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Putting Humpty Dumpty Back Together:
Pricing in Anticommons Property
Arrangements

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Putting Humpty Dumpty Back Together: Pricing in Anticommons Property Arrangements

Ben Depoorter and Sven Vanneste

Abstract

Recently, a new theory has drawn considerable attention in the literature on common property. A number of scholars have pointed to the danger of excessive propertization in the context of what are termed “anticommons” property regimes. Although this theory has found its way into numerous legal and economic applications, the empirical and cognitive foundations of the theory of fragmentation remain unexplored. Based on experimental data, this Article conducts an investigation into the social and personal processes involved in the anticommons.

The results confirm the theoretical proposition that anticommons deadweight losses increase with the degree of complementarity between individual parts and with the degree of fragmentation.

Our study also provides three novel insights into the problem of fragmentation. First, the data illustrate that individual right holders base their reservation price on a proportion of the expected surplus of the bundler-purchaser, disregarding the objective value of the resource. Second, the experiments suggest that uncertainty amplifies the anticommons pricing effect. Individual right holders ignore the expected value of the purchaser’s project, and instead focus on the upper range of profitability and surplus. Willingness to accept is anchored onto a proportion of the maximum profitability, rather than a proportion of the expected benefits of the project. Finally, throughout the experiment reservation prices seem to be consistently lower in cases where there exists large uncertainty within the range of positive outcomes, relative to scenarios where there is relative certainty regarding a positive outcome but which includes the possibility of a (modest) negative outcome. Subjects seem to emphasize the relative low probability of success over the

possibility of a negative outcome.

The experiment provides clear indications of the pricing effect in settings where complementary units are fragmented over individual right holders. Given the stickiness of initial selling prices, and the prospective costs of the required negotiations to drive prices down to the expected value of the project, value maximizing projects might be abandoned, leading to the tragic outcome of under use or idleness. The results thus reinforce the normative hypothesis of the anticommons: property right systems should be careful in allowing the liberal creation and fragmentation of property rights.

***PUTTING HUMPTY DUMPTY BACK TOGETHER:
PRICING IN ANTICOMMONS PROPERTY
ARRANGEMENTS***

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ABSTRACT

Recently, a new theory has drawn considerable attention in the literature on common property. A number of scholars have pointed to the danger of excessive propertization in the context of what are termed "anticommons" property regimes. Although this theory has found its way into numerous legal and economic applications, the empirical and cognitive foundations of the theory of fragmentation remain unexplored. Based on experimental data, this Article conducts an investigation into the social and personal processes involved in the anticommons.

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Our study also provides three novel insights into the problem of fragmentation. First, the data illustrates that individual right holders base their reservation price on a proportion of the expected surplus of the bundler-purchaser, disregarding the objective value of the resource. Second, the experiments suggest that uncertainty amplifies the anticommons pricing effect. Individual right holders ignore the expected value of the purchaser's project, and instead focus on the upper range of profitability and surplus. Willingness to accept is anchored onto a proportion of the maximum profitability, rather than a proportion of the expected benefits of the project. Finally, throughout the experiment reservation prices seem to be consistently lower in cases where there exists large uncertainty within the range of positive outcomes, relative to scenarios where there is relative certainty regarding a positive outcome but which includes the possibility of a (modest) negative outcome. Subjects seem to emphasize the relative low probability of success over the possibility of a negative outcome.

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Keywords: property rights, fragmentation, anticommons pricing

JEL Classification: K0, K11, D42, L12

Putting Humpty Dumpty Back Together: An Experimental Verification of the the Anticommons

1. INTRODUCTION

An anticommons is a property regime in which multiple owners hold effective rights of exclusion in a scarce resource.¹ Economic theory has illustrated how the coexistence of multiple exclusion rights may lead to sub-optimal uses of resources held in common.² If a common resource is subject to multiple exclusion rights held by two or more individuals, each co-owner has incentives to withhold resources from other users to an inefficient level. As a result, exclusion rights will be exercised even when the use of the common resource by one party could yield net social benefits, a problem known as the “Tragedy of

¹ This definition of the anticommons employed by Heller provides a powerful tool for property theory. Heller recently revitalized the concept in an article on the transition to market institutions in contemporary Russia. He discusses the intriguing prevalence of empty storefronts in Moscow. Storefronts in Moscow are subject to under use because there are too many owners (local, regional and federal government agencies, mafia, etc.) holding the right to exclude. See Heller, M.A. (1998), >The Tragedy of the Anticommons: Property in the Transition from Marx to Markets=, 111 *Harvard Law Review*, 621. Frank Michelman coined the term anticommons in an article on ethics. Michelman defined the anticommons as *a type of property in which everyone always has rights respecting the objects in the regime, and no one, consequently, is ever privileged to use any of them except as particularly authorized by others*. This definition has almost no counterpart in real-world property relations. The hypothetical example provided is that of a wilderness preserve that ‘any person’ has standing to enforce. See Michelman, Frank I. (1968), “Property, Utility and Fairness: Comments on the Ethical Foundations of >Just Compensation= Law,” 80 *Harvard Law Review*, 1165-1258. The title of this paper refers to the fairy tale of Humpty Dumpty to illustrate the anticommons. When Humpty Dumpty is shattered into pieces all of the king’s horses and all of the king’s men cannot re-assemble him, which stands in contrast to the ease with which he broke into pieces in the first place. See Heller, Michael A. (1999), ‘The Boundaries of Private Property’, 108 *Yale Law Review* 1163-1223.

² Anticommons theory relies on Cournot's model of duopoly: a single monopolist producing a composite good will charge a price lower than the sum of the prices that would be charged by two complementary duopolists selling the single component parts. A. Cournot, A (1838), *Researches into the Mathematical Principles of the Theory of Wealth* (Nathaniel Bacon, trans., Macmillan 1927).

the Anticommons.”³ Take the example of medical innovation. It is held that awarding private property rights on discoveries promotes innovation and the commercial development of new technologies. In light of the anticommons intellectual property rights on research may actually retard life-saving developments of medical products based on this research when too many owners block each other from the use of these products.⁴ The tragedy of the anticommons may occur because the multiple holders of exclusion rights do not fully internalize the cost created by the enforcement of their right to exclude others.

