

Shall We Vote on Values, But Bet on Beliefs?

Robin Hanson*
Department of Economics
George Mason University†

September 2003 (First Version September 2000)

Abstract

Democracies often fail to aggregate information, while speculative markets excel at this task. We consider a new form of governance, wherein voters would say what we want, but speculators would say how to get it. Elected representatives would oversee the after-the-fact measurement of national welfare, while market speculators would say which policies they expect to raise national welfare. Those who recommend policies that regressions suggest will raise GDP should be willing to endorse similar market advice. Using a qualitative engineering-style approach, we present three scenarios, consider thirty design issues, and then present a more specific design responding to those concerns.

*For their comments, I thank Kathryn Aegis, Tom Bell, Peter Boettke, Nick Bostrom, Tom Breton, Damein Broderick, James Buchanan, Bryan Caplan, Ed Clarke, Joseph Coffey, Roger Congleton, Tyler Cowen, Wei Dai, Hal Finney, David Friedman, William Fischel, Amihai Glazer, Tim Groseclose, Karl Hallowell, Bernardo Huberman, Craig Hubley, Peggy Jackson, Ron Johnson, Michael Kremer, Ken Koford, Hassan Masum, Peter McCluskey, Jim McKinney, Eli Lehrer, Florenz Plassmann, Alexander Tabarrok, Earl Thompson, Nicolaus Tideman, Hal Varian, Karen Vaughn, Gary Wagner, Eliezer Yudkowsky, Richard Zeckhauser, and participants of the Monomedia Berlin: Value conference, the 2000 GMU Public Choice Outreach Seminar, and the 2001 Public Choice Society annual meeting. I thank the Center for Study of Public Choice and the Mercatus Center for financial support, and Edward Stringham for research assistance.

†rhanson@gmu.edu <http://hanson.gmu.edu> 703-993-2326 FAX: 703-993-2323 MSN 1D3, Carow Hall, Fairfax VA 22030

Introduction

The space of possible forms of government is vast and largely unexplored. This fact is illustrated by the new form of government explored in this paper. This new form seems attractive if we accept these three assumptions:

1. Current democracies fail largely by not aggregating enough available information.
2. Speculative markets are the best general institutions we know for aggregating information.
3. It is feasible to, after the fact, tell rich happy nations from poor miserable ones.

The basic plausibility argument goes as follows. Democracies seem to fail often by adopting bad policies, i.e., policies that in effect hurt most voters. If these policies would not have been adopted had all voters known they were bad policies, and if someone somewhere did know or could have known they were bad policies, we can say that such democracies failed because they did not induce people to acquire and share this information. If speculative markets do very well at inducing people to acquire and share information, but are little used in current governmental institutions, then we should consider changing our government institutions to rely more on speculative markets.

Now, in order to get speculative marketes to tell us which policies are bad before the fact, we do require that we can see after the fact whether we have been on net hurt or helped by the sum total of all our policies and other contributing causes. But we can roughly tell after the fact whether nations have been rich and happy, or poor and miserable. Economists even frequently recommend policies that macroeconomic data suggest are causally related to increasing GDP. This suggests that economists think that GDP is often a good enough outcome measure.

To make use of speculative markets, we can “vote on values, but bet on beliefs.” We now use democracy both to decide what we want, and to decide how to get what we want. We might instead still have democracy say want we want, but let speculative markets say how to get what we want.¹ That is, elected representatives might define a formal measure of “national welfare” (analogous to GDP) and manage its measurement after the fact. Market speculators would then say which proposed policies they expected to raise national welfare as so defined. The basic rule of government would then be this: when speculative markets clearly estimate that a proposed policy would increase expected national welfare, that policy becomes law. (Speculative market prices can estimate national welfare conditional on a proposed policy being adopted, and conditional on that policy not being adopted, via called-off trades in assets that pay in proportion to measured national welfare.)

I offer neither a formal theoretical model nor an econometric analysis of this proposal; I instead take an “engineering” approach. That is, I seek to identify relevant design issues, and then seek a basic design that, by seeming to address enough design issues, seems plausible enough to be worth testing at the next level of prototype realism. This paper will therefore qualitatively review the plausibility of the above three assumptions, describe some scenarios of how this approach might work, consider thirty design issues that have been raised, and finally present a more specific design intended to deal with many of these design issues.

¹For no particular reason, I’ve named this alternative “futarchy.”

Information Failures of Democracy

How well-informed is current democratic policy? Half a century ago, empirical research on individual U.S. voters seemed to confirm the worst fears of skeptics of democracy.

Most people made up their minds long before the election ... few citizens paid much attention to politics ... Even on important issues such as government help with jobs, aid to education, or the stationing of American troops abroad, large proportions of the public did not know what the government was currently doing, where the opposing parties stood, or even what they themselves wanted to government to do ... less than 20% ... had 'real and stable' attitudes on ... electric power and housing (Page & Shapiro, 1992).

Such high levels of ignorance continue today (Delli-Carpini & Keeter, 1989). For example, only 29 percent of U.S. adults can name their congressman, and only 24 percent can identify the first amendment of the U.S. constitution.

