Abstract

Farrell’s comparison of Coasean bargaining under incomplete information with second-best centralized regulation is reconsidered by introducing unsure property rights. Rights are unsure, because environmental law is typically incomplete, meaning that the outcome of taking action against environmental regulation is unsure ex ante. I will explore the efficiency implications of a standing to sue for externality victims, whose extent largely differs between countries.

Emerging bargaining incentives will be analysed in a Rubinstein bargaining game, where the environmental damage is private information of the affected party. The ambiguous result derived by Farrell is at least shifted in favor of decentralized bargaining; for some parameter values, private bargaining will unambiguously be welfare-improving, independent of the type distribution.

keyword: environmental bargaining

JEL: C78, D78, K 32.
Environmental Bargaining

Under Unsure Rights and Incomplete Information

Farrell’s *Bumbling Bureaucrat* Reconsidered

Abstract

Farrell’s comparison of Coasean bargaining under incomplete information with second-best centralized regulation is reconsidered by introducing unsure property rights. Rights are unsure, because environmental law is typically incomplete, meaning that the outcome of legal disputes over environmental regulation is unsure ex ante. Legal standing against regulating agencies’ decisions has to be interpreted as an attenuated property right. I will explore the efficiency implications of legal standing for affected third parties, which largely differs between countries. The threat to trigger a trial will be modeled as outside options of the parties in a Rubinstein bargaining game, where the environmental damage is private information of the affected party. It is concluded that a strong legal standing for affected parties may have a preference-revealing quality, when the valuation of environmental damage is private information. The ambiguous result derived by Farrell is at least shifted in favor of decentralized bargaining; for some parameter values, private bargaining will unambiguously be welfare-improving.

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1 Introduction

Should the internalization of environmental externalities be organized by a central authority or is it sufficient to define property rights and rely on the subsequent bargaining between the concerned private parties? This question was intensely debated in environmental economics after the challenge of the Pigovian tradition by Coase 1950, which was often interpreted as a strong argument against a centralized governmental intervention. However, Farrell 1987 convincingly argued that the view of the Coase theorem as a *decentralization result* does not make sense in a world of complete information. In such a setting, both centralized regulation and decentralized bargaining lead to the efficient outcome; therefore, a superiority of the bargaining solution cannot not be proven. Hence, Farrell uses a model of bilateral private information and compares the inefficiency resulting from Coasean bargaining under incomplete information with the inefficiency emerging from second-best centralized regulation. The regulator, who is intendedly welfare-maximizing, but also incompletely informed, uses a rule of thumb to maximize expected welfare. The result of this comparison is ambiguous: depending on the distribution of types, Coasean negotiations may be more or less efficient on the average than the *“bumbling bureaucrat“*. Farrell’s approach was used by several authors to explore more specific, but related issues. Buchholz/Haslbeck 1991 reformulate Farrell’s analysis in a model of one-sided asymmetric information, where the damage function is privately known, and get a similar result. Illing 1992
and Demougin/Illing 1993 also use models of one-sided private information; they compare pure Coasean bargaining with a situation where the bumbling bureaucrat fixes an environmental standard, which serves as a threat point from which the private parties may renegotiate. They show that the introduction of an intermediate standard will improve welfare, when compared to the situation where one of the parties exclusively owns the property right. A similar result was derived by Johnston 1995, where the intermediate standard is generated by an ex post nuisance test by the judicial system.

All these analyses, as well as Farrell himself, assume that the property right’s structure on environmental assets is a perfect policy instrument: the regulator can reallocate rights without limit and, specifically, may implement sure public or private property rights. In the present paper, I will relax this assumption and explore the case of unsure property rights, which I argue to be the more realistic setting.

Indeed, when a polluter can be sued by neighboring pollutees, e.g., under nuisance law, and the trial’s outcome is unsure, sure private property rights do not exist ex ante. The outcome will be unsure, if there are contingencies not considered in a clear-cut way in the underlying system of rights and duties. If, however, the relationship between the users of an environmental asset is complex, it is impossible to consider every contingency ex ante. In this case, it is not possible to establish sure property rights, and disputes over conflicting uses of the asset cannot be avoided. Instead of a sure right, citizens only have a right to solve these disputes through the legal system.

Most environmental problems are not merely addressed under common law, but involve regulation by public bodies. For these cases, a similar reasoning applies for the related public rights: Environmental regulation, e.g., a project-permit prescribing specific activities for environmental protection, is often based on environmental laws which give wide discretion to regulating agencies. This discretion, which, again, has to be granted because of the complexity of the underlying environmental problems, may lead to agency’s abuse of its power; therefore, parties have the right to sue agency decisions. When the trial outcome is unsure, public property rights are unsure ex ante as well. Legal standing of the private parties against the agency decision may be interpreted as an attenuated private property right.

The important policy question is, which parties are entitled to sue agency regulations. Within the permitting of an environmentally harmful project, the investor usually has the possibility to challenge the agency’s prescriptions, when considered too tight. However, the extent to which affected third parties are entitled to bring an action against the project-permit largely differs between countries. The crucial issue is when a party is acknowledged to be negatively affected in a legal sense. In the United States, the legal practice is quite liberal in this respect, under the so-called injury-in-fact-test. For instance, in nature conservation cases, an allegation by plaintiffs that they are using a development area for recreational purposes is generally accepted by the courts as an injury-in-fact (Rodgers 1994, 103). In contrast, the standard established in Germany is much more restrictive. Parties have to show a violation of their subjective rights in order to get standing. The above allegation would not be accepted for standing by German courts, because the use of an area for recreation usually is not fixed in a subjective right

1 For English synopses on the standing issue in German administrative law, see Jarass/DiMento 1993 or Rose-Ackerman 1995.
While the introduction of sure property rights may thus not be within reach of legislative bodies because of complexity and the separation of powers in democratic societies, an extension of legal standing for affected parties is possible by an adequate reform of administrative and environmental law, which changes the mix of unsure rights. The efficiency implications of such a reform will be explored in this paper in a setting of incomplete information.

I will consider a situation where the environmental damage associated with a planned economic project is private information of the affected party, say, a local community represented by a citizen group. The court ruling will be modeled as a lottery over the parties’ pleadings; and the opportunity to trigger a trial is depicted as outside options of the parties in a Rubinstein offer-counteroffer-bargaining game. Mohr 1990 uses this approach for an analysis under complete information to investigate the impact of different agency objectives on the bargaining outcome; however, my results depart from Mohr’s even when information is complete.

The basic model is presented in part 2. Part 3 presents the situation where only the investor has standing. Because of the unsure court outcome, bargaining incentives emerge between the investor and the welfare-maximizing *bungling bureaucrat*. The outcome will be inefficient; moreover, the inefficiency will reveal to be higher than under a bumbling bureaucrat owning a sure public property right. The introduction of standing for the citizen group will yield bargaining incentives between the private parties. It will be shown in part 4 that inefficiencies due to asymmetric information will only result for a specific parameter range. For other parameter values, the strategic problem in bargaining under private information vanishes: the citizen group has an incentive to reveal its type. Efficiency is improved, when compared with the outcome realized by a bumbling bureaucrat under unsure rights. The bargaining outcome may be first-best efficient.

The policy conclusion is that legal standing for affected parties will not only improve efficiency in a setting of complete information, but may also have a preference-revealing quality, when the valuation of environmental damage is private information. In theoretical respect, the ambiguous result derived by Farrell 1987 and Buchholz/Haslbeck 1991 is at least shifted in favor of decentralized bargaining; for an empirically plausible parameter range, private bargaining will be unambiguously welfare-improving under one-sided asymmetric information.

## 2 The Model

*Technology*

I consider an indivisible private project which yields profit $\Pi_0$ for the investor and generates a monetary environmental damage $D_0$. These environmental costs may be reduced through the investor’s additional spending on protective activities. The resulting lower damage of a specific spending level $S$ is described by the function $D = D(S)$, which is assumed to be differentiable twice, and $D_0 = D(0)$. This damage function is private information of the affected persons, e.g., neighbours of the planned project represented by an environmental group. The group will be one of two types: $D(.) \in \{D(.), \overline{D}(.)\}$, where, for every $S$, $D(S) < \overline{D}(S)$ . The probability that $D(.) = \overline{D}(.)$ is denoted by $q$. 
$D(S)$ is assumed to be strictly convex. Spending on the protective activity has diminishing marginal returns for both types: $D' < 0$, $D'' \geq 0$. It is assumed that

(1) $D'(S) > \overline{D}'(S)$ for every $S$.

The optimal spending levels depend on the types and are denoted by $S_*, \overline{S}_*$; thus, $S_* \in \{S_*, \overline{S}_*\}$. Assume an interior solution: $S_*(0, \Pi_0)$ for both types. Conditions for the optimal level of environmental spending are:

(2) $D'(S_*) = -1$, $\overline{D}'(S_*) = -1$ and

(3) $\Pi_0 - D(S_*) - S_* > 0$, $\Pi_0 - \overline{D}(S_*) - \overline{S}_* > 0$.

By assumption, condition (3) is met. Because of (1), $S_* < \overline{S}_*$. Denote $D^* = D(S_*)$ and $\overline{D}^* = \overline{D}(S_*)$. Assume that $D^* < \overline{D}^*$.

Assume furthermore that the spending level which would completely avoid environmental damage is higher than the private profit $P_0$ for both types:

(4) $D^{-1}(0) > P_0$ for $D(.) \in \{D(.), \overline{D}(.)\}$.

