23 Public choice as an experimental science

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This chapter reviews experimental studies in the field of public choice including tests of theories and potential remedies for inefficiencies. Economists conducted experiments as early as the 1930s, but laboratory research has only gained widespread acceptance in the profession in recent decades.[1] Experiments have proven to be extremely useful for testing theories with specific assumptions about key variables such as incentives and information flows. Since many public choice theories fall under this category, it is a popular area for experimental research. In addition, the laboratory provides a safe environment to test and fine tune policies that can not easily be tested with naturally occurring data.

The first section of this chapter examines laboratory studies of individual decision making with externalities. Positive and negative externalities are considered in the context of public good provision and the overuse of common pool resources, respectively. In addition, some tests of the Coase theorem are discussed. The second section examines rent-seeking behavior in the laboratory and the final section reports results from voting experiments.

I. Individual decision making with externalities

The assumption that humans are rational, utility-maximizing actors generates clean behavioral predictions. Generally, self-interest and market forces lead to an efficient allocation of resources. However, observed market failures prompt us to reconsider some aspects of human interaction. Many issues that interest social scientists arise because individual decisions are not made in a vacuum. Spillover effects, which have been termed externalities, can be positive or negative.

Although they are two sides of the same coin, distinct laboratory mechanisms have evolved to examine behavior with positive versus negative externalities.

When an individual contributes to the provision of a public good, others may benefit from the good without compensating the donor. Hence, a positive externality is generated. Among the most commonly cited examples of public goods are national defense and clean air. With self-interested agents, economic theory predicts that these goods will be under-provided. This prediction has been tested using a voluntary contributions mechanism. The mechanism generally applies to pure public goods (i.e., goods that are both non-excludable and non-rival in consumption). When a good is non-excludable, but rival in consumption, a different inefficiency arises, since one individual's consumption of the good diminishes its usefulness for other potential consumers. Hence, one person's consumption exerts a negative externality on other users of the resource. A classic example of a public good that is rival in consumption is a fishery. Negative externalities of this type are analyzed in the laboratory using a common pool resource mechanism. These mechanisms, in addition to possible remedies for inefficiencies, are discussed in the sections that follow.

A. Public goods provision and the voluntary contributions mechanism

One of the first economics experiments was conducted in the early 1950s at the Rand Corporation. Melvin Dresher and Merrill Flood (1952) designed an asymmetric and repeated version of the now familiar prisoner's dilemma game. Because this story so convincingly characterizes the conflicting forces of private incentives and social good, a show of hands in any undergraduate economics course reveals that most students know of the game. Behavior in early prisoner's dilemma experiments was generally inconsistent with the theoretical prediction of

complete defection, and this generated a lively debate among economists. The most voluminous body of laboratory research relating to public choice relies on a variation of this game known as the voluntary contributions mechanism (VCM). The VCM is used to investigate the degree to which people free ride on public goods.

The mechanism works as follows. Each person in a group of size N is given an endowment of tokens and offered the opportunity to contribute to a group account. Tokens kept for private consumption are transformed by some factor, v, and converted to cash earnings (e.g., 1 token = 1 cent). The sum of all tokens allocated to the group account, G, is transformed by some factor, w, and each member of the group gets the amount $G*w$. Importantly, every member of the group receives $G*w$ from the group account, regardless of whether or not they contribute to it. Hence, the group account is a pure public good. In the standard public goods experiment $w < v$, so the dominant strategy Nash equilibrium is for everyone to free ride on others' contributions. This decision problem is a dilemma (specifically, the prisoner's dilemma) when the social benefit of a token donated to the group account outweighs the value of a token kept for private consumption (i.e., $N*w > v$).

