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Gordon Tullock and experimental economics

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Abstract Gordon Tullock's research has substantially influenced the development of economic science in general and experimental economics in particular. We present the first comprehensive survey of this significant achievement. We show how Tullock's research in bioeconomics influenced later developments in neuroeconomics and how his pioneering work on rent-seeking generated a literature of laboratory tests of his hypothesis. We also describe Tullock's own experiments and draw attention to his early insights on trust games.

Keywords Public choice · Rent-seeking · Bio-economics · Trust · Prisoner's dilemma

1 Introduction

Gordon Tullock's research is characterized by its breadth and quality. His research frequently and provocatively challenges the conventional wisdom in areas not traditionally considered the province of economics. In Tullock's own words, "Original contributions very often occur when a scholar looks at a well-established theory with his eyes open, and not closed as so many of us do for so much of our existence (Tullock 1998). The fields to which Tullock has made influential contributions are numerous, including public choice, constitutional political economy, law and economics and bioeconomics. His pioneering contributions to these fields were often very well ahead of the profession, and ever increasingly appreciated with the passage of time.

It is nevertheless perhaps not widely enough appreciated that Tullock's research has substantially influenced the development of economic science in general and experimental economics in particular. Indeed, to our knowledge, there has not yet appeared a comprehensive survey of Tullock's contributions to the field of experimental economics. The purpose of this paper is to take a step towards filling this gap. In particular, we demonstrate that Tullock's

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research in bioeconomics influenced the later development of neuroeconomics. We note also that Tullock's hypothesis regarding rent-seeking was seminal to a literature of experiments. Moreover, Tullock even conducted and published his own original experiments.

We begin our review by discussing Tullock's insightful work on trust. Then we summarize Tullock's contribution to bioeconomics, and therefore its influence on neuroeconomics. We also review various experiments inspired by Tullock's rent-seeking hypothesis.

2 Tullock and trust

It was during the final two decades of the 20th century that experimental economists began to formalize and study trust games. As Cox (2004) summarizes, "Trust" is inherently a matter of the beliefs that one agent has about the behavior of another. An action is "trusting" if it creates the possibility of mutual benefit (when the trustee cooperates), as well as the risk of loss to oneself (if the trustee defects). The structure of the trust game is that the first mover holds a belief about the second mover's willingness to reciprocate trust, and he chooses whether to make an efficiency-increasing transfer to the second mover according to this belief. Note that a binary trust game differs from a prisoner's dilemma only in that the former is sequential whereas the latter is simultaneous.

Tullock (1967a) was to our knowledge the first to emphasize that a simultaneous prisoner's dilemma (PD) game is not a trust game, while it becomes one when played sequentially. Tullock's article was written as a response to an argument that the lack of "mutual trust" is the root of non-cooperative outcomes in prisoner's dilemmas (Wolff 1962; Thompson 1964; Held 1966).

Tullock pointed out that, rather than a "trust" game, the PD is a coordination game.[1] Further, Tullock pointed out that if the game were played sequentially, and if the first mover "trusted," the pecuniary motives are to defect.[2] Importantly, however, Tullock leaves open the possibility of reciprocity when he writes, "The motives for squealing are *stronger* when I know my accomplice will not (italics added)." It is noteworthy that Tullock does not here suggest that people will defect or should defect in this situation, but only that the pecuniary incentives for defection are strong in the case of a sequential PD (or Trust) game.[3] Tullock's early realization was exceptionally forward-looking and foreshadowed the flourishing of trust game research in experimental economics that would only begin to appear more than two decades later (e.g., Camerer and Weigelt 1988; Fehr et al. 1993).

It is worth noting that Tullock (1967a) draws attention to an especially interesting implication of the prisoner's dilemma. In particular, from the standpoint of society as a whole, the confession of prisoners is a desirable outcome. Therefore, the incentive structure of a prisoner's dilemma could perhaps be applied as a technique for social control. He gives an example of a competitive market, in which all of the sellers of a given commodity could have gained from higher prices if they colluded successfully. But the "gigantic" prisoner's

[1] The problem raised by the dilemma is simply that if both parties make the same decision, they are better off if it is "don't squeal" than if it is "squeal." (Tullock 1967a: 229).

[2] "I may have the most perfect confidence that my fellow criminal will never confess without in any way affecting my desirability of confessing." (Tullock 1967a: 229).