Formal analysis has identified many potential problems with democracy, including instability, rent-seeking, coordination failures, and commitment failures (Holcombe, 1985; Besley & Coate, 1998). Formal analysis has not, however, tended to validate what many considered the most serious problem: ignorant policies due to low incentives for voters to become informed (Wittman, 1995). This is because while it is true that voters have very little incentive to be come informed, for rational voters this problem can be mitigated by other features of democracy.

For example, in theory it should be enough to have citizens vote selfishly and retrospectively, and to have policies centrally determined. That is, if it is clear who is responsible for policy, and if citizens voted for incumbents only when their personal lives seemed better than expected, then citizens would not need to understand much about abstract policies. Incumbents would then have the power and incentive to make voters feel good about their lives. Real voters, however, do not in fact seem to vote very selfishly (Sears & Funk, 1990). Thus in order to get informed voter-driven policy, we seem to need most voters to obtain information about broader policy consequences.

In this case ignorant voters, such as those who do not understand the consequences of import quotas, can indeed induce bad policies, such as by voting for politicians because they support import quotas. Democracy seems reasonably capable of overcoming such ignorance, however, at least in theory given rational voters. After all, voters learn many things as a side effect of just living, large elections can average out random errors by individual voters, and political entrepreneurs can take the initiative to inform voters via advertising. Also, a small fraction of informed citizens can determine elections if uninformed citizens either abstain, infer what the informed know from opinion polls, or trust political parties, news media, and other sources that rely on the informed voters.

More recent empirical work has similarly found less to complain about in voters.

Collective public opinion is rational [meaning] ... real, stable, differentiated, consistent, coherent; reflective of basic values and beliefs; and responsive (in predictable and reasonable ways) to new information and changing circumstances ... On most domestic matters, about which elites often compete and provide multiple sources of

%	In U.S. Agree With This Opinion	Cite
47	God created humans in basically present form in last 10,000 years	(Gallup, 1999)
52	'astrology has some scientific truth'	(Davis et al., 1996)
72	believe in angels	(Gallup, 1998)
80	'US government is hiding that it knows of the existence of Aliens'	(CNN, 1997)
85	'Jesus Christ was born to a virgin'	(Group, 1994)

Table 1: Contrarian Public Opinions

information, the public can ... form ... opinions that approximate fully and correctly informed preferences (Page & Shapiro, 1992).

This is not to deny that there are information problems, however. The above quote goes on to say,

In foreign affairs, on the other hand, government monopolies of information (and consensus among elites) may sometimes lead the public astray from preferences it would hold if fully informed (Page & Shapiro, 1992).

And in fact these authors go on to claim that the U.S. public was lead far astray regarding World War II and the Cold War.

Democracy can also suffer from information failures due to long delays in information getting to many people. Such delays (or irrationality) might explain the fact that time series of public opinions do not tend to look like random walks. Even on questions of fact such as the risk of a nuclear power accident, it seems that one can predict future average opinions from trends in past average opinions (Page & Shapiro, 1992).

More relevant evidence comes from systematic deviations between expert and public opinion, about both facts and policy. Economists, for example, are much less concerned about foreign aid and down-sizing, and more concerned about reduced productivity growth (Caplan, 2002), and toxicologists tend to estimate lower risks and higher benefits from chemicals (Kraus, Malmfors, & Slovic, 1995). These tendencies also exist, at a reduced level in (men and) the more highly educated, and these differences are not attributable to factors such as age, income, or ideology. The straightforward interpretation of this data is that experts and those who are better educated actually know more than the general public about which policies are better.

Differences between public and expert opinions might be attributed to public ignorance about expert opinion. But the public also seems to have many contrarian public opinions, such as those listed in Table 1. In these cases, the public seems largely aware of how expert opinion differs from public opinion.

Contrarian public opinions suggest not just ignorance but also irrationality more directly. In theory, on matters of fact rational agents should not knowingly disagree with each other (Aumann, 1976). For example, as two rational agents alternate telling each other their new opinion, neither one should be able to predict the direction in which the other agent will next disagree with them (Hanson, 2002). But people do in fact knowingly disagree with each other on factual claims, especially regarding politics. This suggests that people are not just ignorant,

but more fundamentally non-truth-seeking, and are self-deceived about this fact (Cowen & Hanson, 2002). This is consistent with the view that otherwise puzzling policies and political behavior can be understood in terms of weak but positive voter preferences for irrationality (Caplan, 2001).

Of course misinformed and irrational voters need not prevent informed policy, if voters allow policy to be determined by informed elites such as academic advisors. In many areas, however, such as tariffs or immigration, policy often seems closer to what public opinion would suggest than to what relevant experts advise (Dixit, 1997; Stiglitz, 1998). This suggests that often, and perhaps usually, the public does not defer to experts. Furthermore, many case studies suggest that when governments do use academic experts, they often do so to legitimate predetermined policies, rather than to gain information to help determine policy (Barker & Peters, 1993).

