ELSEVIER International Review of Law and Economics 26 (2006) 104–122

International Review of Law and Economics

From "tragedy" to "disaster": Welfare effects of commons and anticommons dilemmas

Sven Vanneste [a,*], Alain Van Hiel [a], Francesco Parisi [b], Ben Depoorter [c]

[a] *Department of Developmental, Personality and Social Psychology, Ghent University, H. Dunantlaan 2, 9000 Gent, Belgium*
[b] *School of Law and J.M. Buchanan Center for Political Economy, George Mason University, Arlington, USA*
[c] *Center for Advanced Studies in Law and Economics, Faculty of Law, Ghent University, Belgium*

Abstract

In this paper, we explore the alleged symmetry between commons and anticommons dilemmas. Our experimental results reveal an interesting asymmetry. Anticommons situations generate greater opportunistic behavior than an equivalent commons dilemma (Study 1), and anticommons dilemmas yield a greater risk for ineffective use compared to commons dilemmas (Study 2).

The results of the present study bring to light important deviations from the economic model, suggesting that other factors, such as behavioral attitudes towards property and psychological variables, affect cooperation differently in anticommons and commons dilemmas. Our findings complement the existing experimental literature on commons dilemmas and contradict the presumed economic symmetry of commons and anticommons problems. The identification of relevant parameters constitutes an interesting line of future research. Such research could identify the parameters that differentiate between the behavioral outcomes imposed by the two dilemma types, and identify subjective factors that underlie people's behavior in anticommons dilemmas. Our research attests to the potential gravity of the anticommons problem, and we conclude that it is inadequate to extrapolate findings from the commons to the anticommons dilemma.

Keywords: Anticommons; Commons; Welfare effects; Social dilemma; Experimental economics

* Corresponding author.
E-mail address: Sven.Vanneste@UGent.be (S. Vanneste).

0144-8188/$ – see front matter © 2006 Elsevier Inc. All rights reserved.
doi:10.1016/j.irle.2006.05.008

1. Introduction

Over the last three decades economists, psychologists, philosophers and political scientists showed a growing interest in research on social dilemmas. According to Kopelman, Weber, and Messick (2002), social dilemmas can be defined by three core characteristics. First, a noncooperative choice is always more profitable to the individual than a cooperative choice, regardless of the cooperativeness of others. Second, a noncooperative choice is always harmful to others compared to a cooperative choice. Third, the aggregate amount of harm done to others by a noncooperative choice is greater than the individual's profit. Thus, these particular situations are characterized by a direct conflict between private incentives and public interests and therefore constitute a "social dilemma."

In the commons dilemma individuals decide how much they take from a limited and depletable common resource. A standard result of the analysis of the use of common property is that under open access conditions, powerful incentives for overutilization emerge. Because individuals do not consider the full social costs of their activities, total use by all parties exceeds the natural limit and eventually leads to the complete destruction of the common good. Depletion of minerals and oil reserves, deforestation, and extinction of species because of overfishing and overhunting represent real world examples of this process. Hardin (1968) described this process of overuse of common resources as the "tragedy of the commons."

More recently a new concept surfaced in the literature on common property. This concept, first introduced by Michelman (1982) and then made popular by Heller (1998) and others, mirror images in name and fact Hardin (1968) well-known tragedy of the commons. An "anticommons," a property regime in which two or more joint owners hold effective rights to prohibit one another from utilizing a scarce resource, creates conditions for underuse of the common resource (Heller, 1998). Under competitive conditions, each co-owner has incentives to block access to the common resources for other users, although the use of the common resource by one party could yield net benefits. Thus, because multiple holders of exclusion rights do not fully internalize the cost created by enforcing their right to exclude others, the common resource will remain idle even in the economic region of positive marginal productivity. Following Michelman (1982), Heller (1998), and Heller and Eisenberg (1998), the legal and economic literature refers to this process of underusing common resources as the "tragedy of the anticommons."

For instance, Heller and Eisenberg (1998) applied the concept of the anticommons to ownership of intellectual property rights in biomedical research. Biomedical research has been shifting from a commons, where the result of publicly funded research is freely available in the public domain, to a model in which private investment spurs the pace of upstream research. However, downstream product developers face a considerable bargaining problem because they need to solicit licenses from many upstream patent right-holders before they can develop new products and bring them to the market. According to Heller and Eisenberg, granting too many patent rights in pre-market or upstream biomedical research might stifle discovery of life saving products downstream. Hence, in solving the commons tragedy, privatization can go astray and unintentionally create a tragedy of the anticommons, provoking the underuse of scarce resources because too many owners block access to the common resources.

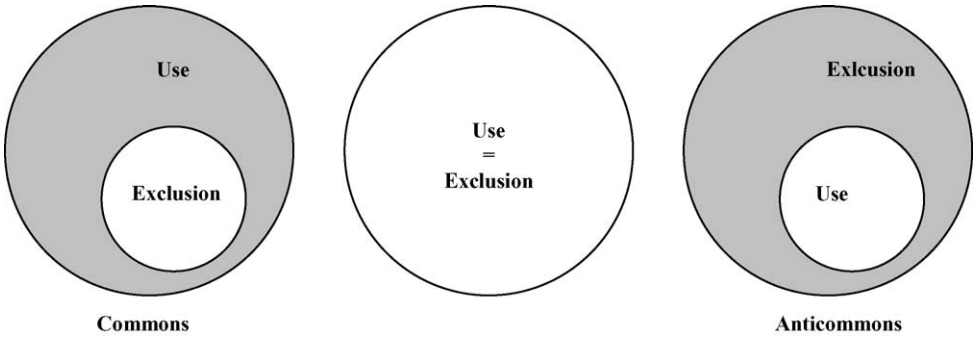

Fig. 1. Use and exclusion in a commons and anticommons regime.

