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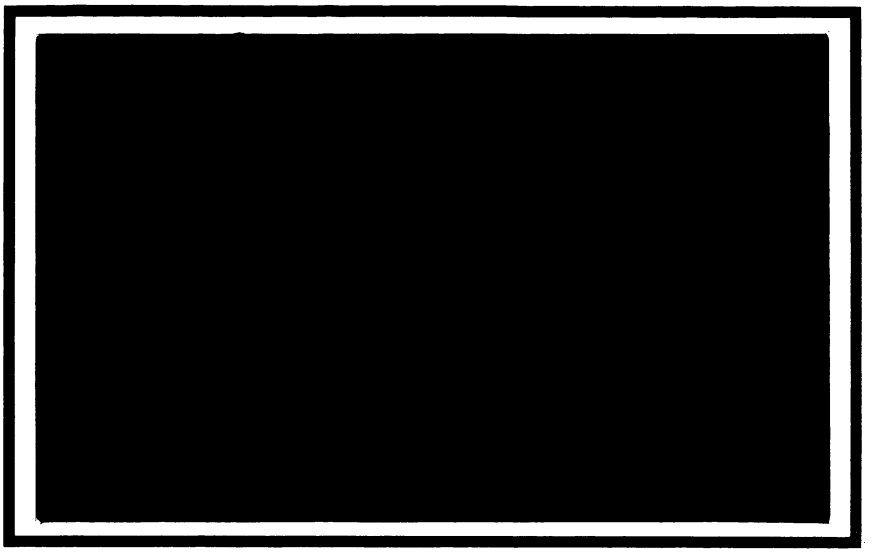
Center for Research on Economic and Social Theory
Research Seminar in Quantitative Economics

Discussion Paper



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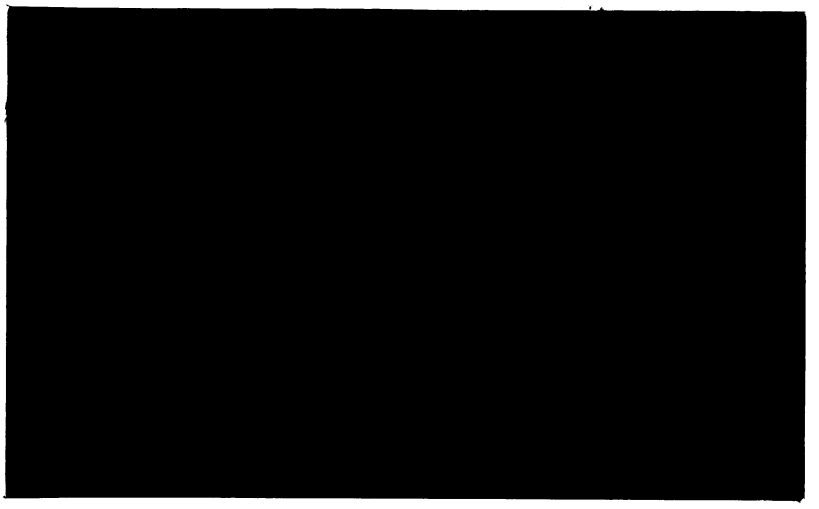

GOVERNMENT BY JURY

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November 6, 1984
current version January 10, 1985

Abstract. We consider a simple model of social choice where the voters find it costly to determine their true preferences. Since the influence of an individual voter decreases as the group size increases, each individual finds it optimal to invest less time in contemplating his values in larger groups than in smaller groups. This suggests that a desirable social choice mechanism might be to randomly choose a relatively small group of electors to make social decisions, since they would then have more incentive think carefully about the issues. We investigate this idea of "government by jury" in a simple mathematical model and establish some of its properties.

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It has often been observed that voting is irrational. The expected impact of a single voter on an election with a large number of participants is negligible, and with any reasonable measure of the costs of voting, individual costs will exceed individual benefits.

Nevertheless, people vote. It is not completely clear *why* they vote, but they vote in surprisingly large numbers. They may vote because they want to *feel* they are a significant part of the political process, or because their high school civics teacher told them to vote, or because of public pressure which encourages voting as a moral duty. Whatever the reason, the benefit and cost calculation described above does not seem adequate to describe actual voting behavior.

But the fact that each voter is an insignificant part of the electorate does show up in other ways. If each person has a very small influence on the outcome of an election, then each person will have a small incentive to think carefully about the issues involved. The costs of seriously investigating the issues and candidates in a typical election can be very large, and the expected benefits are very small. Even though voters can be persuaded by social pressure to show up at the polls, it is much more difficult to use social pressure to persuade a voter to engage in private contemplation of the issues involved in an election. You can lead a voter to the polls, but you can't make him think.

