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When Efficiency Requires Arbitrary Discrimination: Theoretical and Experimental Analysis of Equilibrium Selection

Werner Güth [1] and Hironori Otsubo [2,*]

[1] Max Planck Institute for Research on Collective Goods, Kurt-Schumacher-Straße 10, 53113 Bonn, Germany; gueth@coll.mpg.de
[2] Faculty of Global Management, Chuo University, 742-1 Higashinakano, Hachioji 192-0393, Tokyo, Japan
* Correspondence: otsubo.76t@g.chuo-u.ac.jp

Abstract: Institutions may rely on fundamental principles, e.g., of legal philosophy, but may also have evolved according to institutional fitness, as gauged by a society's well-being. In our stylized framework where two fundamental principles, equality and efficiency, conflict with each other, one of the three players is the third party who faces two symmetric co-players as culprits and determines whether to sanction the two culprits discriminatorily or treat them with parity. Relying on the theory of equilibrium selection, we derived equilibrium solutions and experimentally tested our behavioral hypotheses. We found that asymmetry in wealth between the two culprits let the sanctioning agent hold the richer culprit more responsible. Furthermore, our results demonstrated that when the sanctioning agent's decision was observable, sanctioning the two culprits discriminatorily induced them to coordinate on an efficient outcome.

Keywords: equilibrium selection; discrimination aversion; laboratory experiment; social preferences; arbitrariness in sanctioning

JEL Classification: C72; C92; K00

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1. Introduction

This paper considers a stylized three-person game illustrated and motivated by the following situation. Two agents have the potential to pollute an environment. If only one of them engages in pollution, there is no harm, and that polluter gains from their action. However, if both agents pollute, the environment becomes overwhelmed, unable to assimilate the emissions any longer. In this case, both polluters are regarded as culprits since the third player, their victim, suffers the consequences. This situation mirrors real-world field environments, such as shallow lakes, which can handle a certain level of pollution from one polluter but become incapable of coping with excessive pollution from two polluters. The third agent possesses the authority to administer sanctions as deemed appropriate, possibly by pre-committing to a sanctioning scheme.

Two fundamental principles that conflict with each other in this situation are equality and efficiency. If two polluters are symmetric and jointly cause the damage, it seems natural to hold them equally responsible. However, employing asymmetric sanctions can potentially trigger more efficient and asymmetric equilibria.[1] By preannouncing which culprit would be held fully responsible, the targeted culprit may be discouraged from polluting, while the other agent can proceed with polluting without causing any harm. This approach of introducing efficiency-enhancing asymmetry is not uncommon.[2]

We have two factors in mind that may guide the third party's decision in such a situation. The first one concerns the timing of the third party's decision. Preannouncing whether to sanction the two agents asymmetrically or not, the third party may be able to induce a favorable outcome. Such preannouncement may be in vain if the two agents cannot hear it before making their decisions. The other factor is an inherent inequality in wealth between the two agents. This spurious, theoretically unrelated factor may suggest a sanctioning schedule that holds the richer agent more responsible for the damage. This aspect alludes to what is commonly known as the deep-pocket phenomenon.[3]

This paper theoretically analyzes a three-person game with multiple equilibria, some of which are more efficient than others, and experimentally investigates the effects of the aforementioned two factors in such a game.[4] One of the three players is designated as the third party who may face two symmetric co-players as culprits and determines whether to sanction the two equal culprits discriminatorily or treat them with parity. We derive equilibrium solutions by applying the theory of equilibrium selection [2] and conduct a laboratory experiment designed to address the following research questions:

- Is the third party more likely to choose an asymmetric sanctioning schedule when the two agents differ in wealth than when they are equally wealthy?
- Is the third party more likely to choose an asymmetric sanctioning schedule when the two agents can observe the third agent's choice than when not?
- Does an asymmetric sanctioning schedule induce the two agents to coordinate their decisions to achieve an efficiency-enhancing outcome?

Our experimental design allows for wealth to differ across the two agents. We expect the third party to discriminate for the sake of efficiency-enhancing coordination when the third party perceives some asymmetry of the two agents, even if it does not matter theoretically. Thus, we expect to confirm the deep-pocket hypothesis predicting that the third party punishes the richer one more severely than the other. Not only the third party, but the two potential culprits may also be inefficiency-averse (see [3]). This suggests that inefficiency-averse agents would try to coordinate their decisions to achieve an efficiency-enhancing outcome.

Our results confirm the deep-pocket phenomenon. Wealth asymmetry has a significant impact on the third party's sanctioning behavior. When two agents are equally wealthy, the third party dominantly chooses to sanction them equally. But, when they are equally wealthy, the third party exhibits a strong tendency to treat them discriminatorily by sanctioning a rich agent more than a poor one. Furthermore, our data show that the third party's asymmetric sanctioning schedule helps two agents coordinate their decisions to achieve an efficient-enhancing outcome.

Sanctions and punishment have been very intensively studied in the empirical literature, e.g., [4], and also in the experimental literature, e.g., [5]. These experimental studies differ from our approach since they focus on non-solution (play) punishment.[5] In our game, the punishment choice by the third party is unavoidable and therefore an aspect of equilibrium behavior. This also renders punishment, as studied here, different from off-equilibrium play punishment [6,7].