Sociologists Gerald Marwell and Ruth Ames (1981) conducted one of the first public goods experiments. Unlike the VCM that has come to be the standard in experimental economics, Marwell and Ames administered many of their sessions via mail surveys of high school students. In some cases they were deceptive about the number of people involved, and most students participated only once in the game. Despite these procedural differences, the behavioral pattern observed by Marwell and Ames has held up to many replications. Namely, initial contributions to the group account are near the 50 percent level. Perhaps what drew economists so heavily into this line of research was one discovery that Marwell and Ames chose

to emphasize. They concluded that free riding was not as pervasive as theoretical models might suggest, with one notable exception. The only significant free riding they found was in a group of economics graduate students at the University of Wisconsin. Hence their title became 'Economists free ride: Does anyone else?'

Hundreds of public goods (VCM) experiments have been conducted in the past twenty years. Initial baseline experiments confirmed the finding that people do not free ride to the extent predicted by economic theory. The first significant addition to our understanding of this anomaly was the discovery that free riding increases with repetition. Isaac, Walker and Thomas (1984) had the same group of subjects make contribution decisions for ten periods. At the end of each decision making period, the total number of tokens allocated to the group account (but not individual contributions) was announced out loud, and subjects recorded earnings for the period. In the first period, contributions ranged from 40 to 60 percent of the total token endowment. By the tenth period, contributions fell to the 20 to 40 percent range, which is still well above the Nash prediction of complete free riding. With this discovery, the focus of experimental research turned to isolating variables that influence contribution levels in VCM-based experiments.

Table 23.1 lists treatment variables, relevant studies, and findings for some factors of interest. One of the less intuitive findings from VCM experiments is that increases in the size of the group increase contributions to the group account. A number of prominent theoretical models demonstrate that relatively small groups foster more cooperation than large groups.[2] However, if altruism is the motivating factor for contributions to the group account, the positive relationship between group size and contributions should be expected, since the marginal benefit of each token allocated to the group account increases as the group grows.

Insert table 23.1 about here.

Many of the other effects listed in the table are quite intuitive. For example, contributions to the group account are positively related to the conversion factor (w) for tokens placed in the group account. This simply means that people are more willing to give to the group account as it gets cheaper (i.e., as $v - w$ gets smaller). Given the evidence on repetition, it is also not surprising that contributions to the public account are lower in groups that have previously participated in a VCM experiment. This suggests that subjects merely need time to figure out the dominant strategy. Experienced subjects start at lower initial contribution rates and rates decline faster than is the case with inexperienced subjects. A number of innovations have been introduced to the VCM in attempts to separate learning from other possible hypotheses, like signaling or altruism.

For example, Andreoni (1988) investigated whether the decrease in contributions was the result of learning or strategic signaling. Andreoni used a 2-person partners-strangers version of the VCM in which one subset of the subjects was paired with the same 'partner' for each repetition of the game and the other subset rotated through a group of people, meeting a 'stranger' for each new repetition.[3] All other parameters of the experiment were the same for both treatments. Surprisingly, the strangers were consistently more cooperative, but contribution rates fell over time in both groups. This suggests that the increase in free riding resulted more from learning than strategic play.[4]

Based on a lack of evidence that strategy was a motivating factor for contributions, Andreoni (1995a) introduced another design to separate the giving motive into learning and altruism components. In one treatment, subjects were ranked by token accumulations and paid based on their rank in the group. Another group of subjects played the standard VCM game with all other parameters identical to the rank treatment. Hence, in the rank treatment, private gains

were emphasized over social gains. Andreoni concluded that about half of contributions to the public good were the result of kindness and the other half were due to confusion about the game.

A common characteristic of the above studies is that deviations from the Nash prediction were only possible in the direction of over-contributing to the group account, since negative contributions were not possible. Saijo and Nakamure (1995) and Palfrey and Prisbrey (1996) varied the value of the private good across subjects and across periods. In some cases, full free riding was the dominant strategy and, in other cases, contributing all tokens to the public account was optimal for an individual. Both studies found no systematic tendency to give too much to the public account. In fact, subjects sometimes kept tokens for private consumption when the tokens would have been worth more to them personally in the public account (i.e., when $v < w$). Saijo and Nakamure termed this a 'spite motive', since it appeared that subjects were willing to forego earnings to deny public access of their tokens.

