The tragedy of the anti-commons: effects of uncertainty and accountability.

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Abstract

This paper investigates the effects of uncertainty and accountability in an anticommons dilemma. The anticommons dilemma can be defined by a situation in with a resource has multiple owners who can prevent each other from using it. In the experiment, participates played an anticommons game in groups of three. They had to indicate their willingness to accept (WTA) price for lottery tickets they shared after hearing the willingness to pay (WTP) price ranges of the buyer. These WTP price ranges had different levels of uncertainty in each round. Accountability was tested with an condition in which participants were told to justify their actions in an online chat with their group. A positive effect of WTP uncertainty on WTA was found, indicating that people ask more money when there is uncertainty in the buyers price. No effect of accountability within an anti-commons dilemma was found.

Introduction

Imagine a medicine of which each compound is controlled by a different company. A medicine manufacturer needs these compounds to make this medicine. Each company that owns one of these compounds wants to make money with its patent and therefore wants to sell as much as possible of its compound. Each company has the power to restrict the other companies from selling the medicine by denying the use of its compound, but without the compounds of the other companies, its compound is useless. In this situation, a problem can arise. If the total price for all of these compounds combined is too high, the medicine manufacturer may not want to make this medicine any more or the eventual price of the medicine gets too high, with as a result that the medicine is not produced anymore. In both cases the companies cannot sell their compounds. This means that even though the companies want to maximize their profit, they cannot ask too much or they risk the change of not making any money at all.

This problem was first discussed by Heller (1998) and is referred to as the anti-commons dilemma. The anticommons dilemma is a social dilemma in which a single resource has multiple owners who can prevent others from using it. Since it was first discussed, the anti-commons dilemma has been recognized in many real world situations, from causing many stores in post-communist countries to remain empty

(Heller, 1998), to biomedical patents causing underuse of resources (Heller & Eisenberg, 1998).

In the anti-commons dilemma, all parties have to allow the other parties to use the recourse, to have the resource be used at all. This means there has to be cooperation between those parties. In social dilemmas, uncertainty has been shown to have an effect on the level of cooperation of participants (Gustafsson, Biel, & Gärling, 1999). A recent study shows evidence that environmental uncertainty during negotiations in a anti commons dilemma has a negative effect on cooperative behavior (Stokmans, 2019). Environmental uncertainty is uncertainty about the characteristics of a social dilemma (Messick, Allison, & Samuelson, 1988). This uncertainty occurs within environmental factors, rather than within other human actors. The research by Stokmans (2019) is in line with previous research (Kwaadsteniet, Dijk, Wit, & Cremer, 2006), which suggest that environmental uncertainty undermines efficient cooperation. Other research also suggests that uncertainty can be used to justify non-cooperative decisions (Van Dijk, Wit, & Wilke, 2004). In addition, a study by Chen, Au, and Komorita (1996) found that when people perceived themselves as crucial in the process of public goods, and uncertainty occurred, the amount of cooperation diminished. This research is particularity interesting, because the anti-commons dilemma makes the decision of a single person a crucial factor in the outcome for all people involved.

Another factor known for influencing people within social situations is accountability. While accountability has been found to have large impact in social situations (Lerner & Tetlock, 1999), no study has been conducted on the effect of accountability in a anticommons dilemma. Specifically, accountability can be described as when a person is expected to justify their actions or beliefs (Lerner & Tetlock, 1999). A recent study tested people in a common resource dilemma with a division rule (environmental certainty), as well as with no specific division rule (environmental uncertainty) (Kwaadsteniet, Van Dijk, Wit, De Cremer & de Rooij, 2007). This division rule was implied by the amount of resources available, if they were shared with everyone. Naturally, when the amount of resources was uncertain, no clear division rule exits. For example, dividing three apples over three people creates a clear division rule of one apple per person. If the amount of apples is uncertain, the amount of apples per person is unclear. In the study, participants adhered more closely to the division rule

when they had to justify their decision, and when there was no specific division rule they restricted their amount of acquired goods when they had to justify their decision. This implies people are willing to make more cooperative decisions while they are held accountable within social dilemmas. In the medicine example described in the first paragraph, companies can restrict itself and the other companies from selling their compound and making a profit. If the companies in this example are people in a social dilemma are held accountable, they might ask less money, or sick more closely to a possible division rule, reducing the chance of the medicine manufacturer refusing to buy their compounds. In turn, this could result in the sellers making a profit and prevents the underuse of a resource.