Even when democratic policy does defer to academic experts, the failings of academic-style institutions may lead to poorly-informed policy. In academic-style policy information institutions, such as government research labs, advisory agencies, or advisory committees, experts simply declare their policy advice, without much in the way of clear or direct incentives to be right. Even when such experts are selected on the basis of their “academic reputation,” this basically means they are selected by other experts, and those other experts again have little clear or direct incentive to choose those who would offer accurate policy advice.

Many studies suggest real failures in information aggregation within academia-style institutions (Redner, 1987), such as universities, research labs, and expert advisory committees. In statistical studies, these failures include overconfidence in variance estimates (Henrion & Fischhoff, 1986), strong unacknowledged selection biases (De Long & Lang, 1992), and very high error rates (Dewald, Thursby, & Anderson, 1986). In peer review, failures include very low levels of agreement (Chubin & Hackett, 1990), strong biases against obscure institutions (Peters & Ceci, 1982), and biased objections to methods that give disliked results (Mahoney, 1977).

If familiar political institutions suffer from information failures, how large are those failures? The huge variation in economic growth rates across nations, depicted in Figure 1, suggests that the effects of information failures may be very large (Maddison, 1995). While there are surely other important reasons why some nations are rich and others poor, an important fraction of the variation seems attributable to some nations adopting policies which relevant experts knew to be bad, and thereby becoming poorer than nations which adopted better policies (Olson, 1996; Sachs & Warner, 1995; Ascher, 1999). Since the subgroup of democratic nations also have large variations in growth rates, democracies also seem to often fail to adopt good policies.

Many factors contribute to bad policy, including commitment and coordination failures. But it seems hard to imagine that nations would adopt bad policies nearly as often as they do if it were common knowledge that such policies were bad. Thus at some level bad policy seems to be fundamentally due to a failure to aggregate relevant information.

Information Successes of Speculative Markets

While democratic policy seems to suffer from information failures, speculative markets show striking information successes.

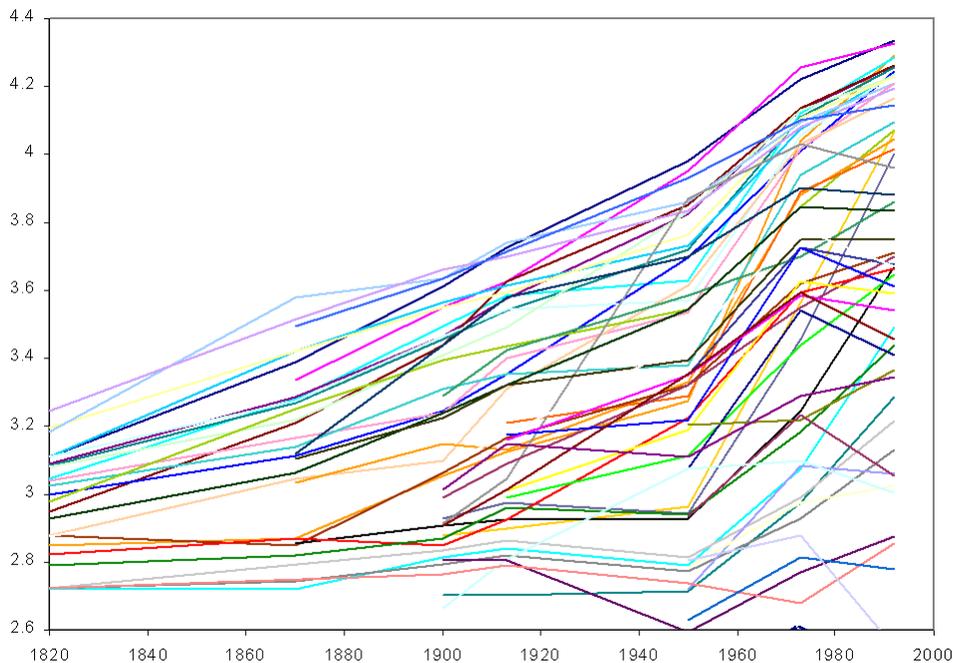


Figure 1: Log GDP Per Capita vs. Year For 56 Countries

Most markets for stocks, bonds, currency, and commodities futures are called *speculative markets* because they allow people to bet on future prices by buying or selling today in the hope of later reversing such trades for a profit. Such opportunities to “buy low, sell high” occur when identical durable items are frequently traded in a market with low transaction costs. Given such opportunities, everyone is in essence invited to be paid to correct the current market price, by pushing that price closer to the future price. Such invitations are accepted by those sure enough of their beliefs to “put their money where their mouth is,” and wise enough not to have lost their money in previous bets.

Betting markets are speculative markets that trade assets that are specifically designed to allow people to bet on particular matters of fact, such as which horse will win a race. The final values of such assets are defined in terms of some official final judgment about the fact in question. By construction, such assets are durable, identical, and can be created in unlimited supply.