The intuition underlying the anticommons is that it is often harder to regenerate separated bundles than it is to fragmentize.⁵ Economic models assume that the costs of rebundling (transaction costs and strategic behavior) independently-owned property fragments are higher than the costs involved in the initial fragmentation. This “stickiness” of fragmentation is problematic when the costs of bundling prevent value maximizing uses of the resource. When a

³ The pioneering articles include Heller, M.A. (1998), >The Tragedy of the Anticommons: Property in the Transition from Marx to Markets=, 111 *Harvard Law Review*, 621; Heller, M.A. (1999), >The Boundaries of Private Property=, 108 *Yale Law Review*, 1163-1223; Heller, M. and Eisenberg, R. (1998), >Can Patents Deter Innovation? The Anticommons in Biomedical Research=, 280 *Science*, excerpted as >Upstream Patents = Downstream Bottlenecks= in 41.3 *Law Quadrangle Notes*, 93_97 (Fall/Winter 1998). The principal follow-up articles are Buchanan, J. and Yong J. Yoon. 2000. “Symmetric Tragedies: Commons and Anticommons Property,” 43 *Journal of Law and Economics* 1-13; Depoorter, B. and Parisi F. (2002), ‘Fair Use and Copyright Protection: A Price Theory Explanation’, 21 (4) *International Review of Law and Economics*, 453-473.

⁴ Heller, M. and Eisenberg, R. (1998), >Can Patents Deter Innovation? The Anticommons in Biomedical Research=, 280 *Science*, excerpted as >Upstream Patents = Downstream Bottlenecks= in 41.3 *Law Quadrangle Notes*, 93-97 (Fall/Winter 1998): “more intellectual property rights may lead paradoxically to fewer useful products for improving human health”.

⁵ In the words of Heller: “Once an anticommons emerges, collecting rights into usable private property may prove to be brutal and slow.” Heller (2001), ‘Symposium: Critical Approaches to Property Institutions: Three Faces of Private Property’, 79 *Or. L. Rev.* 417, 418, 424.

value enhancing opportunity arises which allows for the exploitation of the complementarities between different parts of the fragmented property, the ex-ante rational choice may turn out to be ex-post sub-optimal, given the greater costs of reunification.⁶

To date, the economic literature has omitted analysis of the precise factors that lead reunification efforts to fail. Is the unsuccessful bundling of complementary inputs a result of transaction costs or is the decision-making process clogged by strategic behavior and cognitive error? If so, what social and cognitive processes lie at the root of the anticommons problem? This Article runs a number of experiments. We unpack the economic model of the anticommons, verify its theoretical premises, and suggest further inroads for research.

Section 2 describes the structure of the experiment. Section 3 presents the results of our experiment. Section 4 provides a discussion of the results. The discussion enriches the theoretical foundation of the anticommons by measuring the impact of complementarity, the degree of fragmentation, uncertainty and bargaining in generating deadweight losses. Section 5 concludes.

2. DESCRIPTION OF THE STUDY

We conduct an investigation into the social and personal processes involved in decision-making by individual co-owners of a resource. From these results we deduce a number of propositions on the cognitive processes at root of the anticommons. To this purpose, we surveyed three hundred college students.

The experiment recreates the constitutive elements of an anticommons situation: (1) a valuable resource is divided into fragments, (2) a value enhancing opportunity arises which requires bundling of these fragments.

The survey measures reservation prices under varying 1) degrees of complementarity among fragmented parts; 2) numbers of rights holders with

⁶ See Buchanan, J. and Yong J. Yoon. 2000. "Symmetric Tragedies: Commons and Anticommons Property," 43 *Journal of Law and Economics* 1-13; Schulz, Norbert; Parisi Francesco & Depoorter, Ben (2003), 'Fragmentation in Property: Towards a General Model', 158 (4) *Journal of Institutional & Theoretical Economics* 594-613.

complementary rights into a resource; 3) synergies resulting from fragmentation; and 4) degrees of uncertainty concerning the surplus to be achieved from reunification. The first part of the survey collects data on reservation prices under these varying conditions. In the second part of our experiment we simulated one-time negotiations between the reunifier and each individual right holder.

In the first experiment all participants received a script detailing participants' status as a partial-right holders to a unitary resource,⁷ the presence of a third-party purchaser, and the particulars of the sub experiment. The questions in the script are ordered randomly to avoid learning experiences.⁸ Also, in the second experiment subjects were randomly assigned to a specific condition and informed in a structured information script prior to negotiations. Every experiment was designed to measure the statistical data on a parametrical level. More precisely, we used a multivariate repeated measure ANOVA.⁹ Two sub experiments deviate from this statistical method and were replaced by a one way ANOVA because of the between subject measurement format.¹⁰

⁷ No significant effect was found for age or gender.

⁸ When all subjects receive the script with questions in the same order, the first trial could influence their opinion in the second trial and so on. When subjects receive the scripts in random order the learning effect is nullified.

⁹ This involves the application of the analysis of variance to data in which a single dependent variable is measured on more than one occasion on the same subject. In the case of an orthogonal factorial design, the method essentially combines, in a linear fashion, the information of the several response variables in such away as to detect any existing treatment effects. See Johnson, R. A. and Wichern, D. W. (1998), *Applied multivariate statistical analysis*, New Jersey: Prentice Hall.

¹⁰ Various groups of participants were assigned to the different variables (2, 3, 4 or 5 parts). Every group had to decide on the price of the part assigned to them.

3. RESULTS

3.1. Surveys A and B

Each participant¹¹ is informed that he or she is one of five partial-right holders (owners) to a unitary resource. The participants are informed that a third-party is looking to purchase a number of parts. In the various parts of the tests this number ranges between 2 to 5 parts. Students are further informed that each individual part, by itself, has a market value of 50 dollars.¹² The aggregate value of the unified bundle is 250 dollars. No further information on the incentives of the third-party (such as profitability and synergies resulting from bundling) is disclosed at this point. In a first hypothetical, each student is informed that the purchaser seeks to obtain 2 out of 5 of the parts that are divided among five participants. In a subsequent condition, other participants are informed that the purchaser needs to obtain 3, 4 or all 5 parts. In each of these scenarios the participants list their reservation price¹³ while attempting to maximize their personal gains. The survey thus measures the differences in reservation prices arising in situations involving varying degrees of complementarity. Where the third party only looks to purchase 2 parts, this represents a relative low degree of complementarity, or conversely a case of relatively high substitutability. On the other end, where the hypothetical indicates that the third party needs to purchase all 5 parts, this represents a situation of perfect complementarity.

¹¹ The population of this study consists a random group of first-year students of the departments of law, political science and economics at Ghent University who were randomly assigned to one of the experiments.