The first focus of this study will be to investigate if uncertainty in an anti-commons situation causes people to act less cooperative. Non-cooperative behavior within the anti-commons dilemma can result in the underuse of a resource. Investigating the effect of uncertainty on cooperation could shed light on its effects in real life situations, and possibly aid the prevention of the underuse of a recourse and increase the overall gains for the people involved. Secondly, this study will investigate what effect accountability has on cooperation of people during an anti-commons dilemma. If a positive effect for accountability can be found, applying accountability in real life anti-common situations could also reduce the chance of underusing a resource and increase overall gains for the people involved. These effects will be tested with an anti-commons game in which participants want to sell a set of valuable goods. The participants indicate their willingness to accept (WTA) a price for a set of valuable goods, while varying the uncertainty of the price a buyer is willing to pay (WTP) for these goods. So for example, three participants get a shared ownership over a lottery ticket. They are given an opportunity to sell their ticket to a buyer, and they will be informed about the WTP of the buyer. This could be a fixed WTP like €2, or a random price within a range like €1.5 to €2.5. In this example the range of €1.5 to €2.5 has a higher uncertainty than the fixed price of €2. They are also informed that if the WTA of all three participants combined exceeds the WTP of the buyer, the ticket will not be bought. Because all participants exclude the others while excluding themselves, this experiment creates an anti-commons dilemma. To test the effect of accountability, some participants will have to chat with their co-participants regarding their actions. This group of participants will experience the same experiment, except they are told at the beginning of the experiment that they will have to chat with their

fellow group members. At the end of the experiment they will be put in a chat room in which they have to explain their prices to the rest of their group. Based on the discussed literature the flowing hypotheses are formulated:

H1: Based on the research done by Gustafsson et al. (1999), Stokmans (2019), Kwaadsteniet et al. (2006), and Chen et al. (1996) it is expected that uncertainty during an anticommons dilemma results in more proself behavior. Therefore it is expected that the sellers will demand more money for their good if the uncertainty of the buyer's WTP is high.

H2: Based on the research done by Kwaadsteniet et al. (2007) it is expected that when people are exposed to environmental uncertainty, and are held accountable for their decisions, it is more likely they will restrict the amount of goods they ask in an anti-commons dilemma. Therefore it is expected that the sellers will accept less money for their good if they are held accountable.

Methods

Participants and design

This study was be conducted with 171 participants. The participants can be male or female, have to be 18 years or older, and need to be able to understand English. Because this study will use a 2 (accountability: yes vs no) x 3 (certainty: no vs low vs high) design, 46 3 person groups will be formed. In 23 of those groups the participants will be asked to justify their decisions.

The participants will be presented a 3 person anti commons game. First the participants will receive instructions on how the game is going to work. After those instructions the participant will be asked a few questions regarding the game. This is to test if the participant has a good understanding of the game. The participants in the accountability groups will get a last reminder that they have to explain their decisions afterwards, through the mean of a chat room with their group. The game will have three rounds, each round with a different level of uncertainty for the buyers WTP. In a round the 3 participants are given a lottery ticket that they sell to a buyer for coins. The participants are made aware of the fact that these coins are worth real money which they will receive after completion of the study. They are also told there is a 1 in 36 chance of the winning €20 with the ticket, which makes the suggested value of a ticket around €0.55 or 55 coins. Each round the participants indicate their WTA by selecting an amount of coins they would like to receive for the ticket. If the combined

WTA of the participants are greater than the WTP from the buyer, they keep the ticket and none of the participants receives their indicated amount of coins that round. The WTP has 3 levels of uncertainty, each presented in their own round: certain (200 coins = €2), slightly uncertain (150 to 250 coins = €1.50 to €2.50), or highly uncertain (100 to 300 coins = €1 to €3). After each round the participants are asked to rate the uncertainty of the buyers offer on a scale from 1 to 7. After this, the participants in the accountability groups get three chat windows to explain their decisions for each of the rounds. All participants are asked to what extent they felt they had to justify their decisions to the other sellers, to what extent they felt accountable for their decisions, and to what extent they felt they had to explain their decisions to the other sellers. The participants will get a summary of how many lottery tickets they possess and if they won any money with the remaining tickets. Last, the participants are asked to fill in their age and gender and is paid the amount of money they earned, including a 2€ participation fee.