Our game is also closely related to the Volunteer's Dilemma (VD) game [8,9] in that only one volunteer is required to avoid harm to all players.[6] As explained in more detail in Section 2, the second decision stage of our game can be considered as a two-person VD game. The major departure from the VD game is that at the first decision stage, the third party designs a sanctioning schedule that influences the payoffs of two potential volunteers at the second decision stage. The third party may preannounce an asymmetric sanctioning schedule to induce an efficient-enhancing outcome, i.e., only one player volunteers.

Rationally solving games relies on employing philosophically compelling axioms. However, this approach faces certain behavioral challenges as it overlooks the complexities of human psychology and cognitive limitations. Instead, behavioral game theory [11] should be based on empirical findings. In our study, we confront rational equilibrium selection with actual behavior, possibly aiming at one of multiple equilibria. The games we consider allow for the identification of equality through isomorphic invariance, which is an evident axiom in equilibrium selection theory [2], and becomes behaviorally attractive when fairness concerns come into play (see [12] for a survey of various social preferences).

On the contrary, discriminating between equals violates symmetry and thus isomorphic invariance in equilibrium selection but may enhance efficiency within these games.

We establish benchmark predictions based on common rationality. The theoretical assumption of common(ly known) rationality, particularly in the context of isomorphic invariance in equilibrium selection, is subject to behavioral skepticism. It is highly improbable that experimental participants are aware of all equilibria. They may also need to learn about the potential inefficiency associated with equal sanctioning. Despite attempts to enhance participants' awareness through control questions or pretrials, they may still be unable to identify all equilibria and might require experience to learn that equal sanctioning likely triggers inefficiency.

Section 2 introduces the game models formally and selects among their equilibria. Section 3 describes the experimental design. Section 4 analyzes the experimental data, and Section 5 concludes.

2. Theory

The game has three players, X, Y, and Z, and two decision stages. In the first stage, X chooses a number $p \in S_X = [0, d]$. In the subsequent stage, the remaining players, Y and Z, simultaneously choose $s_i \in S_i = \{R, B\}$, $i \in \{Y, Z\}$.

Table 1 specifies the payoffs of all three players for all four choice constellations of Y and Z, for a given p-choice of X. Each cell lists the three players' payoffs in alphabetical order. If both Y and Z choose R, each of the three players earns a payoff of e. If Y and Z choose differently, the one whose choice is B earns $e + b$ while the other two players earn e each. In these situations, no damage occurs and thereby no sanctions are imposed. However, if Y and Z choose B, players X, Y, and Z earn $e - c$, $e - p$, and $e - (d - p)$, respectively. Here, d is the total sanction amount X freely allocates to Y and Z via the choice of p when Y and Z choose B.[7] We assume that $b > 0$, $c > 0$, and $d > 0$.[8]

Table 1. The trimatrix subgame after X's choice of $p \in [0, d]$ with players Y and Z and payoffs listed in alphabetical order.

Y \ Z	R	B
R	e, e, e	$e, e, e + b$
B	$e, e + b, e$	$e - c, e - p, e - (d - p)$

Two structural features of the game warrant discussion. First, we allow X to choose p in the closed range $[0, d]$. Imposing the binary restriction $p \in \{0, d\}$ instead of $p \in [0, d]$ would have reduced the multiplicity of strict equilibria, while still maintaining X's dilemma of whom to favor. However, in our view, allowing X to choose p in the range $[0, d]$ provides more informative insights. For example, a decrease in asymmetry in sanctioning could suggest that X is hesitant to discriminate.

Second, players Y and Z decide simultaneously so that the (B, B) outcome is possible. It would be easier for Y and Z to achieve efficient outcomes, i.e., one choosing R and the other choosing B, if they decide sequentially. This could avoid the (B, B) outcome and render the p-choice of X irrelevant for their payoffs. Since our primary focus is on X's sanctioning behavior, it seems important that (B, B) cannot be avoided easily. Discrimination in punishing, determined by X's p-choice, is more likely to establish coordination between Y and Z when the sanctions are preannounced. We explore this experimentally through the implementation of the sequential order protocol in which Y and Z are informed of X's p-choice before making their decisions.

Without preannouncement of the sanctions (i.e., p choices), Y and Z are required to anticipate the value of p. However, the p-choice only becomes relevant when both Y and Z choose B (i.e., both engage in pollution). Hence, theoretically, it does not matter whether all players decide independently or whether X decides only after learning about the damage.

For the sake of more p-choice data of X, we consider the simultaneous order protocol with all three players deciding independently, in addition to the sequential order protocol.

2.1. The Sequential Order Protocol

Under the sequential order protocol, Y and Z simultaneously choose either R or B in the second decision stage, knowing X's p-choice in the first decision stage. Thus, backward induction begins with the second-stage subgames, as illustrated in Table 1.

At the second decision stage, there are multiple equilibria. For $p = 0$ or $p = d$, there are two pure-strategy equilibria, $(s_Y, s_Z) = (R, B)$ and $(s_Y, s_Z) = (B, R)$, but only one is strict. For $p \in (0, d)$, there exists a mixed-strategy equilibrium in addition to these pure-strategy equilibria. Denote by $\sigma_i = (\sigma_i(R), \sigma_i(B))$, $i \in \{Y, Z\}$, player i's mixed strategy in which i uses R with probability $\sigma_i(R)$ and B with probability $\sigma_i(B)$. The mixed-strategy equilibrium for a given p-choice is given as follows:

$$\begin{aligned}(\sigma_Y, \sigma_Z) &= \Big((\sigma_Y(R), \sigma_Y(B)), (\sigma_Z(R), \sigma_Z(B)) \Big) \\ &= \left(\Big(\frac{d-p}{b+d-p}, \frac{b}{b+d-p} \Big), \Big(\frac{p}{b+p}, \frac{b}{b+p} \Big) \right) \end{aligned} \tag{1}$$

X earns a payoff of e in each of the pure-strategy equilibria and a strictly smaller expected payoff than e in the mixed-strategy equilibrium. Given these strategies at the second decision stage, X is indifferent between $p = 0$ and $p = d$ at the first decision stage. Thus, it is optimal for X to choose $p = 0$ with probability w and $p = d$ with probability $1 - w$ such that $w \in [0, 1]$.

