Informational Limits to Democratic Public Policy:

The Jury Theorem, Yardstick Competition, and Ignorance[1]

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Abstract

Condorcet's jury theorem provides a possible explanation for the success of democracies relative to other forms of government. In its modern form, the jury theorem predicts that majority decisions are well informed, because they are based upon far more information than possessed by any single individual. On the other hand, it is evident that democratic politicians and policies are not always as good as the jury theorem implies they should be.

This paper uses simulated elections to explore the power and limitations of majority rule as an estimator of candidate quality or policy effectiveness. The simulations demonstrate that slightly informed voters can make very accurate choices among candidates using majority rule. However, as the ratio of slightly informed voters relative to ignorant voters falls, the accuracy of majority decisions declines. The latter implies that institutions, policies, and technologies that promote the dissemination of information also tend to improve the efficiency of democratic governance.

JEL Category: H110

Key Words: Jury Theorem, Rational Ignorance, Elections, Delegation, Expert's Dilemma, Information Aggregation, Yardstick Competition, Informational Policies, Liberal Institutions, Effectiveness of Democracy, Majority Rule, Simulated Elections

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I. Introduction: Information, Scarcity, and Elections

There is considerable survey evidence that voters know very little about government policies and the backgrounds of elected governmental officials. However, there is also considerable evidence that democratic governance works quite well, if not perfectly. This is a great puzzle, upon which this paper attempts to shed a bit of light. Clearly, if democratic outcomes were based entirely on the limited information available to a "typical voter," even the best democratic government imaginable would adopt policies that are far from perfect, because voters know so little about public policy. Yet the experience of the past century suggests that majoritarian polities create attractive rather than repulsive societies. The citizens of the longest-standing democracies have the highest incomes and longevity on Earth. Emigrants from around the world seek them out, often at great cost and personal risk. How is this possible when the typical voter knows so little about public policy?

Several possible explanations exist for the superior performance of democracies. The first and most common is to deny the relevance of survey evidence. For example, Lupia and McCubbins (1994, 1998), Lohmann (1994, 1998), and Wittman (1995) argue that voters can, in fact, learn enough from newspapers, party labels, and politically active interest groups, that relatively few mistakes are made by individual voters or the electorate as a whole. Unfortunately, this argument is circular, because it implicitly assumes a reasonably well-informed electorate. Neither party labels nor political campaigns would provide very much information unless electoral advantage induced parties to favor effective policies that advance the interests of their voters. Feddersen and Pesendorfer (1996) suggest that a well-informed electorate might arise, not because all voters are all well informed, but because well-informed voters are more likely to turn out and cast votes than are less informed voters. Turnout, however, seems to be too high for this to be a satisfactory explanation of the success of democracies, given the survey data. For example, turnout rates often exceed 80 percent in

Scandinavian countries, but the number of reasonably well-informed voters is often well below 50 percent (Paldam and Nannestad 2000).

Another possibility explored below is that voters are actually as ill informed as polling data suggest, but that majority rule itself aggregates voter information in a manner that allows far better policy decisions to be made through elections than possible if policies were made directly by a "typical" voter. The idea that voting improves collective decision making was discussed by Aristotle in approximately 350 BCE,[2] taken up by Condorcet in 1785, and again by Galton in 1907. In the 1980s it was taken up once again by political scientists, political economists, and statisticians. That work developed theories of majoritarian information aggregation grounded in contemporary statistical theory.[3] For example, Nitzan and Paroush (1985), Wit (1998), and McLennan (1998) show that decisions made by majority rule can be far less error prone than any individual voter. Indeed, much of the jury theorem literature implies that large electorates would make essentially no mistakes as long as individual voters are even slightly more likely to be right than wrong. Such informational efficiency may partially explain the use of majority rule by nondemocratic organizations for making major policy and hiring decisions (Congleton 1984).

Several other papers, however, note that the assumptions under which the main jury theorem results obtain are quite demanding. Shapley and Grofman (1984) and Austin-Smith and Banks (1996) note that the informational efficiency of majority rule may be far less than the first statistical proofs suggest. Austin-Smith and Banks, for example, suggest that major-

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[2] "For the many, of whom each individual is but an ordinary person, when they meet together may very likely be better than the few good, if regarded not individually but collectively, just as a feast to which many contribute is better than a dinner provided out of a single purse. For each individual among the many has a share of virtue and prudence, and when they meet together, they become in a manner one man, who has many feet, and hands, and senses; that is a figure of their mind and disposition. Hence the many are better judges than a single man of music and poetry; for some understand one part, and some another, and among them they understand the whole. There is a similar combination of qualities in good men, who differ from any individual of the many, as the beautiful are said to differ from those who are not beautiful, and works of art from realities, because in them the scattered elements are combined, although, if taken separately, the eye of one person or some other feature in another person would be fairer than in the picture." (Aristotle, the *Politics*, Book 3 part xi.)

[3] Levy and Peart (2002) suggest that the statistical foundations of the jury theorem were first stated clearly by Galton in the late nineteenth century.

ity outcomes tend to be no more informed than the pivotal voter is. Goodin and Estlund (2004) turn the jury theorem on its head and suggest that if voters are a bit more likely to get it wrong than right, democracies will nearly always get it wrong, which of course begs the question of how such governments can be successful.

This paper occupies the middle ground between the optimistic and critical jury theorem papers. It uses simulated elections to analyze the information-aggregating properties of majority rule in relatively small number settings in which voters use minimal data sets to appraise the relative merits of incumbents and challengers. On the one hand, the simulations show that many of the asymptotic statistical properties of majority rule are present in small "slightly informed" electorates, which suggests that a good deal of the relatively strong performance of democratic governance could well be the result of majority rule's effective information aggregation. On the other, the results demonstrate that there are limits to majority rule's ability to serve as an effective mechanism for information aggregation. Together the results suggest that majoritarian solutions to public policy and information problems will be very good in many, albeit not all, policy areas.

Section II of the paper characterizes the choice setting used for the simulation experiments. Although most jury theorem research focuses on estimates of binary "true or false" variables, this paper focuses on a continuous variable that has to be estimated by voters. For the purposes of this paper, that variable is considered to be "challenger quality" and estimated challenger quality is used by voters to choose between a challenger and an incumbent office holder or status quo policy. Section III reports the results of several hundred simulation experiments that demonstrate the power and limits of the jury theorem in cases in which the voters just have very small, but complete, data sets. Median estimates can be remarkably accurate in such cases, even in relatively small groups with very limited (but complete) data. However, accuracy necessarily declines when unobservable characteristics are important determinants of the variables of interest.