Analyses

To analyze the first hypothesis, the WTA values were tested within subjects with a repeated measures ANOVA. The within subject factor consisted of 3 levels: *certainty* WTA, *low uncertainty* WTA and *high uncertainty* WTA. This repeated measures ANOVA was calculated with *accountability* as between subjects factor.

To analyze the effect of the *certain*, *low uncertainty*, and *high uncertainty* conditions on the uncertainty the participants experienced, another repeated measures ANOVA was run. The within subject factor of this repeated measures ANOVA consisted of 3 levels: *reported certainty* in *certainty* condition, *reported certainty* in *low uncertainty* condition and *reported certainty* in *high uncertainty* condition. This repeated measures ANOVA was also calculated with *accountability* as between subjects factor.

For the second hypothesis the data was analyzed with a between subjects univariate ANOVA, with participants' mean WTA as depended variable and *accountability* as the independent variable.

<div align="center">**Results**</div>

Participants

171 participants participated in the experiment. Of these 171 participants, 141
completed the experiment in its entirety. These 141 participants will be used for the
final analysis. Of the 141 participants, 106 were female and the remaining 35 were
male. These 141 participants were split into 47 3-person groups. 28 of these groups
were in the accountability condition and the remaining 19 in the normal condition.
This gave the accountability condition a total of 84 participants, and the normal
condition a total of 57 participants. 23 cases were found to be outliers. The outliers
didn't suggest they were caused by issues with the data collection. It is possible that
the outliers were caused by participant error. Tests for both hypotheses were run with
and without the outliers.

Willingness to accept

A repeated measures ANOVA was used to analyze the effect of uncertainty of the
buyer's WTP on the reported uncertainty. The within subject factor consists of 3
levels: reported uncertainty in uncertainty condition, reported uncertainty in low
uncertainty condition and reported uncertainty in high uncertainty condition. This
repeated measures ANOVA was also calculated with accountability as between
subjects factor. Table 1 shows the means, standard deviations and the number of
tested cases. Table 2 shows the same for the test without the outliers.

Table 1

Uncertainty question mean of data with outliers

	Accountability group	Mean	Std. Deviation	N
Certainty question	Not Accountable	2.7544	1.86395	57
	Accountable	2.3452	1.97267	84
	Total	2.5106	1.93323	141
Low uncertainty question	Not Accountable	3.9123	1.43029	57
	Accountable	4.0357	1.68942	84
	Total	3.9858	1.58559	141

High uncertainty question	Not Accountable	4.7895	1.39817	57
	Accountable	4.3929	1.74258	84
	Total	4.5532	1.61875	141

Table 2

Uncertainty question mean of data without outliers

	Accountability group	Mean	Std. Deviation	N
Certainty question	Not Accountable	2.7234	1.81422	47
	Accountable	2.2113	1.88161	71
	Total	2.4153	1.86431	118
Low uncertainty question	Not Accountable	4.0426	1.38246	47
	Accountable	3.9718	1.63857	71
	Total	4.0000	1.53590	118
High uncertainty question	Not Accountable	4.9787	1.24218	47
	Accountable	4.3662	1.70913	71
	Total	4.6102	1.56366	118

The Greenhouse-Geisser correction was used for this repeated measures ANOVA. This was because Mauchly's Test of Sphericity was violated by the data with the outliers [$X^2(2) = 49.364$, $p < .0005$], and without the outliers [$X^2(2) = 33.303$, $p < .0005$].

The buyers WTP showed a significant main effect on the reported certainty, with the outliers [$F(1.538, 213.727) = 70.841$, $p < .0005$, $\eta2 = .338$], and without the outliers [$F(1.598, 185.388) = 75.783$, $p < .0005$, $\eta2 = .395$]

Table 1 and 2 show that the participants generally reported more uncertainty, the higher the uncertainty of the buyer's WTP was. Table 3 shows the contrasts, which confirms that a higher uncertainty of the WTP resulted in a higher reported uncertainty than with a certain WTP, and a higher uncertainty of the WTP also resulted in a higher reported uncertainty than with a low uncertainty for WTP. In addition, table 3 shows that the analysis were significant, with, and without the outliers.