Proposition 1. *In the sequential order protocol, there are the following subgame perfect equilibria:*

- *At the first decision stage, X chooses $p = 0$ with probability w and $p = d$ with probability $1 - w$ such that $w \in [0, 1]$;*
- *At the second decision stage,*
  - *if $p \in \{0, d\}$, then there are two pure-strategy equilibria, $(s_Y, s_Z) = (R, B)$ and $(s_Y, s_Z) = (B, R)$, only one of which is strict;*
  - *if $p \in (0, d)$, then there also exists a mixed-strategy equilibrium (σ_Y, σ_Z), in addition to the two pure-strategy equilibria.*

For $p \in (0, d)$ such that $p \neq d/2$, the subgame equilibria (B, R) and (R, B) are strict but not symmetric so that equilibrium selection theory [2] should be applied. Due to best reply and isomorphic invariance as well as monotonicity, the risk dominant solution is (R, B) if $p > d/2$ and (B, R) if $p < d/2$.[9]

For the mixed strategy equilibria (σ_Y, σ_Z), any $p \in (0, d)$ implies positive probability for X's loss event (B, B). X should therefore avoid choosing $p \in (0, d)$, but is indifferent between $p = 0$ and $p = d$. Again applying symmetry invariance makes X choose $p = 0$ and $p = d$ with probability $\frac{1}{2}$ each as a symmetric correlated equilibrium.

Proposition 2. *Imposing strictness for $p \in \{0, d\}$ and equilibrium selection for $p \in (0, d)$ yields a unique subgame perfect equilibrium, namely:*

- *At the first decision stage, X chooses $p = 0$ and $p = d$ with equal probability;*
- *At the second decision stage,*
  - *if $0 \le p < \frac{d}{2}$, $(s_Y, s_Z) = (R, B)$;*
  - *if $\frac{d}{2} < p \le 1$, $(s_Y, s_Z) = (B, R)$;*
  - *if $p = \frac{d}{2}$, (σ_Y, σ_Z) presented in (1).*

2.2. The Simultaneous Order Protocol

The simultaneous order protocol ensures that no player is informed about another player's choice when deciding. In other words, all three players choose independently, without any knowledge of the others' decisions.

Equilibria are characterized by all players entertaining rational beliefs and best responding to them. For all (pure- or mixed-)strategy combinations of Y and Z, X's payoff does not depend on the choice of p. This implies that the optimal value of p for X does not depend on how players Y and Z behave. Y and Z react to their belief about p. Thus, in any equilibrium of the simultaneous order protocol, Y and Z react to X's choice of p as in the sequential order protocol.

Proposition 3. *Under the simultaneous order protocol, combining any choice of p by X with the corresponding strategy combination for Y and Z in Proposition 1 yields an equilibrium.*

So, it is still ambiguous which p will be chosen by X. To overcome this troubling ambiguity, X should rely on a symmetric correlated equilibrium, i.e., choose $p = 0$ and $p = d$ with equal probability.

Proposition 4. *Assuming the same equilibrium selection as before let X choose $p = 0$ to induce $(s_Y, s_Z) = (B, R)$ and $p = d$ to induce $(s_Y, s_Z) = (R, B)$ with equal probability.*

This has resolved the ambiguity of possible benchmark solutions. Unlike Buridan's Donkey, which is unable to choose between two equally good food items, the sanctioning player X can avoid indifference by mixing. Notwithstanding different ways, we derive the same prediction for the sequential and simultaneous order protocols, namely, X chooses $p = 0$ and $p = d$ with equal probability.

3. Experimental Design

3.1. Treatments and Hypotheses

Two treatment variables are manipulated in our experiment. The first variable is the show-up fee for participants. When the show-up fee is symmetric, all three roles receive the same show-up fee of EUR 5.00. When it is asymmetric, the three roles receive different show-up fees; EUR 5.00 for X, EUR 2.50 for Y, and EUR 7.50 for Z. The other treatment variable is the order protocol. When making their decisions, Y and Z can observe X's p-choice under the sequential order protocol but not under the simultaneous order protocol. Thus, our experiment consists of four treatments that differ from one another in terms of the order protocol (sequential vs. simultaneous) and the show-up fee paid for participants (symmetric vs. asymmetric). They are denoted as sequential order protocol and symmetric show-up fees (Seq-Sym), sequential order protocol and asymmetric show-up fees (Seq-Asym), simultaneous order protocol and symmetric show-up fees (Sim-Sym), and simultaneous order protocol and asymmetric show-up fees (Sim-Asym), respectively.

Theoretically, X randomly chooses and fully sanctions one of Y and Z, regardless of the order protocol and the show-up fee. However, this theoretical prediction may not stand in the treatments of asymmetry show-up fees. When Y and Z receive the same show-up fee, X may feel obliged to treat them equally and choose $p = \frac{d}{2}$, instead of choosing $p = 0$ and $p = d$ with equal probability.