Section IV explores the effects of voter ignorance on majority rule's performance as an information-aggregating procedure. As noted above, survey data suggests that voters are ignorant of many candidate and policy details. Several hundred simulations demonstrate that voter ignorance can be a far greater problem for majoritarian decision processes than small data sets, dependence, or unobservable variables. Ignorance increases error rates for both voters and majoritarian decisions. Section V analyzes two strategies for improving the efficiency of majority rule. It demonstrates that delegation to experts is unlikely to solve the informational problems analyzed in this paper. The efficiency of democratic decision making is more likely to be improved through institutions and policies that increase the pool of broadly informed voters. Section VI summarizes the results and draws conclusions.

Overall, the results suggest that small numbers and small data sets are not always problems for majority decisionmaking, although the results also suggest that neither the information-aggregating properties of majority rule nor delegation to experts can completely overcome the problem of voter ignorance.

II. A Model of Majoritarian Choice with Slightly Informed Voters

This paper focuses on a choice setting in which a group of voters assesses the relative merits of a well-known incumbent and a less well-known challenger. In political settings such choices occur whenever a current office holder runs for reelection. In commercial settings, similar choices occur whenever a hiring committee decides whether to keep or replace their senior executives. Similar choices are also made when a new policy, new procedure, or new law is claimed to be more effective than the status quo. Majority rule is routinely used to make such decisions in elections, referenda, governmental legislatures, and in the governing boards of voluntary associations. In each of these cases, the incumbent's performance can be assessed by direct observation, but that of the "challenger" cannot.

Voters are assumed to evaluate the challenger using an estimated yardstick function that measures quality or effectiveness. The yardstick is used to predict the relative effectiveness of the incumbent and challenger, other things being equal. The yardstick approach requires a somewhat more complex informational environment than normally used in jury theorem papers, insofar as parameters of the quality function and quality itself are continuous rather than binary variables. However, the additional complexity allows us to analyze the effects of sample size, unobservable variables, and voter ignorance separately.

Voters are assumed to be sincere in that they vote for the candidate (or policy) estimated to be of highest quality based on their own information, other things being equal.

Such behavior has been called into question by a few sophisticated papers, as in Austin-Smith and Banks (1996), who suggest that fully rational voters will vote strategically in the context of electoral contests with imperfect information. However, experimental evidence suggests that voter behavior is not strategic (Ladha, et. al. 2004), which is, of course, consistent with the observed voter ignorance. If voter ignorance is rational, a good deal of policy relevant information is considered by voters to be either of too little interest or too difficult to devote significant resources to. If ignorance is natural, it suggests that many details of the problem at hand are unknown to voters and cannot fully be taken into account. Either form of ignorance suggests that lengthy, difficult, and/or costly data collection and analysis are not routinely undertaken by voters, because time and attention are scarce resources.

The use of majority rule to choose between incumbents and new office holders (or new policies) implies that the decision in each case reflects the assessment of the relevant electorate's median voter.

A. A Model of Voter Choice in a Setting of Informational Scarcity

Consider the following model of voter choice, which captures essential features of the decision environment outlined above and is used to simulate electoral outcomes below. Suppose that two candidates compete for elective office and that their platforms have completely converged to the median voter's ideal point.[4] Complete convergence in platforms is an implication of political competition if voters lexicographically prefer policy positions to competence and the domain of voter ideal policy vectors can be mapped into a single dimension.[5] Platform convergence also occurs in stochastic voting models under somewhat more general assumptions.[6]

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[4] Decisions within parliamentary systems of governance under proportional representation can also be represented in median terms if party leaders are elected in competitive contests and the median party's leader is a decisive member of the majority coalition.

Congleton (2001) demonstrates that in cases in which only a few voters are even partially informed, candidate (or party) competition induces candidates and parties to adopt policy positions at the median(s) of the informed voter ideal points. (Voter assessments of candidate platforms are not influenced by policy positions of which they are totally unaware of.)

[5] Lexicographic preferences of this sort imply that voters assess candidate policies first and take account of differences in candidate quality only in cases in which candidate policies positions are indistinguishable from one another. In other cases, Berger, Munger, and Potthoff (2000), and Groseclose

To simplify without significant loss of generality for the purposes at hand, suppose that it is well known that candidate quality for the office being contested is a linear function of one observable characteristic, *E*, (perhaps experience or intelligence) and one unobservable characteristic, *H* (perhaps honesty). Similar assumptions are used in most jury theorem papers, although most such papers assume that a binary "true/false" or "better/worse" parameter is estimated directly, rather than inferred from a model. For the purposes of the simulations, both *E* and *H* are assumed to be randomly distributed among candidates. Observable characteristic *E* is distributed uniformly, $U(E_L,E^H)$ with $E^L = -E^H$. Unobservable characteristic *H* has mean a and variation $u_i \sim U(h^L, h^H)$ with $h^L = -h^H$. The actual quality of candidate *i* is:

$$Q_i = \alpha + \beta E_i + u_i \qquad (1)$$

where E_i and u_i are specific values for candidate i. The challenger's quality can only be perfectly predicted if α, β, E_i , and u_i are known beforehand. However, u_i is unobservable, and parameters α and β are not known to voters a priori, but have to be estimated by each voter.[7]

(2001) demonstrate that convergence to median-voter positions is unlikely to occur in settings in which perceived candidate quality differs. Congleton (1986) makes a similar point for settings in which persuasion is an important feature of electoral campaigns. I adopt this somewhat strong assumption in order to focus on the voter estimation problem. However, under the informational assumptions of this paper, voters are unlikely to be able to distinguish between the positions of candidates that are "reasonably close," even if experts can do so.

[6] It bears noting that convergence also occurs in many other decision environments in which majority rule is used to select between an incumbent and challenger. For example, hiring committee decisions in commerce typically choose between incumbent and alternative candidates, all of whom promise to maximize profits. What might be termed quasi-convergence also occurs in referenda when proposed changes are narrowly parsed. In such cases the objectives are agreed to by those making the decision—e. g. to increase profits or to improve a specific service (safety, transportation, social insurance, or education). In each case, the quality or effectiveness of the proposed change relative to the status quo is evaluated, and in each case voters can distinguish between the alternatives only if they differ in effectiveness.

[7] Such linear models are routinely used in statistical studies in the social sciences. The unobservable determinant of effectiveness or quality implies that point estimates of challenger quality will always be somewhat imprecise, as true in all stochastic models. The assumption that the unobserved determinant of quality is uniformly distributions tends to increase errors somewhat relative to comparable normal distributional assumptions.