This sort of distortion has been mentioned by several other observers of the political process. Kenneth Arrow (1969) puts it nicely:

"... since the effect of any individual vote is so very small, it does not pay a voter to acquire information unless his stake in the initial issue is enormously greater than the cost of information."

Or consider Gordon Tullock (1971):

"The individual voter is producing a public good when he casts his vote, and he has very little, if any, reason for acquiring information to see that his vote is properly cast.

"Under the circumstances, we would not anticipate that voters would bother to become very well informed. Data on information held by voters seems to confirm this hypothesis. People who do not know the names of their congressmen are common. Misjudgments of political issues and, for that matter, belief that the parties are making promises which are directly opposite to the promises that they are actually offering are normal. Granted the public–goods theorem, all of this is what we should expect and what we do observe." (p. 916)

Related statements are contained in Downs (1957) and Tullock (1967).

If this view is correct, it has interesting implications for the theory of public choice. Since the incentive to think and gather information declines with the number of voters, it suggests that society should choose a small electorate rather than a large one. The electorate should be large enough to be representative of society as a whole, but small enough so that each individual actually finds it in his interest to take his role as an elector seriously.

These considerations lead to the suggestion that one choose a set of voters at random from the population and allow them to make the social decisions. The conditions that influence the size of this group will be examined below, but the size we have in mind is roughly the size of

current legislative bodies — one to two hundred people. However, it is misleading to think of these individuals as legislators. They would not be responsible for *making* laws, but just responsible for *choosing* laws. The legislators would have access to all sorts of tools to aid in investigating policy proposals — advisors, consultants, information, etc. Their duty would be to consider the possible implications of a policy, to compare it to their own values, and to pronounce on its desirability.

This is much like the role of a jury – to hear evidence, to evaluate it, and to reach a conclusion. Juries are chosen randomly so as to be representative. Juries are small so that individuals have an incentive to participate seriously. These traits suggest that we might call the proposal outlined above *government by jury*.

It is hardly novel to suggest that a representative government is an improvement over a pure democracy since the legislators have the incentive to study issues more deeply that the electorate. What is novel in this theory is that the representatives should be chosen at random rather than elected. For an election just pushes the problem back one more stage — I may have little incentive to think seriously about national policy, but I also have little incentive to think seriously about who would be the best Senator.

One argument against this policy is that the man on the street may not be capable of functioning as a policy maker. But this argument is an argument against democracy, not an argument against government by jury. If the man on the street is not an effective judge of social decisions when he has enough decisive power to actually take the decision seriously, how can he be an appropriate decision maker in an election which he has *no* incentive to take seriously?

We see the proposal of government by jury as furthering of the democratic ideal, not as an attack on it. It simply advances the idea that the most representative body you can get is a representative sample.

A government by jury can have other advantages as well. The election process tends to select for candidates that have skills in getting elected, not necessarily for those who have skills in governing. Furthermore since individuals decide themselves whether or not to become a candidate, elected representatives are clearly not a "representative" sample — instead it is a sample of people who want to be politicians. Thus there is inherently a bias in the composition of legislatures, and the interests and concerns of the legislators cannot be considered to be an accurate sample of the interests and concerns of the population as a whole.

However, these latter points are beyond the scope of this paper. Instead, we want to build a simple mathematical model of the problems described above and show how it leads to the kind of solution described above. The model is a very simple one, and it obviously leaves out many issues about representative systems that should be considered. Nevertheless, we believe that it offers some worthwhile insights into the nature of democracy and some positive suggestions as to how such systems can be improved.

1. The Social and Individual Objectives

Let us consider a simple model of voting. We suppose that there are m people who are going to make some decision about whether or not to provide some public good — say whether or not to build a new park. We suppose that the decision of how to pay for this project if it is undertaken has been made, so that each individual can consider his net value V_i of the social project. Obviously the project should be undertaken if the sum of the V_i over the population is positive.

However, we suppose that it is costly for each individual to observe his true value of the project.

The more effort he invests, the better estimate he will get of his true value. We will model this in the following way. Each individual has an "estimated value" of the project given by:

$$v_i = V_i + \epsilon_i$$

where ϵ_i is a random variable. This random variable will have an expected value of zero, so that individual's have unbiased estimates of their true value, but have some variance σ_i^2.

Individual i can improve his estimate of his true value by exerting some effort. We will indicate the amount of effort exerted by individual i by t_i — the amount of time he spends "thinking" — and we suppose that this effort incurs some cost to the individual. Of course, the more time he spends thinking, the better estimate of his true value he gets, so that σ_i is also a function of t_i, $\sigma_i = \sigma_i(t_i)$.