Hypothesis 1. *X is more likely to sanction Y and Z equally when the show-up fee is symmetric than when the show-up fee is asymmetric.*

When X perceives some asymmetry of Y and Z, i.e., they receive different show-up fees, X's inclination for equal treatment may be weakened, and X may sanction rich Z more (i.e., $p < \frac{d}{2}$). The design feature of show-up fee asymmetry is intended to test the deep pocket hypothesis by initially assigning different wealth levels to Y and Z. Despite its theoretical irrelevance, we expect X to choose a lower value of p, i.e., sanction Z more severely when the show-up fee is asymmetric than when it is symmetric.

Hypothesis 2. *X is more likely to sanction Z more severely when the show-up fee is asymmetric than when the show-up fee is symmetric.*

The observable p-choices by X may help Y and Z coordinate their decisions to reach an efficiency-enhancing outcome. If X's p-choice favors Y, Y is more likely to choose B and Z is less likely to choose B. If X's p-choice favors Z, Y is less likely to choose B and Z is more likely to choose B.

Hypothesis 3. *Under the sequential order protocol, as p increases, Y is less likely to choose B and Z is more likely to choose B.*

3.2. Procedure

Two hundred and seven student participants from various fields of study at the Friedrich-Schiller University of Jena were recruited via ORSEE software [13] for two sessions per treatment and twenty-seven participants per session.[10] Nobody participated in more than one session. All eight sessions were conducted in the experimental laboratory of the Max Planck Institute of Economics in Jena, Germany, with thirty-two PCs connected in a network. The experiment was programmed and conducted with the software z-Tree [14]. A session lasted about 60 min, including reading instructions and paying participants.

Upon arrival at the laboratory, participants were randomly assigned to computer terminals separated from one another by partitions. Any communication between them was strictly forbidden throughout the session, and questions were answered individually by the experimenter. After reading the written instructions silently at their own pace, the experimenter read the instructions aloud so that all information became common knowledge. Then, participants answered six control questions designed to check their understanding of the instructions.

Each session consists of only three rounds. Before the first round began, the computer randomly formed three groups with nine participants each. Group composition remained the same so that no interaction between groups took place throughout the session. Then, for each group, the computer randomly assigned three participants to the role of X, another three to the role of Y, and the remaining to the role of Z. Hereafter, participants in the roles of X, Y, and Z are called X participants, Y participants, and Z participants, respectively. Participants retained their roles throughout the session.

The instructions mentioned that all participants would be paid the same show-up fees in the Seq-Sym and Sim-Sym treatments and unequal show-up fees in the Seq-Asym and Sim-Asym treatments.[11]

The sequence of each round was identically structured in all treatments. At the beginning of a round, each participant was randomly matched with two other participants in their group who were assigned to the other roles. The perfect stranger design ensures that participants play against each other only once. Each round consists of two stages. In the first stage, only X participants choose one of the eleven different combinations of ten balls. These combinations differed from one another in terms of the number of black and white balls contained. For example, choosing a combination that consists of more black balls than white balls means sanctioning Y more severely than Z. In the second stage, Y and Z participants simultaneously choose either R or B with knowledge of X's decisions under the sequential order protocol and without that knowledge under the simultaneous order protocol. At the end of a round, each participant was informed about all decisions and the earnings in this round.

In the experiment, we set $b = 15$, $c = 5$, $d = 10$, and $e = 15$, respectively, and therefore payoffs were determined according to the trimatrix shown in Table 2. Here, p denotes the number of black balls in the combination chosen by X. Values in each entry are denoted in points.

Table 2. Payoffs in the experiment.

Y \ Z	R	B
R	$15, 15, 15$	$15, 15, 30$
B	$15, 30, 15$	$10, 15 - p, 5 + p$

At the end of a session, only one round was selected for payment as follows; the experimenter randomly chose a volunteer participant, who was asked to draw one ball from a box containing three balls labeled 1 through 3. The drawn number determined the round for payment. The earned points in the selected round were converted to euros at the rate of 1 point = EUR 0.50.

4. Results

4.1. X's Behavior

We report the observed choices of X participants in terms of the number of black balls, which corresponds to the p-choice by X. The smaller (larger) the number of black balls, the more (less) severely X sanctions Z (Y).

Result 1. *Asymmetric wealth reduces the probability that X treats Y and Z equally. Furthermore, it makes X sanction rich Z more severely than poor Y.*

Table 3 presents the observed frequency distributions of X's combination choices by treatment and round. The table also displays the means and standard deviations of the number of black balls. The data confirm a clear dominance of equal sanctioning, which seems weaker in the presence of asymmetry in wealth. The distribution is centered around five black balls in the treatments of symmetric wealth. This means that, on average, X participants treated Y and Z participants equally, i.e., sanctioned them equally. In contrast, the distribution is right-skewed in the treatments of asymmetric wealth, which means that X treated Y and Z participants unequally by sanctioning rich Z participants more than poor Y participants. These behavioral patterns of X participants remained unchanged across three rounds, regardless of which order protocol was implemented. Asymmetric wealth seems to be a strong motivation for X participants to sanction Y and Z participants differently.

Table 3. Observed frequency distributions of the number of black balls (S.D.: standard deviation).