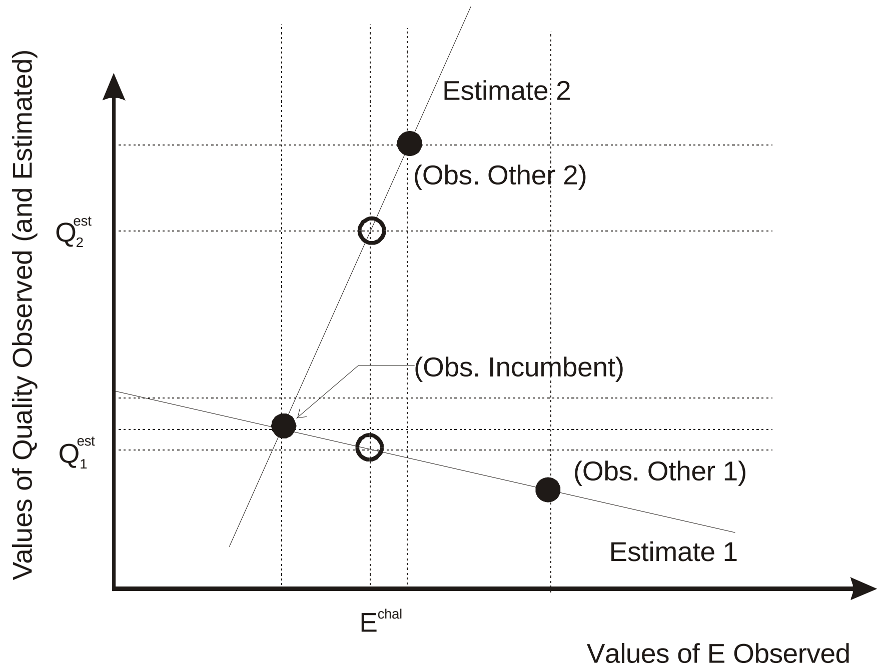
All voters are initially assumed to be “slightly informed;” that is to say, voters are assumed to possess a small amount of information about the observable indices of candidate quality. To reduce voter information to the minimum sufficient for purposes of estimation, it is assumed that all voters know the quality, Q , and the observable characteristic, E, for the incumbent and for one other successful, although different, reference politician. This might be the case, for example, if the voters have lived in different jurisdictions, have read different newspapers, biographies, and blogs, or simply focus on different contemporary or historical figures when thinking about the relative merits of candidates for the office of interest. Similar assumptions are made in the yardstick competition literature (Besley and Case 2003, and Salmon 1987), although in this case the referent is used to calibrate a voter’s yardstick rather than as the yardstick itself. In cases in which “effectiveness” is considered to be a general characteristic rather than a job-specific one, the pool of possible reference candidates expands considerably and may include a voter’s colleagues, friends, teachers, and family members as well as other elected officials.

In this model, it is the sampling process—personal experience—rather than voter preferences that generates differences of opinion regarding the relative merits of candidates. All voters agree about the determinants of candidate quality, and candidate positions have converged to similar platforms. Differences of opinion exist, because voters are assumed to use very small samples to make their estimates. In the cases simulated, each voter's point estimate is a consequence of his or her choice of reference candidate.

Figure 1 depicts estimates of the candidate quality function for two voters who use quite different reference candidates. Each voter has just two observations, the incumbent and his or her referent candidate. Given the linear form of the quality of candidate function and the sample size, the parameters of the quality of candidate function can be estimated by “connecting the dots.” The resulting yardstick is then used to assess challenger quality. In the case depicted, the difference in the voters’ respective yardsticks together with the known value of E for the challenger causes these two voters to disagree about the relative merits of the incumbent and challenger. In figure 1, voter 2 believes the incumbent to be of higher quality than the challenger, and voter 1 believes the challenger to be of higher quality than the incumbent.

Figure 1

Variation in Voter Estimates
of Candidate Quality
For Voters with Different Data Sets



Differences in small data sets can lead to a wide range of voter assessments of challenger quality, because every observation tends to be an influential observation. Indeed, many voter estimates will appear absurd or crazy, even though they are unbiased. Nonetheless, as shown below, the median estimate may accurately assess the *true* underlying quality of the challenger.

III. The Power of Condorcet's Jury Theorem in Small Electorates

Statistical theory implies that the median of a sample of unbiased estimates becomes an increasingly precise estimate of the parameter(s) of interest as the number of estimates in the sample approaches infinity, whenever the parameter of interest is symmetrically distributed. In the present case, individual voter assessments of candidate quality can be regarded as distributions of unbiased estimates and electoral outcomes can be regarded as median estimates whenever the median voter is decisive. As the electorate becomes large, the median voter's estimate becomes essentially perfect in the limit, as demonstrated in many statistical jury theorems.

Unfortunately, this asymptotic precision is unlikely to be found in real world majoritarian settings. Legislatures, juries, expert panels, and committees tend to be relatively small bodies. In large electorates, the number of independent observations tends to be less than the number of voters, insofar as voter opinions are derived from a few dozen common mass media sources. Nor will asymptotic accuracy necessarily be evident in the long-term performance of real world democracies, because the number of national elections is considerably less than a hundred for most contemporary democracies. In practice it will be the small sample properties of majority rule that determine the accuracy and effectiveness of majority rule as a decisionmaking procedure rather, than its asymptotic properties.

The mathematics of median estimators based on small samples, however, is not as well developed or tractable as that of large samples. As a consequence, Monte Carlo simulations are often used to explore the properties of median and related estimators, and this technique is applied below.

i. An Illustrative Monte Carlo Simulation

Consider the range of voter estimates of challenger quality that result when the reference candidates used by voters are drawn randomly from a distribution in which the observable characteristic is uniformly distributed, $E \sim U(-10, 10)$ and the stochastic component of the unobservable characteristic, u, is uniformly distributed, $u \sim U(-2, 2)$, where $H = -4 + u$, and $Q = H + (0.4)E$. Within the present analysis, these assumptions imply that the true candidate quality function is $Q_0 = -4.0 + 0.4 E_0 + u_0$. Voters are initially assumed to know that the underlying quality of candidate function is linear, and, consequently, they use their two data points to estimate the intercept and the slope parameters, α and β, of that function.