In a follow-up study, Prisbrey and Palfrey (1997) attempted to separate 'warm-glow giving' from altruism. When individuals get utility from the act of giving, independent of the benefit to the recipient, it is termed warm-glow giving. Altruism is defined as giving to the public account with the intent of increasing the earnings of others in the group. In this study, the marginal value of the private good varied across both subjects and periods and the (common) value of the public good varied across sessions. This facilitated a comparison of behavior with different relative values and costs for contributions to the private versus group account. Prisbrey and Palfrey found that 'warm glow' played a small but statistically significant role in decision making, but that altruism was not a factor. Using a logistic error model to analyze decisions, it was also concluded that random error played a non-trivial role in decisions.

Despite the fact that under-giving was possible in the two studies described above, the possible equilibria (complete free riding or fully contributing) were still on the boundaries of the choice set. Evidence that under-giving may also be a problem prompted a new line of research with interior equilibria. Interior equilibria are generated by having either a non-linear return from the group account or from tokens kept for private consumption. These studies are reviewed in Laury and Holt (1998).

Most notable from this group, Isaac and Walker (1996) designed three treatments that differed with respect to the Nash prediction for contributions to the group account. Predicted contributions to the group account were either 'low', 'medium', or 'high' relative to a subject's token endowment.[5] Not inconsistent with the two boundary cases discussed above, Isaac and Walker found that contributions were still above the Nash prediction in the low case, close to predicted behavior in the medium case, and lower than the Nash prediction in the high case. Overall, the upward bias in contribution rates was greater than the downward bias.

Another interesting variation of the VCM explored the degree to which negative versus positive framing affected contributions to the public account. In the negatively framed version, all tokens were initially in the public account, and subjects were allowed to transfer a certain number to their private accounts. Andreoni (1995b) termed the positive effect of giving a 'warm glow' and the negative effect of taking the 'cold prickle'. Much more free riding was observed in the negatively framed VCM experiments. By the tenth period, almost all of the tokens were withdrawn from the group account.[6]

There is also evidence that individual specific characteristics, like gender and nationality, affect behavior in the VCM.[7] This is consistent with Palfrey and Prisbrey's (1997) finding that errors and altruistic behavior vary widely across individuals. The challenge for economic

theorists is to define new models that incorporate individual specific rates of learning and other-regarding preferences. Holt and Laury (1997) review some new models that were designed to organize what we have learned from this plethora of public goods experiments into a useful predictive tool.

For policy makers, the pertinent question is 'what can experiments teach us about alleviating the free riding problem?' Two variants of the VCM have resulted in near efficient levels of contributions to the public account. One of these adds a provision point. In the simplest case, if a predetermined number of tokens is allocated to the group account, each member of the group receives a benefit. If the provision point (i.e., minimum level) is not reached, no one receives a benefit from the group account. Isaac, Schmitz and Walker (1989) found that provision points were effective at increasing contributions to the group account as long as tokens allocated to the group account were returned if the threshold was not met. Marks and Croson (1998) reported that contribution rates were also sensitive to the way residual tokens were used when the provision point was exceeded.

The other treatment variable that increases contributions to the group account is the ability of subjects to engage in face-to-face communication. Isaac and Walker (1988) allowed subjects to communicate under a variety of experimental conditions. Interestingly, the effect of communication did not depend on the ability to enforce agreements. In general, however, infrequent opportunities to communicate and impersonal channels for communication diminish its effectiveness at increasing contribution rates. Agreements made during communication periods are often short-lived. In addition, communication via notes or computer terminals have little effect.

Incentive compatible mechanisms

While communication and provision points can alleviate the free riding problem, more formal methods have been developed to assist in the provision of public goods. Many of the laboratory studies in this area are tests of incentive compatible mechanisms (ICMs). These mechanisms are designed to elicit private values for a public good. Further, some ICMs have a fully funding tax scheme in which individuals pay for the public good in proportion to the benefit they receive from it. These studies do not directly address the free rider problem, rather they focus on providing an efficient level of a public good. Also unlike the VCM experiments discussed above, most experimental tests of ICMs induce heterogeneous individual preferences for the public good. Since symmetric outcomes (i.e., subjects evenly split the cost of the public good) are not efficient, this setup actually provides a more stringent test of ICMs.[8] Chen (1998) provides a comprehensive survey of these mechanisms, including many theoretical issues that will not be discussed here.