Treatment	**Round**	**Number of Black Balls**											**Mean**	**S.D.**
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
Sim-Sym	1	0	0	0	0	1	10	3	0	0	0	1	5.467	1.356
	2	0	0	1	1	2	8	1	0	0	1	1	5.2	2.007
	3	0	0	0	0	0	11	1	1	1	0	1	5.733	1.486
Seq-Sym	1	2	1	0	0	1	9	0	2	2	0	1	5	2.635
	2	3	1	1	0	1	8	1	0	0	1	2	4.556	3.110
	3	3	1	1	0	0	8	1	0	0	1	3	4.889	3.359
Sim-Asym	1	3	1	1	3	0	6	2	1	1	0	0	3.833	2.455
	2	3	1	2	3	2	4	0	0	0	1	2	3.944	3.152
	3	5	1	0	1	2	6	0	0	1	1	1	3.833	3.185
Seq-Asym	1	2	2	1	5	4	2	0	0	0	1	1	3.556	2.640
	2	4	1	1	1	2	3	1	2	1	1	1	4.222	3.246
	3	5	1	1	3	1	2	1	0	1	2	1	3.778	3.457

We fitted two regression models to our panel data. Model 1 is a random-effects probit regression where the dependent variable has value one if X chose the combination of five black balls and five white balls and zero otherwise. The independent variables are two treatment dummies, Asym (1 for asymmetric wealth and 0 for symmetric wealth) and Seq (1 for the sequential order protocol and 0 for the simultaneous order protocol), and the interaction variable formed as the product of these dummies. Model 2 is a random-effects ordered probit regression where the dependent variable is the number of black balls (NumBB).

The second and third columns of Table 4 report the estimation results of Models 1 and 2, respectively. In these models, both dummies are negative but only Asym is significant ($p < 0.05$). The interaction term between these dummies is insignificant. Thus, asymmetric wealth discouraged X to treat Y and Z equally (Model 1). It also has a negative impact on X's tendency to opt for combinations containing a higher number of black balls (Model 2). In other words, asymmetric wealth urged X to sanction Z more severely. These results confirm Hypotheses 1 and 2.

Table 4. Estimation results for X participants.

	Model 1	**Model 2**
Asym	−1.939 **	−0.768 **
	(0.901)	(0.313)
Seq	−1.058	−0.320
	(0.879)	(0.226)
Asym × Seq	−0.307	0.287
	(1.171)	(0.394)
Constant	0.870	
	(0.665)	
N	207	207

Standard errors in parentheses, ** $p < 0.05$.

4.2. Behavior of Y and Z

Result 2. *Neither asymmetric wealth nor sequential order protocol has a significant effect on the choice behavior of Y and Z.*

Table 5 reports the observed choice frequencies of Y and Z participants. There is no clear systematic pattern of behavior except the behavior of Y participants under the sequential order protocol; they chose Blue more frequently than Red. This pattern persisted over three rounds, regardless of whether wealth was asymmetric or not. To see whether the treatment dummies, Asym and Seq, have an impact on the choice behavior of Y and Z participants, we estimated a random-effects probit regression model (Model 3). The dependent variable has one if a participant in the second stage chose Blue, and the independent variables are the same as Models 1 and 2. The estimation results reported in the second column of Table 6 reveal the estimated coefficients for all three independent variables to be negative but insignificant.

Result 3. *Under the sequential order protocol, increasing the number of black balls in the combination chosen by X increases the probability of Y choosing Blue and decreases the probability of Z choosing Red.*

Figure 1 shows the choice frequencies of Y and Z participants under the sequential order protocol. The figure is based on the pooled data across three rounds. Under this order protocol, Y and Z participants could observe the number of black balls in the combination chosen by X participants. The curve on the figure is derived from a non-parametric regression method called the locally estimated scatterplot smoother (loess). The curve indicates that the number of black balls and the proportion of choosing Blue are negatively related for Y participants and positively related for Z participants, regardless of whether they are asymmetric in wealth or not.

Did asymmetrically sanctioning Y and Z contribute to achieving an efficiency-enhancing outcome, namely either (Blue, Red) or (Red, Blue)? To formally address this question, we performed a random-effects probit regression separately for Y participants (Model 4) and Z participants (Model 5). The dependent variable equals one if a participant in the second stage chose Blue and zero otherwise. The independent variables are Asym and the number of black balls in the combination chosen by X (NumBB). The third and fourth columns of Table 6 present the estimation results for Y and Z, respectively. In both models, the estimated coefficient for NumBB is significant ($p < 0.01$). The number of black balls has a negative effect on the probability of choosing Blue for Y participants and a positive effect for Z participants. The data provide evidence that X participants could induce an efficiency-enhancing outcome via sanctioning Y and Z discriminatorily when X's choice of p was observable. These results support Hypothesis 3.