Figure 2

Distribution of Parameter Estimates

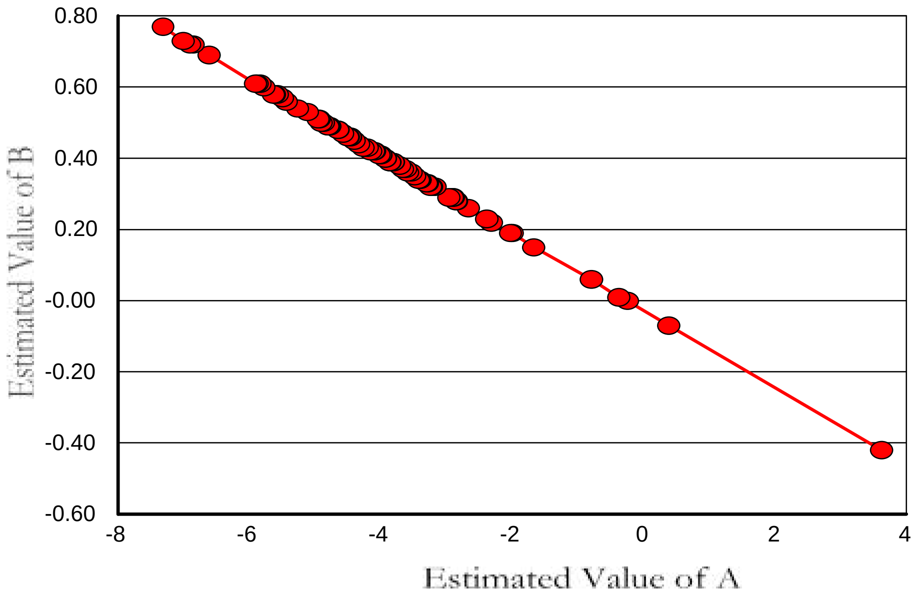
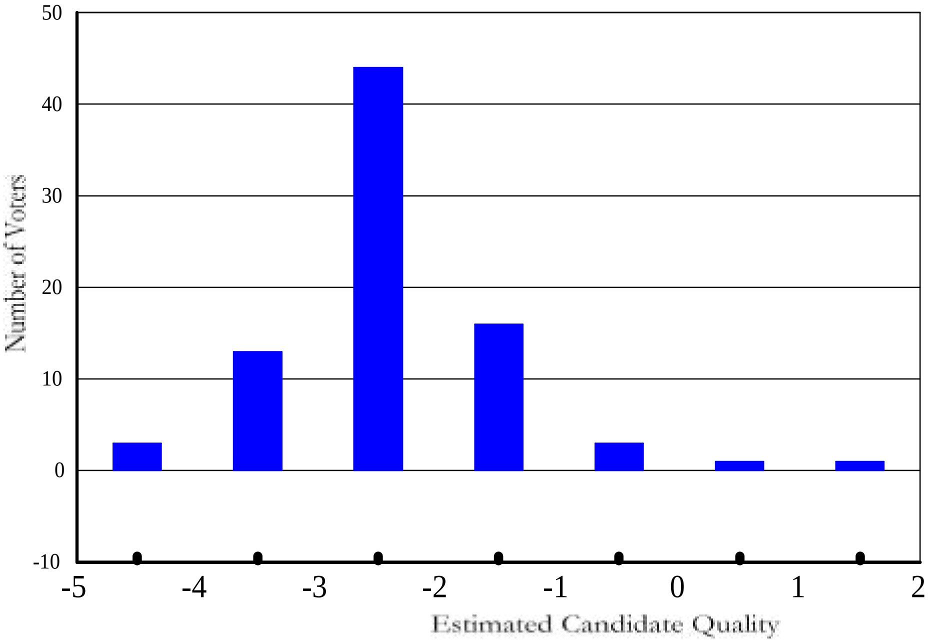


Figure 2 depicts a truncated scatter diagram of voter estimates for a population of 101 slightly informed voters. The high and low tails have been left out, so that the estimates can be tabulated in a more readable form. (The complete range of β estimates ranged from +6 to -9, and that of α ranged from -57 to 83. The middle 80 percent depicted have estimates for β between -0.5 and 0.8 and estimates for α between -8.0 and 4.0.) The linear relationship between the estimated α and β parameters is a consequence of the assumption that voters have only two data points, one of which is in common, and is without particular interest. What is of interest is the wide range of voter estimates obtained and the accuracy of the median estimate.

Even if the outliers are ignored, figure 2 shows that many voter estimates of the quality of candidate function are “way off,” “absurd,” indeed, impossible. Yet, figure 2 also demonstrates that median estimates can accurately characterize the true underlying quality of candidate function. The center of the dense part of the distribution of estimates is approximately -4.0 and 0.4, respectively. (Recall that the true values of α and β are -4.0 and 0.4.)

Figure 3

Frequency Distribution of Estimated Candidate Quality



Voters use their estimated “yardsticks” to predict the quality of the challenger and use that assessment to choose between the challenger and the incumbent. Figure 3 depicts the truncated frequency distribution of estimated challenger quality for the above group of voters, given the known value of *E* for the challenger. The entire range of estimated quality for the challenger varies from +47 to -32. *Many of these estimates are actually impossible given the distributions used in the simulations, but such estimates are nonetheless completely consistent with voter experience, given the small amount of information they have.*[8] Within the “moderate” 80 percent of the electorate tabulated in figure 3, assessments of challenger quality vary far less, but the range of opinion concerning challenger quality is still considerable, from +2 to -5.

Note, however, that *the distribution of estimated challenger quality is centered over the true quality* of the challenger and that a majority of the voter estimates is clustered narrowly about the

[8] In the simulations, voters do not know the distribution of possible candidate qualities E and H, although they know that the quality relationship is linear. Moreover, individual voters have too little data to estimate all the parameters of the distributions of interest. Consequently, some of the estimates imply that the challenger is far better or far worse than is actually possible (which often appears to be the case for more than a few voters in American elections). The possible range of candidates varies from -4 + (.4)(10) + 2 = 2 to -4 + (.4)(-10) - 2 = -10.

true quality of the challenger. In the case depicted, the median estimate is a very accurate assessment of challenger quality, -2.39. (Recall that the actual quality of the challenger is $Q^c = -4 + 0.4\ (4) = -2.40$.) The median voter is not always this accurate, but such accuracy is very common in the simulations. Clearly, the more accurate is the median estimate of challenger quality, the more likely it is that majority rule selects the best candidate or most effective policy.

ii. A Monte Carlo Study of Electoral Estimates of Candidate Quality

The ability of majority rule to aggregate voter information can be explored more fully by simulating a series of elections in which incumbents, reference candidates, and challengers all vary by election. In the next series of simulations, 100 elections are simulated for electorates of increasing size. As in the first simulation, the candidates are drawn from a pool of candidates with characteristic E distributed uniformly from -10 to +10 and $H_i = -4 + u_i$ with $u_j \sim U(-2,2)$. The incumbent and challenger change in every election. New electorates are produced by changing voter reference candidates. Table 1 lists results from six series of simulations for electorates composed of 11, 101, 501, 1001, 2001, and 4001 voters.[9]

The power of the jury theorem is clearly evident even in small electorates. The median voter's estimate of challenger quality is, on average, very accurate, even in the small electorates (juries) that initially attracted Condorcet's interest. The average difference between the median estimate and the average true value is less than 2 percent in each of the election series. Moreover, the size of the electorate does not matter very much, in spite of the extremely limited information used by voters to assess candidate quality and the wide range of voter estimates of candidate quality (recall figure 3). The standard error of the median estimate of challenger quality falls only slightly as the size of the electorate increases.

