Université de Montréal

Does Participation Matter?
The Impact of Subjective Calculus on Participation

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INTRODUCTION

Experimentation has been the foundation of pure science research since the 18th century. Experimental work in the social sciences was born in the first part of the 20th century from a desire to test hypotheses in a controlled environment (Kinder & Palfrey, 1993). By then, political science and economics have already completed a separation. Therefore, it is now difficult to find a clear and generally accepted corpus of hypotheses that could allow comparison between experiments in political science and economics.

This paper is a discussion about probability calculus. Experiments had shown that individuals generally miscalculate probabilities but very few insights have been given on the reasons behind these errors. We argue that subjective calculus is the main responsible for individuals' miscalculations. We argue that three factors cause this miscalculation: preconceived ideas, past social experience and calculus capabilities.

The classical utility maximizing actor model predicts that in absence of coercion devices that increase the cost of deserting, the Nash equilibrium solution to a non-cooperative voluntary provision of a public good is defection of every actor. This means that despite the self-interest of everybody to see the production of the public good, the optimal behaviour of each individual is to free-ride. *Individual rationality is not sufficient for collective action* (Sandler, 1992). This poses an important challenge to rational choice theorists since what is called a prisoner's dilemma is often violated in experiments and in society. Indeed, economists and political scientist are now trying to craft a series of assumptions that take into account empirical and experimental findings.

Until recently, Olson's conclusions about collective action were the best explanation about what was responsible of frequent failure in public good provision (Olson, 1965). During the nineties, Elinor Ostrom's seminal work on successful institutions gave a new birth to collective action studies in political science. The author defines a successful institution as *an institution that enables individuals to achieve productive outcomes in situations where temptations to free-ride and shirk are ever present* (Ostrom, 1990). She argued with quite convincing empirical examples that this kind of institution exists and can last for a long period of time if a series of conditions are respected.

Experimental economics can help social scientists on this question. Experiments conduct in a controlled environment allow investigators to calibrate, estimate and test different hypotheses of their model. For the last twenty-five years, a long series of experiments have been conducted on voluntary provision of a public-good. We use some of their results in this paper. These experiments are not a panacea to every theoretical problem but we believe they are one of the best tools available.

In the first part of this paper, we take a look at the fundamentals of public provision in political science and economics. We define terms and concepts common to that type of situation. Secondly, we review some of the most important assumptions used to explain human behaviour in the situation of voluntary provision of public good and we present a coherent body of hypotheses that flow from these assumptions. We elaborate a definition of the rational actor. We define what we mean by utility and preference. We finally turn our attention to the subjective part of the decision process and to what exactly affects the decision. We argue that preconceived ideas, past social experiences and calculus capabilities are crucial to understand agents' decisions.

In the conclusion, we give some suggestions for future experiments to improve our understanding of individuals' choice mechanisms.

PUBLIC GOOD PROVISION

Definition of a Public Good

We define a public good as *a commodity for which use of a unit of the good by one agent does not preclude its use by other agents and for which it is not possible for an agent to prevent its use by other agents* (Mas-Colell, 1995). We have here the two distinctive characteristics of a public good. First, its utilization by one agent doesn't obliterate or modify the good. Some could argue that fresh water and clean air are public goods and but that they can might from excessive utilization. It is true. We use that narrow definition keeping in mind that our experimental tools are not designed to replicate dynamics of natural resources management.

Secondly, a public good is non-exclusive. Indeed, there is no mechanism available at reasonable costs to assure that only its producers are allowed to benefit from it. This characteristic could be a problem depending on the nature of the public good. Some public goods have increasing costs associated with increased consumption while others, like knowledge, do not suffer from increased utilization. We must make a distinction between the public good produced and the collective action that leads to its production.

The utility derived from the production of a public good is inferior to the one derived from a private good, following this general equation for individual i:

$$U(x_i, y_i) = \beta_i * x_i + \delta_i * \Sigma y_{(1 \text{ to } n)}$$

Where $\beta_i > \delta_i$, β_i is the strength of preference of individual i for the private good x_i and δ_i is the strength of preference of individual i for the public good Σy_i. We suppose, following previous research in experimental economics and classical economic theory, that individuals have a strict preference for private consumption. Public consumption, associated with post-materialist values, generally arises when basic private needs are fulfilled. Also, individuals generally consider public consumption less attractive because they are left with the impression of having paid too much since ownership is shared with the whole community. Strict preference for private consumption is therefore realistic in our model where agents don't face a surplus of revenue and are only concerned by their own well-being. Indeed, participants receive a limited amount of money in the game and do not face post-materialist values observed in wealthy and well-

educated society. Note that utility function could be nonlinear. Using common optimization method, we can identify Nash equilibriums and a Pareto optimum.

A Nash equilibrium is *a situation where each player's strategy choice is a best response to the strategies actually played by his rivals* (Ibid, 246). Formally, A strategy profile $s = (s_1,\ldots,s_t)$ constitutes a Nash equilibrium if:

$$U_i(s_i,s_j) \geq U_i(s'_i,s_j) \text{ for all } s'_i \varepsilon S_i$$

Nash equilibriums exist only if a series of conditions are respected. First, we suppose common knowledge of each others' rationality. Theoretically, this assumption seems quite obvious but it is constraining because, as we will see, rationality faces virulent critics particularly in political science. Secondly, we suppose rationalizability, which means that each agent considers that others take their best decision in face of a choice. Finally, we suppose that agents make the right evaluation of each others' payoffs.