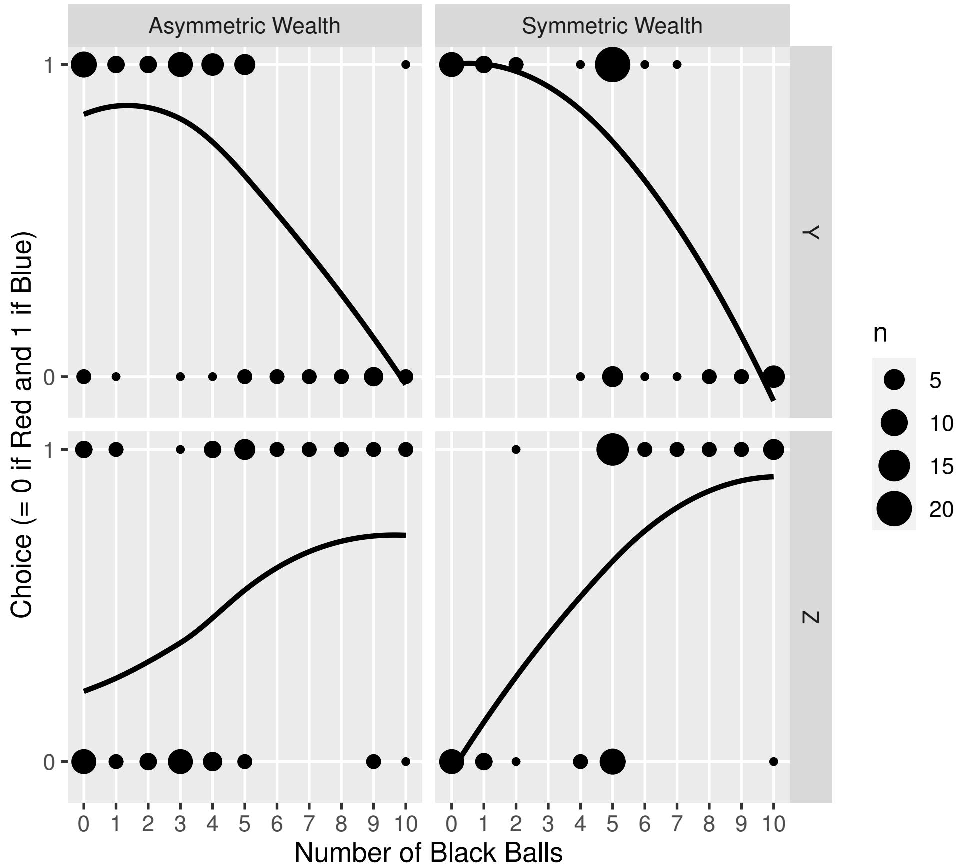

Figure 1. Choice frequencies of Y and Z participants under the sequential order protocol with the locally estimated scatterplot smoother.

Table 5. Observed choice frequencies of Y and Z participants by treatment and round.

Role	Round	Sim-Sym		Sim-Asym		Seq-Sym		Seq-Asym	
		Red	Blue	Red	Blue	Red	Blue	Red	Blue
Y	1	8	7	7	11	7	11	4	14
	2	7	8	7	11	6	12	8	10
	3	4	11	9	9	5	13	7	11
Z	1	8	7	9	9	10	8	13	5
	2	4	11	9	9	7	11	8	10
	3	3	12	6	12	7	11	9	9

Table 6. Estimation results for Y and Z participants.

	Model 3	Model 4	Model 5
Asym	−0.177	−0.466	−0.091
	(0.312)	(0.292)	(0.243)
Seq	−0.049		
	(0.266)		
Asym × Seq	−0.022		
	(0.372)		
NumBB		−0.333 ***	0.227 ***
		(0.123)	(0.070)
Constant	0.384 *	2.218 ***	−0.936 **
	(0.216)	(0.763)	(0.370)
N	414	108	108

Standard errors in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

5. Concluding Remarks

This paper considers a stylized three-person game where equality and efficiency conflict with each other. The sanctioning player X designs a sanctioning schedule for Y and Z when they collectively cause damage. Our primary focus was to investigate whether X would sanction Y and Z discriminatorily for enhancing efficiency, or equally for enhancing equality. To accomplish this goal, we have analyzed the game theoretically and tested the behavioral hypotheses experimentally using a two-by-two factorial design (sequential vs. simultaneous order protocol, symmetric vs. asymmetric wealth levels).

We found a clear dominance of equal sanctioning, which is weaker in the presence of asymmetry in wealth between Y and Z (Hypothesis 1). Asymmetric wealth made the judge-like X balance payoffs by punishing the rich agent more, which confirms the deep-pocket hypothesis (Hypothesis 2). This observation, in light of inequ(al)ity aversion [15,16], provides specific evidence of third-party redistribution behavior. Furthermore, the data highlight that Y and Z participants responded to an asymmetric sanctioning schedule of X by coordinating on an efficiency-enhancing outcome (Hypothesis 3).

Behavioral game playing could be inspired by game-theoretic solution concepts, but it is essential to control empirically how individuals interact strategically. This involves determining whether people are guided by ethical principles such as treating equals equally or driven by personal or welfare incentives. Methodological dualism [17] clearly distinguishes philosophical exercises, e.g., of equilibrium selection, from empirically valid theories of actual game playing. While rationalistic game theory's measuring rod is how philosophically convincing axioms are, behavioral game theory's focus is on empirical validity.

Nonetheless, what is perfectly rational can also be behaviorally attractive. Even when this is not the case, exploring what would be ideally rational remains intriguing and inspiring and satisfies our philosophical curiosity. Furthermore, behavioral game playing can be influenced by participants adapt their behavior based on feedback about their previous (i.e., first and second rounds) outcomes.[12]

Surprisingly, equilibrium selection is often overlooked in both game-theoretic and behavioral contexts, although that the ultimate purpose of game theory is to resolve strategic uncertainty. Games like the one analyzed above exemplify that without selecting among equilibria, strategic uncertainty is difficult to resolve. This is especially true for bargaining games like demand and ultimatum games (see [18]), as well as for games like ours where one player's role is mainly responsible for equilibrium selection. In our view, games with multiple equilibria not only present challenging opportunities to resolve strategic uncertainty but also serve as intriguing paradigms for behavioral approaches to game playing.