Commons and anticommons are symmetrically related to one another (Buchanan & Yoon, 2000; Heller, 2001; Parisi, Schulz, & Depoorter, 2005) and can be framed within a unified conception of property. According to the traditional conception of property, owners enjoy a complementary bundle of rights over their property including, among other things, the right to use the property and the right to exclude others from it.

As can be seen in Fig. 1, commons and anticommons conditions can be conceived as symmetric deviations from the standard bundle of rights, whereby the rights of use and exclusion are in balance. Thus, in commons situations, the right to use stretches beyond the effective right (or power) to exclude others. Conversely, in an anticommons property regime, the co-owners' right of use is crowded out by an overshadowing right of exclusion held by other co-owners.

1.1. Welfare effects of commons and anticommons

In modeling commons and anticommons problems, the recent literature has evidenced symmetrical welfare effects from overuse and underuse of the common resource (see Buchanan & Yoon, 2000; Parisi et al., 2005). The cited literature analyzes the behavior of sellers of a certain good in a market characterized by a monotonically decreasing demand function $P = p(Q)$, with $p' < 0$. Goods are produced at non-decreasing marginal costs $\mathrm{MC} \geq 0$. In the case of unified property, a single owner faces a downward sloping demand curve and will sell at $\mathrm{MR} = \mathrm{MC}$, maximizing total profit. It is worthwhile remarking that the results of the monopoly case hold for any subset of the bundle of property rights, be those complementary exclusion rights or substitutable use rights. Regimes of commons and anticommons generate symmetrical (inefficient) departures from the standard benchmark of privatized property. For illustration purposes and without loss of generality, consider a case where owners face $\mathrm{MC} = 0$ and a linear demand function for their property $\pi = PQ = VQ - Q^2$. Owners can sell exploitation rights on their property and sell the remaining part to the market. The first order condition for the single owner's maximum yields: $Q = V/2$; $P = V/2$; and $\pi = V^2/4$. Let us now consider the equilibrium achievable in a commons situation. Here, we have several co-owners each capable of selling exploitation rights over the common resource. However, the demand and price are affected by the quan-

tity of exploitation rights sold by the other co-owners. By doing so, each co-owner i solves the following maximization problem:

$$\text{Max}\,\pi_i = PQ_i = \left(V - Q_i - \sum_{j\neq 1} Q_j\right) Q_i = VQ_i - Q_i^2 - Q_i \sum Q_j \tag{1}$$

With co-owner i assuming that $\partial Q_j/\partial Q_i = 0$, the first order conditions for a maximum are $\partial\pi_i/\partial Q_i = V - 2Q_i - \Sigma Q_j$. The n co-owner reaction functions can be solved simultaneously for the equilibrium values of exploitation rights Q_i and Q_j to yield $Q_i = Q_j = V/(n+1)$; with a total supply of exploitation rights $nV/(n+1)$; and $P = V - \Sigma Q_j = V/(n+1)$. As expected, in this case the quantity sold increases and the price falls as the number of co-owners increases.

Having derived the price and quantity of exploitation rights under the commons regime, we can now look at the symmetric case of anticommons. The comparison between the two reveals the mathematical symmetry between commons and anticommons dilemmas. Consider co-owners in an anticommons regime. Exploitation rights can be granted to a third party only if every co-owner agrees to the transfer. Co-owners decide independently of one another and can set different prices for their consent to transfer exploitation rights. This is the case analyzed by Buchanan and Yoon (2000), and Parisi et al. (2005), as a model of the anticommons problem. The third party's decision to purchase exploitation rights will be driven by the total price, which is given by the sum of the prices independently charged by the various co-owners, $\Sigma_{i=1,\ldots n} P_i$. Thus, in setting his price, co-owner i faces the following problem:

$$\text{Max}\,\pi_i = PQ_i = \left(V - P_i - \sum_{j\neq 1} P_j\right) P_i = VP_i - P_i^2 - P_i \sum_{j\neq 1} P_j \tag{2}$$

Assuming that co-owner i chooses his price assuming that $\partial P_j/\partial P_i = 0$ (i.e. using the Nash assumption that considers all other players' prices as given) the first order conditions for a maximum are $\partial\pi_i/\partial P_i = V - 2P_i - \Sigma P_j$. The n co-owner reaction functions can be solved simultaneously for the equilibrium values of P_i and P_j to yield $P_i = P_j = V/(n+1)$; with a total price of $nV/(n+1)$; $Q = V - P_i - \Sigma P_j = V/(n+1)$. As the number of co-owners increases, the total price for the exploitation rights increases and the quantity purchased is reduced. In the limit ($n \to \infty$) the price of the exploitation rights becomes arbitrarily high and no units are sold.

Commons	Private property	Anticommons
$P = V/(n+1)$	$Q = V/2$	$P = nV/(n+1)$
$Q = nV/(n+1)$	$P = V/2$	$Q = V/(n+1)$

The economic model generates predictions summarized in the above table on the (inversely) symmetric behavior of players in commons and anticommons problems. These predictions assume the strategic rationality of the players involved. In the present study, we test these predictions to explore which other factors, such as different behavioral attitudes towards property and psychological variables, affect cooperation in these dilemmas. If the results of the present study bring to light important deviations from the economic model, then this suggests that other variables, which are not captured in the strategic economic

models of commons and anticommons, are at work. In particular, this may support the idea that psychological variables influence people's behavior differently in anticommons and commons dilemmas. Such a finding would complement the existing experimental literature on commons dilemmas (see Kopelman et al., 2002; Ostrom et al., 2002) and would contradict the presumed economic symmetry of commons and anticommons problems.