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[9] The larger electorates take several hours to run on a modern laptop computer, because finding the median requires finding the rank order of voter estimates. The number of calculations performed in the uncompiled code used for the simulations is on the order of the number of voters factorial. N! rises rapidly as the number of voters increases, for example, 101! is approximately 10^{160}.

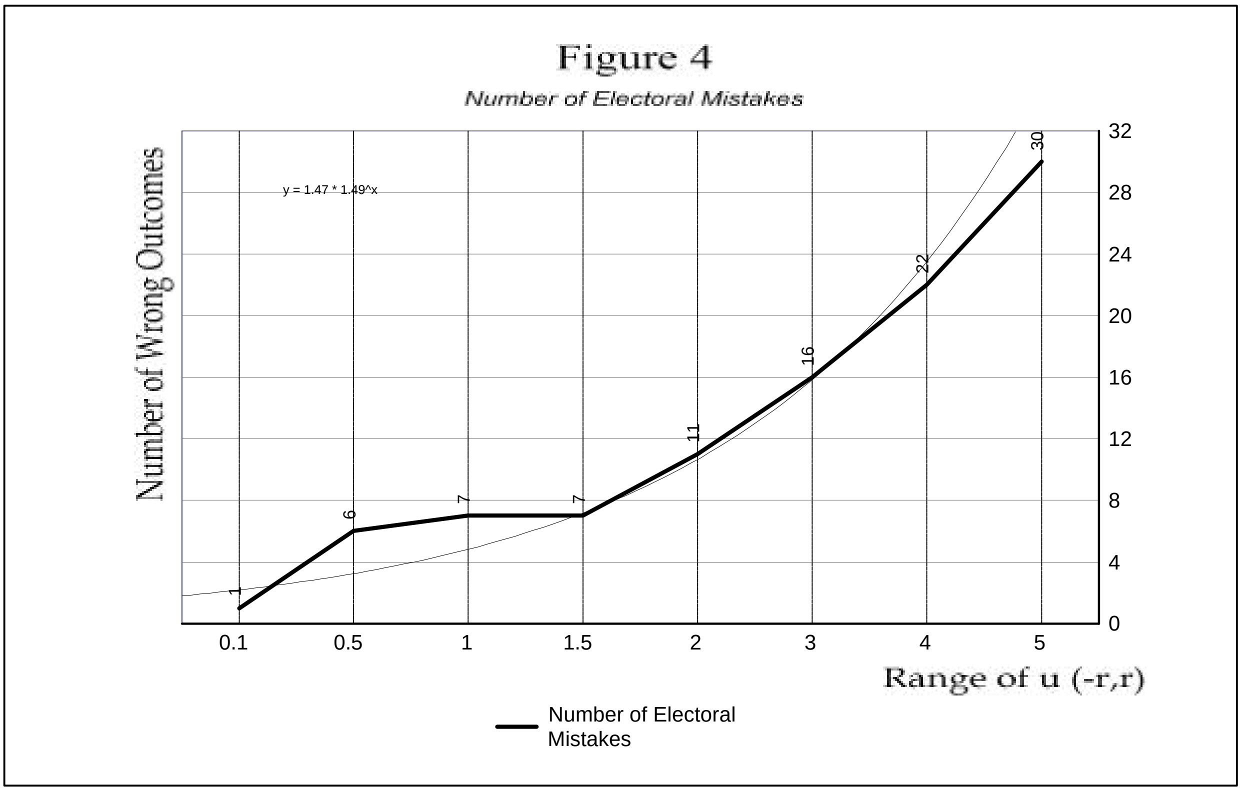
Table 1
Electoral Outcomes as Estimates of Candidate Quality

Electorate Size	Average Challenger Quality in Sample	Median Estimated Challenger Quality	St. Error of Median Est. Candidate Quality	Number of Electoral Mistakes
11	-4.114	-4.068	2.68	13
101	-3.808	-3.975	2.77	14
501	-3.884	-3.827	2.63	14
1001	-3.964	-3.979	2.34	13
2001	-4.071	-4.093	2.31	10
4001	-3.787	-3.746	2.43	13

A hundred elections are simulated for each community of voters. The incumbents, reference candidates, and challengers change in each election.

The last column tabulates the number of electoral mistakes made over the course of the 100 elections simulated. In 10 to 15 percent of the cases, the median voter casts her vote for the candidate of lower quality, because her estimate of challenger quality has wrongly placed the challenger's quality above or below that of the incumbent.[10] These electoral mistakes are not caused by the very small samples on which voters base their candidate evaluations, the fact that their data sets are only partly independent samples, or the small number of voters in the simulations. Rather, these errors are consequences of the fact that not all performance-influencing characteristics of the challenger can be observed or inferred before he or she is elected to office. Statistical methods allow unobservable characteristics to be estimated only on average, whereas the actual challenger quality is partly determined by a specific draw from the distribution of the unobserved characteristic. Such selection errors are unavoidable even when the jury theorem operates perfectly.

[10] Similar mistakes also occur in a yes-no referendum over a proposed new policy. An analogous referendum requires voters to rank the status quo relative to a proposed alternative. Mistakes occur in this case when voters over- or underestimate the net benefits of the new policy relative to that of the status quo. Estimation errors may arise because of unobservable characteristics of the proposed policy or its idiosyncratic interaction with the future environment.



The importance of the unobservable variable is clearly revealed by the next series of simulations, in which the population of voters is fixed at 101 and the domain of the stochastic portion of the unobservable variable is varied from *u~(-0.1, 0.1)* to *u~ (-5.0, 5.0)*. Figure 4 plots the number of times in which the actual quality of the electoral winner is below that of the loser. Note that in cases in which the stochastic portion of the unobservable variable is narrowly distributed, the median voter makes essentially no mistakes. In such cases, the power of the jury theorem is maximized. (This lower tail is, implicitly, the case explored in most of the jury theorem literature.) As the variance of the unobservable determinant of quality increases, the unobservable characteristics of challengers become relatively more important determinants of effectiveness, which causes the number of majoritarian mistakes to increase. For example, when *u~U(-2,2)*, the range used in the previous simulations, the median voter incorrectly casts his or her vote a bit more than 10 percent of the time, as noted above. When the unobservable characteristic is more widely distributed, as with u~U(-5,5), the mistake rate climbs to nearly 30 percent.