Note that $S = D^{-1}(D)$. Denote welfare by $W = \Pi_0 - D(S)$. The welfare level under $S_*$ is $W_*$ and the corresponding profit $\Pi_*$, whereas $W_0$ denotes the welfare level without environmental spending: $W_0 = \Pi_0 - D_0$. Clearly, $W_* \in \{W_*, \overline{W}_*\}$, $\Pi_* \in \{\Pi_*, \overline{\Pi}_*\}$ and $W_0 \in \{W_0, \overline{W}_0\}$.

In part 4, a specific representation of $D(S)$ will be used to simplify the presentation of a proposition. No loss of generality will be incurred. Let damage costs $D$ and abatement costs $S$ depend on a physical variable $E$, where $E$ stands for a physical parameter. $E_0$ is the level of $E$ when no environmental spending occurs. Assume a constant marginal damage and quadratic abatement costs. Thus, $D = D(E) = dE$, where $d \in \{d, \overline{d}\}$ and $d < \overline{d}$;

$S = S(E) = (E_0 - E)^2$, which, by assumption, is defined for $E \in (0, E_0]$.

Taking the inverse function $E(S) = S^{-1}(E)$ and substituting into the damage function yields

(5) $D(S) = d(E_0 - \sqrt{S})$,

which satisfies the above assumptions. Specifically, using (2) shows that $S_*$ is increasing in the marginal damage: $S_* = 0.25 d^2$. Thus, $S_* < S^*$ iff $d < \overline{d}$.

**Actors**

Because of the harmful effects on the environment, the investor needs a permit from a regulating agency before realizing the project. The permit may be conditional: the agency has discretion in prescribing a certain level of safeguards, i.e., a specific spending level on abatement.

Agency discretion can lead to agency's abuse of its power. Therefore, a conditional permit can be taken to court by the investor or even by the citizen group, if it has a standing to sue. I will first

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2 $D$ is assumed to be the aggregate of true individual damages; thus, the familiar problems of group formation and of revealing true preferences within the process of group formation are not considered.
consider a situation where such third parties do not have legal standing. This means that the project, while generating an environmental damage $D$, does not harm (narrowly defined) individual rights of affected parties. Under the German principle of individual rights’ protection, this damage would then not generate standing, while it may do so under the more liberal US-american injury-in-fact test.

Consider first the objectives of the investor and the agency.

The objective of the investor is to maximize net profit $\Pi(S) = \Pi_0 - S$; thus, he will mostly prefer an unconditional permit.

Following the tradition of Farrell (1987), the agency is assumed to maximize expected welfare

$$\hat{W}(S) = \alpha \left[ \Pi_0 - qD(S) + S - (1 - q)(D(S) + S) \right],$$

where $\alpha$ is a dummy variable ($\alpha \in [0, 1]$) reflecting acceptance or rejection of the economic activity. As (3) is met by assumption for every type, the agency will accept the project and set $a=1$. Under complete information ($q \in \{0, 1\}$), the agency would simply prefer the „right“ spending level: $S^* \in \{S^*, \tilde{S}^*\}$. In a world of incomplete information, however, the agency will prefer $\tilde{S}^*$ maximizing expected welfare: $\tilde{S}^* = \arg\max_S \left[ \Pi_0 - qD(S) + S - (1 - q)(D(S) + S) \right]$.

Denote the corresponding welfare level by $\hat{W}^*$.

Under a constant marginal damage and quadratic avoidance costs, expected welfare is $\hat{W}(S) = \Pi_0 - (qd + (1 - q)d)(E_o - \sqrt{S}) - S$. Thus, an agency maximizing expected welfare would use, as a rule of thumb, the weighted mean of the privately known marginal damage $\tilde{d} = qd + (1 - q)d$. This is Farrell’s „bumbling bureaucrat.

The court

The trial will be modeled as a lottery over the parties pleadings: the parties plead in line with their objectives, and the court decides immediately in favor of one of the parties with some positive probability $p_I$. I do not consider litigation costs, as they do not substantially change the results. Parties are assumed to be risk-neutral.

Consider the situation where an environmental group does not have standing. The investor, when fighting the agency’s regulation, pleads for an unconditional permit, while the agency, when sued, will defend the conditional permit it issued. Define as $\tilde{S}^A$ the spending level associated with the protective activities prescribed in this permit. The expected outcome from trial will be

$$\hat{\Pi}^{ca} = \Pi_0 - (1 - p_I)\tilde{S}^A$$

for the investor and

$$\hat{W}^{ca} = \Pi_0 - (1 - p_I)(\tilde{S}^A + qD(\tilde{S}^A) + (1 - q)\tilde{D}(\tilde{S}^A)) - p_I[qD_0 + (1 - q)\tilde{D}_0]$$

for the agency,

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3See Mohr 1990 or Porter 1988. This approach is also consistent with the literature modeling environmental disputes as contests; then, probabilities are endogenized by a contest function. See, e.g. Baik/Shogren 1994 or Heyes 1997. The results derived here will hold for any $p_I \in (0, 1)$. 

where the superscript $c$ stands for court, $a$ stands for asymmetric standing, $p_I$ denotes the probability that the court rules in favour of the investor, and $p_I \in (0,1)$ for the court outcome being unsure.

When litigation costs are zero, the investor always has an incentive fight any permit issued without negotiations, as $\tilde{S}^A > (1 - p_I)\bar{S}^A$. It is this result that yields bargaining incentives between the investor and the agency under unsure rights. This bargaining constellation will be analysed under 3.1.

It results from (7) and (9) that it is optimal for the agency, when it wants to issue a permit without bargaining, to set $\tilde{S}^A = \bar{S}^*$. By assumption, the stipulations of a negotiated permit will formally stated within an enforceable consent decree, with which private parties waive their right to sue against the prescriptions.

**Compensation**

In the Coasean analysis of environmental negotiations under sure rights for the affected party, the possibility of compensation payments is crucial for existence and efficiency of a bargaining solution. In the present analysis under unsure rights, compensation will reveal not that crucial, neither for existence nor for efficiency.

In reality, the possibility of compensation may be limited. First, to pay compensation may not lay within regulatory discretion; then, it is legally prohibited for agencies to pay compensation in form of a cost-sharing of protective activities. Even if there are no legal obstacles, such arrangements will be limited by tight budget restrictions of governmental agencies. This same „fallacy of bankruptcy“-argument applies to compensation payments from citizen groups or environmental organizations. However, it does not apply for compensation payments from investors, as they could, in principle, be financed out of the project’s profit. To reflect this argument, the following analysis will assume that compensation is asymmetric in the sense that only the operator of the project under dispute can pay compensation.

3 **Asymmetric standing and the bumbling bureaucrat**

Under asymmetric standing, only the investor has the right to sue the project permit, while the citizen group has not. This setting will characterized by using $a$ as a superscript for the relevant variables. The analysis will proceed in several steps. First, I will use a setting of complete information and unsure rights. It will be shown that bargaining incentives arise for both parties and that the bargained spending level is always inefficiently low. Then, the case of sure rights and uncomplete information will shortly be restated; this is the usual case of the bumbling bureaucrat. Finally, both parts will be integrated in a setting of incomplete information and unsure rights.

3.1 Unsure rights, complete information

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4 Clearly, this condition may also hold for positive litigation costs.
As the analysis is under complete information, the ~ and the swung dash are omitted. For \( q \in \{0, 1\} \), the agency’s objective (7) and the expected court outcomes (8) and (9) adapt accordingly. Then, \( S^A = S^* \).

In the subsequent analysis, the possibility to use the legal system will be modeled as outside options in a bargaining game. First, the set of possible bargaining solutions without outside options is derived. Outside options are introduced in a next step.

Consider the constellation between an investor and an agency within a procedure of permitting a planned facility. The project is not realized as long as the procedure are ongoing. Thus, the status quo payoff pair is \((0, 0)\). Assume for the moment that the agency can only block the realization of the project, but cannot try to push through an optimal regulation with the help of the court system. This amounts to formulate a bargaining game without outside options. The investor and the regulating agency will bargain over a specific spending level \( S \), which corresponds to a specific level of technical abatement. The solution of the bargaining game will be denoted by \((\Pi^B, \Pi^W)\), the spending level in bargaining equilibrium is \( S^B = \Pi^B - \Pi^W \).

Denoting a possible negotiated spending level by \( S^{na} \) and the corresponding damage by \( D^{na} \), this leads to a specific negotiated payoff pair \((\Pi^{na}, W^{na})\), where

\[
\Pi^{na} = \Pi^B - S^{na}, \text{ and } W^{na} = \Pi^W - (S^{na} + D^{na}).
\]

Because of the assumptions over \( D(S) \) made under 2, it is immediate that there are \( S^{na} \), for which \( \Pi^{na} > 0 \) and \( W^{na} > 0 \). The bounded, convex set of all possible bargained pairs \((\Pi^{na}, W^{na})\) is denoted by \( \Phi_a \). The maximal negotiated payoff of the agency for a given payoff of the investor is described by the function \( \varphi_a(\Pi) ; \varphi_a(\Pi^B) = \Pi^W \). This bargaining frontier contains the set of all technically efficient spending levels, where \( D^{na} = D(S^{na}) \). Under strict convexity of \( D(S) \) and the payoff functions specified in part 2, \( \varphi_a(\Pi^*) = 0 \), \( \varphi_a(\Pi^0 - S^{na}) < 0 \) for \( S^{na} \in (\Pi^*, \Pi^0) \) and \( \varphi_a'(\Pi^{na}) < 0 \). A graphical presentation of \( \varphi_a(\cdot) \) and \( \Phi_a \) is pictured in figure 1.