Table 3

Effect of level of certainty of WTP on certainty question

	df	F	Sig.	Partial Eta squared
Certain WTP vs. high uncertainty WTP	1	94.366	< .0005	.404
Low uncertainty WTP vs. high uncertainty WTP	1	25.195	< .0005	.153
Certain WTP vs. high uncertainty WTP without outliers	1	104.218	< .0005	.473
Low uncertainty WTP vs. high uncertainty WTP without outliers	1	34.843	< .0005	.176

To analyze the first hypothesis, the WTA values were tested within subjects with a 2x3 repeated measures ANOVA. The within subject factor consists of 3 levels: *certainty* WTA, *low uncertainty* WTA and *high uncertainty* WTA. This repeated measures ANOVA was also calculated with *accountability* as between subjects factor. Table 4 shows the means, standard deviations and the number of tested cases. Table 5 shows the same for the test without the outliers.

Table 4

WTA means of data with outliers

	Accountability group	Mean	Std. Deviation	N
Certainty WTA	Not Accountable	92.4737	46.63311	57
	Accountable	95.3095	54.33519	84
	Total	94.1631	51.20653	141
Low uncertainty WTA	Not Accountable	118.0351	69.54597	57
	Accountable	104.8095	64.16310	84
	Total	110.1560	66.46667	141
High uncertainty WTA	Not Accountable	120.7719	74.41750	57
	Accountable	114.6190	71.53345	84
	Total	117.1064	72.51233	141

Table 5

WTA means of data with outliers

	Accountability group	Mean	Std. Deviation	N
Certainty WTA	Not Accountable	73.9362	15.24496	47
	Accountable	73.6761	18.23088	71
	Total	73.7797	17.03648	118
Low uncertainty WTA	Not Accountable	101.1277	59.87437	47
	Accountable	86.3239	49.78404	71
	Total	92.2203	54.27032	118
High uncertainty WTA	Not Accountable	99.8723	51.33421	47
	Accountable	92.2394	47.32697	71
	Total	95.2797	48.88988	118

The Greenhouse-Geisser correction was used for the repeated measures ANOVA on the data without the outliers. This was because the data without the outliers violated Mauchly's Test of Sphericity [$X^2(2) = 7.667$, $p = .022$], whereas the data with the outliers did not.

Consistent with hypothesis 1, the within subject factor showed a significant main effect with the outliers [$F(2, 278) = 13.428$, $p < .0005$, $\eta2 = .088$], as well as without the outliers [$F(1.879, 217.943) = 12.827$, $p < .0005$, $\eta2 = .100$]

Figure 4 and 5 show that participants asked for a higher price when there was *high uncertainty*, compared to the *certainty* condition. This is confirmed by a significant contrast effect between the *certainty* and *high uncertainty* condition, with the outliers [$F(1, 139) = 25.763$, $p < .0005$, $\eta2 = .156$], and without the outliers [$F(1, 116) = 27.431$, $p < .0005$, $\eta2 = .191$]. However, the contrast between the *high uncertainty* condition and the *low uncertainty* condition showed no significant effect, both with the outliers [$F(1, 139) = 1.484$, $p = .225$, $\eta2 = .011$], and without the outliers [$F(1, 116) = .192$, $p = .662$, $\eta2 = .002$].

As shown in Table 6 and 7, no interaction effect was found on the main effect or the contrasts.

Table 6

Interaction of the data with outliers

	df	F	Sig.	Partial Eta squared
Main effect	2	1.429	.241	.010
Between certainty and high uncertainty	1	.918	.340	.007
Between low uncertainty and high uncertainty	1	.472	.493	.003

Table 7

Interaction of the data without outliers

	df	F	Sig.	Partial Eta squared
Main	1.879	1.134	.324	.010
Between certainty and high uncertainty	1	.753	.387	.006
Between low uncertainty and high uncertainty	1	.454	.502	.004

Accountability

For the second hypothesis the data was analyzed with a between subjects univariate ANOVA, with participants' mean WTA as depended variable and the accountability condition as the independent variable. Table 8 shows the mean WTAs, standard deviations and the number of cases. Table 9 shows the same for the test without the outliers.