Pareto optimality is a central concept in microeconomics. Using individuals' utility maximization calculus, it is possible to find *a feasible allocation Ψ that is Pareto optimal (or Pareto efficient) if there is no other feasible allocation $\Psi(x_1,\ldots,x_I; y_1,\ldots,y_J)$ such that $u_I(x'_i) \geq u_i(x_i)$ for all $I = 1,\ldots,I$ and $u_i(x'_i) > u_i(x_i)$ for some i* (Ibid, 313). This means that, under certain conditions, there is an allocation of resources that is optimal for everybody in a sense that it is impossible to improve the well-being of one without affecting negatively the well-being of at least another.

Pareto optimality has nothing to do with equity or fairness. The only criterion for optimality is the general well-being of the group. Classical microeconomics predicts that private provisions of a public good always produce an equilibrium level under the Pareto optimal level[1]. A Pareto optimal allocation (q°) must maximize aggregate surplus and respect the necessary and sufficient first-order condition:

$$\Sigma U_i'(q^\circ)_{(i \text{ to } n)} \leq c'(q^\circ) \text{ with equality if } q^\circ > 0$$

Where c (q°) is a strictly positive and a convex cost function and q° is the Pareto optimal quantity. If $q^\circ > 0$, we have a situation where *the sum of consumers' marginal benefits for the*

[1] For an exhaustive proof about the inefficiency of private provision of public goods, see Mas-Colell, A., M. D. Whinston, and J. R. Green (1995): *Microeconomic Theory*. New York: Oxford University Press, pp. 360-363..

public good is set equal to its marginal cost (Ibid, 361). We can also derive an optimality condition for the supply side of the problem where individuals participate to the production by purchasing the public good. Using a fixed price (p*) to compare marginal utility (profit) of consumer (producer) to marginal cost c'(q°(p*)), we have:

$$\Sigma\, U_i'(q^\circ)_{(i \text{ to } n)} > c'(q^\circ)$$

It is impossible to reach an equilibrium between demand and supply side in a pure environment. It is nonetheless possible to reach a Nash equilibrium that is also Pareto optimal by modifying the utility function or the cost function. This is exactly what most experimenters do when they craft different payoff mechanisms.

So Pareto optimality cannot be attained in a pure environment. Therefore, this level of provision of a public good cannot be equal to the Nash equilibrium. It can be shown that, under our assumptions about rational actors (self-interest, common knowledge, rationalizability, etc.), the Nash solution is that each agent free-rides. This conclusion is derived from the necessary and sufficient first-order condition of utility maximizing where:

$$\frac{d\, U(x_i, y_i)}{d\, x_i} = \beta_i - \delta_i \text{ where } \beta_i > \delta_i \text{ for every } i \in (1,\ldots,n)$$

Consequently, the marginal utility of private consumption is positive for every x. We have a corner solution where every agent decides to free-ride and consume only the private good. It would make sense to consider that in the long run, the marginal utility of private consumption would get close to zero. In that case, it would be possible to reach a point where individuals would be indifferent between private and public consumption:

$$\text{Lim}_{(w \to \infty)}\, \beta_i - \delta_i = 0 \text{ where } w \text{ is the revenue of individual i}$$

However, under the hypothesis that each individual has a budget constraint, this situation is improbable. To recapitulate, we know that the single Nash equilibrium is $y_i = 0$ and the Pareto optimal level of consumption of the public good is $y_i = w_i / p^*$.

Definition of a Collective Action

We define collective action as *an activity that requires the coordination by two or more individuals whose actions are independent* (Sandler, 1992). This definition alerts us to the importance of others' behaviour in the production of collective action. A collective action is not necessary successful in producing the desired public good but it is a proof of the very existence of a voluntary public good provision . Formation of a lobby or a conservation group generates cost that must be supported by its members. Experimental economics can't explain this collective action paradox because guaranteed remuneration is necessary to conduct experiments. We argue that survey analysis is a better tool to answer that peculiar question. Let just say that Robert Putnam work on social capital has shown a declining but still strong engagement of American citizens and a significant investment in money and, to a lesser extant, time in collective action (Putnam, 2000). We now have to understand its dynamics and its outcomes.

Political scientists have quite convincingly demonstrated how important social structures, norms and values are in explaining agents' behaviour. Group size, group heterogeneity and cooperation devices are the most cited factors responsible for the presence or absence of collective action. Big groups tend to fail when trying to conjugate efforts to produce a collective outcome. Heterogeneous groups are more successful because individuals with very intense preference for the public good will burden costs more heavily to reach their objectives. Long-standing cheap devices are more efficient than short-term costly policies (Marwell, 1993). Social pressures and an acquired sense of duty can affect quite heavily individuals' behaviour despite infinitesimal risks of being caught while being anti-social. But much work needs to be done to understand what is happening between small groups' apparent success and large groups' predicted failure. We argue that group size is a significant but indirect explanatory factor of individuals' behaviour because of its consequences on calculus complexity.

Economists believe that agents infer others' utility function on the basis of available comprehensible information and use this estimation in their calculus. Agents are also able to evaluate others' discount rate and their perceptions of threats. We argue that individuals will try to infer others' behaviour using an aggregated proxy instead of multilevel complex calculus. It is a lot simpler and less costly. In short, we have a general definition of public goods, a preference for private consumption and a predicted behaviour: free-riding. We also know that, without institutional devices, the outcome is not Pareto optimal. We now turn our attention to the rational actor model to understand how agents' calculate.