2. The present studies

In the naturally occurring world property regimes are relatively fixed. A comparison of the behavioral consequences of equivalent commons and anticommons dilemmas can therefore not be achieved and, because field data would not allow for examining the research question without noise, the use of experiments is warranted. The aim of the present research is to compare in an experimental setting participants' bids in anticommons and commons dilemmas. Rather than trying to predict the exact amount of money sought in these two types of dilemma – as one would expect from a normative model of game behavior – our explicit goal was to address the question of whether the type of dilemma affects the participants' bids. That is, by creating two situations that were equivalent in all respects but one (i.e. the type of dilemma), we were able to attribute eventual differences in the participants' behavior to the manipulated variable. This might support the thesis that psychological variables, such as framing and endowment effects (Andreoni, 1995; Kahneman, Knetsch, & Thaler, 1991), influence commons and anticommons dilemmas differently.

In Study 1, we conducted an interactive board game with two identical common properties. One of these properties operated under commons property rights, while the other was defined as an anticommons dilemma. In Study 2, we presented scenarios that described either a commons or an anticommons dilemma in order to investigate whether the anticommons dilemma would yield higher prices than the equivalent commons dilemma. The combination of these two methodologies allowed us to benefit from the strengths of each method while also mitigating their weaknesses. That is, a lab study allows one to assess actual behavior in a controlled environment, leading to findings with a high internal validity. The use of a scenario experiment enables one to draw conclusions while maintaining a relatively high degree of mundane realism, leading to high levels of external validity.

2.1. Study 1

In Study 1, participants' interactions with two common goods were tested. Both goods were analogous in all respects, but they were different with respect to the governing property regime: one of the goods was subject to an anticommons property regime, while the other good was subject to a commons property regime. Research Question 1 explored whether participants would request a greater amount of money in the anticommons dilemma than in the commons dilemma.

2.1.1. Participants

Twenty-five undergraduate and five master students in psychology volunteered for this lab study (13 males and 7 females). The students had a mean age of 22.30 years (S.D. = 5.55)

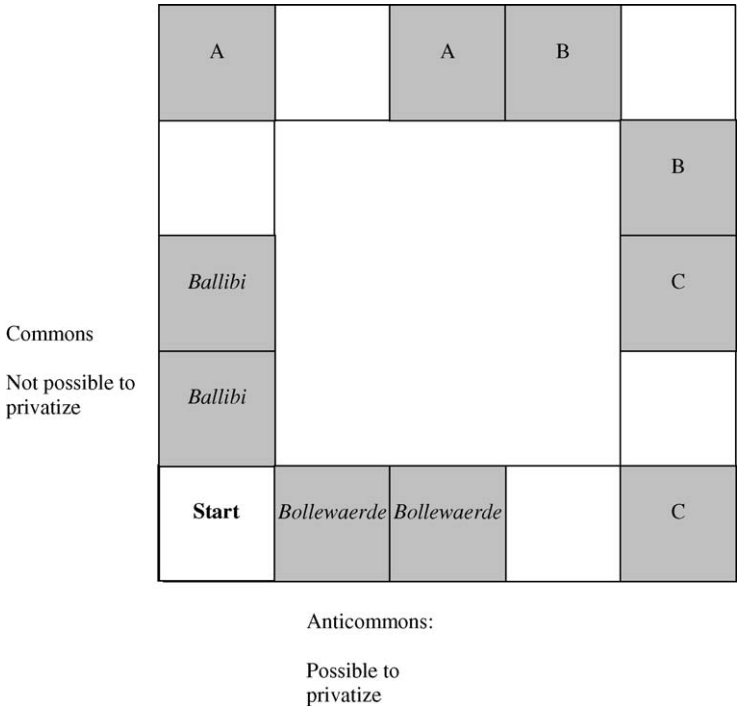

Fig. 2. Game board used in Study 1.

and had not previously taken courses in economics. A research assistant who did not know the participants conducted the experiment.

2.1.2. Procedure

Participants were randomly assigned to one of the board games, each played with three players (A, B and C), and instructed (see Appendix A). At the start of the board game, each participant received € 20 000 as initial capital, as well as a property (indicated as A, B, and C on the board depicted in Fig. 2). Four objects were located on each property and players were able to sell these objects for € 2000 if they needed money (in fact, no players sold their objects).

The aim of this game was to make as much profit as possible. Players move around the board by throwing a die, starting in each trial with player A, followed by players B and C. When players "visited" the property of another player, they had to pay an amount of € 2000 to the owner (if there were only three, two, or one object(s) on the property, visitors paid 1500, 1000, or € 500, respectively).

Each participant was co-owner of two amusement parks, named "Ballibi" and "Bollewaerde" (see Fig. 2). Every time a player visited one of these parks, (s)he received a monetary reward, dependent upon the number of objects present (€ 2000 when four of more objects were present, € 1500 for three objects, and so on). Both parks also had a growth rate, and after seven turns a new object was added.

Ballibi, the first amusement park, was defined as a commons. On every seventh turn, players could request as much money as they wanted. However, in return, an equivalent number of objects were removed from the commons. For example, if players A, B, and C would ask € 0, € 2000 and € 10 000, respectively, a total of six attractions were withdrawn from Ballibi. Players were allowed to ask for any amount, but if the amount sought surpassed the value of the objects on Ballibi, the bank would subtract € 4000 from the deficit during the next seven turns. In fact, participants were instructed that they "even could ask 1 million €."

Bollewaerde, the second park, operated in an anticommons property regime and could be privatized by the players. This park was divided into two parts. On every seventh turn, each player could bid on one of the two parts of Bollewaerde. Importantly, they also had to indicate their reservation price of willingness-to-accept when another player wished to acquire a part of Bollewaerde. After the players placed their bids, the bank checked whether the highest bid surpassed the sum of the asking prices of the two other players. If so, the highest bidder paid the other two players and acquired the property. Otherwise, no player acquired any part of Bollewaerde. When privatization of a part of Bollewaerde occurred, the other players had to pay € 2000 for every subsequent visit (when four objects were present).