One of the first theoretical studies to motivate experimental tests of ICMs was done by Groves and Ledyard (1977). They devised a quadratic tax rule to fund a public good. Each person has a private value schedule for the public good. Based on that schedule, she proposes an amount of the public good to be provided. All of the proposals are collected and the cost for each participant depends on that person's proposal, the cost to produce the public good, the number of people in the group, and the sum of proposals by other people. The scheme has the desirable property that honest revelation of one's preferences is a dominant strategy.

Given the complicated nature of the tax mechanism, the dominance of true revelation is far from apparent. Hence, experimental tests of the mechanism were conducted in an iterative fashion. Subjects were first told their values for the public good, then asked to submit proposals

in rounds. The process ended when all subjects submitted the same proposal twice in a row or after some designated number of rounds passed, in which case everyone earned $0. Iterating in this manner changed the equilibrium, but allowed subjects more time to figure out how the scheme works and to develop a strategy.

Initial experimental tests of the Groves-Ledyard mechanism were encouraging. Smith (1979) found that groups ranging in size from four to eight reached an efficient level of production. However, follow-up experiments by Smith (1980) and Harstad and Marrese (1982) were less encouraging. Specifically, with more complex revisions to the design, like full funding of the public good, individual bids were not demand revealing. Curiously, the quantity of the public good provided was generally close to the efficient level despite individual deviations from the optimal strategy. In another set of experiments, Chen and Plott (1996) introduced a punishment parameter to the Groves-Ledyard mechanism to fine a subject based on the deviation of her proposal from the mean of other proposals. They found that for a high enough punishment parameter, proposals converged to efficient levels. This result was replicated by Chen and Tang (1998).

In related work, Vernon Smith (1979) designed an alternative auction mechanism to reveal individual demands for a public good. In the Smith auction, each person reports how much of the public good she wants provided and how much she is willing to contribute. Each person is informed of the average quantity proposal and a proposed cost to them, which is the cost of the average quantity proposal minus the contributions proposed by all other participants. Subjects can agree to this scheme or veto it. Unanimous approval of a scheme ends the process. The Smith auction is not theoretically demand revealing. However, experimental results suggest

that it is at least as effective as the Groves-Ledyard mechanism at achieving an efficient outcome.[9]

As noted above, the VCM and the tax schemes discussed above are appropriate to analyze pure public goods. Another class of public goods is impure in the sense that they are non-excludable, but rival in consumption. We generally think of individual maximization as imposing a negative externality in this case, since no one takes into account the fact that by using the resource they diminish its value to others. The section that follows includes a discussion of two different lines of laboratory research related to this class of goods. The first subsection reviews common pool resource experiments.

B. Negative externalities

1. Common pool resources

Gardner, Ostrom and Walker (1990) introduced the experimental design that has been used extensively to study common pool resources. Similar to the voluntary contributions mechanism, the common pool resource mechanism (CPRM) has subjects divide tokens between two accounts. One account represents a private good and has a fixed rate of return. The other account represents the common pool resource, and has a potentially higher payoff that is a quadratic function of the total group investment in the account. Unlike the VCM, individual earnings from the common pool resource vary depending on the number of tokens invested in the resource. For example, an individual who invests nothing in the common resource earns nothing from it. The common pool resource is rivalrous in the sense that a token invested in the resource earns a lower return as other people invest more in it. The non-linear payoff function for the common pool resource makes both under-investment and over-investment possible. In the experiments reviewed here, the Nash prediction is between the socially optimal level of investment and

complete depletion of the resource (i.e., with zero or negative individual earnings from the account).