THE RATIONAL ACTOR

Rationality has been defined in many different ways In political science, emphasis is put on the effect of rationality on the political output. It is quite rare for a political scientist to make explicit hypotheses on such questions as perfect information, risk averseness or preference convexity. It doesn't mean that they neglect that part of the process but rather that their analysis generally doesn't require complex modeling.

However, there are some subfields of political science where formal modeling is present (Austin-Smith, 2000). Political behaviour is particularly fertile in terms of debates and theories about the validity of rational choice. The paradox of voting is a good example of limits of rational choice[2]. Since the marginal effect of voting in a sufficiently large group election is almost zero and there is a cost associated with the action of voting (time, information gathering, etc.), a rational actor would have no reason to participate in this activity. However, a majority of eligible citizens do vote at each election

Economists are also preoccupied by the outcome of rational calculus but the process receives more attention. Following Kaushik Basu's definition, *a person is taken to be rational if that person, given his information, chooses the action that maximizes his objective, whatever that objective happens to be* (Basu, 2003). There are three major parts in that definition. First, incomplete information is possible and exogenous in the rational actor model. Secondly, rationality supposes maximization under constraints by the actor. A rational actor does not only maximize her own benefits facing a static environment but she also takes into account other's benefits and objectives. Finally, rational objectives don't have to comfort exogenous beliefs of what seems best for an individual from an outside look. Social norms, but also erroneous common sense, must be workable within the rational actor model.

Utility, Preferences and Decision

The concept of utility has taken a central place in microeconomic theory. Despite its vagueness, utility has nonetheless the advantage of being flexible in term of definition. In experimental economics, money is the indirect measure of utility for participants. Unfortunately,

[2] For good reviews on the question, see Blais, A. (2000): *To Vote or Not to Vote; the Merits and Limits of Rational Choice Theory.* Pittsburgh: Pittsburgh University Press and Green, D. P., and I. Shapiro (1994): *Pathologies of Rational Choice Theory; a Critique of Applicatons in Political Science.* New Haven: Yale University Press.

this proxy brings some problems and we must accept constraining hypotheses to continue our investigation.

The first of these hypotheses is that every individual gets the same utility from money. It is easy to imagine two rational individuals who don't give the same value to a hundred dollars. Despite the fact that these two individuals could buy the same amount of goods with this money, the opportunity cost of that consumption can take a wide range of values, particularly when there is heterogeneity in ability and endowment. For example, someone who owns enough money to live comfortably for the rest of her life certainly doesn't give the same intrinsic value to one hundred dollars than the one who barely has enough to pay his bills at the end of the month. This heterogeneity causes major problems when it comes to modeling because extending our model in *N*x*N* dimensions to allow different utility function forms for every individual would cause technical problems in the maximization process. As we see, this first hypothesis that we call comparable utility of money is the least of two evils. We will assume:

$$U_i(x_i) = U_j(x_j) \text{ for } \forall \{i,j\} \;\&\; U_i(y_i) \neq U_j(y_j) \text{ if } i \neq j$$

Our second hypothesis is about the marginal utility of money as a function of the reference point. We mean by this the assumption that the utility of a marginal increase of revenue is a function of one's reference point (Kahneman, 1979). Indeed, utility gain from money becomes smaller and smaller as this gain gets further away of this reference point. This finding implies that *while people are likely to be risk averse over gains, they are often risk-loving over losses* (Rabin, 1998). Limited resources available to conduct research oblige experimenter to cap money revenues for participants so some interesting situations are lost in the game. There are behaviours that individuals are ready to do to double their earnings if they own thousand dollars but that they would not accomplish for a few more dollars and a small endowment. We shall work with a limited hypothesis according to which individual gives more value to its marginal earnings close to the starting point in the game. We call this the decreasing utility of money around the local maximum.

$$\frac{dU_i(x_i) > 0}{dx_i} \;\&\; \frac{d^2U_i(x_i) \leq 0}{d^2x_i}$$

The final hypothesis is about comparison over time. We assume that utility of money is consistent in time everything else kept equal. Despite the fact that we compare experiments conducted at different moments during the last twenty years, we have to accept that individuals

would enjoy the same utility notwithstanding the moment of the experiment. This hypothesis makes sense for two reasons. First, experiments are conducted in a relatively short period of time going from few weeks to a couple of years and it is plausible to assume that norms and values do not change enough in that period to affect significantly the individuals' utility. Secondly, our main objective is comparison between different controlled environments. Consequently, the absolute difference in results between experiments realized in the early 80's and the late 90's is not a problem as long as relative changes in different controlled environment are robust to time. We call this hypothesis the consistent utility of money over time.

$$U_i(x_{it}) = U_i(x_{i(t+1)})$$

Under very general hypotheses, an indirect utility function $U_i(w_i,p^*)$ can also be derived from individuals' preferences. In the classical model, Samuelson, using the weak axiom of revealed preference, exposed this new way of apprehending rationality by a simple example of choice between *x*, *y* and *z* (Samuelson, 1947). Rationality supposes that if an individual chooses *x* over *y*, the addition of another choice (let say *z*) would not change her preference of *x* over *y*. Also, if *x* is preferred to *y* and *y* is preferred to *z*, then *x* must be preferred to *z*.