The game consisted of 35 turns and the players had five opportunities to indicate the amount of money they wanted to (1) take from the commons property Ballibi, (2) pay for a part of the anticommons property Bollewaerde, or (3) demand for selling a part of Bollewaerde. Participants were not informed how many turns they would receive. At the end of the game, each player's property was counted. That is, we summed their cash money, determined the value of their properties, and included their share (i.e. 1/3) of the commons. The latter amount could be negative if the players had created a deficit in Ballibi.

Two other issues are worth mentioning. First, at the start of the game players were told that they could borrow money from the bank at any time. However, this money had to be reimbursed to the bank at the end of the game. Second, if both parts of Bollewaerde were privatized during the game, an extra part was added to allow players to further acquire private property.[1]

3. Results

Because data collected from individuals in the same group are not statistically independent,[2] the present analyses rely on the group mean as the unit of analysis. The money players took from Ballibi and the selling price of a Bollewaerde part on each of the five sequences constituted the relevant behavioral data in the commons and anticommons,

[1] Only one group privatized the two parts of Bollewaerde before the game ended, so this procedure was applied only once.

[2] Because of the strategic interaction between the group members within each group, data on the individual group members are statistically dependent, and therefore the use of aggregated group level data is recommended (Myers, DiCecco, & Lorch, 1981).

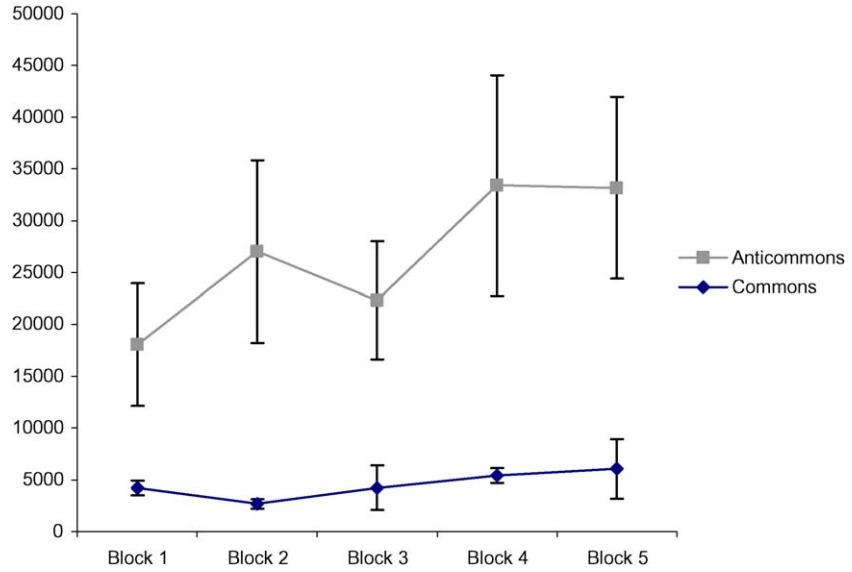

Fig. 3. Mean levels of amount of money taken from the commons and selling prices for the anticommons (Study 1).

respectively. To answer Research Question 1 (see Fig. 3), a two (dilemma, anticommons versus commons) × five (seven-turn sequences, one through five) repeated measures analysis of variance was conducted. It was revealed that the average value taken from the commons, $M = 4523$, was significantly smaller than the average price asked for the anticommons, $M = 26\,797$, $F(1,9) = 13.26$, $p < .05$. Pairwise t-tests confirmed that these differences were significant for each of the five seven-turn sequences, $t\text{s} > 2.52$, $p < .05$.[3]

The F-values for the effect of the seven-turn sequences and the interaction between type of dilemma and sequence did not exceed the conventional significance levels, $F\text{s} < 3.08$, n.s.

4. Discussion

Regarding Research Question 1, our first study reveals that participants demand a higher amount of money for resources within an anticommons property regime than they take from a similar resource in a commons property regime. This suggests that anticommons and commons do not necessarily represent symmetrical problems, but rather that the "tragedy of the anticommons" presents a greater social threat (underuse from blocking the use of

[3] One group had already privatized the two parts of Bollewaerde after three sequences. Re-analysis of the differences between commons and anticommons revealed that the difference for the fourth sequence remained significant, $t = 3.09$, $p < .01$, whereas this difference approached significance for the fifth sequence, $t = 1.98$, $p < .10$.

resources by posting very high selling prices) than the commons dilemma (overuse of resources).

4.1. Study 2

Study 1 shows that people ask higher prices in the anticommons than the monetary amount they take from the commons. However, it remains a possibility that the negative consequences of the dilemmas were hidden from the participants because they did not fully comprehend the situation or because overuse is a more familiar problem than the more ambiguous concept of underuse. Therefore, the question arises whether participants will also show a suboptimal management of their property when the potential dangers of the situation are made clear to them, or, alternatively stated, when the social dilemma is stated more explicitly. Clearly, when a similar effect of dilemma type is obtained under these circumstances, this reduces the risk that the differences observed in Study 1 are attributable to ambiguity or unfamiliarity with the concept of "underuse." In order to enhance the salience of the consequences of the actors' behavior, Study 2 assessed the probability that the source would be exhausted in the commons, as well as the probability that the buyer would agree with the selling price posted in the anticommons.

In Study 2, scenarios describing either a commons or an anticommons dilemma were presented to investigate whether the anticommons dilemma yields higher prices than an equivalent commons dilemma. The use of these two methodologies was preferred because in combining these methods we benefit from the strengths of each method, and compensate for the weaknesses of each method with the strengths of the other method. That is, a lab study allows one to assess actual behavior in a controlled environment, leading to findings with a high internal validity. The use of a scenario experiment enables one to draw conclusions while maintaining a relatively high degree of mundane realism, leading to high levels of external validity.

The following hypotheses were tested in Study 2:

Hypothesis 1. Participants in the anticommons dilemma request an amount of money that is higher than the threshold of 100 percent certainty that the buyer will agree.