¹² We operate from the stylized assumption that there is no difference between the market price of each individual part and the subjective value to each of the owners. In other words, we control for any idiosyncratic qualities of the parts or cognitive attachments to the parts, such as negative endowment effects. The cognitive effects involved in the decision-making process of rebundling are explored further on in this study.

¹³ We employ the term ‘reservation price’ to denote the initial selling price, as stated by the individual right holder. Strictly speaking this price is not necessarily a reservation price in that this stated price is the lowest outcome a negotiator is willing to accept. However, because in all experiments, except *E*, no negotiations are held, we assume that initial right holders do, in effect, not accept an agreement that does not match this initial selling price.

Parts	Mean	Standard Deviation	N
2	64.6	18.65	20
3	69.5	15.27	20
4	76.3	35.57	20
5	100.1	48.34	20

Table 1: Descriptive statistic, between subjects

Parts	Mean	Standard Deviation
2	67.4	19.57
3	72.6	26.38
4	80,2	36.12
5	107.1	57,99

Table 2: Descriptive statistic, within subjects (N = 20)

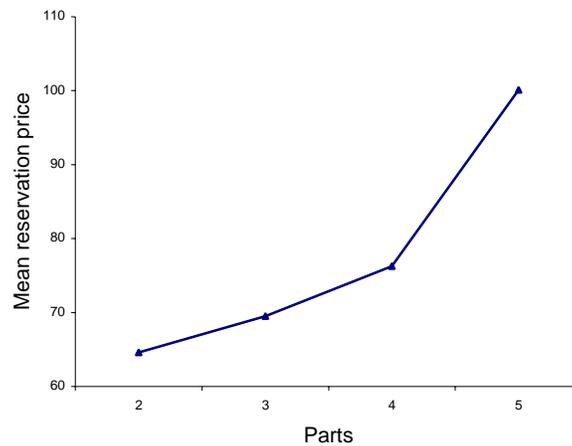


Figure 1: The mean demand price for the different parts measured between subjects (ANOVA, $F(3,76) = 4.73, p < .01$)

Table 1 and accompanying figure 1 map the variation between mean reservation prices. The mean demand price in the case of low complementarity is 67. The aggregate mean price is thus 134; a total of 34 price units above the objective value of two combined parts. In the case of perfect complementarity the mean demand price is 100 dollars, totaling a mean demand price of 500 dollars for the combined purchase of all individual parts. While reservation prices for “2 out of 5 complementarity” total 34% over the objective value, a case of strict complementarity averages a combined demand price that is 100 % above the

objective value. These simple findings confirms the theoretical findings that reservation prices correlate with the strength of veto-right into the successful bundling of the individual parts.

We repeated the same experiment but measured repeatedly with the same subjects in each of the different conditions (2, 3, 4 and 5 parts) (between subjects). This allowed us to verify whether subjects reason differently when asked to list a price in just one of the above scenarios, than when each individual subject is asked to formulate prices for all of the scenarios (within subjects).¹⁴ The results - see *table 2* – significantly correspond with the prior, within subject, findings (Repeated Measure ANOVA, $F(3,17) = 5.42, p < .01$).

3.2 Survey C

In Experiment C we attach various degrees of profitability to the profitablity and measure the impact on the reservation prices of the individual right holders. As before, participants ($N = 84$) are one of five partial-right holders (owners) to a unitary resource. They are informed that a third-party is looking to purchase *all five parts* held by the individual owners. Again, each individual part has an objective value of 50 dollars and the aggregate value of the unified bundle is 250 dollars. By explicitly assigning the value of each right we attempt to eliminate the “attribution effect” whereby people sytematically overvalue the role of their right in the overall project.¹⁵

¹⁴ When an experiment is conducted “within subjects” every participants is assigned to all treatments in a randomly selected order. In such experiment there is a risk that participants’ selling prices differs according to the initial scenario (assembly of 2, 3, 4, or 5 required parts) first assigned to them. Such bias could be attributed to the initial scenarios working as a referent point in the mind of the participants. In such a case participants might not fully focus on the amount of parts the third party seeks to gather (degree of complementarity).

¹⁵ The attribution bias holds that individuals systematically overvalue their assets and disparage the claims of their co-right holders. See L. Ross and Anderson C.A., in *Judgement under Uncertainty: Heuristics and Biases*, D. Kahneman et al., Eds. (Cambridge Univ. Press, Cambridge, UK, 1982, pp. 129-152. Heller and Eisenberg suggest that this particular cognitive bias explains bargaining breakdowns in the biotechnology industry, where scientists tend to overvalue the importance of their discoveries for the development of follow-up, aggregate inventions. See Heller and Eisenberg, p. 701.

This time also the opportunity costs of the third party are disclosed. The participants are requested to state their demand price in each of five hypothetical scenarios *with varying profits to be obtained* by the third-party purchaser from bundling all five parts. In five different scenarios participants are informed that bundling creates a surplus for the third party of 100, 300, 500, 1000 or 10.000 dollars. These scenarios each represent different values resulting from reunification. In the last hypothetical the “sum is worth more than its parts” by 9750 dollar (10.000 – 250). In such scenario, unsuccessful rebundling, imposes considerable deadweight losses— as higher valued uses are not consummated. This represents a more substantial “tragedy” of the anticommons in comparison to the first hypothetical where a modest 100 dollar is at stake in the effort to rebundle. *Figure 2* plots the reservation prices in all five instances of surplus profitability. The vertical axis marks the asking price, expressed in relative percentage to the profits, or synergies of bundling. The horizontal axis indicates the cases of a third party profit of 100, 300, 500, 1000, 10.000 dollars respectively. As *figure 2* below indicates, that there is no significant difference ($F(3,81) = 1.28, p = .168$) between reservation prices in the profit range between 300 and 10.000 dollars: the average price stated by each of the right holders approximates 26%. In the case of a surplus of 10.000, the purchaser is faced with an aggregate mean asking price of 12.300 dollars. This price is 24.6% above the price that he or she can offer lest the project, involving rebundling, remain profitable. Similarly, when the profit from bundling is a more modest 300 dollars (plot 2 on graph 2, a median asking price is 26.6 % or 79.8 dollars per part), the combined reservation price is 399. Thus, the difference between reservation prices in the surplus range of 300 and 10.000 is non-significant.