Overall, the above simulations demostrate that the median estimates rapidly approach the prediction limits determined by the underlying stochastic nature of the phenomenon of interest. On average, the median voter gets it right, or at least nearly right, even in small electorates (committees), although unavoidable errors are continually made, because unobservable candidate (or policy) characteristics often matter. These simulations, thus, affirm the central claim of the jury theorem: majority rule can be an efficient method of aggregating information in cases in which voters understand the relevant model and have some independent private information about all relevant variables.[11] Voter decisions to economize on information by gathering small but "complete" samples does not lead to systematic electoral errors—although *individual voter estimates tend to be very inaccurate* and may be substantially based on common information.[12]

IV. Rationally Ignorant Voters and the Jury Theorem

Small samples, unobservable characteristics, and common information, however, are not the only information problems that can affect voter estimates of the relative quality of candidates and policies. In many cases, rather than obtaining a very small sample of complete information, voters assemble very small and incomplete data sets. That is to say, voters often choose to remain completely uninformed about a subset of relevant variables and parameters in order to economize on information costs. This method of economizing on information is fundamentally different from using a small sample that includes complete in-

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[11] In cases in which the weak independence assumption used in the simulations is questionable, the electoral results become somewhat less accurate as the underlying number of independent data points used (indirectly) by voters diminishes somewhat (Krishna 1992). However, it bears noting that the simulation suggests that the small electorate properties of majority rule are often very good. As long as the model is known and the data of every voter is complete and independent, the median error term tends to be very close to zero.

Similar results would hold in a stochastic voting model in which candidate positions converge, although in this case the electoral outcomes are a weighted average of voter estimates rather than median estimates.

[12] Note that these results also suggest that the convention of modeling voters as if they had complete information about the policy questions at issue will yield accurate electoral and policy predictions for settings in which most voters have just a bit of complete information. However, as demonstrated below (and in Congleton 2001) such simplifying assumptions are more problematic in electoral settings and for policy issues in which voter ignorance is widespread.

formation for each data point, because *it implies that some relevant variables go unmeasured and some parameters go unestimated, and consequently, voter yardsticks tend to be systematically biased* (Congleton 2001). Rational ignorance, thus, creates a more difficult aggregation problem for majority decisionmaking. Estimates of candidate quality may not only be widely dispersed, but systematically incorrect.

The model developed above can be used to analyze three types of ignorance. First, voters may completely understand the underlying quality of candidate relationship, but decide to economize on information by gathering no information about the observable candidate quality characteristic, E. In effect, such voters expect the challenger to be of average quality and cast their votes for the incumbent only if they believe that the incumbent is of above average quality. Whether a particular incumbent is considered to be above or below average depends on a voter's estimate of the average quality of elected officials, which is estimated using the observed quality of his or her reference candidate(s). This characterization of voter decisionmaking is widely used in the modern political economy literature, but works less well than one might have expected.

Second, voters may decide to economize on information by ignoring the effect of the unobservable variable, H, *and focusing all of their attention on the observable variable,* E. This form of ignorance may be a rational choice undertaken with complete knowledge of the model, or simply be the result of natural ignorance as when the existence of variable H is unknown to a subset of voters. Such voters implicitly assign H the value zero and use information about E to estimate the relative quality of candidates. Given the very limited data sets assumed in this paper, such voters know E for only two politicians, the incumbent and some other reference politician, and the slope of this group's implicit yardstick function, $Q = \beta E$, is estimated as $\beta = (Q_{inc} - Q_{other})/(E_{inc} - E_{other})$. Such voters do not always vote for the more experienced or intelligent candidate, however, because they may disagree about the effect of E on candidate quality.

Third, voters may decide to remain rationally ignorant (or simply remain naturally ignorant) about both determinants of candidate quality, E and H. Such voters can only choose between incumbent and challenger using other variables uncorrelated with performance in office. They might, for example, vote expressively on the basis of region, religion, race, accent, height, hair, eye color, or hobbies (Tullock 1972, Brennan and Lomasky 1993). For the present purposes, it is assumed that completely ignorant voters randomly attribute "quality" to the incumbent and challenger. These voters, unlike the other two types of rationally ignorant voters do not have biased assessments, but totally uninformed ones. They vote randomly and do not systematically affect electoral outcomes, although they may contribute to electoral mistakes in a given election.[13]

The simulations below explore cases in which electorates are composed of all four types of voters: the slightly informed voters used in the first series of simulations and the three types of more or less ignorant voters. To distinguish the mistakes induced by ignorance from those associated with irreducible uncertainty, two electorates of approximately 500 voters with different mixes of slightly informed and rationally ignorant voters are simulated, each with four variances of the unobservable variable. Electoral mistakes are tabulated for the median voter of each subgroup and for the overall electoral result. This allows the ameliorating effects of the jury theorem to be assessed within each subgroup and for the electorate as a whole. The first set of simulations assumes that voters with just a bit of complete information are the largest group of voters, about 40 percent, although not a majority. The second set assumes that slightly informed voters are no more common than the other three voter types. Table 2 summarizes the results of 800 simulated elections.

The top half of table 2 demonstrates that majority rule can ameliorate problems associated with voter ignorance (bias) in cases in which a sufficient number of voters have unbiased estimates (complete small samples). Note that electoral outcomes are only slightly more error prone than when only slightly informed voters exist. Evidently, the errors and biases of the rationally ignorant groups are sufficiently extreme and the slightly informed group is sufficiently large that the median voter is from the slightly informed group in the first series of simulations. In the case in which the unobservable characteristic is relatively unimportant,

[13] See Fremling and Lott (1996) for analysis of errors generated by model errors as opposed to the data limits focused on this paper. The problem of bias is clearly much greater when the basic structure of the quality of candidate function is unknown and must be puzzled out by each voter before challenger quality can be estimated.

majority rule yields essentially error-free results, although very substantial error rates occur in each of the ignorant subpopulations.

Table 2
Electoral Mistakes by Median Voters
in Populations of Slightly Informed and Rationally Ignorant Voters
Simulations: 100 elections, with 202 Slightly Informed Voters and 101 of Each Type of Rationally Ignorant Voter

Range of *u*	Slightly Informed Group	Rationally Ignorant of β	Rationally Ignorant of α	Completely Uninformed Group	Overall Electoral Mistakes
+/- 0.1	0	22	42	51	0
+/- 1.0	7	20	41	51	6
+/- 2.0	12	23	38	50	11
+/- 4.0	21	31	36	52	25
Simulations: 100 elections, with 151 Slightly Informed Voters, and 151 of Each Type of Rationally Ignorant Voter					
+/- 0.1	0	26	45	51	29
+/- 1.0	5	29	40	50	27
+/- 2.0	19	33	41	50	33
+/- 4.0	21	34	42	47	38

The bottom half of table 2 demonstrates that the "jury theorem effect" declines as ignorance becomes relatively more common among voters. In the second series of simulations, the error rate of the median of the electorate as a whole is much larger than is the error rate of the median of the slightly informed subset of voters. The second series of simulated elections also demonstrates that the effects of rational ignorance can be more important than the difficulty of the estimation problem faced by voters. There is a systematic increase in mistake rates for the electorate as a whole as the variance of *u* increases, but there is an even larger increase in mistakes generated by the increased proportions of rationally (or naturally) ignorant voters in the bottom half of the table.

