Government by Jury

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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.[1]

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 normal 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. Keeneth 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
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> 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

[1] See Ledyard (1984), Palfrey and Rosenthal (1985), and the summary of their results given in Ordeshook (1986).

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. This is also a very old idea: apparently several Greek city-states in antiquity used the device of randomly chosen representatives. (References and discussion to follow.)

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 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. Voting as a Public Good

We turn now to a formal model. Consider a society with m individuals, of whom n are chosen as an electorate. Each individual i exerts some effort $e_i \geq 0$ in determining some public choice which costs him ce_i. The private benefit to individual i depends on the total effort exerted buy the n electors, $E = \sum_{j=1}^{n} e_j$, and we write the benefit function as $B(E)$. We assume that $B'(E) > 0$ and $B''(E) < 0$; i.e., that individual benefits increase as total effort increases, but that there are diminishing returns to effort.

The individual decision problem can be written as

$$\max_{e_i} B(\sum_{j=1}^{n} e_j^*) - ce_i.$$

Each individual is assumed to choose his effort level optimally, given the effort levels of the other individuals. A Nash equilibrium of this process, (e_i^*) will be characterized by the first-order conditions

$$B'(\sum_{j=1}^{n} e_j^*) = c \quad \text{for} \quad i = 1, \dots, n$$

Since $E^* = \sum_{j=1}^{n} e_j^*$ we can also write this condition as

$$B'(E^*) = c$$

which shows that only aggregate effort is determined in equilibrium. *Any* set of effort levels that sum to E^* is a Nash equilibrium for this model.

We focus our attention on a symmetric equilibrium, e^*, in which $E^* = ne^*$. Such an equilibrium satisfies the first-order condition

$$B'(ne^*) = c.$$

It is easy to state conditions under which such an equilibrium will exist; if it does exist, the assumption that $B''(E) < 0$ guarantees that the equilibrium will be unique.

The first question of interests is how the optimal effort levels vary as the size of the electorate varies. Here we get a very simple and explicit answer. Let $e^*(n)$ be the optimal level of effort in an electorate of size n so that $e^*(1)$ satisfies $B'(e^*(1)) = c$. Then we claim that $e^*(n) = e^*(1)/n$. The proof is simply to note that $e^*(n)$ satisfies the equilibrium first- order condition since

$$B'(ne^*(n)) = B'(ne^*(1)/n) = B'(e^*(1)) = c.$$

Hence, an increase in the electorate size n will induce a perfectly offsetting decrease in average effort $e^*(n)$. This implies, of course, that total effort, $E^*(n) = ne^*(n)$, and the individual benefits, $B(E^*)$, will remain constant as the size of the electorate increases. Free riding in effort will totally offset the benefits from having a larger electorate.

If there are any costs to holding the election — transactions costs, campaigning costs, etc. — it would be optimal to have as small as an electorate as possible. In the limiting case, it would be optimal to choose a *random dictator* who would make all social decisions. If there are benefits from diversity, then it would make sense to have an electorate that was just large enough to capture an appropriate amount of diversity — having any more voters would not contribute anything to the accuracy of the social decisions.

2. Variations on the Basic Model

The basic model presented in the last section is an extreme case. Here we present two elaborations. First we consider what happens if voters have different tastes, so that the benefit function of voter i is written as $B_i(E)$.

In this case, the first-order condition characterizing an interior optimum for agent i is

$$B_i'(E^*) = c. \tag{1}$$

It is clear by inspection that in general not all agents will be at an interior optimum in equilibrium. Indeed, the generic case will involve only one agent exerting effort and all of the other agents free riding.

To see this, let E_i^* be the solution to (1) for each i. Generically, if tastes are really different, we would expect that $E_i^* \neq E_j^*$ for $i \neq j$. In this case, let x be the agent that desires the maximum level of effort, so that $E_x^* = \max_i\{E_i^*\}$. Then we claim that $e_x^* = E_x^*$ and $e_i = 0$ for $i \neq x$ is a Nash equilibrium. That is, only the agent who desires the largest effort contributes any effort at all, and all of the other agents free-ride on his contribution.

The argument is simply to note that agent x satisfies his first-order condition for maximization, and all of the other agents satisfy $B'(E_x^*) < c$. Hence none of the other agents desire to increase their contribution of effort from zero, which establishes that this is a Nash equilibrium.

Since only one agent contributes any effort at all, it is clear that the total amount of effort will be remain content as one increase the number of voters, until one happens to draw a voter that desires a larger level of effort than the existing voters. The effort of free-riding is even more stark when agents have different tastes than when they have the same tastes.

We now turn to the second extension alluded to above, and investigate the structure of the model when there are increasing marginal costs to effort. We write the cost of effort to individual i as $c(e_i)$, and assume that $c'(e_i) > 0$ and $c''(e_i) > 0$.

The first-order conditions characterizing a symmetric Nash equilibrium now becomes

$$B'(\sum_{j=1}^{n} ne) = c'(e).$$

Let $e(n)$ denote the solution to this equation and implicitly differentiate to find

$$e'(n) = -\frac{eB''(E)}{n.B.''(E) - c''(e)} = \frac{e}{c''/B'' - n} \tag{2}$$

Since $c'' > 0$ and $B'' < 0$, it follows that $e'(n) < 0$, that is, that each individual's equilibrium effort is decreasing in the size of the electorate.