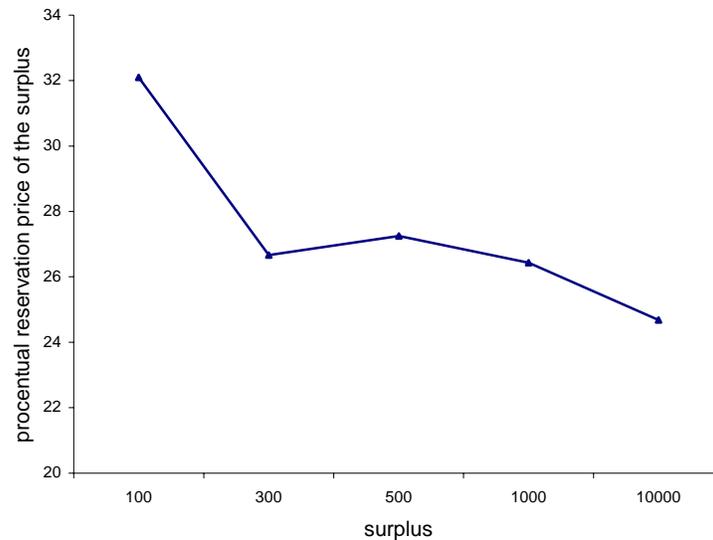


Figure 2: The degree of profitability from bundling of fragmented property entitlements on the prices charged by individual right holders ($F(4, 80) = 5.391, p < .001$)

3.3 Survey D & E

Experiment *D* measures the effect of uncertainty regarding the expected benefits of the bundling of fragmented property entitlements. Again, participants ($N = 40$) are informed that they are one of five partial-right holders (owners) to a unitary resource. A third-party is looking to purchase *all five parts* held by the individual owners. Students are informed that each individual part has an objective value of 50 dollars. The aggregate value of the unified bundle is 250 dollars. As in Section 3, the opportunity costs of the third party are disclosed. This time however, the subjects are also informed that the purchaser faces considerable uncertainty as to the profitability of the project. The participants are requested to state their demand price in each of five hypothetical scenarios *with varying profits to be obtained by the third-party purchaser from bundling all five parts*. This time however, additional information is provided as to the uncertainty regarding the profitability of the project. In four different scenarios participants are informed that bundling creates a surplus for the third party of 100, 500, 1000 or 10.000 dollars with a probability of 10%. In each of the scenarios there is a 90% chance that bundling does not create any surplus. The expected values of each of these projects are

respectively 10, 50, 100 and 1000 dollars. Are the subjects responsive to the lower expected value generated by the high degree of uncertainty? Again, the results give rise to pessimism. From the results it follows that subjects consistently demand a proportional share of 10% of the maximum profit. The mean reservation price, set by one individual right holder, is 14.25% of the surplus (see Fig. 3). Put differently, the aggregate reservation price is 7 times above the expected value of the project ($F(3,37) = 20.31, p < .001$).¹⁶ Given the expected benefit of the project (market value of the parts) the gap between purchaser's willingness to pay and individual owner's willingness to accept is non-negligible.

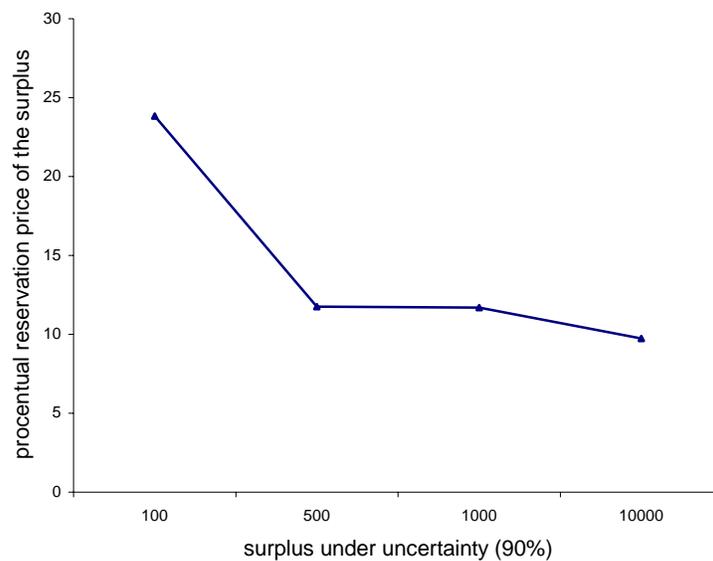


Figure 3: The expected profit of bundling the fragmented property under a 90% uncertainty for the individual holders. ($F(3,37) = 4.43, p < .01$)

These results are confirmed in a second similar test (see Fig. 4) under a higher degree of uncertainty – where there is a 99% chance that bundling does not create any surplus. The expected value of each of these projects is respectively

¹⁶ When there is certainty of 10% of surplus from bundling, this means that every individual holder maximum price is 2% of surplus. When asking 14.25% the aggregate price totals seven times the expected value of the projects. The statistical difference between the 2% case and the observed reservation prices ($F(3,37) = 20.31, p < .001$) is significant.

1, 5, 10 and 100. Again, the subjects seem unresponsive to the lower expected value generated by the high degree of uncertainty. From the results it follows that subjects consistently demand a proportional share of 11.44% of the maximum profit. The median price, set by one individual right holder, is 57 times above the expected value of the project. The aggregate the individual right holder's willingness to accept is 57 beyond the willingness to pay-price of the purchaser, given the expected benefit of the project.

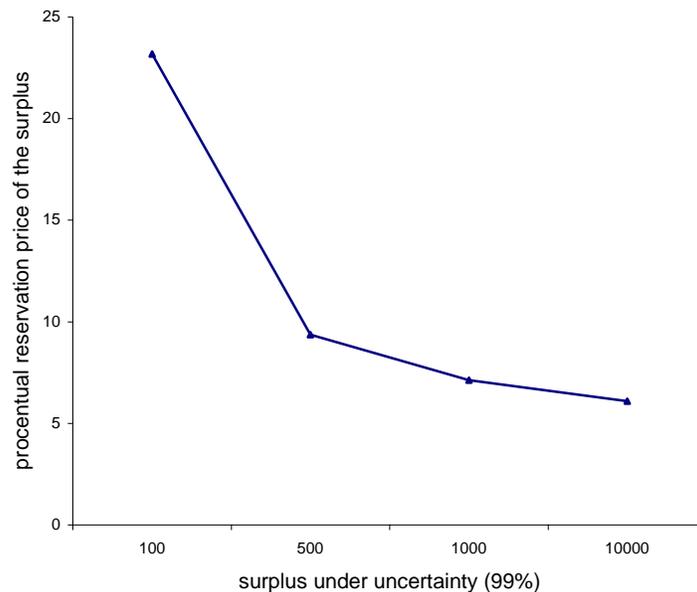


Figure 4: The expected profit of bundling the fragmented property under a 99% uncertainty for the individual holders. ($F(3,37) = 2.40, p < 0.05$)

c(3 times the amount of the gains of the positive outcome). Again, subjects ($N = 78$) were informed that they are one of the partial-right holders to a unitary source and that a third-party is interested to purchase all five parts. Each individual part has a value of 50 dollar and when the third-party bundles the five parts this generates surplus of 125 dollars with a probability of 80% and a 20% probability of a loss of 450 dollars. In two different scenarios students were asked the same questions but with a surplus of 1250 or 12500 and a loss of 4500

or 45000. The expected values of each of these projects are respectively, 10, 100 and 1000 dollars.¹⁷