This conclusion has potential flaws. First, on a theoretical basis, feasibility sets can give information that changes one's choice. Amartya Sen gives the example of a meeting with someone you barely know. If she offers you a tea, suppose you accept (choice *a*) and drop the option of leaving while refusing the invitation (choice *b*). Suppose now that you have a third option that is taking cocaine with her (*choice c*). You might change your mind and leave right away for home because you don't want to fraternize with a drug-addict (Sen, 1993, 496). Basu claims that while it is possible to point out some situations where internal consistency seems violated, as long as these situations remain marginal it only proves that WARP can be falsified (Basu, 2003, 38-41).

Secondly, internal consistency supposes that, facing exactly the same choice set, a rational individual always makes the same decision. It seems that it is not always the case. Quattrone & Tversky did an experiment in 1988 to test the invariance of preference. Two representative groups were asked to make a choice between two different policies that had the following characteristics:

Table 1: The Framing Effet (Quattrone & Tversky 1988)

Group A (N=126)			Group B (N=133)		
Choice	Work Force Unemployed	Rate of Inflation	Choice	Work Force Employed	Rate of Inflation
X	10 %	12%	X	90%	12%
Y	5 %	17%	Y	95%	17%
X=36% of respondents and Y=64%			X=54% of respondents and Y=46%		

As we can see, these two situations are exactly the same in term of absolute effect. Nevertheless, the outcomes were quite different. The authors explained the difference with the ratio-difference principle. Individuals calculate changes in ratios instead of absolute values. Knowing that ratio of unemployment is 2 for the group A and close to 1 in group B; the authors affirm that there is a significant difference for individuals in these two problems because of that. Internal consistency still stands.

But the problem with internal consistency is that it is useless when in comes to predicting behaviour. It is impossible to find an equilibrium because no variables can be optimized or calibrated. It's like saying that a human is formed with individual cells and then trying to predict what he will eat in a fast-food restaurant. We will thus stick to the classical model but treat Quattrone & Tversky's findings as a consequence of individuals' calculus limitations.

So, are individuals utility maximizers in their decision? We answer yes but the question is then what are they maximizing[3]. Political scientists will tend to take into account social constraints in the maximisation process while economists consider a more individual-centered decision by agents. Everybody agrees that some external factors alter the maximisation process. Let us compare the results of three experiments[4].

Table 2: Different Characteristics, Different Outcomes

	# of Players	Mean % of Free-riders	# of Rounds
Dawes, Orbell & al. (1986)	7	49%	1
Androeni (1985)	5	27%.	10
Keser, Montmarquette (2003)	3	33%	100

Two main conclusions can be derived by this table. First, experimental protocol engineering has an effect on free-riding behaviour. These three experiments, while quite similar, had different

[3] For a great example of modeling and Pareto optimality in presence of altruism, see Eduardo Ley (1997)
[4] These numbers were picked from experiments with basically similar in terms of dominant strategies. It does not mean that their experimental devices were the same.

settings, group size and number of rounds. Secondly, something is happening that can not be explained by the classical microeconomic model. We argue that this flows from subjective probability calculus.

Free-riding, Altruism and Fairness

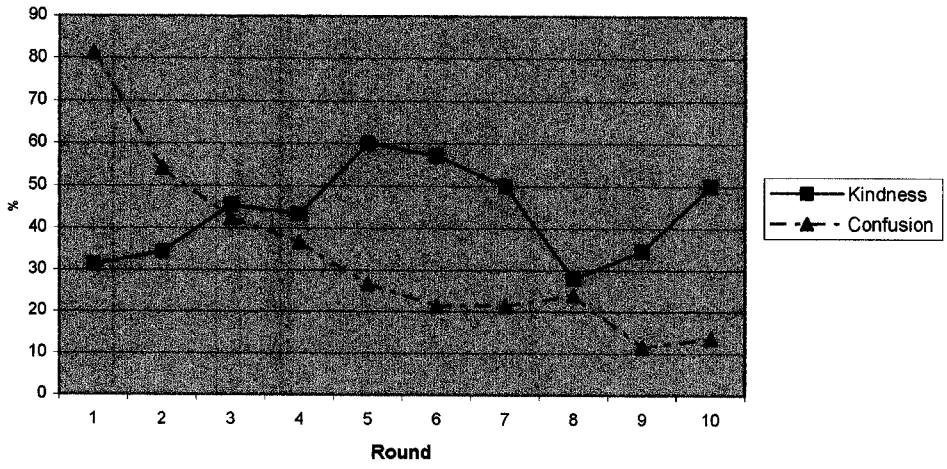
One of the most common critics of the rational actor theory concerns the negligence of norms and values in the analysis of choice and behaviour. According to the critics, these values have a significant impact on individuals that cannot be taken into account by the usual formal models. Altruism, catharsis and fairness are good examples of psychological mechanisms that are shaped by these norms and values. Dennis Chong considers that rational choice would have better explanatory value if two assumptions were incorporated in our model. First, *individual calculations of self-interest weigh social pressures and incentives alongside more tangible material factors*. Second, *current interests are contingent on past decisions* (Chong, 2000, 13-14). His first assumption is present in society but uneasily replicable in laboratory. It is part of the group size specification problem. His second assumption is that individuals are shaped by their past experience. As we will see in our discussion about subjective calculus, it is desirable to include a lag process in our behaviour prediction model.