Define by \( \Phi^I_a(\cdot) \) the inverse function for the segment of \( \varphi_a(\cdot) \) on domain \([\Pi^*, \Pi^0] \). Specifically, \( \Phi^I_a(\cdot) \) gives, for an agency (bargained) payoff, the maximal payoff for the investor. For all given agency payoffs \( W^{na} < W^* \), any \( \Pi^{na} < \varphi^I_a(W^{na}) \) is pareto-dominated. It may be concluded that any bargaining solution must be such that \( \Pi^B \in [\Pi^*, \Pi^0] \).

For any \( W^{na} \in [0, W^0] \), \( \Phi^I_a(W^{na}) = \Pi^0 \). Any welfare level strictly lower than \( W^* \) may also be realized by zero environmental spending: in the negotiations, the investor cannot gain more than \( \Pi^0 \). Clearly, these points are not technically efficient.

The trial

The possibility to use the legal system is modeled as an outside option for the parties, meaning that, at a specific stage of the bargaining game precised below, one party has the opportunity to quit the negotiations and trigger a trial. Specifically,
• the investor may terminate the negotiations. In this case, the agency will issue a permit over \( S^* \). Under the assumptions on the possible court outcome, the investor has an incentive to sue this permit, as \((1 - p_i)S^* < S^* \) for \( p_i > 0 \).

• The agency’s outside option is to quit the bargaining table and issue the permit \( S^* \), against which the investor will take action.

\[ \text{The bargaining protocol} \]

The bargaining process between the investor and the agency will be modeled as a strategic offer-counteroffer bargaining game (Rubinstein 1983, Sutton 1986), where parties may take their outside option after they rejected an offer. Specifically,

• The investor starts the negotiations in period \( t=0 \) with an offer over a specific spending level \( S \). The agency may accept or reject this offer. If it accepts, the game ends with the payoffs \( (\Pi^{Bu},W^{Bu}) \). If it rejects, it may quit and issue a permit over \( S^* \), thus taking its outside option. In this case, the game ends immediately with the payoffs \( (\Pi^{ca},W^{ca}) \). However, the agency may also submit a counter-offer. Preparation of this counter-offer needs time, meaning that

• the agency submits a counter-offer in period \( t=1 \). Acceptance by the investor terminates the game. A rejection against opens two opportunities: the investor may take his outside option, or decides to submit a second offer in period \( t=2 \).

• The game is repeated until one party accepts an offer or takes its outside option.

The common discount factor of both parties is \( \delta^\Lambda \); where \( \delta^\Lambda \in [0,1] \) and \( \Lambda \) is the period’s length. When not indicated otherwise, \( \Lambda = 1 \). Thus, bargaining is costly, because the payoffs associated with a delayed agreement have to be discounted. Any party realizing a specific payoff in period \( t \) has to be offered by its adversary at least the discounted value of this payoff in order to accept an agreement one period earlier, in \( t-1 \).

\[ \text{The bargaining solution} \]

An explicit solution of the strategic game is relegated to appendix 1. Here, I will use the axiomatic characterization of the bargaining solution, which applies when \( \Lambda \to 0 \), the time period elapsing between offer and counteroffer being „very small“. The solution is based on two well-known results from bargaining theory:

• The solution of a strategic model of offer-counteroffer bargaining without outside options converges, for a common discount factor \( \delta^\Lambda \) and for \( \Lambda \to 0 \), to the symmetric Nash-solution (Nash 1950) of the game (Sutton 1986, Binmore/Rubinstein/Wolinski 1986, 182-3).
• The outside option principle: Outside options affect the solution of the bargaining game only when the a party’s threat to take the outside option is credible in a given subgame. In this case, the other party has to agree on a bargaining solution which guarantees the value of the outside option to the threatening party. If the threat is not credible, the outside option does not affect the bargaining solution. Therefore, the introduction of outside options should not be modeled by shifting the status quo-point, which depicts the payoffs during negotiations. 

For this characterization of the bargaining solution, the question of which party submits the first offer is unimportant, as any bargaining advantages stemming from being the first mover disappear for \( \Lambda \to 0 \).

Denote Nash’s solution of the game by \( (\Pi^{Na}, W^{Na}) \), where \( N \) stands for Nash; thus, \( (\Pi^{Ba}, W^{Ba}) = \arg\max_{S} \{\Pi W\} \) subject to \( (\Pi, W) \in \Phi_{a} \), and \( S^{Na} = \Pi_{a} - \Pi^{Na} \).

**Lemma 1.**

(i) Bargaining between the investor and a welfare-maximizing agency will always result in an immediate agreement on an inefficiently low spending level: \( S^{Ba} < S^{*} \).

(ii) For a common discount factor \( \delta^{a} \) and for \( \Lambda \to 0 \), bargaining incentives between the investor and the agency exist for any \( p_{I} \in (0, 1) \),

(iii) For a common discount factor \( \delta^{a} \) and \( \Lambda \to 0 \), the solution of the bargaining game is characterized as follows:

- When \( \Pi^{ca} > \Pi^{Na} \) and \( W^{ca} \leq W^{Na} \),
  
  the investor’s outside option is a credible threat. The bargaining solution is
  
  \( (\Pi^{Ba}, W^{Ba}) = (\Pi^{ca}, \varphi_{a}(\Pi^{ca})) \).

- When \( \Pi^{ca} \leq \Pi^{Na} \) and \( W^{ca} \leq W^{Na} \),
  
  no outside option is credible, and the Nash solution is the solution of the game:
  
  \( (\Pi^{Ba}, W^{Ba}) = (\Pi^{Na}, W^{Na}) \).

- When \( \Pi^{ca} \leq \Pi^{Na} \) and \( W^{ca} > W^{Na} \),
  
  the agency’s threat with its outside option is credible, and the solution is
  
  \( (\Pi^{Ba}, W^{Ba}) = (\varphi_{a}(W^{ca}), W^{ca}) \).

**Proof.** See the appendix. 8

Figure 1 gives an illustration of this result. The parameter \( p_{I} \) is chosen such that the threat, by the investor, to take his outside option is credible. As the Nash-solution has to be on the downward-
sloping segment of $\varphi_a(\cdot)$, it is immediate from figure 1 that the Nash-solution yields an inefficiently low spending level $(\Pi_{Na}^* \in (\Pi^*, \Pi_0])$.

Thus, legislators cannot avoid negotiations when regulating agencies have to be granted discretion because of complexity, and when discretionary decisions by the agency may be scrutinized by the courts in favour of investors. Under the formulation of the court used here, bargaining incentives may result even in the absence of legal costs or risk aversion. Furthermore, the bargaining will always result in too low a spending level on protective activities, even when the agency is welfare-maximizing. The analysis under complete information yields a bargaining-theoretical explanation of the implementation deficits of environmental policy, without recurring to a bureaucratic-theoretical framework.

When $p_i \in \{0, 1\}$, public, resp. private property rights on the environment are sure. If $p_i = 0$, bargaining degenerates into the investor’s immediate acceptance of a permit prescribing a optimal spending level $S^*$. 

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*Fig. 1: Negotiations between Investor and Agency*
Given the assumptions on the outside options, i.e., the modeling of the expected value of a court decision, the inefficiency result may not seem surprising. However, it does not depend on the credibility of the investor’s threat to trigger a legal dispute during negotiations: the Nash-solution also implements too low a spending level. The intuition behind this result is that the agency is interested not only in reducing environmental damages through environmental spending, but also in realization of the investor’s profit, which is as well part of society’s well-being. Therefore, the agency will take a „soft“ stance even in negotiations where no outside option is a credible threat.

3.2 Incomplete information

Under a sure public right, \( p_l=0 \); thus, the investor does not have an incentive to sue a permit prescribing a positive level of protective activities.

Under incomplete information, the agency will prescribe the spending level \( \tilde{S}^* \) maximizing expected welfare, as specified by the agency’s objective function presented under 2. This is the bumbling bureaucrat. The expected inefficiency is

\[
q[D(\tilde{S}^*) + \tilde{S}^* - D(S^*) - S^*] + (1 - q)[\bar{D}(\tilde{S}^*) + \tilde{S}^* - \bar{D}(S^*) - \bar{S}^*].
\]

Thus, either unsure rights or incomplete information give rise to inefficiencies:

- under unsure rights and complete information, bargaining over \( S \) will result, with an inefficient outcome \( S_{ba} < S^* \);
- under incomplete information and a sure public right, the rule of thumb applied by an agency maximizing expected welfare - the bumbling bureaucrat - would lead to a spending level \( \tilde{S}^* \).

The level is different from the one(s) implemented, would the damage function be known publicly; the resulting efficiency loss is given by (10).

Consequently, the result of the analysis may be stated by

**Proposition 1.** Under uncomplete information about environmental damages and unsure rights, bargaining incentives emerge between the investor and the bumbling bureaucrat. The bargained outcome will lead to a higher inefficiency, when compared with a bumbling bureaucrat’s regulation who has a sure public property right.

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\(^6\) Whereas Mohr 1990, when assuming a welfare-maximizing agency, inplausibly models the negotiations as a simply linear division problem over the „pie“ \( \Pi_{p_l} \) and gets \( S_{Na}^{\Pi_{p_l}} = 0.5 \ \Pi_{p_l} \). See the appendix for details.
Proof. Immediate from a restatement of lemma 1 for $q \in (0,1)$ and the definition of $\tilde{S}^*$. 8

The bumbling bureaucrat under incomplete information, who has to bargain with an investor because of an unsure public right, will not even be able to implement a spending level $\tilde{S}^*$ which maximizes expected welfare, but only a smaller $\tilde{S}^{ba}$. Thus, the inefficiency arising under incomplete information will be higher in a setting of unsure public rights.