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Appendix A. Instructions for Treatment Seq-Asym (Originally Written in German)

Appendix A.1. Introduction

Welcome! You are about to participate in an interactive decision making experiment funded by the Max Planck Institute of Economics. If you have a mobile phone, please switch it off now.

Please read the instructions carefully. Your decisions, as well as the decisions of the other participants, will determine your payoff according to the rules that will be explained shortly.

Please note that hereafter any form of communication between the participants is strictly prohibited. If you have any questions, please raise your hand. The experimenter will come to assist you.

Appendix A.2. Detailed Information on the Experiment

This experiment is fully computerized. You will be making your decisions by clicking on appropriate buttons on the screen. All the participants are reading the same instructions and taking part in this experiment for the first time, as you are.

A total of 27 persons are participating in this experiment. At the beginning of the experiment, the computer will randomly assign nine participants to the role of X, other nine participants to the role of Y, and the remaining nine participants to the role of Z. Therefore, there are nine Xs, nine Ys, and nine Zs. Your role will remain the same throughout the experiment and so will the roles of the other participants.

The experiment consists of three rounds. In each round, you will be matched with two other participants who are assigned to different roles. For example, if you are X, then you will be matched with one Y and one Z every round. The composition of your group will change every round. This means that your group members will be different from one round to the next. You have no chance of interacting with the same participants more than once.

In the experiment, we will use "points" as the currency. At the end of the experiment, one of the three rounds will be selected for payment by the procedure that will be explained at the end of the instructions. The points you have earned in the selected round will be converted to euro at the rate of 1 point = EUR 0.50 and paid to you in cash.

In addition, each participant will be paid a show-up fee for having shown up on time. The show-up fee differs across the three roles. You will receive a EUR 5.00 show-up fee if you are X, a EUR 2.50 show-up fee if you are Y, and a EUR 7.50 show-up fee if you are Z.

Appendix A.3. Description of the Task

Each round consists of two stages:

Stage 1: X will be asked to choose one of the 11 different combinations of black and white balls shown in the table below. In each combination, the upper number represents the number of black ball(s) and the lower number represents the number of white ball(s). As you see, each combination contains exactly10 balls.

	Combinations										
Black	0	1	2	3	4	5	6	7	8	9	10
White	10	9	8	7	6	5	4	3	2	1	0

Stage 2: At the beginning of Stage 2, Y and Z will be informed which combination has been chosen by X in Stage 1. In other words, both Y and Z will know the numbers of black and white balls in that combination. Then, Y and Z will be asked to *simultaneously* choose either Red or Blue. In other words, Y and Z will choose one of the two alternatives without knowing the other's decision.

Appendix A.4. How to Compute Payoffs

After completion of Stage 2, the computer will automatically compute your payoff as well as the other group members' payoffs for the current round according to the following rules:

1. If both Y and Z chose Red in Stage 2,

$$\boxed{\begin{array}{l} \text{X's payoff} = 15 \quad \text{points} \\ \text{Y's payoff} = 15 \quad \text{points} \\ \text{Z's payoff} = 15 \quad \text{points} \end{array}}$$

   regardless of the combination chosen by X in Stage 1.
2. If Y chose Red and Z chooses Blue in Stage 2,

$$\boxed{\begin{array}{l} \text{X's payoff} = 15 \quad \text{points} \\ \text{Y's payoff} = 15 \quad \text{points} \\ \text{Z's payoff} = 30 \quad \text{points} \end{array}}$$

   regardless of the combination chosen by X in Stage 1.
3. If Y chose Blue and Z chooses Red in Stage 2,

$$\boxed{\begin{array}{l} \text{X's payoff} = 15 \quad \text{points} \\ \text{Y's payoff} = 30 \quad \text{points} \\ \text{Z's payoff} = 15 \quad \text{points} \end{array}}$$

   regardless of the combination chosen by X in Stage 1.
4. If both Y and Z chose Blue in Stage 2,

$$\boxed{\begin{array}{l} \text{X's payoff} = 10 \quad \text{points} \\ \text{Y's payoff} = 15 - \text{number of black ball(s) in the combination} \;\; \text{points} \\ \text{Z's payoff} = 15 - \text{number of white ball(s) in the combination} \;\; \text{points} \end{array}}$$

Below are examples illustrating how to compute payoffs:

Example 1: In Stage 1, X chose a combination with 9 black balls and 1 white ball. In Stage 2, both Y and Z chose Red. Then, each of them will earn 15 points.

Example 2: In Stage 1, X chose a combination with 4 black balls and 6 white balls. In Stage 2, Y chose Red whereas Z chose Blue. Then, X and Y will earn 15 points each whereas Z will earn 30 points.

Example 3: In Stage 1, X chose a combination with 7 black balls and 3 white balls. In Stage 2, Y chose Blue whereas Z chose Red. Then, X and Z will earn 15 points each whereas Y will earn 30 points.

Example 4: In Stage 1, X chose a combination with 2 black balls and 8 white balls. In Stage 2, both Y and Z chose Blue. Then, X will earn 10 points, Y will earn 13 ($= 15 - 2$) points, and Z will earn 7 ($= 15 - 8$) points.

Appendix A.5. Feedback Information at the End of Each Round

After completion of Stage 2, the computer will exhibit a results screen that shows:

- Your decision as well as the decisions of the other two members in your group;
- Your payoff for the current round.