Gardner, Walker and Ostrom (1990) present results from baseline CPRM experiments. Players were identical with respect to token endowments and marginal returns from the private account and the common pool resource. They found that aggregate investment in the common resource was close to the Nash prediction with a 'low' token endowment. However, individual behavior was not consistent with a symmetric Nash outcome. The most common individual strategy was to invest all tokens into the common account as long as its return was greater than the (fixed) return from the private account. If the return from the common account fell below the return from the private account, in the subsequent period all tokens were invested in the private account. Hence, behavior in these experiments was erratic with no discernable trends. When subjects were given a relatively high token endowment (25 versus 10), holding all other parameters constant, there was significantly more over-investment in the common pool resource.

Walker and Gardner (1992) introduced a probability that the common resource will be destroyed to the CPRM setup. The probability of destruction increased with the number of tokens invested in the common pool resource. In one treatment there was a 'safe option' where the probability of destruction was zero as long as the investment in the common account was below some threshold. With the probability of destruction, behavior was close to theoretical predictions. In all cases, the resource was destroyed, normally within a few decision making periods.

As with the VCM, communication helped to remedy the overuse of the common pool resource. Ostrom and Walker (1991) investigated the use of communication as a potential remedy for over-investment in the common pool resource. With a costless, one-shot opportunity

to communicate, there was an immediate improvement in efficiency. However, subjects subsequently defected on agreements about 25 percent of the time. With repeated opportunities to communicate, efficiency gains were more persistent. When subjects were offered the opportunity to purchase a discussion period, they did so, even though it required coordinating to pay for the privilege. This costly discussion also improved efficiency in the use of the common pool resource. In addition, Ostrom, Walker and Gardner (1992) found that subjects were willing to incur a cost to punish people who over invested in the common pool resource.

In a related study, Casari and Plott (1999) altered the CPRM so that one subject was an inspector who could monitor and punish subjects who over-invested in the common resource. They found excessive monitoring, despite the fact that it was costly for the inspector. Further, their results suggested that a good model of behavior in this environment incorporates heterogeneous preferences for altruism and spite.

2. The Coase theorem

As noted above, while generally effective, agreements reached during communication periods were not binding in the experiments discussed thus far, since there was no designated enforcement agency. Hoffman and Spitzer (1982) designed an experiment with the opportunity for discussion and a mechanism for enforcing agreements. Their experiment was a direct test of the Coase (1960) theorem. Subjects were paired and had to jointly choose an activity level. The activity was a good for one of the people (person A) and imposed a negative externality on the other person (person B). Hence, person A preferred a high activity level and person B preferred a low activity level. One person in the dyad was designated ‘controller’ by flipping a coin, meeting Coase’s property rights requirement. The controller ultimately chose the activity level, but could

be offered side payments to compensate her for deviating from her individually optimal choice (the highest activity level).

Hoffman and Spitzer found that subjects frequently reached an efficient outcome, but controllers rarely exploited their power by demanding side payments that were large enough to fully compensate them. In follow-up experiments, Hoffman and Spitzer (1985) had subjects earn the right to be the controller in a game of skill. Their basic finding was the same, but controllers were more aggressive in demanding side payments when they perceived their positions as having been earned.

McKelvey and Page (1998) stress-tested the Coase theorem by relaxing the full information condition. In a variation of the Hoffman and Spitzer (1982) experiment, subjects communicated via computer terminals and, in one treatment, were only given private information about payoffs. The controller role was randomly assigned. Results from their full information treatment were consistent with Hoffman and Spitzer's, but they found that the Coase theorem failed to predict behavior in the private information treatment.

A huge body of literature related to Coase's work explores market-based solutions for negative externalities in the context of tradable pollution permits. Though beyond the scope of this review, permit experiments are especially interesting from a public choice perspective because much of the early work in this area was influential in the design of actual permit trading schemes. Some initial experiments (e.g., Plott 1983) demonstrated that permit trading dominates traditional command and control on efficiency grounds. Much of the current experimental work was motivated by policy proposals and initial implementation problems. An indication of the popularity of this topic is that the most recent volume of *Research in Experimental Economics* (Issac and Holt 1999) is devoted entirely to permit related studies.