This result can readily be explained with figure 1 by adding swung dashes, where necessary; thus, substitute $\varphi_a(.)$ by $\tilde{\varphi}_a(.)$, $W^*$ by $\tilde{W}^*$, and so on. For the bumbling bureaucrat under sure public property rights, set $p_I=0$. Bargaining would degenerate into the investor’s immediate acceptance of $(\tilde{\Pi}^*,\tilde{W}^*)$, meaning that $\tilde{S}^*$ will be implemented. Remember that under incomplete information, the values of the parties’ outside options are given by

\begin{align}
\tilde{\Pi}^{ca} &= \Pi - (1 - p_I)\tilde{S}^* \quad \text{for the investor, and} \\
\tilde{W}^{ca} &= \Pi - (1 - p_I)(\tilde{S}^* + \tilde{D}^*) - p_I[q\tilde{D}_0 + (1 - q)\tilde{D}_0] \quad \text{for the agency, where} \\
\tilde{D}^* &= q\tilde{D}(\tilde{S}^*) + (1 - q)\tilde{D}(\tilde{S}^*).
\end{align}
4 Symmetric standing and private bargaining

Consider now the situation where both the investor and a group of affected citizen have standing against a permit over $S^*$. I will first analyse the bargaining incentives and possible outcomes in a setting of complete information. Here, Coasean negotiations under sure private rights will emerge as a special case. In a second step, asymmetric information will be introduced. Variables applying in the setting of symmetric standing will be characterized by using the superscript $s$.

4.1 Complete information, unsure rights

Under complete information, the $\ldots$ and the swung dashes can again be omitted.

The legal standing for the environmental group, besides offering the formal right to sue an agency permit, is assumed to be substantial, in the sense the court will indeed decide in favour of the organization with a specific probability. Assume that, when going to court, the environmental organization cannot ask for compensation. The organization will then plead for a rejection of the project. Denote by $p_E$ the probability that the court decides in favour of the environmental organization.

The organization has an incentive to sue any permit negotiated without its participation. Denote the environmental damage associated with this permit by $D^{Ba}$. Then,

$$-(1 - p_E)D^{Ba} > -D^{Ba} \quad \text{for any } p_E > 0.$$  

Therefore, the other parties accept the environmental organization as a bargaining party, when it has standing.

Consider now the bargaining situation where the environmental organization participates. As soon as one the private bargaining parties decides to quit the bargaining table, bargaining would break down. This is so, because the investor, as well as the environmental organization, also has an incentive to sue a permit negotiated without his participation:

$$p_I \Pi_b + (1 - p_I) \Pi^B > \Pi^B \quad \text{for any } p_I > 0 \text{ and any } \Pi^B < \Pi_0.$$  

When bargaining breaks down, the agency would issue a permit over $S^*$. The question is, whether at least one private party has an incentive to sue this non-negotiated permit. After failed bargaining, no party does waive its right to sue. Thus, if at least one party has an incentive to sue the permit over $S^*$, the other private party will plead in court as well, in order to defend its stake. Denote by

---

6 Such a far-reaching second-guessing by the court may seem rather improbable within the permitting of a new project. The analysis can readily adapted to a situation where the organization is entitled only to ask for a complete compensation. Even a mere remand by the court would favor the citizen. Since the decision-making process of the agency is time-consuming in reality, a remand means that the construction of the project is delayed. For this period of time, the environment remains in the state most preferred by the affected citizen.
the probability for the investor to get granted an unconditional permit,

\( p_A \) the probability for the agency to get the permit \( S^* \) confirmed by the court, and

\( p_I + p_A + p_E = 1. \)

To ensure comparability with the situation of asymmetric standing, I assume that the probability of the investor's winning in court does not change, as the substantial merits of the case remain the same.

Thus, denoting the negative payoff for the citizen group by \( -D^c \), the values of the trial for the respective parties are given by:

\[
\Pi^{cs} = p_I \Pi + p_A (\Pi - S^*) ,
\]

\[
-D^{cs} = -(p_I D_0 + p_A D^*) ,
\]

\[
W^{cs} = (p_A + p_I) \Pi_0 - p_A (D^* + S^*) - p_I D_0 .
\]

Welfare resulting from trial is thus modeled to be reduced by the introduction of third-party standing: \( W^{cs} < W^{ca} \). Note the difference between having an incentive to sue and pleading in court to present one's stake. When the latter is not possible without filing suit, parties may take legal action only in response to other parties' suing, without having an incentive to do so independently of the other party's activities.

In the following analysis, it is assumed that it is the investor and the environmental group which are actually bargaining, whereas the agency takes a passive role in this process. This assumption may be defended on several grounds:

- First, a strategic game of offer-counteroffer-bargaining with three parties may generate a multiplicity of equilibria (Osborne/Rubinstein 1990, 63-65). By avoiding this problem, the assumption ensures tractability.

- Second, this formulation allows for an immediate comparison with an analysis of environmental bargaining under sure rights and complete information (Coase 1960) and sure rights and incomplete information (Farrell 1987). The Coasean analysis will emerge as a benchmark of the model presented here.

- Last but not least, the assumption is reasonable on substantive grounds: Note that, for every outcome \( S_{ns} \) and \( D_{ns} \) bargained between the investor and the environmental group, it is better for the agency to accept this outcome than to risk a trial. This can clearly be seen by restating the incentives to negotiate in terms of the associated costs. Incentives to negotiate exist then, if there is a pair \( S_{ns}, D_{ns} \), for which

\[
(13a) \quad S_{ns} \leq p_A S^* + p_E \Pi_0 \quad \text{for the investor},
\]

\[
(14a) \quad D_{ns} \leq p_A D^* + p_I D_0 \quad \text{for the citizen group},
\]
(15a) \[ S_{\text{ns}} + D_{\text{ns}} \leq p_A(S^* + D^*) + p_iD_0 + p_E\Pi_0 \]
for the agency.

If (13a) and (14a) are true, which has to be the case for every bargained outcome, then (15a) must be true, too.

Consider now the situation where the investor or the citizen group decides to quit the bargaining table, and the subsequent permit over \( S^* \) issued by the agency will not be challenged by any private party. This will happen, if

\[
\Pi^c \leq \Pi^*, \text{ and} \\
-D^c \leq -D^*. 
\]

Thus, the value of the parties’ outside options in the subsequent bargaining game is no longer automatically be given be the expected value of the court outcome. Denote the values of the respective party’s outside option by \((\Pi^\text{out}, -D^\text{out})\). Then,

\[
(\Pi^\text{out}, -D^\text{out}) = \begin{cases} 
(\Pi^*, -D^*) & \text{iff } \Pi^c \leq \Pi^* \text{ and } -D^c \leq -D^*, \\
(\Pi^c, -D^c) & \text{ else.} 
\end{cases} 
\]

The structure of the total bargaining game considered here may be summarized as follows:

- The agency is asked to undertake a regulatory activity by the submission of a permit application by an investor. Because of (11), the agency will propose negotiations with the environmental group, when incentives to negotiate exist. Negotiations start immediately. If no incentives exist, the agency will issue a permit over \( S^* \).

- Analogously to part 3, the bargaining game between the investor and the environmental group (the agency being passive) is modeled as a strategic game of offer-counteroffer-bargaining, where each party may take its outside option after rejection of an offer from the adversary. By assumption, the environmental group submits the first offer.

- Parties opt out by quitting the bargaining table. Then, the agency will immediately issue a permit over \( S^* \), against which each party will sue, when it has an incentive to do so. If a party has an incentive to sue, the agency and the other private party will also defend their respective stake in court. Again, the court will also decide immediately.

- When agreeing on a negotiated permit, each private party waives its right to sue.

The solution of this strategic game is presented in the appendix. Here, I will again use the axiomatic characterization of the game, which holds for a common discount factor \( \delta^\Lambda \) and \( \Lambda \rightarrow 0 \).