Nonetheless, even toward the bottom of table two, where the range of *u* and the electorate composition are the least favorable to democratic decision making, majority rule still ameliorates the problem of rational ignorance to some extent. The final outcome is less error prone than two of the three rationally ignorant subpopulations, although it is far more error prone than is the median voter of the group that has just a small amount of complete information.

V. Public Policies to Overcome Voter Ignorance

Overall, the simulations imply that both unobservable and unobserved variables can generate electoral mistakes. The more important are unobservable variables, the more mistakes majority rule is bound to make. The greater the fraction of voters who remain ignorant of potentially observable variables, the more mistake prone majoritarian decisionmaking tends to be. Both these information problems limit the extent to which democracies can choose representatives or enact policies that systematically advance the interests of the median voter, and both imply that public policies will necessarily be imperfect. However, only the latter can be ameliorated through informational policies.

A. Limits of Delegation: Dilemma(s) of the Expert

There is a sizable literature on delegation within firms and a smaller literature on delegation within elected legislatures that suggests that delegation can be used to overcome a variety of information problems (Calvert, McCubbins, Weingast 1989; Lupia and McCubbins 1994; Pollack 1997). The previous round of simulations seems to suggest that a well-informed and properly motivated expert can improve on majority rule-based decisions in policy areas in which voters are substantially uninformed. This approach is widely favored by the experts themselves, and seems nearly self-evident if one ignores the wide variety of agency problems associated with delegation. If voters are ignorant of relevant policy details because the cost of being well-informed is too high, why not hire an expert to make informed decisions? There are, however, several problems with the use of experts to solve information problems in majoritarian settings.

First, experts may not actually be able to make better choices than the electorate, even if there are no agency problems and the typical expert has a much larger information base than the typical voter (larger and more complete samples). To see this, consider the case in which a well-motivated expert is delegated responsibility for choosing officials or policies. The expert uses his or her more sophisticated yardstick to assess challenger quality using a larger sample of the available data. Expert data sets are assumed to consist of relatively large samples of reference politicians (or policy experiments), which allows simulation of expert assessments of quality using the model and quality of candidate parameters developed above. Expert estimates are generated using samples of reference candidates drawn from the E~U(-10,10) and u~U(-2,2) distributions. For purposes of illustration, the expert is assumed to have variously 10, 20, 50, or 100 times as much information as a typical voter and is assumed to use regression analysis rather than simple interpolation to calibrate their "expert's yard-stick." Table 3 shows the results of four simulated expert estimates and also the results of a referendum by 1001 slightly informed voters.

Table 3
Expert Estimates vs. Median Voter Estimates

Expert Sample size	Expert Estimate of A	Expert Estimate of B	Implied Challenger Quality	Standard Error of Estimate
N=10	-4.34	0.33	-3.02	1.48
N=25	-4.11	0.37	-2.63	1.14
N=50	-4.19	0.42	-2.51	1.09
N=100	-4.19	0.42	-2.51	1.14
Actual Values	*-4*	*0.4*	*-2.4 = -4.0 +.4(4)*	-
Median Voter Estimates*	-3.79	0.35	-2.39	0.968

*Average median voter estimates from ten elections with 1,001-person electorates, each voter with a sample of N=2, one independent observation and the incumbent.

The simulations summarized in table 3 demonstrate that experts who are better informed than the typical voter are not always "better informed" than the electorate as a whole in policy areas in which voters possess just a bit of complete information and decisions are made via majority rule, as in a referendum. A larger sample size clearly increases the precision of the expert regression estimates, but these estimates are not necessarily more precise than the median estimate of a large pool of slightly informed voters. Direct democracy in such cases yields results that are equal or superior to those of experts with far more information than the typical voter, even if there are no agency problems.

Second, it is clear that the expert has to be selected in some way. If this is done directly or indirectly via elections, as it must in a democracy, the simulations above demonstrate that the task of selecting experts (or those that hire the experts) is not fool proof. In areas in which unobserved characteristics are unimportant and voter data is complete, few mistakes will be made. However, in such cases, direct democracy works effectively, and the main advantage of delegation is reduced transactions costs (holding fewer elections) rather than improved decisionmaking. In policy areas in which ignorance is a significant problem, a properly motivated expert can, in principle, improve policies over direct democracy. However, such electorates will often mistakenly choose “experts” who are less competent than they believe, as demonstrated by the simulations of table 2. And, monitoring agency problems associated with the delegation of policy making authority to experts in such circumstances will be highly imperfect.

Third, in cases in which an expert is successfully identified and properly motivated, and his or her decisions are superior to those of the median voter, whether because of extreme sample differences or widespread voter ignorance, there is another dilemma associated with democratic delegation. To act on the basis of their own expert judgment rather than median assessments of the relative merits of current and alternative policies, an elected candidate (or senior official appointed by an elected candidate) will often risk losing his or her job, unless policy results are observable within a single election or hiring cycle. This logic applies both to elected representatives and to experts appointed by such representatives, insofar as elected representatives are held accountable for their appointments and appointed personnel are replaced when incumbents lose an election. Voters, after all, have to assess the quality of incumbent decisions and can only use the information present in their own minds to make that assessment. Consequently, it will often be in the interest of well-informed and well-motivated experts to put aside their own informed judgment in order to remain in office, whether the expert is directly elected or is appointed by an elected representative that wants to remain in office.

If the simulation results do not provide much support for the use of experts, they do provide a clear rational for the use of referenda in policy areas in which voters have just a bit of complete independent private information. In such policy areas voters can avoid agency problems associated with delegation at little cost. In less informationally favorable circumstances, losses associated with electoral errors may be offset by reduced agency problems.

B. Reducing Ignorance through Public Policy: Public Education, Transparency, and a Free Press

If the simulations do not support delegation as a solution to voter ignorance, they do suggest that the decisionmaking performance of democracy can be improved by adopting policies and institutions that reduce voter ignorance. Thus, it is not surprising to find that most long-standing democracies have a variety of policies and institutions that reduce voter ignorance. For example, constitutional protections for the press, political speech, assembly and requirements for the publication of legislative debates and decisions tend to reduce natural and rational ignorance by increasing the number of independent information sources and by broadening public debate, which brings new policy issues to the attention of voters and reduces the costs of being (slightly) informed about a broad cross section of policy-relevant variables. Public education also tends to reduce voter ignorance and increase the size of voter data sets, although it does not necessarily increase independence.[14]

Democratic governments also routinely collect and publish a variety of statistical measures of political and economic performance that provide both experts and laymen (often indirectly) with the means to assess the effectiveness of policy alternatives more accu-

[14] Both Bayesian and ignorance conceptions of learning are evident in modern education systems. For example, educators use a good deal of "repeated and varied iteration" to induce students to increase their understanding of phenomena about which they are already familiar. Educators also attempt to reduce ignorance by introducing students to phenomena and properties they have never seen or imagined before. For example, few students know about demand curves, median voters, utility functions, indifference curves, the voting paradox, deadweight losses, Pareto efficiency, or Nash equilibrium before being introduced to them by their college professors.