Hypothesis 2. Participants in the commons dilemma request an amount of money that is higher than the threshold of 100 percent certainty of resource replenishment.

Hypothesis 3. Participants in the anticommons dilemma request more money than participants in the commons dilemma.

5. Method

5.1. Participants

A total of 258 undergraduate students at Ghent University (106 male and 152 female students, average age 18.68 years, S.D. = 2.76 years) participated in one of the two scenario

studies as part of a classroom assignment. They individually completed the questionnaire. They had not followed any economics class.

5.2. Design

Participants were randomly assigned to one of the two dilemmas (anticommons or commons) and were presented one of two scenarios (see Appendix B). The timber company scenario was adapted from Sheldon and McGregor (2000) and the oil well scenario was written for the present study. Besides some relevant changes, these scenarios were completely analogous. The situation and the actors described in the scenario were purely hypothetical. Participants were always assigned to the role of co-owner A.

5.3. Procedure

The description of the procedure is based on the timber company scenario. Participants first read the scenario and subsequently made a bid. Participants confronted the following situation: "You are co-owner of a forest. In addition to your own timber company, four other co-owning companies operate in the same region." Participants further read a text dependent upon the experimental condition. In the anticommons condition, the scenario described a situation in which the danger of underuse was mentioned, whereas in the commons condition the pertinent danger of overuse was mentioned.

In the anticommons condition, it was thus asserted: "At this very moment co-owner B wants to cut part of the forest, but the four other companies (including yourself) have to grant their permission. You should know that the amount of forest gained by B cannot be cut by you in a later phase. You should also know that there is some regeneration because the trees in the forest grow each year and as a result the forest can regenerate itself to some extent. Of course, if every year the forest is used to a substantial degree, it is obvious that the forest will eventually disappear.

Owner B wants to compensate you financially for the part of the forest (s)he wants to cut. You do not know the exact profit gained by owner B in this case. However, it is certain that owner B will try to minimize his/her risks by giving a maximum amount of money. In other words, when the selling price rises, the chances diminish that B will buy part of the forest. The total amount of money you can ask B to pay ranges from € 0 to € 60 000.

If all companies restrict their asking price to a maximum of € 10 000, then it is 100 percent certain that B will buy the forest. One obvious danger is that the companies ask too much money for their property, making it very likely that B will not buy part of the forest, leaving the other companies (A, C, D and E) "out in the cold." Thus, it may be to the four companies' collective advantage to make smaller bids. However, another danger is that a company will not do as well because it asks less money than the other three companies. Thus, it may be to each company's individual advantage to make larger bids. It is possible that B will buy a part of the forest if, for example, two companies ask large amounts of money and the other company asks a small selling price."

Finally, participants were reminded of the danger of underuse of the anticommons: "We remind you that when all companies ask a high price there is a risk that B will not buy

Table 1
Payoff matrix–anticommons dilemma

I ask a value of . . . €	Probability that B wants to buy part of the forest, so that the forest is no longer unproductive (percent)
0	100
5000	100
10000	100
15000	90
20000	80
25000	70
30000	60
35000	50
40000	40
45000	30
50000	20
55000	10
60000	0

the forest, leaving it underused and unproductive." They then made a bid and marked their choice on the following payoff scheme.[4,5] (Table 1).

In the commons condition, it was asserted: "Each year you have to make a bid stipulating how many hectares of forest you want to cut. You do not know how many hectares the other companies plan to cut. There is some regeneration of the forest because new trees grow each year and hence the forest can regenerate itself to some extent. The forest area you can cut will be expressed as an equivalent amount of money ranging between € 0 and € 60 000.

If all companies restrict their harvests to a maximum of € 10 000, then it is 100 percent certain that the forest regenerates itself completely. One obvious danger is that the forest eventually will be cut above the sustainable yield, leaving all five companies "out in the cold." Thus, it may be to the five companies' collective advantage to limit their harvests. However, another potential danger is that a company does not want to gain less than the other four companies. Thus, it may be to each company's individual advantage to make larger bids. However, the forest may also be preserved if, for example, two companies make large bids and two companies make small bids.

Finally, participants were reminded of the danger of overuse of the common property: "We remind you that when all companies ask a high harvest there is a risk that the forest becomes overused and unproductive." They then filled out a payoff scheme[6] that was com-

[4] The payoff schemes used in the commons and anticommons conditions consisted – from the amount of € 10,000 on-of a linear association between monetary value and probability of regeneration and buying respectively. We have chosen to use a linear association in the present experiment because of its apparent simplicity. The use of complex rules would make the dilemma more difficult to comprehend. By choosing this linear function we do not want to imply that a linear function would be present in naturally occurring world circumstances.

[5] In order to test that participants fully understood the pay-off scheme we asked them to indicate the amount of money required so that the buyer will certainly buy the property (€ 10 000), as well as to indicate the amount of money that certainly would induce the buyer to forsake acquiring the property (€ 60 000). These questions were answered correctly by 77.42 percent and 87.90 percent of the participants in the anticommons condition.