[3] Tullock distinguishes between "motives" and "payoffs." By "motives" Tullock seems to mean payoffs and psychological factors in addition to payoffs. His argument seems to recognize that one might be motivated to reciprocate, even if the payoff maximizing choice is to defect.

dilemma in this market structure prevents the collusive outcome, and this is welfare enhancing for society as a whole. This forward-looking reasoning was later developed and formalized by game theorists.

Tullock raises a puzzle that, in ordinary life, people do not observe as much cheating as predicted by the prisoner's dilemma. He points out that it is the "discipline of continuous dealings" (Adam Smith 1776) that takes care of this matter. The difference between a prisoner's dilemma game and an ordinary competitive market is that the partners in a prisoner's dilemma game are pre-selected and cannot change; however, the players in a competitive market select their partners.

This insight is closely related to the issue of endogenous partner choice that has gained popularity lately in experiments. In fact, Tullock (1999) designs an experiment to test his own hypothesis. Interestingly, the design he employs is an early precursor of experiments allowing endogenous partner choice.

Tullock (1999) calls his experiment the *non-prisoner's dilemma*. It has three treatments: Subjects could pre-select their partners; subjects could communicate with each other; subjects could change their partners in the middle of transactions. These three conditions were different from the common settings of experiments on prisoner's dilemmas around that time—the people playing are selected by the experimenter, are not permitted to communicate, and cannot change their partners.

The result of the experiment demonstrated that, under these three conditions, there was a very high degree of cooperation, as opposed to the result predicted by the prisoner's dilemma model. More than half of the teams in the experiment played cooperatively from the beginning. Two of the teams tried non-cooperative plays at first, but quickly switched to cooperation in the later eight rounds. The one team that played badly was the result of genuine lack of understanding by one player, as observed by Tullock. The main significance of the experiment, as Tullock summarized, is to provide evidence that people in most natural environments can (and will) engage in cooperation.

3 Pioneering work on bioeconomics[4]

In a paper summarizing the relationship between neuroeconomics and bioeconomics, Vromen (2007) holds that Tullock is a founder of bioeconomics. Since it is viewed by some as a natural extension of bioeconomics, Tullock's contributions have also benefited the field of neuroeconomics. For example, Tullock (1971a) seeks to find the structural similarities between economics and biology through an example of the coal tit as a "rational" shopper. He argues that "It can be said that the coal tits are maximizing the return to their labor in searching out food supplies. We need not, of course, argue that the coal tits have thought the matter out in the same way that human beings would. Presumably, they have inherited an efficient pattern of behavior resulting from natural selection which would eliminate inefficient heritable behaviors."

In other words, if the ancestors did not evolve in that pattern, their offspring would not have survived the natural selection. Therefore, it's reasonable to assume that coal tits have inherited certain efficient patterns for decision making, as if they were optimizing shoppers. In that paper, Tullock shows that fruitful economic analysis can be applied in the biological realm.

[4]This section draws heavily from Vromen (2007).

Tullock acknowledged that, at least up until the twentieth century, there has been a transfer of ideas and concepts from economics to biology. Tullock also observed that ever since Darwin's *The Origin of Species*, the biological analogue of constrained maximization (or optimization), adaptation, has been part and parcel of (evolutionary) biology. However, the constrained maximization framework remained hidden and implicit in biology.

Tullock holds that biology could benefit from an explicit and comprehensive adoption of the constrained maximization framework. The burgeoning cross-disciplinary work in game theory, though not identified with bioeconomics, fits well within this general framework.

While bioeconomics uses evolutionary biology to build models that predict human behaviors, neuroeconomics seeks to discover the biological foundations of economic choice behavior (Houser and McCabe 2008). Bioeconomists concentrate on studying past processes of natural selection (Tullock 1971a, 1971b; Becker 1976). Neuroeconomists investigate how current behavior is caused by ongoing brain processes. The pioneering work done by Tullock on bioeconomics expanded the boundary of economics and laid a foundation for neuroeconomics.

4 Tullock's rent-seeking hypothesis

Tullock (1967b) famously argued that social inefficiency occurs when resources are spent in an attempt to become the recipient of monopoly rents. Naturally then, an important question that arises is how much the total rent-seeking expenditure might be, given that the same resource could be otherwise used for more productive purposes. In the early literature, rent seekers are price takers in a perfect competition model. This framework implies that the total amount of rent will be dissipated by the expenditures. In a later and quite important paper *Efficient rent-seeking* (1980), Tullock presents an alternative model where the process of rent-seeking is described as a lottery.