Questions about norms and values are common in political science but rarely discussed in economics. While economists put the emphasis on what drives individuals' behaviour, political scientists are more preoccupied by constraints imposed by institutions and social pressure. Experimental economics provides a nice tool to calibrate the importance of social constraint versus self-interest, but there is a clear risk of tautology in incorporating social parameters in utility maximization and researchers must be sure to mark a difference between exogenous benefits and endogenous utility gained by an individual while participating to the common good.

It is evident that reciprocity is present in society. Ostrom's work on farmers' mutual help, Putnam's research on non-profit organizations and multiple field studies in anthropology showed how human beings naturally encourage and reward such behaviour. Experiments conducted by the CIRANO conclude that individual tends to cooperate significantly more if they experienced cooperation in the previous rounds (Keser, 2003, 22). However, it is not always clear why people act like that. Keser and Montmarquette don't clearly distinguish between confusion (gambler's fallacy) and kindness.

It is indeed hard to measure the real impact of sincere kindness and simple confusion. As a matter of fact, they both decrease free-riding but for different reasons. To solve this problem, Andreoni crafted an experimental protocol to measure non-exclusive kindness and confusion (Andreoni, 1995). He tested three experimental designs where different levels of information and different incentives. Andreoni argued that as participant gets frustrated by others' behaviour after a few rounds [5-8] they tended to free-ride more (decay phenomenon). We observe an increase in "kindness" at the end because slow learners would try cooperation before free-riding.

Figure 1: Andreoni's Measure of Confusion and Kindness



A brief review of literature has shown that free-riding is not the rule in experiments because individuals have values and social norms profoundly integrated in their lives. However, we must not forget that free-riding is still present and is a very common behaviour. Some would say experimental designs are crafted to encourage free-riding but social scientists try to replicate real life situations in their experiments and every day life is full of incentives toward cheating and shirking. In fact, experiments give more latitude to cooperation than it is usually the case because the relative triviality of issues at stake encourages altruism.

In our model, individuals gain utility from private and public consumption with a preference for the first type. They are also affected by framing and integrated social norms. In the last part of this paper, we argue that the main reason why individuals do not play Nash is subjective calculus. We argue that social norms, values, framing effect and reciprocity are the fruits of cognitive reflexes rationally constructed by individuals.

SUBJECTIVE CALCULUS

As we have seen in the previous section, a rational actor compares expected utility from different outcomes and makes a choice to maximize this expected utility. We've also seen that under the assumption of concavity of utility function, the rational actor is risk averse that is she prefers a certain outcome y to an uncertain one z if these two outcomes deliver the same utility. A risk premium will be necessary to change her decision. Kahneman has shown twenty-five years ago that individuals behave differently when facing a risk of losing or a chance of winning. To assure consistency, we have to assume strict convexity of utility function for negative utility (losses). While it is not always clear why inconsistency is present, we argue that a large part of it is due to subjective calculus. We argue that three kinds of cognitive mechanisms affect human behaviour: preconceived ideas, past social experiences and calculus capabilities.

Preconceived Ideas

The rational actor model argues that an individual is capable of measuring different outcomes' probabilities in a satisfactory way. Individuals' criticalness calculus and efficiency of their probabilistic calculations are the major features of probabilistic calculus. Dawes & al. made an experiment in 1986 where they investigated the factors organizing collective action (Dawes, 1986). Groups of seven persons were formed and each person was given 5$ at the beginning and offered to participate in a public good provision game that needed a certain level of participation (5) and could earn 10$ to each participant.

Three devices were then tested on different groups. In the first device, the 5$ was lost if not enough persons participated to the public good provision (Standard dilemma). In the second one, subjects were guaranteed to receive their money back in case of collective failure but could still free-ride on others (Money-back guarantee). In the final group, the maximum payment acceptable was 10$ so if an individual tried to free-ride to get 15$, she would lose 5$ (Enforced contribution). There was no pecuniary reason to free-ride in this device. Contribution was going from around 65% in the standard dilemma and the money-back guarantee device to 93% in the enforced contribution device. Using Amnon Rapoport's (1985) paper, the authors defined the probability of being futile (ρ) as the probability of insufficient participation of the others that causes provision failure, the probability of being critical (τ) and ($1-\rho-\tau$) the probability of being redundant as enough participants, excluding one self, contribute to the public good provision. Participants were then asked the three following questions:

1. What is the likelihood of fewer than four others choosing to invest, that is to say, one, two, three other members of the experiment?
2. What is the likelihood of exactly four others choosing to invest?
3. What is the likelihood of more than four others choosing to invest, that is to say, five or all six of the other members of the experiments?

Surprisingly, cooperators did not perceive themselves as more critical in the provision process than defectors in the standard dilemma and the money-back guarantee devices (Dawes, 1986, 1180). For the enforced contribution device, defectors were more inclined to feel futile while co-operators had the same feeling about the redundancy. There is however a clear general pattern about free-riders: Notwithstanding the type of mechanism in place, they were clearly more pessimistic about the likelihood of the collective good being provided.