Appendix A.6. End of the Experiment

After completing the experiment, the computer will display a history screen that presents your payoffs (in points) in the three rounds. Then, the experimenter will determine a seat number by drawing one chip from a box that contains 27 chips labeled 1 through 27. The participant with the selected seat number will be a *volunteer*. The volunteer participant will be asked to come forward and then draw one ball from a box that contains three balls labeled 1 through 3. This will determine the round for payment.

A summary screen will display:

- The round chosen by the volunteer;
- The points you have earned in the chosen round;
- The corresponding earnings in euros;
- Your show-up fee;
- Your total earnings in euros.

Please remain at your cubicle until asked to come forward and receive payment for the experiment.

When you are ready for the experiment, please click on the I'm ready button on the screen. When all participants have pressed this button, the experimenter will start reading the instructions aloud. After that, you will have to answer a series of six questions designed to check your understanding of the instructions. After all participants have completed answering the six questions, the experiment will begin.

Please remember that no communication is allowed during the experiment. If you encounter any difficulties, please raise your hand. The experimenter will come to assist you.

Appendix B. Control Questions for Treatment Seq-Asym (Originally Written in German)

Q.1 (True/False Question) Your role will change every round.

True / False

Answer: False. Your role will stay the same throughout the experiment.

Q.2 (True/False Question) You may be matched with the same participants more than once.

True / False

Answer: False. You will never be matched with the same participants again.

Q.3 (True/False Question) Each participant will be paid a EUR 2.50 show-up fee.

True / False

Answer: False. The show-up fee differs across the three roles. You will receive a EUR 5.00 show-up fee if you are X, a EUR 2.50 show-up fee if you are Y, and a EUR 7.50 show-up fee if you are Z.

Q.4 (Multiple Choice Question) In Stage 1, X chose a combination with 7 black balls and 3 white balls. In Stage 2, both Y and Z chose Red. How many points will they earn for this round?

A. X will earn 10 points, Y will earn 8 points, and Z will earn 12 points;
B. X will earn 10 points, Y will earn 12 points, and Z will earn 8 points;
C. X will earn 15 points, Y will earn 30 points, and Z will earn 15 points;
D. None of the above.

Answer: D. Since both Y and Z chose Red in Stage 2, each of the group members will earn 15 points.

Q.5 (Multiple Choice Question) In Stage 1, X chose a combination with 4 black balls and 6 white balls. In Stage 2, both Y and Z chose Blue. How many points will they earn for this round?

A. X will earn 10 points, Y will earn 9 points, and Z will earn 11 points;
B. X will earn 10 points, Y will earn 11 points, and Z will earn 9 points;
C. Each of them will earn 15 points;
D. None of the above.

Answer: B. In Stage 1, X chose a combination with 4 black balls and 6 white balls. Since both Y and Z chose Blue in Stage 2, X will earn 10 points, Y will earn 11 ($= 15 - 4$) points, Z will earn 9 ($= 15 - 6$) points.

Q.6 (Multiple Choice Question) In Stage 1, X chose a combination with 1 black ball and 9 white balls. In Stage 2, Y chose Red and Z chose Blue. How many points will they earn for this round?

A. X will earn 10 points, Y will earn 6 points, and Z will earn 14 points;
B. X will earn 10 points, Y will earn 14 points, and Z will earn 6 points;
C. X will earn 15 points, Y will earn 15 points, and Z will earn 30 points;
D. None of the above.

Answer: C. Since Y chose Red and Z chose Blue in Stage 2, both X and Y will earn 15 points each, whereas Z will earn 30 points.

Notes

1. Arbitrarily selecting only one polluter as fully responsible parallels the legal practice of holding just one out of multiple culprits accountable for the entire damage.
2. In best-shot public good games where the level of public good provision is contingent on the largest individual contribution, efficiency requires that only one of several contributors should contribute the efficient level.
3. When attributing responsibility, judges are often influenced by case-unrelated discrepancies. For instance, they may hold richer employers responsible in labor disputes based on their financial status.
4. Roth and Malouf [1] studied equilibrium selection in bargaining scenarios.
5. In the ultimatum game, it is an equilibrium in weakly dominated strategies when the proposer offers more than the minimal amount which the responder would accept.
6. Feldhaus and Stauf [10] theoretically and experimentally examined whether cheap talk could lead to an efficient outcome in a three-person VD game. In the second treatment of their experiment, one randomly chosen player had to send the other group members a one-way message regarding the strategy she would play. In sharp contrast to cheap talk in their game, the third party's sanctioning schedule is a costless but binding decision.
7. The assumption that X is not at all affected by the p-choice can be justified by viewing X as an independent entity, thus eliminating confounding efficiency concerns associated with varying total punishment levels.
8. Specifically interesting scenarios of such a game class are small c and large d, cases where X does not suffer much but is free in allocating sanctions, as well as large c rendering X as seriously harmed and strongly motivated to avoid common polluting. Additionally, scenarios with small b and large d could discourage Y and B from choosing different strategies.
9. Isomorphic invariance implies symmetry invariance.
10. Since we could not recruit twenty-seven participants for the second session of treatment Sim-Sym, we decided to run this session with eighteen participants instead.
11. The English instructions and control questions for treatment Seq-Asym are available in Appendix A and Appendix B, respectively.
12. An additional avenue for exploration could have been to investigate how advice suggesting that (extreme) discrimination is more likely to enhance efficiency would impact game playing, particularly regarding the sanctioning behavior of X participants.

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