The model in Tullock (1980) involves two competing agents expending resources to influence the probability of acquiring a given rent. The more an individual spends, the greater his chance, *ceteris paribus*, of winning the prize. In other words, the outcome of the competition is uncertain, but the odds of being the recipient of either the monopoly rent or the lottery prize increase with one's expenditure and decrease with the expenditures by others. In a two person contest between A and B, Tullock (1980) modeled the probability of person A winning the prize as $P_A = A^r/(A^r + B^r)$ where $r = 1$.

The parameter r determines the impact of differences in expenditures on probability of winning the prize. For example, if $r = 1$, the contest has constant return to expenditure. Each agent's chance of winning the lottery is equal to his share of total expenditures. If the return to expenditure is infinite, the contest becomes a discriminative auction, and the competitor who spends the most wins the prize (Anderson and Stafford 2003). The Cournot-Nash outcome for the $r = 1$ case is that each individual makes an expenditure equal to one-quarter of the monopoly rent. Thus, rent-seeking activity would dissipate half of the monopoly rent. However, if $r = 3$, the optimal expenditures with the Cournot-Nash outcome indicates a dissipation of 150% of the monopoly rent.

Tullock pointed out that when $r = 3$, the sum of the payments made by the individual players is greater than the prize. When $r > 3$, the players make payments that exceed the value of the prize. Though the action might seem "irrational", people sometimes do play games of this sort. He shows that such an outcome would occur through a sequence of small steps in which each player increases his expenditures. Each step is optimal in the sense that the expected marginal return is greater than the marginal cost, holding the other person's

Table 1

Experiments that reject Nash predictions	Experiments that support Nash predictions
Millner and Pratt (1989)	Shogren and Baik (1991)
Millner and Pratt (1991)	Weimann et al. (2000)
Davis and Reilly (1998)	
Anderson et al. (1998)	
Potters et al. (1998)	
Weimann et al. (1998)	
Anderson and Stafford (2003)	
Öncüler and Croson (2004)	
Morgan and Vardy (2007)	
Schmitt et al. (2004)	
Parco et al. (2005)	
Schmidt et al. (2006)	
Lim and Matros (2009)	
Anderson and Freeborn (2010)	
Sheremeta (2010, 2011)	

expenditure constant. But the cumulative effect is to spend more than the monopoly rent (Millner and Pratt 1989).

Tullock's seminal work has generated a rich theoretical literature. The books "Efficient Rent-seeking: Chronicle of An Intellectual Quagmire" (Lockard and Tullock 2001) and "40 Years of Research on Rent Seeking" (Congleton et al. 2008) are a comprehensive summary of the theoretical development of the rent-seeking literature.

Tullock's insights have also brought forth many valuable and interesting empirical studies and laboratory experiments. Because it can be difficult to obtain data on resources devoted to rent-seeking activities in natural occurring settings, lab experiments provide a useful alternative for model evaluation. Tullock's efficient rent-seeking hypothesis has been tested and modified since 1989. The experimental literature on rent-seeking reflects new developments in the theoretical literature and points to new directions for theoretical research.

5 Experiments testing Tullock's rent-seeking hypothesis

Most rent-seeking experiments are run based on the simplest Tullock (1980) model, which makes predictions regarding the social cost of seeking monopoly rents. In broad brush stroke, each subject chooses a level of rent-seeking activity, and the payoff is the prize minus the rent-seeking cost. Economic scientists were interested in measuring the welfare loss created by rent-seeking and discovering whether monopoly profit can be taken to be the same as the value of resources devoted to rent-seeking activities, as predicted by Tullock's model. Much effort has been spent discussing the possibility of over-dissipation of rents.

Table 1 summarizes laboratory findings regarding rent dissipation. Except for two cases, experiments find over-dissipation of rents. This is inconsistent with the Nash Equilibrium of the tested models.