Table 8

WTA means for accountability group with outliers

Accountability group	Mean	Std. Deviation	N
Not Accountable	110.4269	52.64405	57
Accountable	104.9127	57.40588	84
Total	107.1418	55.40448	141

Table 9

WTA means for accountability group without outliers

Accountability group	Mean	Std. Deviation	N
Not Accountable	91.6454	32.78229	47
Accountable	84.0798	30.55749	71
Total	87.0932	31.54390	118

Contradicting to hypothesis 2, no significant effect of accountability was found on the WTA, both with the outliers [$F(1, 139) = .335$, $p = .564$], and without the outliers [$F(1, 116) = 1.636$, $p = .203$].

Discussion

In this study both uncertainty and accountability were manipulated in a anticommons game with real money. Confirming hypothesis 1, this study showed that sellers will ask more money for their good if the uncertainty of the buyers WTP is high. This highlights that uncertainty during an anti-commons dilemma results in more proself behavior. However, this study did not show that show proself behavior was influenced by accountability. Because accountability had no significant effect on the amount of money asked for their good, the second hypothesis can be rejected.

Main findings

Firstly, this study found that sellers will ask more money for their good is the uncertainty of the buyers WTP is high. This is in accordance with previous research by Gustafsson et al. (1999), Stokmans (2019), and Kwaadsteniet et al. (2006), which suggested that uncertainty in social dilemmas results in proself behavior. Specifically, the present study found that in a anti-commons dilemma with certainty on the WTP of a buyer, participants asked significantly less money for their good, when compared to a social dilemma with high uncertainty on the WTP of a buyer. However, this study did not find and a significant difference between the amount of money asked in a social dilemma with high uncertainty of the buyers WTP, compared to an anti-commons dilemma with a modest amount of uncertainty. This suggests that the participants experienced the same amount of uncertainty in both the high and low uncertainty condition. However, the analysis of the reported levels of uncertainty, show that the people experience a significantly higher level of uncertainty in the high uncertainty condition, compared to the low uncertainty condition. If this is the case, this would suggest that uncertainty has an effect on proself behavior, but is not affected by the level of uncertainty.

Secondly, this study did not find any significant effect of accountability on the WTA. Although previous studies found that accountability could result in more prosocial behavior (Kwaadsteniet et al., 2007), this study was the first to test the effect of accountability in the context of the anti-commons dilemma. While the means show that participants who had to chat with their group members did ask less for their goods, this difference was not found to be significant. A possible explanation for this insignificant effect could have something to do with participants using the uncertainty as justification for non-cooperative behavior, without feeling they were socially

obligated to make prosocial decisions. This effect has been shown in previous research by (Van Lange, Joireman, Parks, & Van Dijk, 2013).

Limitations and suggestions for further research

A limitation of the current study was the way in which accountability was induced in participants. The participants had to justify their actions made in the anti-commons game through a chat with the rest of their group. While they had to justify their actions to actual group members, these conversations did not go face to face. It is possible that the participants were less affected by accountability, because a digital environment creates a distance between people. Future research might benefit from inducing accountability with face to face conversations, instead of digital chat rooms, which might even find an effect of accountability within the anti-commons dilemma. Secondly, due to a limited amount of participants, most groups were formed by acquaintances. These participants would place themselves in the same time slot as their friends or classmates. Because most groups consisted of acquaintances, social behavior and the effects of accountably might have been influenced. Future research could try to improve on this by forming random groups within their participants.

Conclusion

The present study gives more insight in the previously researched effect of uncertainty in a anticommons dilemma, by showing a significant effect between certainty and high uncertainty, but not between modest uncertainty and high uncertainty. This study also investigated the effect of accountability within a anti commons dilemma, but no significant effect was found. Therefore, it is better to avoid uncertainty in anti-common dilemmas, but if uncertainty is the case, the amount of uncertainty is irrelevant.

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