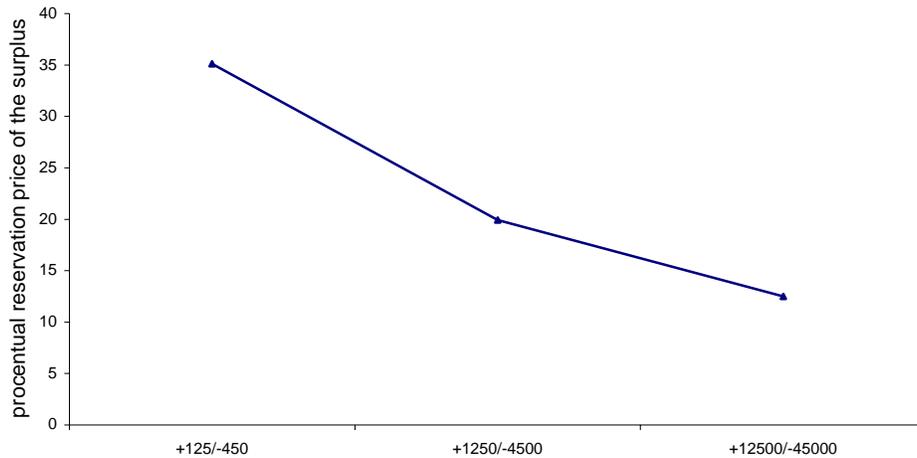


Figure 5: The expected profit of bundling the fragmented property for the holders under a 80% certainty of a surplus vs. 20% uncertainty of losing an amount of money for the purchaser. ($F(2,76) = 15.19$, $p < .001$)

Figure 5 confirms the findings of the other experiments. When stakes are minor the individual right holders set disproportionately high reservation prices – 35% in the case of a project with expected value of 100 dollars (this totals a combined reservation price of 175%). When stakes are higher the average reservation price remains relatively stable at 14-19% of the expected surplus.

Next we compare the reservation prices in cases of high uncertainty of high outcomes and high certainty of modest outcomes (with a possible negative result) while expected benefits are equal. In the case of a positive outcome of 100 with 10% probability the mean reservation price was 24% of the expected value, compared to 35% of the expected value of the *low risk-low profit* variant of experiment E. In the case of positive outcome of 1000 with 10% probability in D (*high risk-high profit*) the mean reservation price was 12%, versus 19% in the *low risk-low profit* variant of E. In the case of positive outcome of 10000 with 10% probability in D (*high risk high outcome*) the mean reservation price was

¹⁷ A probability of 80% to win a surplus of 125 dollar gives a expected value of 100 dollars, while a chance of loss is 450 dollars with a probability of 20% which us 90 dollars. 100 dollars minus 90 dollars gives us expected benefit of 10 dollars.

10%, versus 13% in the *low risk-low profit* variant of E (80% chance of +12500 and 20% chance of -45000). Although the expected values of each of these scenarios are identical, reservation prices seem to be consistently lower in cases where there is large uncertainty regarding a strictly positive outcome than when there is relative certainty but with a chance of a negative outcome (See *Figure 6*, $F(2,75) = 4.92$, $p < .01$). Upon further examination we find analogous results for instances where the surplus amounts to 100 dollars and 1000 dollars (see *Figure 7*) under high risk levels vs. low risk levels ($F(2,75) = 10.43$, $p < .001$).

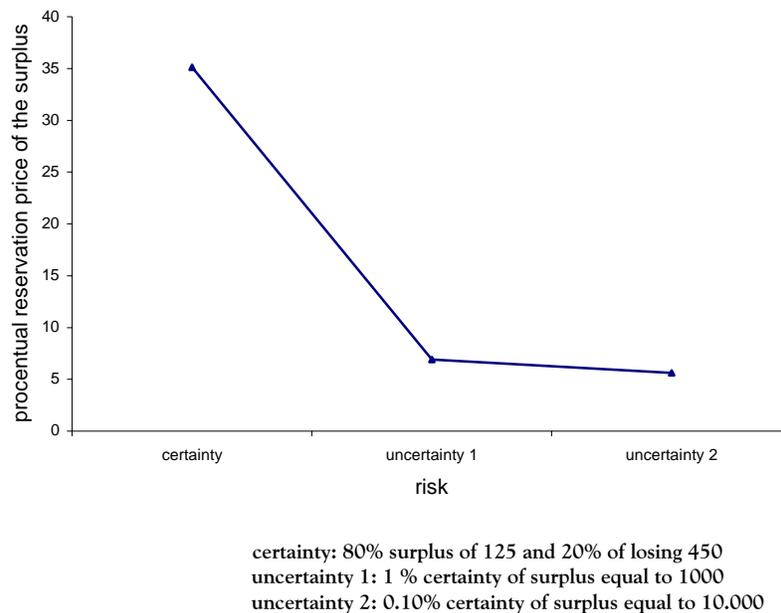


Figure 6: Different results for under certainty and uncertainty under identical expected surplus (10 dollars) ($F(2,75)=4.92$, $p < .01$)

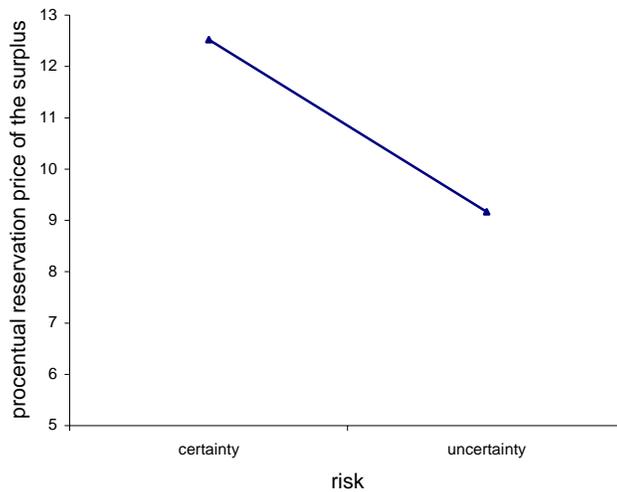


Figure 7: Different results when a same surplus (1000 dollars) given under certainty and uncertainty $F(1,76) = 4.13, p < .05$