[6] In order to test that participants fully understood the pay-off scheme we asked them to indicate the amount of money required so that the property will certainly regenerate itself (€ 10 000), as well as to indicate the amount

Table 2
Payoff matrix–commons dilemma

I take a value of . . . €	Probability that the forest regenerates itself, so that the forest is no longer exhausted (percent)
0	100
5000	100
10000	100
15000	90
20000	80
25000	70
30000	60
35000	50
40000	40
45000	30
50000	20
55000	10
60000	0

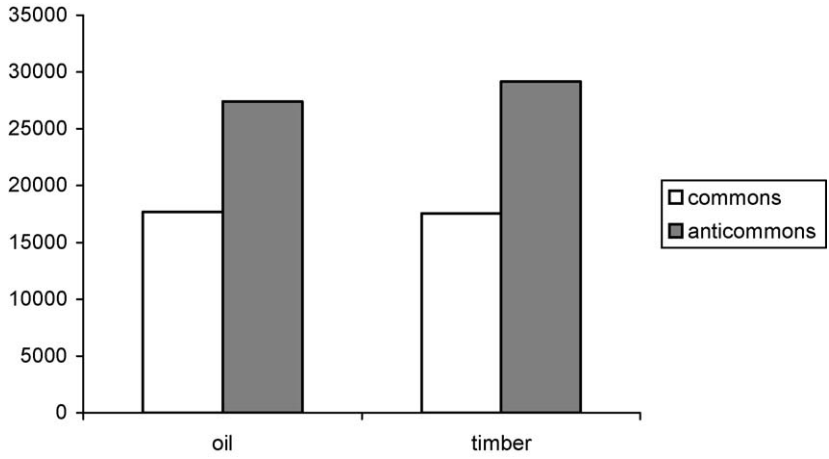

Fig. 4. Mean levels of bids in the commons and anticommons dilemmas (Study 2).

pletely analogous to the anticommons dilemma, with the exception that the percentages had another (Table 2).

6. Results

The results of Study 2 corroborate all of our hypotheses. Fig. 4 shows the means for the commons and anticommons dilemma condition for each of the two scenarios. In line with

of money required to exhaust the forest (€ 60 000). These questions were answered correctly by 83.97 percent and 78.63 percent of the participants in the commons condition.

Hypothesis 1, stating that anticommons lead to underuse, analysis of the bids revealed that participants asked an amount of money that significantly exceeded the € 10 000 threshold. This result was obtained with each of the two scenarios: $M = 27.397$, S.D. = 10.643, $F(1, 72) = 195{,}06$, $p < .001$ for the oil well scenario, and $M = 29.151$, S.D. = 14.269, $F(1, 52) = 95.48$, $p < .001$ for the timber company scenario, respectively.

In line with Hypothesis 2, the bids in the commons condition reveal that participants asked an amount of money exceeding the threshold of € 10,000 that guaranteed regeneration of the forest. This result was obtained for each scenario: $M = 17.706$, S.D. = 8713, $F(1, 84) = 66.48$, $p < .001$ for the oil well scenario, and $M = 17.553$, S.D. = 11.367, $F(1, 46) = 20.75$, $p < .001$ for the timber company scenario.

In line with Hypothesis 3, it was shown that participants made significantly higher bids in the anticommons than in the commons dilemma condition, $F(1, 156) = 39.59$, $p < .001$, and $F(1, 98) = 19.86$, $p < .001$ for the oil well and timber company scenario, respectively.[7]

7. Discussion

The results of Study 2 corroborate our hypotheses. Both scenario studies confirm that when selling off parts in a common resource, individuals set high prices that make it likely that the buyers forego the opportunity to utilize the jointly owned resource (Hypothesis 1), which is a danger of underuse because the jointly owned good remains idle. Another finding was that people consistently harvest more resources of a limited good, posing a real threat for the replenishment of the commons (Hypothesis 2), a relative overuse of the commons.[8] Finally, both studies revealed that the bids were significantly higher in the anticommons than in the commons dilemma, thus revealing an experimental asymmetry in the otherwise symmetric commons and anticommons problems (Hypothesis 3).

8. Conclusions

Buchanan and Yoon (2000) and Schulz, Parisi, and Depoorter (2003) proposed a theoretical model implying that anticommons and commons tragedies are exact mirror images of each other. This model leads them to expect that the severity of underuse (in anticommons dilemmas) and overuse (in commons dilemmas) should be equal. However, the present studies empirically document that anticommons seem to elicit more individualistic behavior than commons dilemmas. Moreover, these results were obtained with different methodologies (i.e. lab experiment versus scenario experiment), different research designs (i.e. simultaneous presentation of the two types of dilemma resulting in a within-subjects design versus presentation of different dilemmas in a between-subjects design), and different modalities

[7] Re-analysis of the data with exclusion of the participants who did not correctly answer the questions with respect to the pay-off scheme remained highly significant (Fs = 22.23 and 18.72 for the oil well and timber company scenarios respectively).

[8] By using a single trial game in Study 2 one could expect a lower concern for conserving the common good. As a result, the dilemma type effect might be even larger when more than one trial is involved.

(e.g. free bidding versus the use of a payoff scheme), attesting to the stability of these findings and their broad generality.

Our results unequivocally supported the proposition that anticommons yields higher prices than the commons dilemma (Study 1) and that anticommons dilemmas are more prone to underuse than commons dilemmas are to overuse (Study 2). If commons lead to "tragedy" (see Hardin, 1968), anticommons may well lead to "disaster."

These findings have very important policy implications. Given the greater levels of wealth dissipation induced by anticommons problems, commons regimes may be preferable whenever functional units of private property cannot be established. For example, whenever it is not possible to divide the common garden of a condominium building, commons regimes may be preferred to anticommons regimes. Condominium owners should be allowed to use the common resource without needing others' permission. Even though this regime may lead to an overuse of the common resource, the resulting inefficiency would be lower than the inefficiency generated by an anticommons regime, where condominium owners could use the common garden only when all others gave them permission to do so. More generally, the present results suggest that privatization of commons property should be implemented with caution to avoid transforming a commons tragedy into an anticommons disaster.

Clearly, there are important behavioral effects when anticommons property entitlements are created. Anticommons owners have a right to exclude others and a right to veto any transformation of the common resource. The prerogatives of an anticommons owner are perceived as something that they "own," and psychological attitudes are triggered for the protection of such entitlement. No sense of "harm" is associated with one's exercise of the property right, even though others may suffer a possible economic prejudice. Commons users instead do not perceive their opportunity to use the commons as something that they own. When overexploiting a common resource, they fully realize that they are imposing an economic prejudice to others and partially restrain from such abusive behavior.