Table 3: Experiments on perceived criticalness (Dawes & al. 1986)

	Average probability of being futile or redundant	Average probability of being critical
Standard Dilemma Cooperators	0.70	0.30
Standard Dilemma Defectors	0.82	0.18
Money-back Guarantee Cooperators	0.71	0.29
Money-back Guarantee Defectors	0.79	0.21
Enforces Contribution Cooperators	0.77	0.23
Enforces Contribution Defectors	0.75	0.25

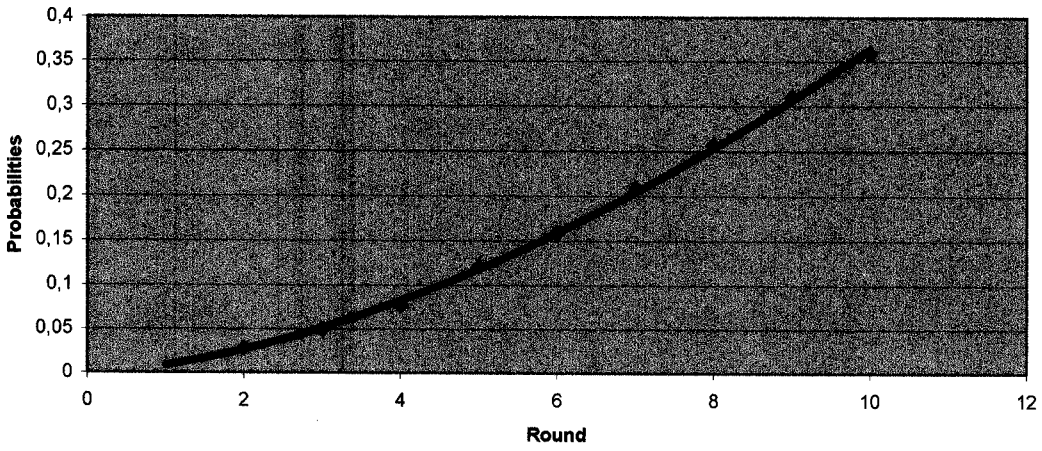
Even though it is not clear why these numbers don't corroborate with mathematical probabilities, these experiments give us some interesting results. First, people seem to free-ride more when they are asked about different outcome probabilities (results not shown here). Secondly, as argued by the authors, free-riders are more affected by their perceived chances of making more money than by their perceived probability of being suckered as shown by the absence of difference between the first and the second devices.

How long does it take for individuals to learn how to maximize their earnings? Using a series of pooled experiments conducted under James Andreoni's direction[5], we simulated the average predicted probability of playing Nash equilibrium in a classic non-cooperative game and the average percentage of public consumption for every round (See Appendices A and B). It would have been interesting to observe more rounds but a simple conclusion can nevertheless be drawn from this figure: People learn fast. Zaller (1992) in his classic book on public opinion affirmed that individual's opinion was the weighted balance of divergent considerations. In

[5] We are deeply grateful to James Andreoni who made available all his data on his web page: www.ssc.wisc.edu/~andreoni/

experimental economics, information takes the form of a dichotomic failure/success variable and after few rounds cold calculus overwhelms preconceived ideas on human nature.

Figure 2: Playing Nash Equilibrium (Andreoni 1988)
A Probit Simulation



In a nutshell, preconceived ideas do have a significant impact on participants' behaviour even though successive failures in the provision of the public good quickly convince participant to adjust their cognitive proxy.

Past Social Experiences

It is difficult to evaluate the impact of past social experiences in experimental economics. Some researchers have tried to simulate this factor by exposing participants to short stories about good and bad behaviour (Rabin, 1998). This method is not correct because it becomes impossible to differentiate between framing effects (Quattrone, 1988) and cognitive effects. Indeed, exposition to fresh information could affect individual's behaviour on the short term and modify his choice. We believe this effect does exist but is independent to the long-term effect. In order to evaluate the effect of past social experiences on contribution to a public good, we used the 2000 Canadian Electoral Study to measure the impact of past social experiences on the provision of the collective action *par excellence*: voting. Our probit model is:

$$Vote = \beta_0 + \beta_1 * Volunteering + \beta_2 * Religiosity + \beta_3 * Work + \beta_4 * Couple + \beta_5 * Sex + \beta_6 * Education + \beta_7 * Interest + \beta_8 * Party\ Identification + \beta_9 * Age + \beta_{10} * West + \beta_{11} * Quebec + \beta_{12} * Maritimes$$

Where Volunteer is a additive scale (0 to 1) made from a series of question about participation to costly collective action (Helping a candidate, join a boycott, attend a lawful demonstration, join an illegal strike, occupy a building or a factory) and Vote is a dummy 0-1 (0=vote,

1=abstention). We controlled for socio-demographic characteristics (having or not a job, sex, high school education, religiosity, age, region) and personal disposition toward politics (interest in politics, party identification).