Betting and other speculative markets have been around for many centuries, and for many decades economists have studied the ability of such markets to aggregate information. The main finding of this research is that such markets tend to be relatively “efficient” in the sense that it is hard to find information that has not been incorporated into market prices (Lo, 1997; Hausch, Lo, & Ziemba, 1994). The main apparent exceptions seem to be long-term aggregate price movements, and a long-shot bias in high-transaction-cost betting markets.

Many have suggested that, compared to what seems rational, asset markets seem to have

too much long-term aggregate price variation, such as stock market “bubbles” (Shiller, 2000). These kind of price movements are where risk and delay most reduce the extra returns to speculators for correcting pricing errors, and where theory says that “noise” traders can actually gain superior returns (though not utility) from their irrationally-large risk-taking (De Long, Shleifer, Summers, & Waldmann, 1990). Long-term aggregate prices, however, are also where it is hardest to empirically distinguish irrationality from rational shared information about changes in the nature of the economy (Barsky & De Long, 1993), and where selection effects most pollute the available data (Jorion & Goetzmann, 2000). So it remains unclear just how irrational long-term aggregate price movements really are.²

Furthermore, even if speculative markets are subject to irrational bubbles, it is not clear that any of our other information institutions do better. For example, while stock markets may have suffered recently from a “dotcom” bubble, no other information institution in our society, such as academia or news media, consistently predicted that we were overinvesting in high tech companies. Yes some individual academics or reporters may have so predicted, but so did some individual stock investors.

Speculators have a much stronger incentive to eliminate price biases that vary over shorter terms and that are independent of the few aggregate price dimensions that command a “risk-premium.” High transaction costs, however, can deter speculators from eliminating such biases. Parimutuel betting markets, for example, typically charge about an 18% transaction fee, and many suggest that they tend to display a “long shot bias,” over-estimating the chances of unlikely outcomes (Hausch et al., 1994), though contrary results have also been found (Sobel & Raines, 2003). Such a longshot bias is plausible because those who favor a low probability outcome need to spend proportionally less money to have the market price reflect their views, and transaction costs can deter speculators from correcting this bias.

Over the last few decades economists have also studied speculative markets in laboratory experiments, where they have more control over trader information and preferences. Such experiments find that speculative markets aggregate information well, even with four traders trading \$4 over four minutes, and even when such traders know little about their environment or other traders (Sunder, 1995). For example, traders can aggregate information well when they are experienced in their role and abstractly know the payoffs of players in other roles (Forsythe & Lundholm, 1990). If the structure of traders’ information is complex enough relative to the number of assets available to trade, however, information “traps” can occur where individual traders have no direct incentive to reveal their information (Noeth, Camerer, Plott, & Webber, 1999). Such problems are typically, though not always, reduced by allowing trading of more kinds of related assets, since that allows more kinds of arbitrage, i.e., risk-less profits from correcting market prices.

The key policy question about any institution is how it performs *relative* to alternative institutions in the same situation or environment, or range of environments. A few studies have presented field data on this question, directly comparing real world speculative markets with other real world institutions for aggregating information. For example, racetrack market odds improve on the prediction of racetrack experts (Figlewski, 1979). Florida orange juice

²If this were a real identifiable bias, then a federal agency given deep pockets should be able to help correct this bias, and turn a handsome profit in doing so. The lack of support for creating such an agency suggests a lack of confidence in our ability to identify such a bias.

commodity futures improve on government weather forecasts (Roll, 1984). Betting markets beat major national opinion polls 451 out of 596 times in predicting U.S. presidential election results (Forsythe, Nelson, Neumann, & Wright, 1992). Finally, betting markets beat Hewlett Packard official forecasts 6 times out of 8 at predicting Hewlett Packard printer sales (Chen & Plott, 1998; Plott, 2000).

Unfortunately, no studies have directly compared estimates from speculative markets to estimates from academic-style institutions (though a study has been proposed (Hanson, 1995a)). We do know, however, that those who do best at betting on horse races are smart in ways they can not articulate, and in ways unrelated to I.Q. (Ceci & Liker, 1986). Academic-style institutions, in contrast, seem largely limited to aggregating articulated knowledge from those with high I.Q.

Academic institutions place a great deal of weight, perhaps too much, on the opinions of experts relative to more ordinary people. One might worry that betting markets where anyone could join would place too much weight on ordinary people relative to experts. We know, however, that speculative markets seem to, if anything, put too much weight on advice from experts, both public and private (Figlewski, 1979; Metzger, 1985; Lichtenstein, Kaufmann, & Bhagat, 1999). Thus one cannot reasonably claim that while academic institutions may place too much weight on experts relative to ordinary people, betting markets place too little weight. If speculative markets place more weight on contributions from ordinary people than academia does, they thus do better at this weighting choice.

How can betting markets beat opinion polls when they use the same fallible human sources? A study of election betting markets found that traders overall suffered from standard biases such as expecting their favored candidate to win, and seeing that candidate as having won debates. "Market makers," however, were found to be unbiased on average. These were traders who made offers that others accepted, rather than accepting offers made by others. Compared to other traders, market makers invested twice as much, traded more, earned higher returns, and made one sixth as many errors. They also tended to be more highly educated, and experienced at trading (Forsythe et al., 1992; Forsythe, Rietz, & Ross, 1999). Betting markets seem to beat opinion polls and other competing institutions in part because of the disproportionate influence such markets give to more rational and informed traders. We also know more generally that people with stronger incentives to be accurate show fewer cognitive biases (Kruglanski & Freund, 1983).