Why, then, do people ask higher prices in the anticommons dilemma than the monetary amount they would simply take from an equivalent commons dilemma? One type of possible explanations refers to perception and psychology. It is possible that the implications of the anticommons dilemma are much more ambiguous than those of the commons dilemma. In particular, future implications in the anticommons dilemma may be much more ambiguous than in the commons dilemma (see Schulz et al., 2003). Indeed, given its prevalence in the real world, most people readily comprehend that unrestrained use of common resources leads to total depletion of resources in the long run, and that those who take more than their share out of the commons preclude others from partaking of its benefits. However, it should be noted that while this explanation might be true for our first study, the consequences of asking high prices has been clarified in the instructions of our scenario experiment.

Another possibility is that framing the anticommons dilemma as a "selling problem" rather than as a "sharing problem" lies at the heart of the marked differences between commons and anticommons dilemmas. That is, many studies have shown that people often demand much more to give up an object than they would be willing to pay to acquire it (Kahneman et al., 1991).

Some important limitations of the present studies should also be mentioned. The present research was aimed at showing the gravity of the potential problems accompanying anti-commons dilemmas. However, this research should only be considered a necessary first

step, and the replication of the present results with other designs, methods, and experimental situations is needed to fully substantiate the claim that the anticommons dilemma poses a greater threat to the collective welfare than comparable commons dilemmas. If the detrimental effects of the anticommons property regime are fully acknowledged, the next logical steps for future research are twofold. First, from the viewpoint of economic science, the identification of parameters-in general models-that can be used to predict theoretically derived outcomes constitutes an interesting line of future research. In particular, such research could identify the parameters that differentiate between the behavioral outcomes imposed by the two dilemma types. Secondly, from a psychological point of view, the identification of subjective factors that underlie people's behavior in the anticommons dilemma constitutes an important yet unexplored avenue for future research.

In conclusion, the present research attests to the potential gravity of the anticommons problem. These results suggest that it is inadequate to extrapolate findings from the commons to the anticommons dilemma.

Appendix A

This game looks like a traditional Monopoly game. The aim of the game is to collect as much profit as possible. Every player starts with two properties ("streets"), with a hotel on each (equalling the value of four houses). Every time another player lands on your property, (s)he has to pay you a monetary reward depending on the number of houses present. Of course, every time you land on your own property, nothing happens (you do not have to pay yourself). Moreover, you can sell your hotels as a whole or in sections. The value of a hotel is equal to four houses, which each have a value of € 2000, totalling € 8000 per hotel. If another player lands on your property, you receive an amount of € 2000 of that player, but only if there are four houses on your property. Alternatively, you receive € 1500 for three houses, € 1000 for two houses, and € 500 for one house.

There are also a few differences from the ordinary Monopoly game. Two amusement parks (Bollewaerde and Ballibi, each of them divided into two parts) are common property, owned by everyone. Every time a player lands on one of these parks, (s)he receives a monetary reward, depending on the number of objects (i.e. attractions) present: € 2000 when four or more objects are present, € 1500 for three objects, € 1000 for two objects, and € 500 for one object.

Ballibi and Bollewaerde are not entirely similar, and they differ in the following ways. With Ballibi, the first amusement park, is it possible to request as much money as you want. Every seven turns you will be asked to indicate how much money you want. In return, an equivalent number of objects are removed from the property. Remember that each attraction has a value of € 2000. For example, if players A, B and C each request € 2000, four attractions will be removed from Ballibi. If players A, B and C request € 0, € 2000 and € 10 000, respectively, a total of six attractions will be removed. Another example: If one player requests € 16 000, then all eight attractions will disappear. In the case that there are no more attractions on Ballibi, a player will receive no payment when (s)he lands on the property. However, if there are four attractions left on Ballibi, you will

receive € 2000 when you land on it. When the players ask for an amount that surpasses the value of the objects on Ballibi, the bank will subtract the deficit during the next round.

At regular intervals, after every seven turns, the bank will put an attraction on each Ballibi lot. Also after every seven turns, each player must inform the bank how much you want to collect from Ballibi.

The second amusement park, Bollewaerde, also consists of two parts, but it is another type of park. As with Ballibi, every time a player lands on Bollewaerde (s)he receives an amount of € 2000. After every seventh turn, an attraction is placed on both properties. However, unlike the other amusement park, you cannot collect attractions from these properties. Also unlike Ballibi, after every seventh turn players may privatize these lots.

Since Bollewaerde is the property of all three players, in order to privatise a portion of the property, a player must purchase it from the other players, through a bidding system. Thus, the relevant question here is what do you want to pay to obtain part of Bollewaerde? Each player must also indicate how much (s)he minimally wants to receive from other players who want to acquire Bollewaerde. This is called the asking price. If there is a player who is prepared to pay a certain amount that is larger than the sum of the asking prices (the total price) of the other two players, (s)he obtains Bollewaerde. The player then pays the respective asking prices to the two other players. However, when there is no offer higher than the total price, Bollewaerde remains common property.

After every seventh turn, write your secret bid and asking price on separate pieces of paper. The bank will check each time whether there is a bid that meets the asking prices.

The impact of privatization is simple. The new owner of Bollewaerde will receive money from the other player every time that player visits his/her property. Also, the attractions become property of the new owner, and (s)he is able to sell them to the bank. In addition, if there are fewer than four attraction on the property, then the amount that the owner receives if another player lands on the property is relatively smaller (i.e. € 1500 for three objects, € 1000 for two objects, and € 500 for one object). Also, take into account that after every sequence of seven turns the bank will put an extra attraction on these properties.

Every player receives € 20 000 at the beginning of the game ($1 \times 10\,000$; 1×5000; 1×2000; 1×1000; 4×500). If you need to raise money during the game, you are allowed to sell your houses. In addition, you can borrow as much money as you want from the bank. However, the money you borrowed must be reimbursed to the bank at the end of the game.