To characterize the bargaining solution, consider the bargaining game without taking the outside options into account. When bargaining over the permit for a new project, the status-quo point is \((0,0)\). Denote by \( \varphi^s(\Pi^\text{ns}) \) the maximal negotiated payoff level of the environmental group for a given payoff level of the investor. Introduce now the asymmetric compensation assumption presented in part 2. Thus, in addition to spend on protective activities, the investor may pay a
compensation financed out of profit, while the other parties cannot, due to tight budgets. Denote a specific negotiated level of compensation by $C_{ns}^\text{ns}$, $C_{ns}^\text{ns} \neq 0$. Denote the environmental group’s total payoff by $Q_{ns}^\text{ns}$. Thus, the parties’ payoff for given $S_{ns}^\text{ns}$ and $C_{ns}^\text{ns}$ is

\[
\Pi_{ns}^\text{ns} = \Pi_0 - S_{ns}^\text{ns} - C_{ns}^\text{ns} \quad \text{for the investor, and}
\]

\[
Q_{ns}^\text{ns} = -D(S_{ns}^\text{ns}) + C_{ns}^\text{ns} \quad \text{for the environmental group.}
\]

From the definition of $\varphi_s(.)$,

\[
(19) \quad \varphi_s(\Pi_{ns}^\text{ns}) = \max_{S_{ns}^\text{ns}, C_{ns}^\text{ns}} \left[-D(S_{ns}^\text{ns}) + C_{ns}^\text{ns}\right] \quad \text{s.t.} \quad S_{ns}^\text{ns} + C_{ns}^\text{ns} = \Pi_0 - \Pi_{ns}^\text{ns} \quad \text{and} \quad C_{ns}^\text{ns} \geq 0.
\]

Kuhn-Tucker first-order-conditions of (19) are

\[
-D(S_{ns}^\text{ns}) - y = 0, \quad 1 - y \leq 0, \quad C_{ns}^\text{ns} \geq 0, \quad \text{and} \quad C_{ns}^\text{ns}(1 - y) = 0,
\]

where $y$ is the Langrangean multiplier. For $C_{ns}^\text{ns} = 0$, $D(S_{ns}^\text{ns}) \geq -1$, implying that $S_{ns}^\text{ns} \leq S^*$. For $C_{ns}^\text{ns} \geq 0$, $D(S_{ns}^\text{ns}) = -1$, implying $S_{ns}^\text{ns} = S^*$. Thus, it can be stated that

\[
(20) \quad \varphi_s(\Pi_{ns}^\text{ns}) = \begin{cases} 
-D(S_{ns}^\text{ns}) & \text{for} \quad \Pi_{ns}^\text{ns} > \Pi^*, \\
-D(S^*) + C_{ns}^\text{ns} & \text{for} \quad \Pi_{ns}^\text{ns} \leq \Pi^*.
\end{cases}
\]

The graph of $\varphi_s(.)$ is depicted in fig. 2. Denote the transfer level which completely compensates an environmental damage $D(S^*)$ by $C_{\text{min}}$, and the corresponding profit by $\Pi_{\text{min}}$, thus, $\Pi_{\text{min}} = \Pi_0 - S^* - C_{\text{min}}$. Denote the equilibrium outcome of the bargaining game between the investor and the citizen group by $(\Pi_{\text{Bs}}, Q_{\text{Bs}})$.

\[\text{Lemma 2.}\]

(i) Bargaining incentives between the investor and the environmental group exist for $p_I, p_A, p_E \geq 0$.

(ii) For a common discount factor $\delta^\Lambda$ and $\Lambda \rightarrow 0$, the unique solution of the bargaining game between the investor and the environmental group is characterized as follows:

- When $\Pi_{\text{out}}^\text{out} \leq 0.5\Pi_{\text{min}}$,

the outside options of both parties do not constitute credible threats. The bargaining outcome is

\[
(\Pi_{\text{Bs}}, Q_{\text{Bs}}) = (0.5\Pi_{\text{min}}, 0.5\Pi_{\text{min}}).
\]
• When $\Pi^\text{out} > 0.5\Pi_{\text{min}}$, the investor’s threat to quit the bargaining table is credible. The solution results from (18) and (20):

$$\langle \Pi^B_s, Q^B_s \rangle = \langle \Pi^*, -D^* \rangle, \quad \text{iff} \quad \Pi^\text{cs} \leq \Pi^* \quad \text{and} \quad -D^\text{cs} \leq -D^*,$$

$$\langle \Pi^B_s, Q^B_s \rangle = \langle \Pi^\text{cs} \varphi_s(\Pi^\text{cs}) \rangle \quad \text{else, where}$$

$$\varphi_s(\Pi^\text{cs}) = \begin{cases} -D(\Pi_0^s - \Pi^\text{cs}) & \text{for} \quad \Pi^\text{cs} > \Pi^s, \\ -D(S^*) + C^B_s & \text{for} \quad \Pi^\text{cs} \leq \Pi^*. \end{cases}$$

Proof: See the appendix.

The intuition behind lemma 2 can readily be given with the help of figure 2.

The threat of the environmental group to opt out and thus trigger the issuance of a permit over $S^*$ and a possible trial will never be credible. This is so, because the expected outcome from the outside option will be negative, whereas the status quo payoff, for the environmental group, is zero.

The Nash solution results, when no party’s threat to quit the negotiations is credible. In this case, the parties equally share the profit remaining after spending $S^*$ for environmental protection and complete compensation of the damage $D^*$. In figure 2, the Nash solution is denoted by $\langle \Pi^{Ns}, Q^{Ns} \rangle$; thus

$$\langle \Pi^{Ns}, Q^{Ns} \rangle = (0.5 \Pi_{\text{min}}, 0.5 \Pi_{\text{min}}).$$

This solution also results for the case of Coasean bargaining under sure property rights. To see this, note that all expected court outcomes (13) to (15) turn zero for $p_E^E = 1$, meaning a sure property right for the affected party represented by the environmental organization. Coasean bargaining corresponds to the bargaining game without outside options.

Therefore, the Coasean analysis is a special case of the more general setting presented here. Furthermore, it can be concluded that complete property rights are not a prerequisite neither for existence nor for efficiency of a bargaining solution. Specifically, the efficient solution under sure property rights may also emerge for „almost sure“ property rights, as long as the investor’s outside options does not constitute a credible threat.

The possibility of compensation payments is necessary for bargaining incentives to emerge under sure-rights-bargaining à la Coase. Under unsure rights, however, compensation is not necessary for existence of a bargaining solution. When compensation payments are ruled out, (20) always gives

$$\varphi_s(\Pi^\text{ax}) = -D(\Pi_0 - \Pi^\text{ax}) \ .$$

Then, the investor’s outside option will always be credible, and the parties will agree on an outcome as given by the second part of (ii) in lemma 2.
Obviously, compensation is crucial for efficiency of the bargaining solution, when the investor’s threat is not credible. When his threat is credible, compensation is crucial, as long as a non-negotiated permit by the agency would be challenged in court by at least one of the private parties. Consider, however, the case when $\Pi^\text{out} > 0.5 \Pi_{\min}$, $\Pi^c \leq \Pi^*$ and $-D^c \leq -D^*$. Here, the investor threatens not to trigger a trial, but, by letting negotiations fail, the issuance of a permit $S^*$ by the agency, against which no party has an incentive to sue. It results that the parties, in negotiations, would also agree on a spending level $S^*$. The standing rights of the private parties against the agency’s decision neutralize each other. The solution will be efficient even in the absence of a compensation payment. This result stems from private bargaining occurring under the supervision of a (welfare-maximizing) agency, a setting which is empirically plausible.
Figure 2: Private bargaining under complete information

The analysis presented here yields an argument for why environmental organizations may be ready to accept compensation when bargaining over a new project. Consider the case where $\Pi_{\text{out}} > 0.5 \Pi_{\text{min}}$, $\Pi^c < \Pi^*$ and $-D_c > -D^*$. The investor’s threat to trigger a trial is credible, and the bargaining outcome, following (20), contains a positive compensation payment. As the investor is guaranteed only his reservation value (the expected value of triggering a trial), it is the environmental group which reaps all efficiency gains from compensation. In figure 2, these efficiency gains are depicted by the distance a-b.

By comparing lemma 1 and lemma 2, it can be stated as an intermediate result that

**Proposition 2.** When bargaining parties are completely informed and property rights are unsure, the introduction of legal standing for affected third parties generates an efficient bargaining outcome or an efficiency improvement, when compared to the outcome under asymmetric standing.

**Proof.** Asymmetric standing generates bargaining incentives between the investor and the agency, which resulted in an efficiently low spending level. In the symmetric standing situation, as long as $\Pi^c \leq \Pi^*$, bargaining will be efficient; the parties either agree on the efficient permit $S^*$, or on the efficient spending level $S^*$, plus an additional compensation payment.

When $\Pi^c > \Pi^*$, the investor’s threat to trigger a trial is credible, and it results from (20) that the investor and the environmental group will agree on an inefficiently low spending level. To see the efficiency improvement, consider the following situations under asymmetric standing:

- The investor’s threat is also credible under asymmetric standing. For a given $p_I$, the expected value of going to court is smaller, for the investor, under symmetric than under asymmetric standing, implying a higher spending level: $\Pi^{ca} < \Pi^{ca}$.

- The investor’s threat is not credible under asymmetric standing. In this case, either the Nash solution applies, or the agency’s threat is credible, implying

$$\Pi^{ca} < \Pi^{Na},$$

or

$$\Pi^{ca} < \phi^I(W^{ca}).$$

As $\Pi^c < \Pi^{ca}$, the negotiated spending level under symmetric standing will again be higher. ■
The possibility of compensation payments is crucial for proposition 2 to hold unambiguously. When compensation is ruled out, and when $\Pi^{cs} < \Pi^{*}$ and $-D^{cs} > -D^{*}$, the spending level may „overshoot“, in the sense that the investor and the environmental group agree on too high a spending level. This, however, presumes that the environmental group is ready to forego all efficiency gains from compensation.

It results that a standing to sue for affected third parties of environmental regulation will improve efficiency in a setting of complete information. This is so, even while the welfare from trial is reduced. The question is, how this result of unsure rights has to be modified when the environmental damage is private information of the externality victim. The analysis of part 3.3 gives a partial answer: the inefficiency emerging from bumbling under private information will be higher, when rights are unsure. In the remaining part, private bargaining under unsure rights and private information has to be explored.