3.4 Survey F

Experiment *F* is constructed along the lines of the previous surveys. Again, subjects ($N = 62$) are informed that they are one of five partial-right holders of a unitary resource and that a third party is looking to purchase all five parts. Every individual part is valued at 50 dollars. When the purchaser rebundles the five parts he obtains a surplus in a range between a minimum and a maximum expected value. In a random order the six trials indicated an expected surplus between respectively 100-500, 1000-5000 and 10.000-50.000 in the different trials. This experiment differs from section 4.1 and 4.2 in that the probability and exact profit remain unknown. The knowledge of subjects is restricted to the range within which the profits are situated. This experiment is more realistic because, as in real-life situations, precise probabilities remain unknown. For instance, when a real estate developer seeks to purchase 5 adjacent tracts, it is more likely that the land owners base their initial reservation prices on a rough, highly subjective estimate of the value to the entrepreneur, rather than probability and profit estimates of the individual provided to subjects in sections 4.2 and 4.3.

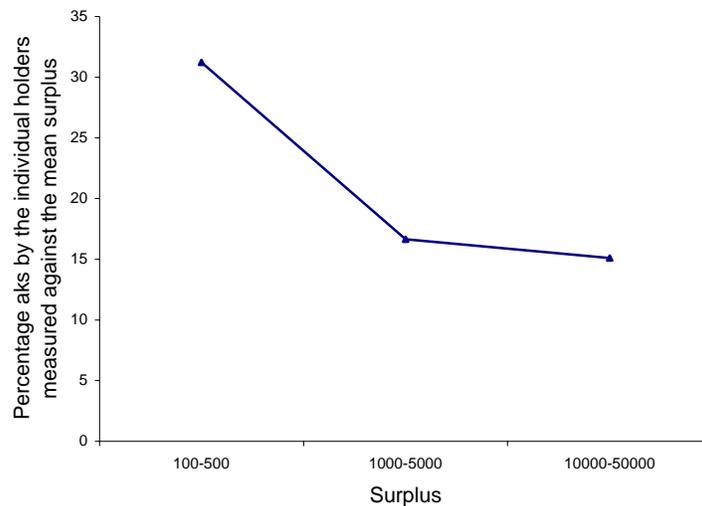


Figure 8: The expected profit of bundling the fragmented property for the holder's purchaser under the uncertainty about the amount of the surplus. ($F(2,60) = 4.15$, $p < .05$)

When the surplus is situated in the 100-500 range, the individual owners demand 32% or 83 dollars of the average surplus of 300. The average reservation price is 415 dollars. With regard to the higher profit ranges the average reservation price is 17.5% of the average surplus of 3000 and 30000. Again two observations appear. First, participants employ all or nothing tactics, demanding relatively high prices, when stakes are minor.¹⁸ Secondly, when stakes are high, subjects' reservation prices are based on a percentual amount of the expected profit of the buyer, irrespective of objective market value of an individual part.

4. DISCUSSION

4.1. SURVEY A & B: COMPLEMENTARITY

In survey A and B we measured the magnifying effect of complementarity of fragmented property entitlements on the occurrence of anticommons losses.

¹⁸ The wider variance within this cell suggests that this finding possibly is a confound resulting from the low values.

Prior theoretical research on anticommons fragmentation claims that the severity of the deadweight losses from concurrent possession of complementarity right increases monotonically with the number of independent holders: “The greater the number of individuals who can independently price an essential input, the higher the equilibrium price that each of these individuals will demand for his own license. At the margin, as the number of [right] holders approaches very large numbers (or infinity), complete abandonment of valuable resources will result.”¹⁹

While reservation prices for “2 out of 5 complementarity” total 34% over the objective value, a case of strict “5 out of 5” complementarity averages a combined demand price that is 100 % above the objective value. These simple findings confirms the theoretical findings that reservation prices correlate with the strength of veto-right into the successful bundling of the individual parts.

This basic result of surveys A and B are not surprising. Selling prices are higher when a seller has more individual bargaining power. The following Section will illustrate that the anticommons effect goes beyond the classical deadweight losses of monopoly and will indicate problems that are intrinsic to joint monopolies regarding complements.

4.2. SURVEY C: RESERVATION PRICES AND THE SIZE OF THE PIE

Experiment C examines the influence of higher degrees of profitability on the reservation prices of the individual right holders. We contrast situations where reunification of fragmented parts resulted in very substantial profits with situations where reunification created very modest gains. The results give little reason to believe that, from the perspective of uncoordinated selling prices, the problem is less pronounced in the case of higher potential waste or underuse. The results indicate that the anticommons problem does not discriminate between cases that entail considerable opportunity for profits and minor ones. As illustrated in *figure 2* above, there is no significant difference of reservation prices in the profit range between 300 and 10.000 dollars: the average price stated by each of the right holders approximates 26%. In the case of a surplus of

¹⁹ Depoorter, B. and Parisi F. (2002), ‘Fair Use and Copyright Protection: A Price Theory Explanation’, 21 (4) *International Review of Law and Economics*, 460-61.

10.000, the purchaser is faced with an aggregate mean asking price of 12.300 dollars. This price is 24.6% above the price that he or she can offer lest the project, involving rebundling, remain profitable. Similarly, when the profit from bundling is a more modest 300 dollars (plot 2 on graph 2, a median asking price is 26.6 % or 79.8 dollars per part), the combined reservation price is 399. Thus, the difference in reservation prices between a surplus of 300 and 10.000 is non-significant.

The implication is that, in attempting to rebundle subdivided parts, a third party purchaser faces reservation prices that significantly outweigh the expected profitability of the attempted reunification, regardless of the size of the interest at stake. All else being equal, a third party with a highly profitable or with a more modest project, faces prices that are, to the same proportion, beyond the expected value of the project. An oil company seeking to acquire 4 adjacent parcels of land for the purpose of optimal drilling with a potential for efficiency savings of 2 million dollars faces a negotiation problem comparable to an editor trying to assemble the copyrights from 4 different authors for an anthology on American writing (with profitability of 1000 dollars). This confirms the findings of Libecap and Wiggins that unitization of oil fields, involving multiple right holders, might fail despite the tremendous gains that can be reaped by unitisatizing oil fields.²⁰

This survey indicates that subjects hold a certain percentage (approximately 25%) of the profit as a focal point as to what they deem to be the price at which they are willing to sell their individual part. Regardless of any endogenous motivation for this proportion (evaluations of fairness, etc) the fact of the matter is that 5 people are each asking a demand price of 25% of the expected benefits. The overall result is a total selling price that is beyond the expected value of the project.