Suppose now that $n \leq m$ people are selected to be voters. We suppose that each individual will correctly state his own estimated value and the project will be undertaken if the sum of the estimated values is positive. We can either think of this as occurring naturally, or that some incentive scheme such as a Clarke-Groves tax or a Groves-Ledyard tax is implemented to obtain this kind of behavior.

Let $\bar{v}_n$ denote the average value of v_i if there are n voters. That is,

$$\bar{v}_n = \sum_{i=1}^{n} \frac{v_i}{n}$$

The Central Limit Theorem implies that for large n, $\bar{v}_n$ will have a Normal distribution with a variance given by:

$$\sigma_{\bar{v}}^2 = \sum_{i=1}^{n} \frac{\sigma_i^2}{n^2}$$

Each individual chooses t_i so as to maximize his expected value from the election. A larger value of t_i lowers the variance of his estimate of his true value and thus lowers the social variance of $\bar{v}_n$. This in turn lowers the probability that an incorrect decision will be made, and thus affects individual i's utility.

The probability of making an incorrect decision is an increasing function of the social variance. Thus each individual will increase his expected utility if he chooses t_i to *decrease* the social variance:

$$\sigma_{\bar{v}}^2 = \sum_{i=1}^{n} \frac{\sigma^2(t_i)}{n^2}$$

Of course, choosing t_i in this way incurs a cost to the individual that we will denote by $c_i(t_i)$. The optimal choice of t_i for the individual will involve minimizing the total costs of this choice, so we take his objective function to be:

$$U_i = \min_{t_i} \sum_{i=1}^{n} \frac{\sigma^2(t_i)}{n^2} + c_i(t_i)$$

We suppose that each individual chooses t_i so as to minimize this expression, taking the other individual's choices as given. The resulting Nash equilibrium $(t_1^*, \ldots, t_n^*)$ is the outcome of this voting game. This outcome in turn implies some distribution of utility $(U_1^*, \ldots, U_m^*)$ for the m constituents which is our primary interest. From this distribution of individual utilities, we can calculate the social utility $U^* = \sum_{i=1}^{m} U_i^*$ and see how it varies with the size of the electorate n.

2. A Simple Example

Let us take an extreme case. First we will suppose that everyone is identical in all respects — they have the same true values for the public project, they have the same costs of thinking, etc. — but they have different estimated values due to the randomness of the error terms. We further suppose that t_i influences σ_i^2 in the following simple way:

$$\sigma_i^2(t_i) = \frac{\sigma^2}{t_i}$$

Thus thinking for t_i periods is just like sampling t_i people insofar as it affects the variance of the social decision. Finally, we also suppose that $c_i(t_i) = c^2 t_i$ — i.e., that costs are linear in the time spent thinking. (Writing the constant marginal costs as c^2 makes the formulas below a little simpler.)

With these parameterizations, we can write representative individual's choice problem as:

$$\min_{t_i} \sum_{i=1}^{n} \frac{\sigma^2}{n^2 t_i} + c^2 t_i .$$

Taking the derivative with respect to some individual t_i and solving for the optimal choice we have:

$$t_i^* = \frac{\sigma}{cn}$$

Thus the optimal time for an individual to think is decreasing in n and c and increasing in σ as one would expect. Now let us plug this choice back into each individual's objective function to calculate the social cost. This will be m times the variance of the social decision — which affects everybody — plus n times the voting costs which are borne only by the people who actually vote. Explicitly:

$$m\frac{\sigma^2}{nt_i^*} + nc^2 t_i^*$$

$$= c\sigma(m+1)$$

Thus in this simple model the social costs are independent of the size of the electorate. A larger electorate leads each individual to decrease the time he spends thinking, since he is only a small part of the whole — but the result is that everyone thinks less and the total social variance remains constant.

If there are any *social* costs to holding a large election, we should choose the smallest possible electorate — one individual — and give him sole decisive power. In this model, such an individual will do just as well at making a social decision as a larger electorate because he will have more incentive to invest effort in determining what should be done. Thus we are led to a form of government by a randomly chosen dictator.

3. The Incentives for the Random Dictator

Although a randomly chosen dictator will, in our example, make just as accurate a decision as an arbitrarily large electorate, he still does not have the proper incentives to put the right amount of effort into the decision process. As Gordon Tullock (1971) has put it, in his discussion of a judge's decision making:

"He can produce a quick solution the the problem without much thought. If, however, he wants to be sure that he makes the "correct" decision, he must devote a great deal of time and thought to it. This is a private cost, and ... ordinary public–goods reasoning would imply that he would underinvest in this private expenditure ..." (p. 915)

Let us examine this insight in the context of our model. The random dictator will choose his effort t so as to minimize variance plus his private costs:

$$\min_t \frac{\sigma^2}{t} + c^2 t$$

But the time he spends thinking will lower the variance of the social choice for everybody. The *socially optimal* amount of effort by the random dictator is the solution to:

$$\min_t m\frac{\sigma^2}{t} + c^2 t$$

which will certainly be larger.