The number of topics on which markets can create estimates is limited by the number of markets one can create. There are fixed costs to create and run markets, and dividing attention among more markets also raises trader liquidity and volatility costs, i.e., costs due to difficulties in finding trading partners and fluctuations in prices (Pagano, 1989). However, while it was once thought that speculative markets could only be viable if they annually traded millions of dollars, say 10,000 trades of \$100 each (Carlton, 1984), it is now clear that much smaller markets are viable. For example, laboratory experiments consistently show the viability of markets with only four people trading \$4 over four minutes. Very low internet mechanical transaction costs are also now spurring a burst of innovation exploring a great many new market forms, many of which are small (Varian, 1998; Shiller, 1993). Play money web markets are now available where anyone can create new betting topics, and where a handful of traders betting play pennies once every few weeks are typically successful at aggregating information into prices (see, for example,

hsx.com, ideosphere.com (Kittlitz, 1999; Pennock, Giles, & Nielsen, 2001)).

It remains widely illegal, however, to create real money markets like these play money markets, and so most speculative markets still trade millions of dollars a year. This regulatory block on financial innovation should not be surprising, however, because all of our familiar financial institutions were once prohibited by laws against gambling and usury. For example, a thirteenth century decree by Pope Gregory IX prohibited maritime insurance as usury. The 1570 Code of the Low Countries outlawed life insurance as gambling (Brenner & Brenner, 1990). In response to speculation in the South Sea Bubble, in 1720 Britain basically banned the formation of joint-stock companies (Kindleberger, 1984). And futures markets were banned as gambling in the late nineteenth century U.S. (Brenner & Brenner, 1990).

The history of financial regulation can thus be roughly summarized as everything being banned as gambling (or usury) until an exception was granted for some newly legitimized higher purpose. For each purpose, such as capitalizing firms, insuring idiosyncratic risk, or insuring common risk, laws and regulations were created to ensure that generic gambling could not slip in. We may thus reasonably hope to someday legitimate, and thereby legalize, markets whose main function is to aggregate information on questions that matter (Bell, 1997).

Measuring Welfare

Since speculative markets do so well at a task that democracies have troubles with, it is tempting to try to improve democracy by making them rely more on speculative markets. However, in order to use speculative markets to advise national policy, we need to be able to settle bets about how well off a nation has been.

Many have argued that we typically know too little about individual preferences to help people via detailed interventions into their daily lives (Buchanan, 1988). As we aggregate more across people, time, and contexts, however, many of these uncertainties seem to cancel, allowing us to make more accurate judgments about how well off people are on average. It seems reasonably clear, for example, that on average people in Ethiopia today are less satisfied with their lives than people in the United States today. This can be true even if we would find it difficult to advise any random Ethiopian on what he should eat for lunch.

The development of national accounts, i.e., the collection of statistics such as GDP, has been justifiably called one of the greatest economic innovations of the twentieth century. While such measurements are made with error, and leave out a great deal, they seem to be a sufficient basis for many policy recommendations. For example, most researchers in empirical growth economics seem willing to presume that policies are good if they causally induce sustainably higher GDP. And frequent travelers find it hard to escape the impression that, comparing nations with large differences in measured GDP, most people who live in the high GDP nations are richer and better off than most people who live in the low GDP nations.

Furthermore, economists spending modest budgets have already explored many promising extensions to current GDP measures, such as lifespan, home production, leisure, environmental assets (Boskin, 2000; Nordhaus, 2000). Economists also have well developed frameworks for discounting future welfare, and for dealing with risk aversion and inequality. Direct measures of happiness can even be included (Oswald, 1997). It therefore seems plausible that with greatly

increased funding and the full attention of our elected representatives, we could devise even more accurate and robust measures of national welfare.

Consider a person who is willing to recommend a certain policy in a given situation because macroeconomic statistical analysis suggests that those policies tend to cause GDP to rise in such situations. Such a person should also be willing to recommend this policy if speculative markets were to estimate that this policy was expected to increase GDP in this situation. Speculative market estimates are probably no less accurate than a typical statistical analysis. After all, if a statistical analysis is persuasive then speculators should agree with it, and if speculators disagree with a statistical analysis they probably have good reasons.

Therefore, if one is willing to recommend policies that statistical studies suggest will increase (a time average of future)GDP, one should be willing recommend policies that speculative markets estimate will increase GDP, and so one should be willing to consider a form of government which relies more on such market estimates in choosing policies. While GDP leaves out many things, most nations that consistently adopt the best possible policies for increasing (a time average of future)GDP should in a few decades probably be much richer (and happier) than they would otherwise have been. And one should be even more willing to consider basing policy on speculative market estimates of their effects on GDP+, i.e., an improved measure of national welfare.