II. Rent seeking

One of the contentious issues in administering a decentralized or market based corrective policy is choosing winners and losers. Someone must decide who is designated controller or how pollution permits are distributed. These decisions give rise to another inefficiency that has come to be known as 'rent seeking'. Rent seeking refers to the wasteful use of resources in pursuit of some 'prize'. Early theoretical papers focused on competition for the right to be the monopolist or to receive favorable trade status through tariffs as the prizes that spawned rent seeking behavior.

Tullock's (1980) groundbreaking theory of 'efficient' rent seeking explored the relationship between rent seeking expenditures and the mechanism that translates expenditures into probabilities of winning the prize. Specifically, with two competitors, the probability of winning the prize is calculated as $P_A = A^r/(A^r + B^r)$, where A and B are lottery tickets purchased by players A and B, respectively. The parameter *r* determines the impact of differences in expenditures on probabilities of winning.

Millner and Pratt (1989) designed the first laboratory test of Tullock's model. In the experiment, two people were offered the opportunity to buy lottery tickets for a prize of known value. Students were told that the probability of winning was based on the function above, and this probability was calculated for them and displayed on their computer screens as purchasing decisions were made. In one treatment, the probability of winning was equal to a person's share of the total expenditure on lottery tickets (i.e., $r = 1$). In another treatment a larger exponent ($r = 3$) was used to calculate probabilities. Each purchasing period lasted two and one half minutes

and subjects could purchase tickets at any point during the period. In addition, all purchasing information was public information and was updated on computer screens throughout the period.

Millner and Pratt found that subjects spent more than the Cournot-Nash prediction on lottery tickets in the $r = 1$ treatment and less than the Cournot-Nash prediction in the $r = 3$ condition. Overall, the amount spent on lottery tickets was lower in the $r = 1$ treatment than in the $r = 3$ treatment. Shogren and Baik (1991) replicated Millner and Pratt's $r = 1$ treatment, but had one a one-shot investment decision without information about others' purchasing decisions. They found that individual expenditures were consistent with the Cournot-Nash prediction. Millner and Pratt (1991) replicated their own 1989 study but added a pre-test to group people by risk preferences. In their 'less risk averse' group, expenditures were higher than the Cournot-Nash prediction. In the 'more risk averse' group, expenditures and rent dissipation were not significantly different from theoretical predictions.

Davis and Reilly (1998a) tested a variation of Tullock's model with two main changes. First, they compared results using the lottery ticket competition described above with a 'perfectly discriminative auction', in which the highest bidder wins the prize. Second, they added a strategic buyer who engaged in rent defending. This buyer was meant to represent consumer groups who might oppose the awarding of monopoly rights. The authors demonstrated that the value of being a monopoly seller might be lower than the value of blocking the monopoly to potential buyers. Hence, the rent defender was operationalized by adding a buyer with a higher value for the prize than other bidders in the auction. In all cases, five bidders participated. The role of the rent defender rotated among the subjects and was randomly determined by the throw of a die. In each auction, subjects submitted sealed bids and the results were announced aloud. This sequence was repeated 15 times for each group of subjects.

Davis and Reilly found that expenditures were higher in the discriminative auction than in the lottery based auction. They also found that the presence of a strategic buyer reduced expenditures. However, expenditures were consistently higher than predicted by theory. In a follow-up study, Davis and Reilly (1998b) added additional rent defenders and concluded that expenditures increased relative to having only one rent defender.

In another extension of Tullock's (1980) theory, Onculer and Croson (1998) examined rent seeking behavior when the value of the prize was uncertain. They also varied the initial endowment and the size of the group from two to four people. Subjects participated in only one decision making sequence. They found that subjects spent more on average than the Nash prediction and expenditures increased with group size and endowments.