Table 2 provides a categorization of experiments that test Tullock's rent-seeking hypotheses. The categories refer to the environment within which the hypothesis was tested. Notice

Table 2

Category	Authors
The First Experiment on Rent-Seeking	Millner and Pratt (1989)
Bounded Rationality	Shogren and Baik (1991)
	Anderson et al. (1998)
Risk Aversion	Millner and Pratt (1991)
Risky Rent	Öncüler and Croson (2004)
Rent Defending Expenditure	Davis and Reilly (1998)
Fixed Cost and Asymmetric Cost Structure	Potters et al. (1998)
Cost Heterogeneity and Entry Fee	Anderson and Stafford (2003)
Sequential Rent-Seeking	Weimann et al. (1998)
	Weimann et al. (2000)
	Morgan and Vardy (2007)
Multiple Stage Contest	Schmitt et al. (2004)
	Parco et al. (2005)
	Sheremeta (2010)
Multiple Prizes	Anderson and Freeborn (2010)
	Sheremeta (2011)
	Schmidt et al. (2006)
Variation in Group Size	Lim and Matros (2009)

there is overlap among categories. For example, the same study might be viewed both from the perspective of risk preference as well as multipleprizes. Many of the studies in the table are discussed further below.

The first experiment evaluating rent-seeking theories, conducted by Millner and Pratt (1989), examines the effect of changes in the probability of receiving the rent on the amount of rent dissipated in rent-seeking activities. In particular, they focus on how mean expenditures compare to Nash Equilibria and how much of the monopoly rent is dissipated by the rent-seekers. The experiment involved two participants and was based on Tullock's analysis of rent-seeking as a lottery. They allowed sequential decisions within a given time interval instead of using a simultaneous single-decision design.

Although their result lends support to Tullock's hypothesis that the mean individual expenditures and mean dissipation rates will be greater when $r = 3$ than when $r = 1$, the result deviates from the Nash Equilibria value predicted by the model. The experimental results indicate that when $r = 1$, mean expenditures and rent dissipation rates exceed the predicted values, while when $r = 3$, the rates fall below the predicted values. It is worth mentioning that later articles point out that Millner and Pratt's paper mistakenly arrived at a pure strategy solution for $r = 3$, leading to an errant evaluation of the theory.

5.1 Bounded rationality

In a comment on Millner and Pratt (1989), Tullock argues that the experimental data's divergence from theory predictions was probably due to complex experimental instructions combined with the bounded rationality of the subjects. If Tullock's speculation is correct, a simpler experimental design that gives subjects clear instructions about possible strategies should generate results more consistent with theory predictions. Testing this was the purpose

of the experiment conducted by Shogren and Baik (1991). They showed that when $r = 1$, with a new experimental design utilizing an explicit expected payoff matrix, the result is consistent with both Nash Equilibrium and dissipation hypothesis. When $r = 3$, no Nash Equilibrium exists; there is therefore no theoretical benchmark.

Their paper explains why the evidence from Millner and Pratt's experiment was inconsistent with the theory; and their simpler experimental design generates findings that are consistent with Tullock's predictions. However, by letting subjects play against the same opponent repeatedly, their design is not completely consistent with the model. In a repeated setting, rent-seeking expenditures may be lower due to coordination between players. Sample size is also a potential problem in their experiment (Potters et al. 1998).

Anderson et al. (1998) develop a model that formalizes the consequence of bounded rationality in rent dissipation. They introduce the possibility that players are not perfectly rational. Bid choices are probabilistic, with an error parameter that allows perfect rationality in the limit. The equilibrium concept they develop provides predictions consistent with laboratory findings.

5.2 Risk aversion

Millner and Pratt (1991) examine the effect of risk aversion on rent dissipation. Hillman and Katz's (1984) theoretical work shows that when there is a large number of risk-averse rent seekers, increases in risk aversion diminish the extent to which rents are dissipated. Millner and Pratt (1991) extend their work to a small number case and demonstrate that rent dissipation depends on the structure of the risk attitudes of two risk-averse individuals. The result of their experiment shows that mean individual expenditures and mean dissipation rates of the less risk-averse group exceeded those for the more risk-averse group. Therefore, they attribute the inconsistency with the prediction of Tullock's hypothesis in their 1989 experiment to the effect of risk aversion rather than the failure of the model. The advantage of their second experiment is in controlling the risk attitudes of individual rent seekers.

5.3 Risky rent

Öncüler and Croson (2004) discuss the impact of risky rent. Their intuition is that the value of the rent is not certain, but instead risky, and may depend on the rent-seeking decisions that players make. Their model is related to previous models of endogenous rent formation. However, the model's Nash Equilibrium prediction regarding rent-seeking expenditures was not observed. In their experiment, the rent-seeking expenditures were significantly higher than the theoretical predictions, which they attributed to myopia on the part of the subjects.