Decision Market Mechanics

Even if we can see after the fact how well off a nation has been, how can speculative markets tell us before the fact which policies are expected to make the nation well off? The trick is to use markets whose prices can be interpreted as decision-conditional estimates (Hanson, 1999).

Consider a simple market where one can bet on the event B , i.e., Bush wins the 2004 presidential election. In such a market a bank can without risk accept \$1 in payment for the pair of contingent assets, “Pays \$1 if B ” and “Pays \$1 if not B .” This transaction carries no risk because exactly one of these assets will be worth \$1 in the end. Since the expected value of “Pays \$1 if B ” is $\$p(B)$, someone who buys this asset for \$0.60, that can be interpreted as saying that the chance that Bush will win is at least 60%. And a market price of \$0.60 can be interpreted as a consensus that $p(B) \approx 60\%$.

Now imagine a market like the one above, where people can trade an asset “Pays \$1 if B ” for some fraction of \$1, but where such trades are called off unless there is the event K , i.e., Kerry is not the nominee of the Democratic party. When a trade is called off, the exchange does not happen, and each side instead keeps their original assets. In this situation, traders should estimate the value of the asset conditional on this event K , and so a market price of \$0.70 can be interpreted as a consensus that that $p(B|K) \approx 70\%$, i.e., that the conditional probability of Bush winning, given that Kerry is the nominee, is 70%.

Another way to do the same thing is to have a market where, instead of trading the asset “Pays \$1 if B ” for some fraction of \$1, people trade the asset³ “Pays \$1 if B and K ” for some fraction of the asset “Pays \$1 if B .” Since this is trading an asset worth $p(B\&K)$ for some

³A bank can without risk accept \$1 in payment for the set of four assets “Pays \$1 if B and K ,” “Pays \$1 if not B and K ,” “Pays \$1 if B and not K ,” “Pays \$1 if not B and not K .”

fraction of an asset with $p(K)$, the market-price-fraction can be interpreted as an estimate of the ratio $p(B\&K)/p(K)$, which is by definition equal to $p(B|K)$. Thus if the Democratic party wanted to know which nominee would give them the best chance of beating Bush, they could compare the market estimate of $p(B|K)$ to similar estimates for other Democratic candidates.

Speculative markets can estimate not only probabilities, but also expected values. Let the variable x denote the Bush's fraction of the total vote in the presidential election. A bank can accept \$1 in payment for the pair "Pays \$ x " and "Pays \$ $1 - x$," and then the fraction of \$1 required in trade for the asset "Pays \$ x " can be interpreted as a market estimate of $E[x]$. Similarly, the fraction of the asset "Pays \$1 if K " traded for the asset "Pays \$ x if K " can be interpreted as a market estimate of $E[x|K]$.

In 1996, the Iowa Electronic Markets actually had markets whose prices could be combined to represent estimates of Clinton's expected vote fraction conditional on various possible Republican party nominees (Berg & Rietz, 2003). Market prices then indicated that Dole, the actual Republican nominee, was a weak candidate; there was always another candidate who speculators said would have received a higher expected vote fraction than Dole.

One can similarly create markets to estimate whether a new policy N is an improvement over the status quo Q in increasing national welfare W . Given a measure of national welfare W , normalized to be between zero and one, then markets that trade assets "Pays \$ W if N " for some fraction of "Pays \$1 if N " give a market estimate of $E[W|N]$. When the market estimate of $E[W|N]$ is clearly greater than $E[W|Q]$, the markets are saying that this new policy is expected to increase national welfare.

The Engineering of Institutions

It is tempting to use the success of betting markets as information institutions to solve the problems of democracies as information institutions. But do we know enough about either type of institution to be proposing new forms of government based on this idea?

It depends on whether one thinks like a scientist or like an engineer. A scientist (or at least a caricature of one) insists on saying "I do not know" about a theory until it has robust empirical support, or has clear theoretical support from some other empirically-supported theory. A scientist thus bases policy recommendations only on relatively direct data, or on well-supported theory. A scientist who studies social or biological systems also tends to assume that existing systems are functional, and uses that as data to refine theory. A scientist therefore stays quiet about radical new forms of government, which can not possibly have direct empirical support, and which are too complex for our theories to make direct predictions.

An engineer, on the other hand, is more interested in improving systems than in improving theory. An engineer is thus willing to make cruder judgments, farther removed from theory. An engineer is happy to work on a concept with a five percent chance of success, if the payoff from success would be thirty times the cost of trying. An engineer uses theory explicitly as far as it will go, but also uses theory-informed intuitions to more informally think about a wide range of design issues. Given a survey of design issues, an engineer then typically moves on to a series of increasingly realistic and expensive "proof of concept" *prototypes*, from computer simulations, to laboratory "wind tunnel" models, to field tests. While scientists usually have

little use for prototypes and their tests, being neither basic theory nor data that tests theory, prototypes are what make the engineers' world go round.