Table 4: Probit Estimation of Vote and Abstention

Independent Variables	Robust Coefficients
Volunteering	1.5223**
	(0.5069)
Interest	0.1000**
	(0.0281)
Work	0.2907
	(0.2076)
Couple	-0.0060
	(0.1662)
Female	-0.0564
	(0.1538)
High School Education	0.1502
	(0.1945)
Religiosity	0.1216
	(0.1853)
Party Identification	0.1083
	(0.1817)
Age	0.0135*
	(0.0055)
West	0.5945**
	(0.2009)
Quebec	0.5017*
	(0.1986)
Maritimes	0.0067
	(0.2156)
Constant	-1.0457*
	(0.4292)
N = 506	
Log Likelihood = -178.96625	
Pseudo-R2 = 0.1279	

** 5% level of significance ** 1% level of significance*

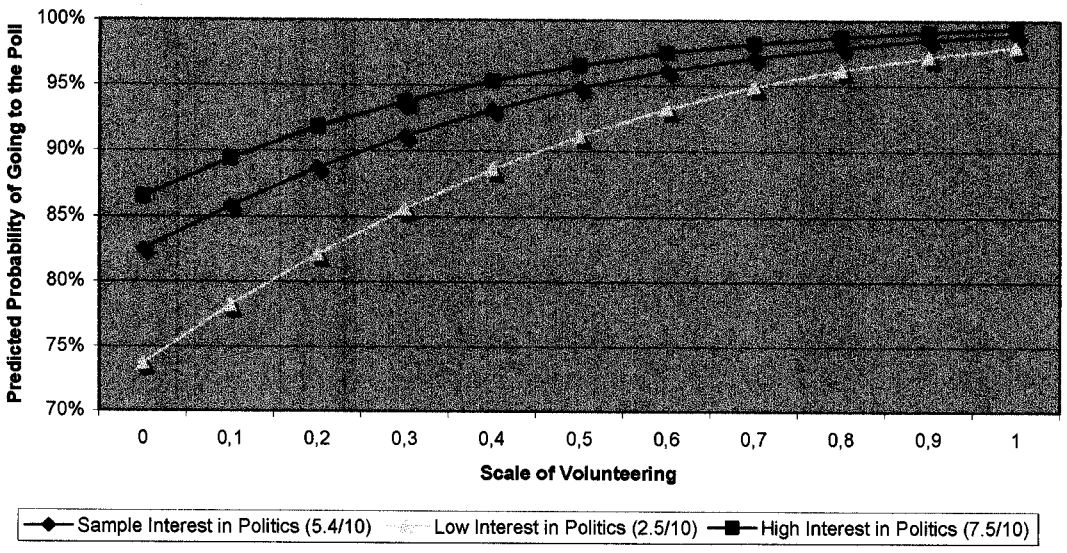
We found that past volunteering has a positive and significant effect on vote. Those who had experienced collective action before were more likely to vote[6]. Rational choice literature has always consider voting an irrational activity for the self-interested actor (Downs, 1957) but past

[6] During the 2000 federal election, only 62.8% of eligible Canadians went to the polls (Elections Canada). Respondents to the CES survey said in a proportion of 74% that they intended to vote. Our results are thus conservative.

social experiences without consideration about success or failure of these experiences seems to incite individuals to diverge from their best strategy. We also found a significant and positive relation between interest in politics and attitude toward voting. This makes sense since those who are interested in politics are more affected by "sense of duty" and by the importance of "saving democracy". Older people are also more likely to vote than young citizens. However, we found that some collective action consumers (married people and churchgoers in this case) were not less likely to free-ride in the election. This result is compatible with our assumption first argued by Dennis Chong: Individuals weight social pressure when they make a decision (Chong, 2000). Marriage and church attendance are in part dictated by social expectations in the community and free-riding brings significant costs. It is not necessarily the case for an election.

We simulated the impact of climbing up the scale of volunteering on probabilities to vote or not. We measured this for three levels of interest (0-10) in politics found in the CES survey. We found that the impact of past volunteering is particularly important on people not very interested in politics (2.5/10) but still present when level of interest rises.

Figure 3: Effect of Past Volunteering on Vote



It seems that for those not very interested in politics, volunteering tends to bring them back to the poll. We have shown that past participation in collective action had an effect on individual's calculus toward voting but is it also true for smaller group situation where an agent decision is critical in the production of the public good?

Most experiments on provision of public goods take the form of a non-cooperative game. Van de Kragt, Orbell and Dawes crafted an original device to test how criticalness changes participants' behaviour (Van de Kragt, 1983). Groups of seven were formed and were allowed to discuss during ten minutes before the experiments. They could decide about a strategy to maximize everybody's payoff by contributing just enough to enjoy public good provision. When the meeting ended, those who were declared providers were necessarily critical in the provision of the good. The authors' main result was that those who had to provide private resources actually respected their word and Pareto optimality was reached for a large majority of groups, compare with 35% of failure when discussion was prohibited (Ibid, 1983, 115).

The rational actor model would have predicted exactly the contrary. If a participant knows that it takes only one cheater to lose the public good and her private contribution, she would certainly shirk as all other providers. The only reasonable explanation for participation is trust toward people. The authors concede that some of the participants knew each other before the experiment. But since very low amounts of money were at stake, cheating was not a question of life and death. We argue that this experiment is a good example of inference on past events. Indeed, these participants used proxies of their life to anticipate others' behaviour. By the same logic they cross confidently the street when the light turns green and cars are coming the other way, they believe people will play straight and that drivers will stop at the red light. Van de Kragt & al. observed the very same phenomenon in laboratories.

Calculus Capabilities

But how good are individuals' perceptions on a larger scale? In 1993, André Blais and Robert Young (2000, 65) distributed questionnaires to students in political science, economics and sociology. Students were asked about their perceived chances of being critical in their 1993 riding. It is quite difficult to estimate that kind of probability in a first-past-the-pole system but Blais and Young estimated around 1 out of 45,000. 36% of the students answered somewhere close to the right category while 27% overestimated it and 23% said they didn't have any idea. Unfortunately, the gross nature of this estimation doesn't allow a clear conclusion. We can at least affirm that there is miscalculation among a large scale group because despite some two hundred years of democratic life in the Western hemisphere, strategic voting survives and voters are still looking for a vote that counts (Cox, 1997).