If we can observe the effort expended by the social dictator, we can choose to reward him as a function of the effort he spends in studying the social choice. It is easy to see that the optimal reward structure is to pay him $c^2(m-1)/m$ per unit of effort. This gives him a choice problem of the form:

$$\min_t \frac{\sigma^2}{t} + c^2 t - \frac{c^2(m-1)}{m} t =$$

$$\min_t \frac{\sigma^2}{t} + \frac{c^2}{m} t$$

which is easily seen to lead to the socially optimal choice of effort.

But what if the effort is not observable? How can we induce the random dictator to minimize the total social costs? It turns out that there is a simple way to do this, at least in the context of this model if the dictator's utility is only a function of the mean and variance of his wealth. The procedure is as follows.

We simply choose a person at random and ask him for his off-the-cuff opinion about the social project. He will respond with $v_i = V + \epsilon_i$. We now tell the random dictator that he will have to pay an "incentive payment" equal to $(m-1)$ times the difference between his estimate of V and the randomly chosen person's estimate.

To see that this leads to the optimal decision, we let v_i be the random individual's value and v_d be the dictators value, and note that since these have the same mean, the dictator is only interested in minimizing the variance of $(m-1)(v_d - v_i)$. But this implies that the dictator wants to minimize:

$$(m-1)\sigma^2 + (m-1)\frac{\sigma^2}{t} + \frac{\sigma^2}{t} + c^2 t = (m-1)\sigma^2 + m\frac{\sigma^2}{t} + c^2 t$$

which is equivalent the problem of choosing the socially optimal amount of time.

This incentive scheme is based on the fact that we have two ways of estimating V — an imprecise estimate from the man-on-the-street and a precise estimate from the random dictator. We simply use the imprecise estimate to induce the correct behavior in the random dictator.

4. Differences in Tastes and Costs

The above model of the random dictator gives extreme results because it is an extreme model. First, everyone is presumed to have the same underlying values, and secondly, the costs of thinking are assumed to be linear in the effort. Both of these assumptions can easily be relaxed.

Let us first consider allowing for different values. Suppose now that $v_i = V_i + \epsilon_i$ where the V_i terms differ from person to person. The decision of whether or not to undertake the project will still depend on $\bar{v}_n$, but now the averaging involves the democratic benefits from averaging the true values, and the estimation effects from averaging the error terms.

We can write individual i's value as

$$v_i = V + \delta_i + \epsilon_i$$

where δ_i is the deviation of individual i from the average over the n participants and ϵ_i is the estimation error of individual i.

Each individual still has an interest to minimize the variance of the social decision due to his estimation error, so the Nash equilibrium choice of t_i^* doesn't change. However, the social costs of having n electors now involves an extra term that reflects the benefits from more representation — the fact that having a larger sample will improve the estimate of V.

Thus the expression for total social costs will be the expression derived earlier plus the 'representation effect:'

$$c\sigma_\epsilon(m+1) + m\sigma_\delta^2/n$$

Since the first term is independent of the size of the electorate and the second term is decreasing in the size of the electorate, if there are no costs to holding elections, it is clear that we would want n as large as possible. However if there *are* costs to holding elections we may want to choose $n < m$.

For example if the marginal cost of an additional voter is some constant k, then we would want to choose n to minimize total social costs given by:

$$c\sigma_\epsilon(m+1) + m\sigma_\delta^2/n + kn$$

The solution to this minimization problem is:

$$n = \sigma_\delta\sqrt{m/k}$$

Thus the larger the variance of the values across the population the larger electorate we would want, independently of σ_ϵ. The optimal size of the electorate for purposes of optimal representation is independent of the effort decision.

The second problem mentioned above is the assumption that costs are linear in effort. We can relax this assumption by modelling costs as:

$$c_i(t_i) = (c^2 t_i)^\gamma$$

If γ equals 1, we have the same model we had before. If $\gamma < 1$ then we have costs of thinking rising less than linearly. Then the comparative advantage of thinking over sampling is even better than in the linear case — so again we want to choose the smallest possible sample size: a random dictator. On the other hand $\gamma > 1$ gives a comparative advantage to sampling over thinking, so we end up with an optimal electorate larger than a single individual.

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