What about equilibrium aggregate effort, $E(n) = ne(n)$? Differentiating yields $E'(n) = ne'(n) + e$, and substituting from (2) we find

$$E'(n) = \frac{ne}{c''/B'' - n} + e = \frac{e}{1 - n.B.''/c''} > 0. \tag{3}$$

Hence, aggregate effort is strictly increasing in the size of the electorate.

Aggregate net benefits with an electorate of size n are given by $mB(ne(n)) - nc(e(n))$, since the total population m will benefit from the social decision, but only the n electors will pay the costs of investigating the issues. Differentiating aggregate net benefits with respect to n yields

$$mB'(E)E'(n) - nc'(e)e'(n) - c(e).$$

The first term in this expression is the benefit from having a higher level of aggregate effort due to the addition of a new voter. The second term measures the reduction in the costs of all other voters due to the fact that they can now free ride to some degree on the effort of the new agent. Since $E'(n) > 0$ and $e'(n) < 0$, both of these terms contribute positively to aggregate benefits.

The last term measures the effort cost incurred by the new voter. It makes a negative contribution to aggregate net welfare. In general the sum of the three terms is ambiguous. However, if the population size m is large enough, the first term will dominate and thus the whole expression will be positive. In other words, if there is a large enough population, then a larger electorate is always better, even given the free rider problem. This offers some justification for popular democracy, and an argument against government by jury.

3. An Example

Here we consider a special case which gives some more structure to the benefit function. We suppose that there are m people who are going to make a 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 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

$$V_i = V + \epsilon_i$$

where ϵ_i is a random variable. This random variable will have an expected value of zero, so that individuals have unbiased estimates of their true value, but have some variance σ_i^2. By assumption, all agents would value the public good in the same way, if there were no errors.

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 e_i, and we suppose that this effort imposes some cost on the individual measured by ce_i. Of course, the more effort the agent exerts, the better the estimate of his true value he gets, and we parameterize this effort by $\sigma_i = \sigma_i / e_i$.

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 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,

$$\bar{V}_n = \sum_{i=1}^{n} \frac{V_i}{n}$$

Given our assumptions, $\bar{V}_n$ will have a variance given by

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

Each individual choose e_i so as to maximize his expected value from the election. A larger value of e_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.

We assume that 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 e_i to *decrease* the social variance. Of course, choosing e_i in this way imposes a cost on the individual, which we donate by $c^2 e_i$ (Writing the constant marginal costs as c^2 makes the resulting formulas a little simpler. The optimal choice of e_i for the individual will involve minimizing the total costs of his choice, so we take his objective function to be

$$\min_{e_i} \sum_{i=1}^{n} \frac{\sigma_2}{e_i n^2} + c^2 e_i.$$

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

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

Thus the optimal effort of an individual is decreasing in n and c and increasing in σ as one would expect. Note that the total effort, $E = ne$, is independent of the size of the electorate.

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 every body — plus n times the voting costs which are borne only by the people who actually vote. Explicitly

$$m\frac{\sigma^2}{ne_i^*} + nc^2 e_i^* = c\sigma(m+1)$$

Thus in this example the social costs are independent of the size of the electorate. 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 jest 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.

4. 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 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 e so as to minimize variance plus his private costs

$$\min_e \frac{\sigma^2}{e} + c^2 e.$$

This leads to a *privately* optimal effort of $e = \sigma/c$. But the effort he puts into his decision will lower the variance of the social choice for everybody. The *socially optimal* amount of effort by the random dictator is the solution to

$$\min_e m\frac{\sigma^2}{e} + c^2 e$$

Thus the socially optimal amount of effort is $m\sigma/c$, which is m times as large as the privately optimal amount of effort.

If we can observed 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

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

$$\min_e \frac{\sigma^2}{e} + \frac{c^2}{m} e$$

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. 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 $v_i = V + \epsilon_i$. By choice of units, we think of this agent putting effort $e_i = 1$ into this decision, so that ϵ_i has a variance of σ^2. We now tell the random dictator that he is liable for an "incentive payment" equal to $(m-1)$ times the square of the difference between his estimate of V and the randomly chosen person's estimate.

To see that this leads to the optimal decision, we consider the form of the dictator's maximization problem. Since the mean values are the same by hypothesis, the incentive payment will be given by $V + \epsilon_d - V - \epsilon_i = \epsilon_d - \epsilon_i$. Assuming expected value maximization, the objective function of the dictator now becomes

$$\frac{\sigma^2}{e} - c^2 e + (m-1)E(\epsilon_d - \epsilon_i)^2,$$

where E signifies the expectation operator. This objective function is equivalent to

$$\frac{\sigma^2}{e} - c^2 e + (m-1)\frac{\sigma^2}{e} - (m-1)\sigma_2,$$

which is, of course, the appropriate objective function for the social maximization problem.

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.

5. Summary

We have seen that if marginal costs of effort are constant, and the accuracy of an election depends on the number of voters, then the *equilibrium* accuracy of an election will be independent of the number of voters. Free riding essentially cancels out any benefits from agglomeration. However, if the marginal costs of voters are increasing then the accuracy of the election will increase as the number of voters increase if marginal benefits are decreasing in efforts and marginal costs of voting are increasing in effort.

Even if the size of the electorate is kept to the minimum possible size — a randomly chosen dictator — the dictator will still not invest the optimal amount of effort in making social decisions. However, under certain assumptions, an incentive scheme based on the deviation of the dictator from the average opinion can be designed that will induce the optimal effort.

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