4.3 SURVEY D & E: THE ROLE OF UNCERTAINTY

Next we measured the effect of uncertainty regarding the expected benefits of the bundling of fragmented property entitlements. Surveys *D* and *E* respectively examine conditions of high degrees of uncertainty regarding strictly positive

²⁰ See Libecap, Gary D. and Wiggins Steven N. (1984), 'Contractual Responses to the Common Pool', 74 *American Economic Review* 84.

outcomes (with large upsides) and conditions of low degrees of uncertainty regarding more modest outcomes (with a modest chance of substantial losses).

4.3.1. High Degrees of Uncertainty with Large Upside

From the results it follows that subjects consistently demand a proportional share of 10% of the maximum profit. The mean reservation price, set by one individual right holder, is 14.25% of the surplus (see *Fig. 3* above). In our results aggregate reservation prices are 7 times above the expected value of the project.

These results suggest that subjects ignore the expected value of the purchaser's project, and instead focus on the upper range of profitability. Willingness to accept seems to be anchored onto a proportion of the maximum profitability, rather than a proportion of the expected benefits of the project. Subjects seem to take the most positive outcome of bundling as a focal point for the division of surplus with the purchaser. At first blush, this strategy may simply reflect a profit maximizing rationale on the part of complementary right holders.

In the aggregate, however, this presents a gloomy scenario. The third party needs to drive reservation prices, as initially stated by the individual right holders, down to a price level that is below 50% of the initial stated price. Prior experimental research has demonstrated that initial selling prices are sticky, i.e. they influence the outcome of negotiations.²¹ In the advent of these expected bargaining costs, projects with uncertainty have a higher chance of failing, by placing such considerable negotiation burdens on those engaged in high risk projects. The prospect of such high demands by complementary right holders, may lead projects that involve higher degrees of uncertainty to be forsaken, despite positive expected values.

These findings are particularly relevant for the domain of patent law. Intrinsically, the development of medical products from broad based inventions

²¹ Doob, A. *et al.* (1969), Effect of initial selling price on the subsequent sales, 11 (4), *Journal-of-Personality-and-Social-Psychology*, 345-350. A number of field experiments investigated the effect of an initial selling price on subsequent sales of common household products. The results are consistent with dissonance theory in that subsequent sales prices track initial prices.

involve a high risk of uncertainty – history has demonstrated that the path of innovation is unpredictable.²² In this area substantial investments in research and development provide no guarantees. When the risk of research and development is high and this risk is not accounted for in the licensing prices of upstream patents, medical research may be biased towards low-risk enterprises. The counter-intuitive result is thus that that broad patent protection lowers research in path breaking, high risk-high payoff research activities.

On a general level, the profits obtained by bundling the individual parts can be conceptualized as a commons. To the extent that right holders own complements to a valuable resource they are concurrent owners of a shared opportunity. As with overharvesting of common resources, uncertainty about the size of a commons leads to lower levels of cooperation. In our anticommons findings higher degrees of uncertainty regarding the profitability of the project leads to higher demands by the stakeholders. In the face of these increasing demands, projects with higher uncertainty (even if they have identical expected values) are more likely to be forsaken as right-holders demand more themselves, while expecting that others will demand more (see Budescu et al. 1990, 1992, 1995). The results thus indicate that anticommons property conditions share with common resource dilemmas the negative behavioral impact of pool size uncertainty.

²² Historical examples of the unprofitability of getting to an accurate estimation of the expected value of present inventions include IBM's underestimation of the future market of home computers. Merges, Robert P. (1994), 'Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents', 62 *Tenn. L. Rev.* 75, footnote 41 (citing Rosenberg, Nathan (1994), *Exploring the Black Box: Technology, Economics and History* 220: 'The computer was regarded by its inventors as a purely scientific device...' (quoting from Katz, Barbara G. And Phillips, Almarin (1980), 'The Computer Industry', in Nelson, Richard R. (Ed.), *Government and Technological Progress* 162, 171. See also Elster, Jon (1983), *Explaining Technical Change* 111; Mokyr, Joel (1990), *The Lever of Riches: Technological Creativity and Economic Progress* 154; Freeman, Christopher (1982), *The Economics of Industrial Innovation*, 2nd ed., Cambridge, M.A., MIT Press, 75.

4.3.2. Low Degrees of Uncertainty with Large Downside

Experiment *E* measured prices under situations where the purchaser/entrepreneur faces a high probability of modest gains but at the same time there is also a modest risk of a more substantial loss (*low risk-low profit model*).

Although the expected values of each of the several scenarios were identical, reservation prices were consistently lower in cases with a large uncertainty regarding the size of the (strictly) positive outcome than in cases with relative certainty but with a modest chance of a negative outcome (See *Figure 6* above). A possible explanation for this result is that subjects emphasize the relative low probability of success in *D* over the possibility of a negative outcome in *E*.

Following, the framing effect as described by Tversky and Kahneman,²³ it is assumed that individuals adopt different reference points as decision outcomes are framed differently. Similarly, our results illustrate the influence of the communicated frame by the bundler. Although the expected value from the projects in survey *D* and *E* are identical, reservation prices were lower when the expected value was denoted solely in terms of gains. There are a number of possible interpretations of this outcome. The results parallel the findings of de Deu et al. that individual right holders are less likely to make price concessions

²³ The prototype of a framing task is the Asian disease problem. Participants are told about an epidemic of Asian flu, which is expected to kill 600 people in the USA. They then have to choose between two options: option A saves 200 people with certainty; option B saves all 600 people with probability $p = 1/3$ or nobody. Options A and B are framed as gains. Options C and D introduce a negative framing. By implementing option C 400 people will die for sure, and by implementing option D all 600 people will die with probability $p = 2/3$ or nobody will die. Although each of the options have an identical expected value (in terms of lives saved), it is attributed to the framing effect that participants prefer option A (the sure option) over B (the risky option) in the positive framing condition, and prefer option D (the risky option) over C (the sure option) in the negative framing condition. See Kahneman D. and Tversky, A. (1979), 'Prospect theory: An analysis of decision under risk', 51 *Econometrica*, 263-291; Tversky, A. and Kahneman, D. (1981), 'The Framing of Decisions and the Psychology of Choice', 221 *Science*, 453-458.