III. Voting

When inefficiencies, such as the ones discussed above, cannot be corrected with decentralized or market based methods, collective action is often required. As early as the 1940s, economists were analyzing the majority voting rule and possible problems with it.[10] Fiorina and Plott (1978) conducted the first committee voting experiments. Subjects were given payoffs in a two-dimensional decision space. They were told that outcomes were decided by majority rule and very little additional structure was imposed on the situation. The authors were surprised to find recurring behavioral patterns.[11]

A major concern with pair-wise voting on a number of alternative proposals is the possibility of agenda manipulation. Consider the following example from Holt and Anderson (1999). A community is considering a school project and a highway project. One project, both projects, or neither project may be funded. Each voter pays a tax of $200 per approved project. If

a voter uses a project, its value to her is $400. Otherwise, it has no value to her. There are seven members on the community board, two of which prefer to fund both projects, two prefer to fund only the highway, and three prefer to fund only the school. Pair-wise voting over the alternatives can result in many different outcomes. For example, a voter with a preference for both projects can guarantee that outcome with the following three-vote agenda: Vote 1: School versus Highway, Vote 2: Winner of Vote 1 versus No Project, Vote 3: Winner of Vote 2 versus Both Projects. Furthermore, the agenda can be designed so that any outcome is possible.[11]

In a more complicated laboratory environment, Plott and Levine (1978) designed a scenario with five possible outcomes. By manipulating the agenda, they were able to force three of the outcomes in only four sessions of the experiment. This result suggests that models assuming forward-looking individuals are inappropriate because, armed with information about the order of votes, subjects could vote strategically in early votes and ultimately avoid undesirable outcomes. Specifically, strategic voting in this context is voting against one's preferred outcome in early rounds when it makes it more likely to reach a desirable outcome in later rounds or voting.

Eckel and Holt (1989) had subjects vote on pairs of options in sequence with full information about the upcoming agenda. Subjects voted naively initially, but experience increased the incidence of strategic voting. Holt and Anderson (1999) replicated this finding in a less controlled classroom setting.[12]

The focus of some recent voting experiments has shifted to alternatives to majority rule. Forsythe *et al*. (1996) compared results in three-candidate elections using plurality rule, approval voting and Borda rule. In these experiments, Condorcet losers won more often under plurality

than either of the alternatives. As in Eckel in Holt (1989), subjects voted more strategically as they gained experience.

McKelvey and Palfrey (1998) examined voting behavior of juries when a conviction required unanimity. In their clever design, subjects were given imperfect private information about the innocence or guilt of the defendant without using voting-related terminology. A red jar and a blue jar represented innocence and guilt, respectively. At the beginning of the experiment, subjects saw these jars and their contents. The red jar contained seven red balls and three blue balls. Symmetrically, the blue jar contained seven blue balls and three red balls. Subjects were told that one jar (i.e., innocence or guilt) was to be randomly chosen by the roll of a die. Then each subject saw a private draw of a ball (but not the jar used for the draw), and was asked to predict which jar was used for the draw.

Payoffs depended on the group decision. In one treatment, subjects were rewarded if a majority of the decisions were correct. In another treatment, red (guilty) was the group decision only if all of the subjects predicted red. Otherwise, blue was the group decision, and subjects were rewarded only if the blue jar was actually used for the draws. In addition to varying the voting rule, there were two different jury sizes (3 people or 6 people), and in some cases a straw poll was conducted prior to the actual prediction round.

McKelvey and Palfrey found that votes (i.e., predictions) revealed a person's private signal 94 percent of the time with the majority voting rule. With the unanimous voting rule, most people voted guilty (i.e., predicted red) when their draw indicated guilty, but with an innocent (blue) draw, mixed strategies were commonly used. In three-person juries, 36 percent of the people voted guilty when they saw an innocent signal. In six-person juries, this number increased to 44 percent. With the straw poll, more than 90 percent of the votes revealed private signals in

the polling round. In the actual voting round, 80 percent of the people voted in favor of the option chosen most frequently in the straw poll. Overall, fewer innocent people were convicted under majority rule under a rule of unanimity. In addition, larger juries convicted fewer innocent people when unanimity was required.