Academic study of social systems is now mostly dominated by a scientific, rather than an engineering, style. The most respected proposals for new economic and political institutions are based firmly on established theory. For example, economists have sometimes persuaded authorities to consider pollution emissions trading, new auction forms, and approval voting, but largely on the basis of theoretical arguments or endorsement by economic theorists, rather than on the basis of laboratory or field experiments. The 2002 Nobel prize in economics was awarded in part to celebrate Vernon Smith's pioneering of "wind-tunnel" economics, but such engineering efforts remain marginalized.⁴

The new form of government proposed in this paper is intended to be taken in the engineering spirit. While motivated in part by theory, no formal models are presented here. The lack of real world trials with this form of government also precludes econometric analyzes of such trials. The purpose of this paper is not to induce high confidence in readers that this concept would work well, but merely to raise readers' confidence up to a level that would justify further exploration via the next level of prototype. This paper thus, from this point forward, mainly takes on an engineering tone, qualitatively identifying and addressing a wide range of design issues.

Scenarios

This general idea of using speculative markets more widely to aggregate information has been discussed before, both in academic journals (Hirshleifer, 1971; Leamer, 1986) and in science fiction (Brunner, 1975; Stiegler, 1999), as has the more specific application of aggregating policy-relevant information (Zeckhauser & Viscusi, 1990; Hanson, 1995b, 1999; Berg & Rietz, 2003). While such markets could be placed in an informal advisory role, the following three scenarios illustrate how they might be given a more formal role in corporate, agency, and national governance.⁵

Corporate Governance

Most corporations are in effect small democratic governments. The corporate charter is the constitution, and the owners of stock are the citizens. The charter authorizes citizens to vote in proportion to their holdings for a board of directors, who choose and compensate the CEO, who runs the company. The CEO compensation plan usually gives the CEO a strong incentive to try to maximize the stock value, but the directors usually have weak incentives, and are often chosen by the CEO. As a result, one of the mistakes corporations tend to consistently make is to wait too long before firing a bad CEO.

Once smaller scale experiments were successful, corporations might consider using speculative markets to advice big corporate decisions. Imagine that the corporation OldTek amended its

⁴A few social scientists have informally proposed more radical institutional changes, such as random selection of legislators (Carson & Martin, 1999), or fine grain private choice of legal systems (Friedman, 1989), but these efforts are far from the mainstream.

⁵One could also imagine international decision making scenarios. For example, a uniform international carbon emissions tax level might be set by markets that estimate future world product conditional on different tax levels.

corporate charter so that the continued tenure of its CEO depended on certain market prices. A financial house agrees to ensure that there are always dump-the-OldTek-CEO stock markets, trading stock conditional on dumping the current CEO at the end of the current quarter.

In an ordinary stock market people agree to trade cash for stocks, and so the ratio of cash to stock in such trades is the market price, with the bid and ask prices being the prices at which people offer to buy and to sell stock. In a dump-the-CEO market, in contrast, people would still agree to trade cash for stocks, but these agreements to trade would be called off (i.e., made null and void) if the CEO were not dumped by the end of the current quarter.⁶ The OldTek corporate charter might say that if the dump-the-CEO bid price of OldTek stock stays higher than the regular OldTek stock ask price for 90% of the last week of a quarter, the board must dump the CEO within the next quarter.

If non-corporate-insiders were guaranteed trading anonymity, then Disgruntled Jones, a junior OldTek employee, could avoid retribution if he made offers in the dump-the-CEO market to buy OldTek stock. The CEO might accept sell in this market in order to try to keep his job, but the OldTek charter might say that his trades and offers must identify him, and that his compensation must be public knowledge. (These rules might apply to all OldTek insiders.) Thus while the CEO might want to bias the dump-the-CEO stock price, observers would have information to help them correct for such a bias. If enough traders agreed with Disgruntled Jones to dump the CEO, and if OldTek prospered because of this, traders like Jones would be financially rewarded.

Agency Governance

After some successful examples of using speculative markets in corporate governance, a federal agency might consider trying it.

For example, the central banks of most nations periodically make changes to short-term interest rates, reserve requirements, currency conversion rates, and other monetary policy parameters. It is widely agreed that such actions are made in an attempt to smooth out business cycles, limit inflation, and promote high average growth rates. In fact, the future values of GDP growth rates, inflation, and unemployment are generally considered to describe of the main outcomes of interest.

While specialists in this area sometimes disagree about the relative weight to give to smoothing unemployment versus lowering inflation versus increasing growth, what they mostly disagree on is *how* to change monetary policy in order achieve these outcomes. For example, some argue that central banks should hire knowledgeable people, keep them independent, and then let them choose as they see fit. Others argue that central banks should be more politically accountable, and still others argue that central banks should just announce some policy rule and then stick to it (Taylor, 1999).

Monetary policy is thus a policy area where people largely agree on a few statistics by which one can tell, after the fact, the quality of the policy outcome, and where they agree on a few control variables to use to get a good outcome. Monetary policy is thus a good candidate for getting advice from speculative market. To get such advice, the government would choose some

⁶Alternatively, the assets could be contingent instead of the trades. That is, assets of the form “Pays \$1 if CEO dumped” could be traded for assets of the form “Pays one OldTek stock if CEO dumped.”

explicit function describing good outcomes. This function would presumably be increasing in future employment, deflation, and GDP growth, and be concave in these in order to reward stability.