National educational curricula and concentrated ownership of mass media, however, tend to reduce independence, with the result that voters come to be exposed to essentially the same historical facts, theories, and assessments. Some basic overlap in knowledge is, of course, necessary to hold a conversation or debate, but beyond some point, uniformity reduces prospects for independent discussion, analysis, and voting.

rately. Substantially independent analysis of the data collected occurs in scholarly journals and seminars and also in the mass media and, thereby, in homes, restaurants, classrooms, and blogs. Rivals in electoral contests and referenda often disseminate a good deal of useful information about alternative policies and about the observable characteristics of candidates.

The simulation results suggest that such long-standing *informational policies and institutions* of successful democracies are not historical accidents, but rather prerequisites for majority rule to produce tolerable policy outcomes. Without the relatively low information costs produced by public education, a free press, government statistics, and the publication of legislative decisions, the data base used by voters would be even more narrow than survey evidence indicates to be the case, and far more selection mistakes would be made.

Of course, even in reasonably well-functioning democracies, information costs are not always as low as they should be because of various agency problems. Neither elected officials nor the bureaucracy are inclined to provide as much information about their weaknesses and mistakes as about their strengths and successes. Many of the data sets provided by government agencies, consequently, tend to be somewhat "noisy" and biased in a manner not so different from that provided by other groups with policy interests.

Such agency problems are reduced to some extent by freedom of information laws, interagency competition, and informative organizations that are outside the normal political and budgetary processes (Breton and Wintrobe 1975). Within the United States, the Census Bureau, CBO, and GAO serve the latter role to some extent, and the mass media, universities, and private think tanks play similar roles outside government. At the constitutional level, there is evidence that referenda and bicameralism increase public information by increasing public debate and control of public policy issues (Frey and Stutzer 2006; Benz and Stutzer 2004). Persson, Roland, and Tabellini (1997) demonstrate that divided government may also increase voter information.

The simulation results suggest that institutional devices that encourage the dissemination of information and increase transparency in governance also tend to improve the efficiency of majority decisionmaking, because they increase the pool of slightly informed voters.

VI. Conclusions: Informational Limits to Democratic Public Policy

In a world in which information costs are trivial, each voter's estimate of candidate quality and of the future consequences of their preferred policies would be based upon large data sets and sophisticated analysis, and would be accurate to the limits of science and statistical theory. However, in a world in which time and attention are scarce resources and policy issues are complex, the typical voter's expected private marginal benefit from additional information and analysis soon reaches a point where his or her anticipated marginal benefits are low relative to his or her marginal cost. In such settings, voter decisions will often be based upon a cursory analysis of small and/or incomplete data sets.

The simulation results reported in this paper demonstrate that majority rule can produce remarkably accurate assessments of the effectiveness of alternative candidates and policies, if a sufficient subset of voters has just a bit of complete information and median voter results obtain. Although individual voter assessments of the relative merits of candidates or policies may be very inaccurate, the median estimate tends to have a relatively small error associated with it. Voters can, thus, radically economize on information without affecting the effectiveness of majoritarian decisionmaking, as long as most voters are slightly informed and elections are competitive. In symmetric distributions of unbiased estimates, the median error approaches zero in the limit. However, the simulations also demonstrate that the informational assumptions of the jury theorem results are important. As unobservable variables or voter ignorance increase, median voter outcomes produce more policy and delegation mistakes, because of irreducible uncertainty and systematic voter error.

In more complex decision settings than those simulated above, it is clearly possible for voters to be slightly informed about some candidates and policies, while remaining ignorant about others. If the estimation problems are separable, ignorance may bias a voter's estimated yardsticks in the policy domains or among candidates for which he or she is uninformed, without biasing estimates in those areas in which the voter is at least slightly informed. In such settings, two broad domains of public policy may be said to exist. First, there is a political domain in which a majority or large minority of voters have reasonably complete (if shallow) knowledge of candidates and policy outcomes. In these areas, majoritarian decisions are likely to be effective in the sense that public policy systematically advances the true interests of the median voter. For example, policies concerning pure public goods or uniformly provided government services are likely to be well chosen, because all voters have direct personal experience with such services. Second, there are policy areas in which voters have little direct experience and ignorance is commonplace or in which unobservable variables are important and of high variance. In these areas, such as economic regulation and foreign policy, policies are likely to be error prone in the sense that the policies adopted often worsen, rather than increase, the welfare of the median voter. In those areas, electoral mistakes will be commonplace, either because of majoritarian mistakes and / or because voters are not consulted. Ineffective candidates and policies may be elected, while others are chosen secretly behind closed doors free from electoral pressures. The success of majoritarian governance in the West suggests that the first domain of policy has been more important than the second for the past century or two, in part because the first domain has been broadened by public education and other supporting informational institutions.

Overall, the analysis provides a rare public choice defense of democratic procedures and liberal institutions (Buchanan and Tullock 1962, Coleman and Ferejohn 1986). The simulations suggest majority rule can be an effective method for aggregating voter information, as long ago suggested by Aristotle and Condorcet. The results also suggest that the effectiveness of majority rule is increased by many of the "standard" institutions of liberal democracy. Together they suggest that such liberal policies, rights, and institutions are prerequisites for effective majoritarian decisionmaking, rather than artifacts of a particular political philosophy or historical jetsam. Although a free press, public education, freedom of assembly and speech, and publication of laws can be justified using various liberal and utilitarian normative theories (Riker 1982, Hardin, 1999), one does not have to be a liberal to benefit from selecting the most qualified leader or the most effective public policy, nor to favor the use of majority rule over many other decision rules.

Indeed, as Hayek (1945) argued concerning competitive markets, information aggregation is one of the most attractive properties of democratic procedures. Majority rule allows incomplete information dispersed in the minds of millions of voters to be organized in a manner that yields decisions that take account of far more information than any single person is likely to possess. In the standard deterministic model of electoral outcomes used above, majoritarian effectiveness occurs because of the statistical properties of median estimates, rather than collective dialogue, synthesis, or a consensus of the electorate as a whole. There is no “collective mind” or “popular will” at work here. Information aggregation within democracies is largely a consequence of a particular decisionmaking procedure, rather than agglomeration. Knowledge remains dispersed, decentralized, and heterogeneous before, during, and after an election.

Majority rule clearly does not solve all informational problems, but it has done so well enough to select political leaders and policies that on average have produced attractive societies with broad economic and cultural opportunities, rather than the calamities that may have been predicted. Although far from perfect, the long-standing democracies are widely regarded as attractive places to live and work, as emigration pressures in the West clearly attest.

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