4.2 Private bargaining under unsure rights and incomplete information

(11) and (12) still hold. Specify the assumption of a „passive“ agency in the way that the agency does not sit at the bargaining table, but will accept the negotiated outcome, because of a suitably adaptation of (13a)-(15a):

(13b) \[ S_{ns} \leq p_A \tilde{S}^* + p_E \Pi_0 \]

for the investor,

(14b) \[ \bar{D}(S_{ns}) \leq p_A \bar{D}(\tilde{S}^*) + p_I D_o \]

for the low-type citizen group,

(15b) \[ S_{ns} + q\bar{D}(S_{ns}) + (1-q)D(S_{ns}) \leq p_A (\tilde{S}^* + q\bar{D}(\tilde{S}^*)) + p_I (qD_o + (1-q)D_o) + p_E \Pi_0 \]

for the agency.

This specification is crucial for the following result to hold, and thus allows to state an additional institutional requirement for environmental bargaining under private information. This issue will be discussed below.

When negotiations break down, the bumbling bureaucracy will issue a permit over $\tilde{S}^*$, which the private parties may fight in court. Assume for presentational reasons that either both group types or no type has an incentive to challenge this permit; the assumption holds for the functional form of $D(S)$ introduced by (5), as can easily be ascertained.\(^7\) Then, the parties’ outside options are defined by

\(^7\) When, e.g., only the low type has an incentive to challenge the permit, the expected value of the investor’s outside option will be $q\Pi^{cs} + (1-q)\Pi^{*}$. The results to be derived will hold accordingly; no loss of generality is incurred.
\[(\tilde{\Pi}_{\text{out}}, -D_{\text{out}}) = \begin{cases} (\Pi^*, -D(\tilde{S}^*)) & \text{iff } \tilde{\Pi}^* \leq \tilde{\Pi}^* \text{ and } -D^* \leq -D(\tilde{S}^*), \\ (\tilde{\Pi}^{cs}, -D^{cs}) & \text{else}, \end{cases} \]

where

\[(\tilde{\Pi}^{cs}) = p_j\Pi_0 + p_A(\Pi_0 - \tilde{S}^*), \]

\[D^{cs} = -(p_jD_0 + p_AD(\tilde{S}^*)), \]

and the values of \(D\) are type-contingent: \(D \in \{D, \tilde{D}\}\).

Denote by \(\Pi^{Ns}\), \(\Pi^{Ns}\) the Nash payoffs for the investor when bargaining with the low, viz., the high type under complete information. As \(D^* < D\) and \(S^* < S\), \(\Pi^{Ns} > \Pi^{Ns}\). Also, \(\Pi^* > \Pi^*\).

**Proposition 3.** Under unsure property rights and private information about the environmental damage and when \(\tilde{\Pi}^{cs} \geq \Pi^{Ns}\), the introduction of third-party standing and the resulting private negotiations unambiguously improves welfare.

(i) Bargaining incentives between the investor and the environmental group exist for \(p_k, p_A, p_{E} > 0\).

(ii) For \(\tilde{\Pi}^{cs} \in [\Pi^{Ns}, \Pi^*]\) and \(-D^{cs} > -D(\tilde{S}^*)\), \(D \in \{D, \tilde{D}\}\), bargaining between the private parties will be first-best efficient.

(iii) For \(\tilde{\Pi}^{cs} \in [\Pi^*, \Pi_0]\), the outcome may be first-best efficient. At least an efficiency improvement will result, when compared to the outcome negotiated between the bumbling bureaucrat and the investor.

(iv) At least for \(\Pi^{cs} \in [\Pi^{Ns}, \tilde{\Pi}^*]\), the outcome will be more efficient than under a bumbling bureaucrat owning a sure public property right.

**Proof.** For \(\tilde{\Pi}^{cs} \geq \Pi^{Ns}\), the investor can credibly threaten to opt out irrespective of the group type he confronts in the negotiations. The environmental group cannot influence the value of the investor’s outside option by strategically misrepresent private information. When the threat is credible for both types, the investor is guaranteed his outside option payoff as bargaining outcome, according to lemma 2; thus, \(\tilde{\Pi}^{Bs} = \tilde{\Pi}^{out}\).

(i) This is a restatement of the proof of (i) from lemma 2. Instead of \((\Pi^*, -D^*)\) and \((\Pi_0, -D_0)\), use \((\tilde{\Pi}^*, \Phi'_j(\tilde{\Pi}^*))\), \((\Pi_0, D_0)\) for the low type and \((\tilde{\Pi}^*, \Phi'_s(\tilde{\Pi}^*))\), \((\Pi_0, D_0)\) for the high type.

(ii) For \(\tilde{\Pi}^{cs} \in [\Pi^{Ns}, \tilde{\Pi}^*]\) and \(-D^{cs} > -D(\tilde{S}^*)\), the permit issued after the investor’s opting out would be challenged by the environmental group; then, \(\tilde{\Pi}^{out} = \tilde{\Pi}^{cs}\). The investor’s
bargained outcome is given by $\tilde{\Pi}^{Bs} = \tilde{\Pi}^{cs}$, and, as $\tilde{\Pi}^{cs} < \Pi^* < \Pi^*$, it follows from (20) that

$$-D(S^*) + C^{Bs} > -D(S^{ns}) + C^{ns}$$

for any $S^{ns} \neq S^*, C^{ns} \neq C^{Bs}$, and

$$-\tilde{D}(\tilde{S}^*) + C^{Bs} > -\tilde{D}(\tilde{S}^{ns}) + C^{ns}$$

for any $S^{ns} \neq \tilde{S}^*, C^{ns} \neq \tilde{C}^{Bs}$, where

$$\Pi_0 - S^* - C^{Bs} \bigg| _{\Pi_0 - S^{ns} - C^{ns}} = \tilde{\Pi}^{cs}.$$  

Both types have an incentive to reveal their private information, in order to get the type-specific optimal mixture of environmental spending and additional compensation.

(iii) For $-D^{cs} > -D(\tilde{S}^*)$, a permit over $\tilde{S}^*$ would not be challenged by the environmental group. When the permit would not be challenged at all, $\Pi^{out} = \tilde{\Pi}^*$. When the investor would challenge the permit, $\Pi^{out} = \tilde{\Pi}^{cs}$. The reasoning under (i) can be applied accordingly: Strategic incentives to hide the private information vanish.

For $\tilde{\Pi}^{cs} > \Pi^*$, the bargained agreement may be inefficiently low at least for the high type. Efficiency improvements, when compared to the setting of asymmetric standing and unsure rights, will result, because $\tilde{\Pi}^{cs} < \tilde{\Pi}^{ca}$, and the proof of proposition 2 applies accordingly.

(iv) Consider the benchmark case $\tilde{\Pi}^{Bs} = \tilde{\Pi}^{cs} = \tilde{\Pi}^*$. In the bargained solution, the investor spends the same amount than under a bumbling bureaucrat owning a sure public right. Note that $\tilde{\Pi}^* \in (\Pi^*, \Pi^*)$. The spending level for the high type will be inefficiently low, leading to a welfare loss of

$$\Pi^{out} - \Pi^{*}.\]$$

$$\Pi^{out} - \Pi^{*}.\]$$

However, the low type will agree on an efficient spending level plus an additional compensation. An increase of the bargained spending level ($\tilde{\Pi}^{Bs} < \tilde{\Pi}^*$) will decrease (24). For $\tilde{\Pi}^{Bs} \leq \tilde{\Pi}^*$, (24) vanishes. A comparison of (24) with (12) completes the proof.

Figure 3 depicts this result. When $\tilde{\Pi}^{cs} \geq \Pi^{Bs}$, the ambiguity between regulation by a bumbling bureaucracy and private bargaining disappears under unsure rights.

It is crucial that the environmental group, by revealing the private information, cannot not influence the agency’s pleading and, hence, the value of the investor’s outside option. The information transmitted to the investor has to be confidential. That is why it is important that

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8Bargaining in environmental policy implementation under participation of third party representatives is an empirically relevant phenomenon in the United States, as is shown by the literature on „environmental dispute resolution“ (see, e.g., Bacow/Wheeler 1984, Bingham 1986).
the agency is not present at the bargaining table. Would this be the case, the agency could adapt its pleading according to the information given by the group. Consequently, the low type will not have an incentive to reveal its type, when

$$\phi(\Pi^*) + C < \phi(\Pi^* + C),$$

where $\Pi^* + C = \Pi^{cs}$ and $\Pi^* + C = \Pi^{cs}$ denotes the investor’s outside option when the agency, in response to the low-type information, would correctly plead for a permit over $S^*$. As a theoretical aside, in the case of $\tilde{\Pi}^{cs} \geq \Pi^{Ns}$, the citizen group has „all the bargaining power“ in the sense that the investor is guaranteed only his reservation payoff, i.e., the value of his credible outside option, whereas the group reaps type-specific bargaining gains $\phi_s(\Pi^{out}) - D^{out}$. Therefore, the situation is analogous to a „bargaining“ protocol where the group is the principal and makes a take-it-or-leave-it offer. For such contract-design problems, Maskin/Tirole (1990, proposition 11) indeed show that under quasi-linear utility functions (like the one used here for the environmental group), private information of the principal has no strategic value. Most of the cited literature on environmental bargaining uses this static mechanism-design approach; then, results crucially depend on the - somewhat arbitrary - modeler’s decision whom to exogenously allocate all the bargaining power. However, the model presented here, via the credibility of outside options, gives a rationale for when to assume that a specific party has all the bargaining power. Specifically, it suggests that, for a given status quo and given values of the parties’ outside options, the modeler may not be free to allocate all the bargaining power to any party she wishes. For instance, giving the investor „all the bargaining power“ by assuming that he makes a take-it-or-leave-it offer to the environmental group would not make sense, when environmental negotiations over a planned project are addressed.

