010**, *17*, 1197–1199. [CrossRef]
7. Lim, B.L.; Shogren, J.F. Unilateral Delegation and Reimbursement System in an Environmental Conflict. *Appl. Econ. Lett.* **2004**, *11*, 489–493. [CrossRef]
8. Baik, K.H.; Kim, I.-G. Contingent Fees versus Legal Expense Insurance. *Int. Rev. Law Econ.* **2007**, *27*, 351–361. [CrossRef]
9. Park, S.-H.; Lee, S. Legal Contests with Unilateral Delegation. *Asian J. Law Econ.* **2020**, *11*, 20190031. [CrossRef]
10. Baumann, F.; Friehe, T. Contingent Fees Meet the British Rule: An Exploratory Study. *Public Choice* **2012**, *150*, 499–510. [CrossRef]
11. Baumann, F.; Friehe, T. A Note on the Timing of Investments in Litigation Contests. *Eur. J. Law Econ.* **2013**, *35*, 313–326. [CrossRef]
12. Park, S.-H. Contingent Fees and Endogenous Timing in Litigation Contests. *Eur. J. Law Econ.* **2022**, *54*, 453–473. [CrossRef]
13. Miller, G.P. Some Agency Problems in Settlement. *J. Leg. Stud.* **1987**, *16*, 189–215. [CrossRef]
14. Dana, J.D.; Spier, E.K. Expertise and Contingent Fees: The Role of Asymmetric Information in Attorney Compensation. *J. Law Econ. Organ.* **1993**, *9*, 349–367.
15. Bebchuck, L.A.; Guzman, A.T. How Would You Like to Pay for That? The Strategic Effects of Fee Arrangement on Settlement Terms. *Harv. Negot. Law Rev.* **1996**, *1*, 53–63.
16. Liston-Heyes, C. Setting the Stakes in Environmental Contests. *J. Environ. Econ. Manag.* **2001**, *41*, 1–12. [CrossRef]
17. Matros, A.; Armanios, D. Tullock's contest with reimbursements. *Public Choice* **2009**, *141*, 49–63. [CrossRef]
18. Carbonara, E.; Parisi, F.; von Wangenheim, G. Rent-Seeking and Litigation: The Hidden Virtues of Limited Fee Shifting. *Rev. Law Econ.* **2015**, *11*, 113–148. [CrossRef]
19. Katz, M. Game-Playing Agents: Unobservable Contracts as Precommitments. *Rand J. Econ.* **1991**, *22*, 307–328. [CrossRef]
20. Koçkesn, L.; Ok, E. Strategic Delegation by Unobservable Incentive Contracts. *Rev. Econ. Stud.* **2004**, *71*, 397–424. [CrossRef]
21. Ursprung, H.W. Public Goods, Rent Dissipation, and Candidate Competition. *Econ. Politics* **1990**, *2*, 115–132. [CrossRef]
22. Nitzan, S. Collective Rent Dissipation. *Econ. J.* **1991**, *101*, 1522–1534. [CrossRef]
23. Hurley, T.M. Rent Dissipation and Efficiency in a Contest with Asymmetric Valuations. *Public Choice* **1998**, *94*, 289–298. [CrossRef]
24. Dickson, A.; MacKenzie, I.A.; Sekeris, P.G. Rent Dissipation in Simple Tullock Contests. *Games* **2022**, *13*, 83. [CrossRef]
25. Li, G.; Guan, X.; Mukhopadhyay, S.K. The impact of decision timing on the suppliers' interactions: Simultaneous moves versus sequential moves. *J. Oper. Res. Soc.* **2016**, *67*, 248–258. [CrossRef]
26. Bag, P.K.; Roy, S. On Sequential and Simultaneous Contributions Under Incomplete Information. *Int. J. Game Theory* **2011**, *40*, 119–145. [CrossRef]
27. Varian, H. Sequential Contributions to Public Goods. *J. Public Econ.* **1994**, *53*, 165–186. [CrossRef]
28. Gachter, S.; Nosenzo, D.; Renner, E.; Sefton, M. Sequential versus Simultaneous Contributions to Public Goods: Experimental Evidence. *J. Public Econ.* **2010**, *94*, 515–522. [CrossRef]
29. Amir, R.; Chalioti, E.; Halmenschlager, R. University-Firm Competition in Basic Research: Simultaneous versus Sequential Moves. *J. Public Econ. Theory* **2021**, *23*, 1199–1219. [CrossRef]
30. Kubler, D.; Muller, W. Simultaneous and Sequential Price Competition in Heterogenous Duopoly Markets. *Int. J. Ind. Organ.* **2002**, *20*, 1437–1460. [CrossRef]
31. Kovenock, D.; Morath, F.; Münster, J. Information Sharing in Contests. *J. Econ. Manag. Strategy* **2015**, *24*, 570–596. [CrossRef]