5.4 Rent-defending expenditure

Ellingsen (1991) brings forward the idea of rent-defending expenditure as opposed to rent-seeking activities. Rent-defending expenditures are socially beneficial, even if buyers lose the auction. For example, in a public interest group, buyers may find it rational to make costly efforts to limit or prevent a monopoly. Ellingsen (1991) shows that under general conditions, rent-defending activities by a single representative of all buyers reduce the expected social cost of rent-seeking.

Davis and Reilly (1998) develop an experimental design to test Ellingsen's hypothesis. Their experiment evaluates performance in each of six auction variants. Additionally, they included a "strategic buyer" who had a higher prize value than other subjects. They find that

in all auction types, aggregate social costs substantially exceed Nash Equilibrium levels. The treatment of adding a strategic buyer generally reduces the social cost, though the effect is smaller than predicted. They also find that experiences generally reduce over-dissipation. But even with experience, rent-defending buyers persistently bid far too much. Therefore, they suggest that future research may want to study behavioral explanations for over bidding.

5.5 Fixed cost, asymmetric cost structure and entry fee

Potters et al. (1998) make interesting points with respect to Davis and Reilly's experiment. One is that agents are cash constrained in their setup. This affects equilibrium spending behavior. Also, there are multiple Nash Equilibria in the game, so that straightforward predictions cannot be obtained from the model. In addition, their analysis uses aggregate results and may be affected by the sequence in which the experiment was conducted (so-called "order effects").

Potters et al.'s design focuses on the $r = 1$ and $r = \infty$ cases. Following Shogren and Baik (1991), they use an explicit expected earnings table to ease the informational problem for the subjects. They find that although qualitative (directional) predictions of the model are supported by the data (mean bid and dissipation, the variance of bids and dissipation as well as the incidence of over-dissipation are all smaller for $r = 1$ than $r = \infty$), the quantitative results of their experiment are not consistent with the theoretical prediction- the level of dissipation is persistently higher than what the model predicts. Unlike Millner and Pratt (1991)'s interpretation regarding risk aversion, they offer a behavioral explanation for the data's divergence from theoretical predictions. In particular, they suggest that subjects may behave as "gamesmen," or they may simply be confused and thus randomize.

Anderson and Stafford (2003) design an experiment to test Gradstein's (1995) rent-seeking model that includes a variable number of participants, cost heterogeneity, and an entry fee. The model predicts that all competitors will participate when costs are homogeneous and when there are no fixed participation fees.

However, the result of the experiment shows that participation is not always 100% under the homogeneous cost structure. The data support the prediction that introducing cost heterogeneity decreases participation. The effect of the entry fee on participation is also consistent with theoretical predictions. They also find that group size is negatively related to participation, although the model does not predict this relationship.

Regarding rent-seeking expenditures, they find that adding an entry fee decreases expenditures at the individual level. Expenditures increase with the size of the group. Experimental results do not appear to support the theoretical predictions with respect to cost heterogeneity. Under some conditions heterogeneity is inversely related to expenditures, as predicted, but in other cases expenditures increase with the degree of cost heterogeneity.

5.6 Sequential rent-seeking models

Weimann et al. (1998) conduct a series of experiments that modify Tullock's simultaneous-move setup to a sequential one. Weimann et al. develop a model that has a unique subgame perfect equilibrium in which the first mover has a strategic advantage and receives the maximum payoff.

However, their data undoubtedly show that the second mover is successful in the contest. A remarkable observation is also that the theoretically feasible, efficient "fair" outcome never prevails. Second movers have the chance to exploit the situation. In a finite version of the sequential rent-seeking game, a considerable amount of the rent is dissipated because preemptive bids have to be very high.

But Weimann et al. (2000) show the result of efficient rent-seeking. They point out that in an infinite setting (if the contest is open ended), the so called "Tullock paradox" disappears because the fear of retaliation and escalation will lead contenders to stop increasing their effort early, as if they "agree" on some cooperative solution. An especially appealing feature of their experiment is the fact that convergence towards efficient rent-seeking consistently results, despite the difference in environment. It did not matter whether there were other games proceeding, role changes, fixed payments, different group sizes, or differences in the competitiveness attitudes of subjects. Subjects learn to play the efficient outcome when the threat of escalation is real.