Since Mancur Olson's *Logic of Collective Action,* the most common explanation of the effect of number on the outcome of a collective action is that beyond a critical mass of individuals, self-interest drives a rational calculator to free-ride on the assumption that her participation on the cost-burden associated with the production of a public good is insignificant. More precisely, Olson's thesis is:

> *Indeed, unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational self-interested individuals will not act to achieve their common or group interests. In other words, even if all of the individuals in a large group are rational and self-interested, and would gain if, as a group, they acted to achieve their common interest or objective, they will still not voluntary act to achieve that common or group interest (Olson, 1965).*

Using the market as an illustration of his thesis, Olson affirms that, like small firms who would benefit from price collusion, individuals in a group have the same interest in cooperation with other members. The problem is with the incentive to cheat on others. Why share the costs of the collective action if you can dodge them? Marwell and Oliver reckon the presence of free-riding but they argue that a large group don't always lead to a collective failure. They believe that the level of heterogeneity can save a collective action from disaster (Marwell, 1993, 51). Large group heterogeneity of preference would induce "exploitation of the great by the small". Individuals with intense preference for the collective action will pay a much larger part of the costs and allow indifferent individuals to free-ride.

We argue that the size of a group is not intrinsically a factor when it comes to voluntary public good provision. Voting, the most common and widespread form of collective action, is generally performed by a large part of the population without significant distinction between heterogeneous (United States, Canada, Spain) and homogeneous countries (France, Ireland). As we have seen earlier, perception of criticalness, communication and cost burden affect directly the outcome while group size effect comes earlier in the process and affect indirectly the final outcome. The interesting question however is how these factors evolve as size increases. This is a major and unanswered question.

As we have seen earlier with Andreoni's measure of confusion and kindness, participants do make important and durable mistakes when they choose their best strategy. Andreoni wanted to know if contribution at a sub-optimal level was due to kindness or confusion. So he tested different mechanisms of payoff going from classical pay-as-you-earn to more complex ones with ranking. In his classical experiment, each subject was given 60 units to share between a private

and a public good. Using common hypotheses about the utility given to private and public goods, he fixed to one cent the value of one unit of private consumption and half a cent for public good. Andreoni noted that during the first round of play, 20 percent of participants did what was their utility-maximizing strategy following a classical microeconomic model: free-ride. Was it another example of rational actor model limitations or only noise arising out of confusion?

The answer is not clear. As experiments continue, individuals' behaviour changed in favour of free-riding. Did these people learn how to play the game efficiently or was it simply frustration toward free-riders that drove them? His results are not completely convincing but it is clear that, purged from the effect of kindness, the results still show divergence from Nash equilibrium. It has all the characteristics of confusion we would have needed more information about individuals' perceptions before and after the game to confirm Andreoni's assumptions.

CONCLUSION

We have argued in this paper that classical assumptions about rational actor are not efficient when it comes to explaining political and economic choices. Among endogenous factors affecting individuals' behaviour, subjective calculus plays a significant role. Preconceived ideas, inference from past experiences and calculus limitations play an important role in the cognitive process. But how can we take these new variables into account in formal analysis? The answer is not simple but a first step would be to estimate their effects and to weigh their roles in the dynamic process. More experiments will be needed to succeed in that task. I propose a protocol that could help move forward in our exploration of choice mechanisms.

An ideal experiment would be done in three steps. First, an exhaustive questionnaire should be distributed to each participant. Questions about socio-demographic variables (sex, education, age, social background) would be included in it. Also, the questionnaire should include a long series of question on probabilities under different devices (chances of being critical, success of the enterprise, risk averseness, etc.) to estimate participants' calculus capabilities and limitations. A third section should include questions about past experiences in everyday life (Have you ever been stolen by somebody you trusted?, If you were lost in a unfamiliar city, would you ask for help on the street?, etc.). Finally, the questionnaire should include some questions about the predicted outcomes of the game and about expected behaviour of the others participants. But what if this questionnaire has an effect on participant's behaviour by making them think differently than in their real life? A control group should be set up to measure this effect.

During the experiments, average earning and public consumption in the previous rounds should be given to each participant to allow learning during the game. An ideal game should last 100 periods or more and the participants should not be aware of how much more rounds they will play. We would thus purge the results from artificial end-game decay. Finally, some individuals should be told that they are playing with three, five, 20 or a hundred players so we could control for the group size effect. Some participants could also play against computers to analyze the consequence of rationalizability. After the experiment, another questionnaire should be distributed to collect information about strategies employed by players during the game and what made them chose theses strategies (sense of duty, money, etc.). Some of these suggestions

have been tested in previous research conducted at CIRANO but we believe the complete protocol should be tested to judge its validity.

Experimental economics allowed the development of a whole new field of research. This methodology, as all others, has its limitations and flaws. However, working in a controlled environment allows a huge range of possibilities with relatively limited resources. We believe political scientists and economists should use these possibilities to test and calibrate their models. Modern econometrics and formal methodology can merge with experimental social science to explain political and economic choices in a new and better way.

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