When $\tilde{\Pi}^{cs} < \Pi^{Ns}$, Farrell’s ambiguity result holds, but is shifted in favour of private bargaining. This is so, because proposition 1 is valid even when the property right for the citizen group is „sure enough“ to yield Coasean bargaining under incomplete information, where the low type may have a strategic incentive to misrepresent private information.

Resulting bargaining inefficiencies under private information were widely analysed in the literature (see the cited references for analyses within the environmental setting). There may also be a substantial reason why not to reiterate this issue. To generate „almost sure“ property rights for the environmental organization, $p_A$ and $p_I$ need to be rather small. Empirically, however, it could be argued that, while public rights may be unsure, they will not be „very unsure“, in the sense that courts will confirm legal challenges of agency activities „very often“. Hence, if $p_A$ is high, this case is rather improbable.
5 Conclusions and possible model extensions

When rights are unsure and the investor’s outside option is a credible threat, bargaining between private parties will lead to a better outcome than bargaining with a bumbling bureaucrat resulting from asymmetric standing. In this case, the distribution of types is irrelevant; there is no type-specific ambiguity concerning the superiority of private bargaining over the performance of the bumbling bureaucracy.

If the investor’s outside option is not credible, standard inefficiencies emerging from asymmetric information may result in private bargaining. Here, the type-specific ambiguity may still hold, but is shifted in favor of private bargaining because of proposition 1: under unsure rights, the bumbling bureaucrat’s performance is worse than under sure rights.

The policy conclusion is that a third party legal standing against public environmental regulation, by changing the bargaining constellation, may implicitly reveal privately-known environmental preferences. Therefore, an extension of standing rights may not only be desirable from a viewpoint of complete information, but may also be a pragmatic instrument to reduce the valuation problem.

Implications for the formulation of environmental and administrative law are straightforward especially for Germany, where public law traditionally has been very reluctant to extend legal standing beyond immediate neighbours of environmentally harmful projects. But even in the United States, the issue is far from being moot. Recent jurisdiction by the Federal Supreme Court has tightened the liberal standing requirements, which was intensely debated by legal scholars (see Rodgers 1994, 108-9).

Some comments can be made concerning the structure of the model:

Continuum of types. The model can be reformulated for a continuous, instead of a discrete, distribution of $d$. The two types of $d$ may then define the corresponding support. The qualitative results of the analysis would not change. Using a bumbling rule would still be inefficient; bargaining under unsure rights would increase this inefficiency. If the investor’s outside option is credible in private bargaining, every type still has an incentive to reveal its true marginal damage.

Regulation of new or of existing projects. An important part of environmental policies focus on the regulation of already existing and producing facilities. A reformulation of the analysis by shifting the status quo point shows that in the asymmetric standing case, the outside option of the agency is then always credible. In the symmetric standing case, it is the citizen group’s outside option which would be credible. Here, the value of this option depends of the group’s
type, which may yield strategic incentives in the bargaining game. The investor may try to screen the group’s type, in turn, inefficient outcomes may result. Thus, the derived preference-revealing quality of third party standing applies only for planned projects. However, as unsure rights still increase the inefficiency of regulation by a bumbling bureaucrat, the ambiguity result is still modified in favour of private bargaining.

Bilateral private information. A superiority of private bargaining may not exist, if the investor also holds private information (e.g., on expected profits). In this case, the value of the investor’s outside option may depend on his type, which yields strategic incentives for the investor to hide this information in bargaining under both asymmetric and symmetric standing. Therefore, the policy conclusion of the analysis should primarily apply to cases where project-specific information is fairly well known, and where private environmental preferences are the decisive informational bottleneck.

References


Appendix

In the appendix, the superscripts $s$ and $a$ will be omitted.

Proof of lemma 1

The proof exploits the stationarity property of the bargaining game in the tradition of Shaked/Sutton (1984).

First step: Bargaining without outside options

Existence and inefficiency


$$
\Pi^{sup} = \varphi' (\delta \varphi (\delta \Pi^{sup})) \quad \text{and}
$$

$$
\Pi^{inf} = \varphi' (\delta \varphi (\delta \Pi^{inf}))
$$

as conditions for the supremum and the infimum payoff the investor may realize in a subgame-perfect equilibrium$^1$.

<table>
<thead>
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<th>period</th>
<th>offer made by</th>
<th>inv. gets at most/at least</th>
<th>agency gets at least/at most</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t=T-2$</td>
<td>investor</td>
<td>$\varphi' \delta \varphi (\delta \Pi^{sup/inf})$</td>
<td>$\delta \varphi (\delta \Pi^{sup/inf})$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\varphi' (\delta \varphi (\Pi^c))$</td>
<td>$\delta \varphi (\Pi^c)$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\varphi' (W^c)$</td>
<td>$W^c$</td>
</tr>
<tr>
<td>$t=T-1$</td>
<td>agency</td>
<td>$\delta \Pi^{sup/inf}$</td>
<td>$\varphi (\delta \Pi^{sup/inf})$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\Pi^c$</td>
<td>$\varphi (\Pi^c)$</td>
</tr>
<tr>
<td>$t=T$</td>
<td>investor</td>
<td>$\Pi^{sup/inf}$</td>
<td></td>
</tr>
</tbody>
</table>

Table A.1

Note that $\Pi^{inf}$ and $\Pi^{sup}$ are fixpoints of $\varphi' (\delta \varphi (\delta .))$. Denote such a fixpoint by $\Pi^*$ and the corresponding welfare by $W^*$. As $\varphi' (\delta \varphi (\delta .))$ is a continuous mapping from the compact interval $[\Pi^*, \Pi_0]$ into itself, Brouwer's fixed point theorem applies: (At least) one fixpoint exists on $[\Pi^*, \Pi_0]$. Furthermore, it is immediate from $\varphi' (\delta \varphi (\delta .))$ that $\Pi^*$ cannot be a fixpoint. This proves (i) and (ii) of proposition 1 for the game without outside options: a bargaining solution exists, and any bargaining solution will yield an inefficiently low spending level.

Uniqueness

$^1$ Would this bargaining problem be one of how to split the pie $\Pi_0$ between the parties, $\varphi(\Pi)=\Pi_0-\Pi$. Clearly, this is not plausible for a welfare-maximizing agency.
Uniqueness implies $\Pi^\inf = \Pi^\sup$. A formulation will be used that leads, for $\Lambda\to0$, directly to the Nash-solution of the bargaining game. For $(\Pi^*,\Pi_0]$, $\varphi(.)$ is decreasing in $\Pi$; furthermore, as $D(S)$ is strictly convex by assumption, $\varphi(.)$ is strictly concave. The proof needs only concavity.

It follows from the definition of $\varphi'(.)$ that $W^+ = \max[\delta \varphi(\delta \Pi^+),W_0]$. Consider two cases.

For $\delta \varphi(\delta \Pi^+) > W_0$, a fixpoint may also be defined by $W^+ = \delta \varphi(\delta \Pi^+)$, where trivially $W^+ = \varphi(\Pi^+)$. Thus,

(A.1) $\frac{\varphi(\Pi^+) - \varphi(\delta \Pi^+)}{(1 - \delta \Pi^+)} = \frac{\delta \varphi(\delta \Pi^+) - \varphi(\delta \Pi^+)}{(1 - \delta \Pi^+)}$.

Geometrically, the left-hand side of (A.1) is the difference quotient $\frac{\Delta \varphi}{\Delta \Pi}$. Rearranging the right-hand side yields

(A.1a) $\frac{\varphi(\Pi^+) - \varphi(\delta \Pi^+)}{(1 - \delta \Pi^+)} = -\frac{\varphi(\delta \Pi^+)}{\Pi^+}$.

Differentiating the right-hand side with respect to $\Pi$ gives

(A.2) $\left[ -\frac{\varphi(\delta \Pi)}{\Pi} \right]_\Pi \equiv \frac{\varphi(\delta \Pi) - \varphi'(\delta \Pi)\delta \Pi}{\Pi^2}$.

This expression is positive, if $\varphi(\delta \Pi) - \varphi'(\delta \Pi)\delta \Pi > 0$. Expanding gives

(A.3) $\varphi'(\delta \Pi)\Pi < \varphi(\delta \Pi) + \varphi'(\delta \Pi)(\Pi - \delta \Pi)$.

$\varphi(.)$ being concave implies that $\varphi(\Pi) \leq \varphi(\delta \Pi) + \varphi'(\delta \Pi)(\Pi - \delta \Pi)$. As $\varphi'(\Pi) < 0$ for $\Pi > \Pi^*$, $\varphi'(\delta \Pi)\Pi < \varphi(\Pi)$. Therefore, (A.3) is fulfilled under concavity of $\varphi(.)$. The derivative (A.2) is positive, and the right-hand side of (A.1) is monotonically increasing in $\Pi$.

It is immediate that the difference quotient is nonincreasing in $\Pi$ for $\varphi(.)$ being concave. This property, taken together with the monotonicity property of the right-hand side in (A.1) implies that, when (A.1) holds, it does so for a unique $\Pi^+$.

When $\delta \varphi(\delta \Pi^+) \leq W_0$, a corner solution applies, where $\varphi'(\delta \varphi(\delta \Pi^+) = \Pi_0$, and $(\Pi^+,W^*) = (\Pi_0,W_0)$. When the corner solution applies, it is also unique. As $\delta \varphi(\delta \Pi^+) < \varphi(\Pi^+)$, the above properties of the expressions in (A.2) imply:

(A.3) $\frac{\varphi(\Pi^+) - \varphi(\delta \Pi^+)}{(1 - \delta \Pi^+)} > \frac{\varphi(\delta \Pi^+)}{\Pi}$ for all $\Pi < \Pi_0$.