At the end of the game, we will calculate your total property. All houses and possible attractions (which have been privatized) are worth € 2000. Moreover, the money you have in your possession will also be added. Common property attractions will return to the bank with no payment to the players.

Appendix B

B.1. Anticommons

You are co-owner of an oil well. In addition to your own oil company, four other co-owning companies operate in the same region. At this very moment co-owner B wants to drill part of the well, but the four other companies (including yourself) have to grant their

permission. You should know that the amount of oil gained by B cannot be gained by you in a later phase. You should also know that there is some regeneration because the oil in the well grows each year, and as a result the oil can regenerate itself to some extent. Of course, if every year the oil is used to a substantial degree, it is obvious that it eventually will disappear.

Owner B wants to compensate you financially for the part of the well (s)he wants to drill. You do not know the exact profit gained by owner B in this case. However, it is certain that owner B will try to minimize his/her risks by giving a maximum amount of money. In other words, when the selling price rises, the chances diminish that B will buy part of the oil well. The total amount of money you can ask B to pay ranges from € 0 to € 60 000.

If all companies restrict their asking price to a maximum of € 10 000, then it is 100 percent certain that B will buy the oil well. One obvious danger is that the companies will ask too much money for their property, making it very likely that B will not buy part of the well, leaving the other companies (A, C, D and E) "out in the cold." Thus, it may be to the four companies' collective advantage to make smaller bids. However, another danger is that a company will not do as well because it asks less money than the other three companies. Thus, it may be to each company's individual advantage to make larger bids. It is possible that B will buy a part of the oil well if, for example, two companies ask large amounts of money and the other company asks a small selling price.

We remind you that when all companies ask a high price there is a risk that B will not buy the oil well, leaving it underused and unproductive.

I ask a value of . . . €	Probability that B wants to buy part of the oil well, so that the oil well is no longer unproductive (percent)
0	100
5000	100
10000	100
15000	90
20000	80
25000	70
30000	60
35000	50
40000	40
45000	30
50000	20
55000	10
60000	0

B.2. Commons

You are co-owner of an oil well. In addition to your own oil company, four other co-owning companies operate in the same region. Each year you have to make a bid stipulating how many barrels of oil you want to drill. You do not know how many barrels the other companies plan to drill. There is some regeneration of the well because new oil is produced each year and hence the oil well can regenerate itself to some extent. The oil you can drill will be expressed as an equivalent amount of money ranging between € 0 and € 60 000.

If all companies restrict their harvests to a maximum of € 10 000, then it is 100 percent certain that the oil well will regenerate itself completely. One obvious danger is that the well eventually will be drilled above the sustainable yield, leaving all five companies "out in the cold." Thus, it may be to the five companies' collective advantage to limit their harvests. However, another potential danger is that a company does not want to gain less than the other four companies. Thus, it may be to each company's individual advantage to make larger bids. However, the oil well may also be preserved if, for example, two companies make large bids and two companies make small bids.

We remind you that when all companies ask a high harvest there is a risk that the oil well becomes overused and unproductive.

I take a value of . . . €	Probability that the oil well regenerates itself, so that the oil well is no longer exhausted (percent)
0	100
5000	100
10000	100
15000	90
20000	80
25000	70
30000	60
35000	50
40000	40
45000	30
50000	20
55000	10
60000	0

References

Andreoni, J. (1995). Warm-glow versus cold-prickle: The effects of positive and negative framing on cooperation in experiments. *Quarterly Journal of Economics*, *110*, 1–21.

Buchanan, J. M., & Yoon, Y. J. (2000). Symmetric tragedies: Commons and anticommons. *Journal of Law and Economics*, *43*, 1–13.

Hardin, G. (1968). Tragedy of the Commons. *Science*, *162*, 1243–1248.

Heller, M. A. (1998). The Tragedy of the anticommons: Property in the transition from Marx to markets. *Harvard Law Review*, *111*, 621–688.

Heller, M. A. (2001). Critical approaches to property institutions. Three faces of private property. *Oregon Law Review*, *79*, 417–434.

Heller, M. A., & Eisenberg, R. S. (1998). Can patents deter innovation? The anticommons in biomedical research. *Science*, *280*, 698–701.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies—The endowment effect, loss aversion, and status-quo bias. *Journal of Economics Perspectives*, *5*, 193–206.

Kopelman, S., Weber, J. M., & Messick, D. M. (2002). Factors influencing cooperation in Commons dilemmas: A review of experimental psychological research. In E. Ostrom, T. Dietz, N. Dolsak, P. C. Stern, S. Stonich, & E. U. Weber (Eds.), *The drama of the commons* (pp. 113–156). Washington, DC: National Academy Press.

Michelman, F. I. (1982). Ethics, economics, and the law of property. In J. R. Pennock & J. W. Chapman (Eds.), *Ethics, economics, and the law (NOMOS series-24)*. New York: University Press.

Myers, J. L., DiCecco, J. V., & Lorch, R. F. (1981). Group-dynamics and individual performances—pseudogroup and quasi-F analyses. *Journal of Personality and Social Psychology*, *40*, 86–98.

Ostrom, E., Dietz, T., Dolsak, N., Stern, P. C., Stonich, S., & Weber, E. U. (2002). *The drama of the commons*. Washington, DC: National Academy Press.

Parisi, F., Schulz, N., & Depoorter, B. (2005). Duality in property: Commons and anticommons. *International Review of Law and Economics*, *25*, 578–591.

Schulz, C., Parisi, F., & Depoorter, B. (2003). Fragmentation of property: Towards a general model. *Journal of Institutional and Theoretical Economics*, *159*, 594–613.

Sheldon, K. M., & McGregor, H. A. (2000). Extrinsic value orientation and "the tragedy of the commons". *Journal of Personality*, *68*, 383–411.