when the payoffs of the bundler are conceptualized from a loss perspective.²⁴ Also, in our experiment subjects seem to emphasize probabilities over possible losses.²⁵ Put differently, in considering selling off their rights, sellers seem to discount the purchaser's potential losses more than uncertainty on the positive side. The tendency of the right holders to decrease reservation prices when the reference-outcome is positive, suggests a higher willingness of right holders to cooperate with positive projects. Alternatively, the added complexity in the aggregate calculation of expected values involving positive and negative outcomes might lead to more exaggerated demands because of the stronger non-calculative nature of collective decision making in those instances.²⁶

5. CONCLUSION

The "Tragedy of the Anticommons" denotes situations where veto rights are exercised even when the use of the common resource by one party could yield net benefits for all parties involved. This experiment explores how, when a common resource is subject to multiple exclusion rights held by two or more

²⁴ See de Dreu, Carsten K.W., et al. (1994), *Effects of Gain-Loss Frames in Negotiation: Loss Aversion, Mismatching, and Frame Adoption*, 60 *Organizational Behavior and Human Decision Processes* 90-107.

²⁵ The adoption of a positive or negative frame has empirically been found to affect the outcome of dyadic negotiations. Such frames may influence the outcome of further negotiations. For example negative framing induces greater risk seeking so that negotiators with a negative frame make fewer concessions and more often fail to reach agreement than negotiators with a positive frame. Bazerman, M. H., Magliozzi and T. Neale, M. A. (1985). 'Integrative bargaining in a competitive market'. 34 *Organizational Behavior and Human Decision Processes*, 294-313; Bottom, W. P. and Studt, A. (1993). Framing effects and the distributive aspects of integrative bargaining. 56 *Organizational Behavior and Human Process*, 459-474; Neale, M. A. and Bazerman, M. H. (1985). 'The effects of framing and negotiation overconfidence on bargaining behaviors and outcomes'. 28 *Academy of Management Journal*, 34-49.

²⁶ See Colett, P. (1977), *The Rules of Conduct*, in P. Colett (ed.), *Social Rules and Social Behavior*, Oxford: Basil Blackwell. (Individuals often seek fast and satisfactory solutions rather than rational consideration of all choices).

individuals, these co-owner may withhold these right from other users to an inefficient level.

Four main results can be drawn from the experiment:

1. Our results confirm the theoretical proposition that anticommons deadweight losses increase with the degree of complementarity between individual parts, and with the degree of fragmentation. This paper illustrates the pricing effect of the anticommons. The results in experiment *A* and *B* show a clear positive correlation between the percentage of the surplus holders demanded by the individual property right holders and (i) the degree of complementarity of individual parts into the buyer's project (*A*); and (ii) the number of individual right holders (*B*).
2. Individual right holders base their reservation price on a proportion of the expected surplus of the bundler-purchaser. They disregard the objective value of the good altogether. In one instance (experiment *C*) the purchaser faces *five* subjects that each demanded 25% of the expected value of his project.
3. In cases of uncertainty the anticommons pricing effect is amplified. The results in experiments *D* and *E* suggest that the subjects ignore the expected value of the purchaser's project, and instead focus on the upper range of profitability of surplus. Willingness to accept seems to be anchored onto a proportion of the maximum profitability, rather than a proportion of the expected benefits of the project. In Experiment *D* this focal point led to a total reservation price that was 7 times above the expected value of the project. This created a serious gap between what individual right holder were asking, on the one hand, and what a third party entrepreneur could reasonable offer.

Another more subtle response to risk emerges from the comparison of experiments *D* and *E*. Reservation prices seem to be consistently lower in cases where there is large uncertainty but a possible positive outcome, relative to scenarios where there is relative certainty but with a chance of negative outcome (see *figure 6*). Subjects seem to emphasize the relative low probability of success in *D* over the possibility of a negative outcome in the *E*.

4. When stakes are minor the individual right holders state disproportionately high reservation prices – 35% in the case of a project with expected value of 100 euros. Where stakes are higher, the average reservation price remains relatively

stable at 14-19% of the expected surplus. This all-or-nothing strategy surfaces throughout the various experiments.

* * *

To summarize, our experiment provides clear indications of the pricing effect in settings where complementary units are fragmented over individual right holders. Absent price coordination among these right holders, the independent pricing decisions place a high burden on a third party interested purchaser.

Our experiment leaves the dynamics of negotiations among fragmented owners to further research.²⁷ Instead, the results provide a proxy of the burden of negotiation that rest with a buyer who seeks to rebundle independently-owned property fragments. The results provide an indication of the extend of the price concessions that a prospective seller will need to obtain to bring the price of bundling within the limits of the net expected value of bundling. If we assume that initial selling prices are sticky,²⁸ the prospective costs of negotiations might lead to abandonment of value maximizing projects, leading to the tragic outcome of under use or idleness.

²⁷ On the impact of discussion and interaction in enhancing cooperation in social dilemmas, *see e.g.*, Dawes, et al., 'Cooperation for the Benefit of us – Not me, or my conscience', in Mansbridge, Jane J. (ed.) (1990), *Beyond Self-Interest*, Univ. of Chicago Press.

²⁸ When the height of reservation prices is due to the attribution effect it is likely that price concessions will be hard to obtain. Cognitive psychology documents people's inclination to discount new evidence that conflict with their prior beliefs (belief perseverance). According to confirmatory bias, people tend to misconstrue or misinterpret information so that it becomes additional information that supports the initial hypothesis. The initial experiments include Darley, John M. & Gross, Paget H. (1983), 'A Hypothesis-Confirming Bias in Labeling Effects', 44 (1) *J. Personality & Social Psychology* 20 (identical additional information is interpreted differently because of prior beliefs of backgrounds); Schrag, Joel (1999), 'First Impressions Matter: A Model of Confirmatory Bias', 114 *The Quarterly Journal of Economics* 37 (a formal model demonstrating how confirmatory bias may induce overconfidence).

In this regard, our results reinforce the normative hypothesis of the anticommons: property right systems should be careful in allowing the liberal creation and fragmentation of property rights.²⁹ Strong property rights in complementary resources can be too much of a good thing.

²⁹ See Parisi, Francesco (2002), 'Entropy in Property', *50 American Journal of Comparative Law* 701-738.