IV. Summary and conclusion

Laboratory studies in the public choice arena provide mixed results when externalities arise from individual decisions. The evidence on public goods provision suggests that conventional theories are not good at predicting behavior. Further, theoretically irrelevant variables often influence decisions. In a sense, this failure is encouraging from a policy perspective, because we have learned that people do not free ride on public goods to the degree predicted by theory. Further, provision points and the ability to communicate can alleviate the problem. Experiments with common pool resources show that over-use is a problem, and in some cases, even more so than predicted by theory. However, communication also improves efficiency in this setup and subjects are willing to incur a cost to punish over use of the resource.

Experiments also suggest that people engage in inefficient rent seeking, even with a prize of unknown value. Adding one rent defender decreases the amount spent by others, but expenditures are higher with multiple rent defenders than with none at all. Little experimental work has been done in this area relative to the number of theoretical studies. Hence, this is a fertile area for laboratory research in public choice.

Laboratory studies of voting behavior confirm the finding from VCM experiments that behavior is not always consistent with theory, especially when subjects have little experience with a particular design. A common theme throughout the studies reviewed here is that theories

that assume homogeneous agents fail to predict behavior in the laboratory. Many person-specific characteristics such as learning, risk preferences, altruism and spite are significant factors in predicting the decisions people make. This heterogeneity complicates the job of policy makers and mandates that theorists and experimentalists continue to work together on more general models of behavior.

Table 23.1. Treatment variables in voluntary contributions experiments.

Variable	Study	Effect on contribution rates
Repetition	Isaac, Walker and Thomas (1984)	Negative
Size of group	Isaac, Walker, and Williams (1994)	Positive
Conversion factor for tokens in public account	Isaac, Walker and Thomas (1984)	Positive
Experience	Isaac, Walker and Thomas (1984)	Negative
Framing as a public bad	Andreoni (1995b)	Negative
Anonymity	Laury, Walker and Williams (1995)	None
Provision point	Isaac, Schmidtz and Walker (1989)	Positive
Communication	Isaac and Walker (1988)	Positive
Heterogeneous agents	Chan, Mestelman, Moir and Muller (1998)	Positive

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Notes

[1] See Chapter 1 of *The Handbook of Experimental Economics* (Kagel and Roth, eds.) for a thorough history of experimental economics.

[2] See for example Coase (1960), Buchanan (1965) and Olson (1965).

[3] Subjects were told either that they would meet the same person each period or that they would meet a different person each period, depending on the treatment.

[4] Some replications of the partner-stranger design have been inconsistent with this initial finding. See, for example, Croson (1996), Keser (1996), Keser and van Winden (1996), and Weimann (1994). These results are reviewed in Andreoni and Croson (1998).

[5] In the 'low' treatment, the Nash prediction was for 19.4 percent of each person's tokens to be allocated to the group account. In the 'medium' and 'high' treatments, predicted contributions were 50 percent and 80.6 percent of the endowment, respectively.

[6] Sonnemans, Schram, and Offerman (1998) found similar results in a slightly different environment. Bulando and Hey (1997) only use the negative version and their results fell between Andreoni's (1995b) positively framed and negatively framed results.

[7] See, for example, Brown-Kruse and Hummels (1993) for an analysis of gender differences in the VCM. Burlando and Hey (1997) compare contribution rates across several countries.

[8] There is mixed evidence regarding the effect of variable and asymmetric marginal values for the public good on free riding (see, for example, Chan, Mestelman, Moir and Muller 1998).

[9] See Smith (1979) and Banks, Plott and Porter (1988) for results from laboratory tests of the Smith auction.

[10] See, for example, Black (1948).

[11] McKelvey and Ordeshook (1990) discuss this experiment and survey the literature on voting experiments done prior to this decade.

[11] See Chapter 7 of this volume.

[12] The Holt and Anderson (1999) setup was used to demonstrate the possibility for agenda manipulation and strategic voting at a conference on classroom experiments held at the University of Virginia in the Spring of 1997. Conference participants, who were mostly college professors from Virginia and nearby states, also failed to vote strategically initially.