In Tullock's original model in which players move simultaneously, commitment is valuable: If a player can choose between moving before or at the same time as a rival, he prefers to move earlier. Since all competing parties share the same incentive, they will compete to move at the earliest possible time. Morgan and Vardy (2007) study the value of commitment in sequential contest when the follower faces small costs of observing the leader's effort. They show that the value of commitment vanishes entirely in this type of game. The value of commitment is preserved only when observation costs are sufficiently small. Their explanation is that for commitment to have value, the second mover must choose to observe the first mover's action with positive probability. This happens only when the first mover's strategy is indeed valuable.

In the setting of the sequential contest, actually observing adds no value to the second mover. This result highlights that the ability to observe the effectiveness of effort—rather than the effort itself—creates the value of commitment.

5.7 Multiple stage contest

Schmitt et al. (2004) contribute to a growing body of literature on multi-period rent-seeking contests. They test a model in which a player's effort affects the probability of winning a rent-seeking contest in both the current and future periods. They allow for the possibility that some rent-seeking expenditures carry over from one period to the next.

The theory predicts that relative to a multi-period non-carryover rent-seeking game, rent-seeking effort will be shifted forward from later to earlier periods. The result of the experiment supports the prediction of the theory—Schmitt et al. (2004) find a significant shift forward in rent-seeking expenditures when carryover is allowed. The shift forward in rent-seeking efforts is positively related to the rate of carryover. In other words, a higher carryover rate leads to a greater increase in rent-seeking effort in the first period, and a greater decrease in the second period. They also suggest that average rent-seeking expenditures are lower in a two-period carryover contest than in an equivalent non-carryover contest.

Parco et al. (2005) design a two-stage contest experiment to test the Stein-Rapoport equilibrium model in which the budget constraint may or may not be binding. Their experiment does not consider carryover between stages. In the first stage, agents compete within their group by expending resources, and in stage 2, the winners of each group compete to win the prize by expending additional resources subject to the budget constraint. The result of the experiment rejects the Nash Equilibrium solution due to over-expenditure in stage 1. Their explanation for the deviation from the prediction is the non-monetary utility of winning and misperception of the probability of winning.

Sheremeta (2010) studies two-stage contests between political parties. The expenditures in the first stage by the winning candidates are partially or fully carried over to the second stage. He studies the effects of expenditure carryover and information disclosure on the individual behavior.

His findings also indicate that expenditures in both stages exceed the theoretical predictions, which is different from the findings of Parco et al. (2005), who report significant overspending only in the first stage of a two-stage contest with budget constraints. Sheremeta (2010) attributes the disparity to the removal of budget constraints. Moreover, his experiment shows that the first stage expenditures and the total expenditures increase in the carryover rate, and the second stage expenditures decrease in the carryover rate. Disclosing information about the opponents' carryover rate increases the second stage expenditures and decreases the first stage expenditures.

5.8 Variation in group size

Lim and Matros (2009) design an experiment with a setup isomorphic to Tullock's basic model of contest theory. They focus on varying the group size to ask how large a community has to be before raffles become profitable. They discuss the impact on participants' expenditures that occurs when all agents care only about their own earnings.

In the rent-seeking literature, these expenditures are viewed as social losses. In Lim and Matros's paper, there is no rent dissipation, only direct transfer from participants to the organizers of raffles. The result of their experiment shows that individual spending in lottery contests does not decrease as the number of contestants increase. Therefore, the prediction of the risk-neutral Nash Equilibrium does not hold. This can occur at a surprisingly small group size, with only four participants. Subjects do not strategically reduce spending as group size increases. The lack of strategic response cannot be explained by learning direction theory, quantal response equilibrium, or level-k reasoning models.

6 Conclusion

This paper discusses Gordon Tullock's major contributions to experimental economics. Tullock (1967a) was the first to clarify the difference between the structure of a prisoner's dilemma and that of a trust game. He also conducted his own experiments on the non-prisoner's dilemma. The main contribution of this experiment is to provide evidence that people in most natural environments can (and will) engage in cooperation. Tullock's theory of bioeconomics has greatly influenced the later development of neuroeconomics, which some might view as an extension of bioeconomics. We also summarize experiments testing Tullock's highly influential theory of rent-seeking.

It should be noted that this paper does not seek to exhaust all of Tullock's contributions to experimental economics. For example, we have not covered Tullock's work on military tactics. More broadly, there is an expanding literature in the field of experimental public choice (see, e.g., Houser and Stratmann 2008). We nevertheless hope that this paper helps scholars in these and other experimental fields recognize that the debt they owe to Gordon Tullock is even greater than they had previously recognized.

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