This unique bargaining equilibrium can be implemented by the following (stationary) strategies of the parties. The investor offers $W^+ = \varphi(\Pi^+)$ in every even period and accepts in every odd period any offer of at least $\delta \Pi^+$. The agency offers $\delta \Pi^+$ in every odd period and accepts, in any even period, any offer of at least $W^+ = \varphi(\Pi^+)$. 

A2
It results that the investor will offer, in $t=0$, $W^+ = \varphi(\Pi^+)$; this offer will immediately be accepted by the agency.

**Convergence to the Nash solution**

The symmetric Nash solution is $(\Pi^N, W^N) = \arg\max_s \Pi(W)$ s.t.

(i) $W = \varphi(\Pi)$,  
(ii) $\Pi \leq \Pi_0$.

Solving for the first-order-conditions gives

\begin{align*}
(A.4) \quad \varphi'(\Pi^N) &= - \frac{\varphi(\Pi^N) - y}{\Pi^N}, \\
(A.5) \quad y \geq 0, \quad \Pi_0 - \Pi^N \geq 0, \quad y(\Pi_0 - \Pi^N) = 0,
\end{align*}

where $y$ is the Lagrange multiplier of constraint (ii) and $(\Pi^N, W^N)$, $W^N = \varphi(\Pi^N)$ denotes the Nash-solution.

Consider the condition $\delta\varphi(\delta\Pi^+) > W_0$ for a interior solution $\Pi^+ < \Pi^*$ in the strategic game. For $\Lambda \to 0$, this turns into $\varphi(\Pi^+) > W_0$, or $\Pi^+ < \Pi_0$, which corresponds to the second expression of (A.5). Then, constraint (ii) is not binding, and $y=0$. It results the interior solution: By using L’Hôpital’s rule, the limit of (A.1) for $\Lambda \to 0$ yields (A.4), for $y=0$. For $\varphi(\Pi^+) \leq W_0$, constraint (ii) is binding. It results the corner solution; $y \geq 0$, and $(\Pi^N, W^N) = (\Pi_0, W_0)$. Thus, $(\Pi^+, W^+) = (\Pi^N, W^N)$ for $\Lambda \to 0$.

**Second step: Outside options**

Consider table A.1. The investor has the opportunity to quit the bargaining table in any odd period. The threat to take this option is credible, if $\Pi^+ > \delta\Pi^+$. In this case, the agency has to offer the value of the outside option in order to keep the investor from quitting the bargaining table. By assumption, the investor would accept any offer which equals the value of its outside option; he prefers an out-of-court settlement, whenever possible. The reasoning presented above may now repeated; it results that the investor will submit an offer $\delta\varphi(\Pi^+)$ in $t=0$, which the agency will accept immediately.

The agency has the opportunity to take the outside option in every even period. In table A.1, this is period $T-2$. The agency’s outside option is a credible threat, when $W^+ > \delta\varphi(\delta W^+)$. In this case, a similar reasoning yields that the investor has to submit a corresponding offer, and he will realize $\varphi'(W^+)$. The limit of these outcomes for $\Delta \to 0$ yield the the corresponding expressions in part (iii) of lemma 1.

Consider part (i): When an outside option is a credible threat, an inefficient low spending level is immediate from the values of the outside options for $p_i \in (0,1)$. 

A3
When $\Pi^c \leq \delta\Pi^+$ and $W^c \leq \delta\varphi(\delta\Pi^+)$, both outside option do not constitute credible threats. The solution of the game without outside options remains valid: $(\Pi^B, W^B) = (\Pi^+, W^+)$. 

To see the bargaining incentives under outside options, note that $(\Pi^c, W^c)$ is a convex combination of $(\Pi^*, W^*)$ and $(\Pi_0, W_0)$. However, $\varphi$ is strictly concave on $[\Pi^*, \Pi_0]$, implying that $(\Pi^c, W^c)$ must lay below $\varphi$ for $p_\Pi \downarrow (0, 1)$. ■

Proof of lemma 2

The bargaining game without outside options


(A.6) $Q^* = \varphi_E(\delta\varphi_E^-(\delta Q^*))$ or, equivalently,

(A.7) $\varphi_E^-(Q^*) = \delta\varphi_E^-(\delta Q^*)$.

As $\varphi_E(\cdot)$ is decreasing in negotiated profit, $\varphi_E^-(\cdot)$ is decreasing in the environmental group’s payoff. Assume $Q^* < 0$. Then, $Q^* < \delta Q^+$, and $\varphi_E^-(Q^*) > \varphi_E^-(\delta Q^+)$, implying that (A.7) cannot hold for positive profit levels. Therefore, any bargaining solution of the game without outside options must yield a positive payoff for the environmental group, and, thus implies that $Q^* > -D^* + C_{min}$, or $\Pi^+ < \Pi_{min}$. In the bargaining solution, the investor at least spends $S^*$ and totally compensates the damage $D^*$. Denote the investor's compensation payment exceeding $C_{min}$ by $C^+$; thus, $Q^* = C^+$ and $\Pi^+ = \Pi_{min} - C^+$. The game simply consists of how to split the „pie“ $\Pi_{min}$:

(A.8) $\varphi_E^-(Q^*) = \Pi_{min} - Q^*$.

Substituting (A.8) into (A.7) yields the usual solution for such a splitting-a-pie-problem:

$\Pi_{min} - Q^* = \delta(\Pi_{min} - \delta Q^*) \iff Q^* = \frac{1-\delta}{1-\delta^2}\Pi_{min}$, and $\Pi^+ = \frac{\delta(1-\delta)}{1-\delta^2}\Pi_{min}$.

For a discount factor $\delta^\Lambda$ and $\Lambda = \lambda$, the environmental organization has a first-mover-advantage. This advantage disappears for $\Lambda \to 0$. Applying L’Hôpital’s rule gives

$$\lim_{\Lambda \to 0} \left( \frac{1-\delta^\Lambda}{1-\delta^\lambda} \Pi_{min} \right) = 0.5 \Pi_{min}, \text{ and } \lim_{\Lambda \to 0} \left( \frac{\delta^\Lambda(1-\delta^\Lambda)}{1-\delta^\lambda} \Pi_{min} \right) = 0.5 \Pi_{min}.$$  

It is straightforward that these expressions correspond to the (symmetric) Nash solution of a splitting-a-pie bargaining problem.
According to (18), the values of the parties’ outside options are given by

\[(\Pi^c, -D^c) = \begin{cases} (\Pi^*, -D^*) & \text{iff} \quad \Pi^c \leq \Pi^* \quad \text{and} \quad -D^c \leq -D^*, \\ (\Pi^*, -D^*) & \text{else.} \end{cases} \]

The value of the group’s outside option is negative in any case. The worst contingency for the group, when it rejects an offer, but does not opt out (thus making a counter-offer) is that the investor will reject and opt out in the next period. This yields a better outcome for the group, when compared to opt out immediately, as no environmental damage occurs during this additional period: the negative outcome associated with the outside option is delayed by one period. Thus, the group’s threat to opt out will never be credible.

The investor’s threat will be credible, when \(\delta\Phi^{-1}(\delta\Omega^*) = \Pi^* < \Pi^c \). Inspection of Table A.2 and (18) shows that the outcome will be given by

\[(\Pi^c, -D^c) = (\Pi^*, -D^*) \quad \text{iff} \quad \Pi^c \leq \Pi^* \quad \text{and} \quad -D^c \leq -D^*, \]

\[(\Pi^*, -D^*) \quad \text{else.} \]

### Existence

Denote the set of possible bargaining solutions by \(\Phi\) (the area on and below \(\Phi\)). The existence of outside options restricts this set, by defining a subset of \(\Phi\) for which \(\Pi^c \neq \Pi^c\) and \(\Omega^c \neq -D^c\). Thus, the condition for (degenerate) bargaining incentives to exist under outside options is \((\Pi^c, -D^c) \in \Phi\). This is obviously fulfilled for \((\Pi^c, -D^c) \in \Phi\). Thus, it has to be investigated whether \((\Pi^c, -D^c) \in \Phi\).

Consider the benchmark case where \(\rho_{c} \to \emptyset\). In this case, \((\Pi^c, -D^c)\) approximates a convex combination of \((\Pi^*, -D^*)\) and \((\Pi_0, -D_0)\), where \((\Pi^*, -D^*) \in \Phi\) and \((\Pi_0, -D_0) \in \Phi\).
As $\Phi$ is concave, any $(\Pi^c, -D^c)$ will be element of $\Phi$ in this benchmark case.

This argument may be restated for the case where $p_A \rightarrow 0$, $(\Pi^c, -D^c)$ approximating a convex combination of $(\Pi_0, -D_0)$ and $(0,0)$, and for the case where $p_I \rightarrow 0$, $(\Pi^c, -D^c)$ approximating a concex combination of $(\Pi^*, -D^*)$ and $(0,0)$. Thus, bargaining incentives exist for any $p_I, p_E, p_A > 0$.

Consider figure 2 for a graphical intuition. The benchmark cases construct a triangular area characterized by the corner points $(\Pi_0, -D_0)$, $(\Pi^*, -D^*)$ and $(0,0)$. Any $(\Pi^c, -D^c)$ with $p_I, p_E, p_A > 0$ lays within this area.