The outcome function might, for example, be the sum over each of the next forty quarters of (a constant plus) the GDP growth rate minus the unemployment rate minus the inflation rate, minus the absolute value of how much each of these parameters changes each quarter. Outcome assets would be created that paid off in proportion to the value of this outcome measure as determined twelve years from now. That is, the outcome measure would end up being some specific number, and each outcome asset could then be exchanged for that number of a certain chosen base asset (perhaps inflation-indexed bonds). These outcome assets could not pay less than zero nor more than some large maximum value. Anyone could trade this maximum amount of base assets for one asset like this, plus one asset that paid the complementary value (the maximum amount minus the outcome measure value).

For example, each week there could be a set of markets that determine whether interest rates should change at week's end. In each market, people would trade some amount of cash for this outcome asset, except that these trades would be called off if interest rates were not a given amount. If any of these markets had a consistently higher price over that week than the other markets, interest rates would be changed to the rate given by that highest market.

Information about the state of the economy that is now given privately to monetary officials would instead be made public, and hence available to market speculators. Supposed monetary experts would have to persuade market speculators in order to influence monetary decisions. And market speculators would have to decide which, if any, of these experts to believe.

National Governance

Once some federal agencies were successful in getting decision advice from speculative markets, a nation might consider changing its constitution to put such markets at the core of its government. With such a government, we would vote on values, but bet on beliefs. The job of elected representatives would be limited to defining and overseeing an after the fact measurement of *GDP+*, a measure of national welfare. The basic rule of government would be:

When an approved betting market clearly estimates that a proposed policy would increase expected *GDP+*, that proposal becomes law.

Democracy would still say what we want, but betting markets would now say how to get it.

A very simple definition of *GDP+* would be a few percent annually discounted average (over the indefinite future) of the square root of GDP each period, normalized so that it is almost sure to fall in the range zero to one. A not quite as simple *GDP+* definition would use a normalized sum over various subgroups of the square root of a GDP assigned to that subgroup. Subgroups might be defined geographically, ethnically, and by age and income. (Varying the group weights might induce various types of affirmative action or discrimination policies.) A more complex *GDP+* could include measures of lifespan, leisure, environmental assets, cultural prowess, and happiness.

One might also want to include consequences for foreigners and animals in a national welfare function. In fact, treaties between nations might take the form of each nation agreeing to

explicitly giving the other nation's welfare function some particular weight in its own welfare function. Finally, the most difficult choices in defining welfare may well be how to treat changes in national population due to births, immigration, and emigration.⁷

In addition to defining GDP+, we would have to choose some base asset in which payoffs are denominated. (The "base asset" in "Pays \$1 if B" is the asset \$1.) This base asset should have competitive returns over the long term, if people are to hold them over the long term. Long-term inflation-indexed government bonds or shares of broad stock index funds are reasonable options. The "welfare" assets traded would then be of the form "Pays GDP+ units of the base asset." So if the base asset were index fund shares, then once GDP+ was determined to be 0.127, each welfare asset could be exchanged for 0.127 index fund shares.

Welfare assets would then be traded for the base asset, both conditional on various proposals being adopted, and on their not being adopted. Prices in markets where trades are called off if some specific proposal is not adopted would determine an expected value of GDP+ conditional on adopting that proposal. Similarly the other set of markets would determine expected values of GDP+ conditional on not adopting proposals. If the expected value of GDP+ conditional on adopting some proposal were clearly higher than conditional on not adopting that proposal, even after considering bid-ask spreads and price fluctuations, then it is constitutionally required that this proposal immediately becomes law.

Design Issues

Most ideas that seem promising at first glance seem less so after one considers more details. Let us therefore, in engineering fashion, identify and briefly discuss thirty design issues, each expressed as an objection to this overall approach. After this we will present a more detailed proposal for a form of government.⁸

We Should Appeal To Higher Motives Than Money

If we could reliably pay off bets in "higher" forms of value, we might want to do so. We want to induce people to tell us what they know, and we need to offer them something that we can reliably produce, can distribute in controlled amounts, and know that most people value. Only money now satisfies these requirements.

A Market-Based Approach Is Biased In Favor of Markets

Even though the mechanism of "betting on beliefs" is market-based, it need not favor markets. It could in principle result in anything from an extreme socialism or an extreme minarchy, depending on what legislators say they want, and on what speculators think will achieve those

⁷We might, for example, give a 10% relative weight to any person anywhere, and a 50% weight to our allies, possible children, and likely immigrants and emigrants.

⁸Because of limited space, these design issues are not discussed here: hidden losers may fight a transition, you cannot pay off bets if Earth is destroyed, infinity never arrives in welfare measurement, risk premia and excess volatility may distort estimates, a combinatorial explosion of possible policies, and multiple solutions when betting wins are included in national welfare.

goals. We do need there to be some community of speculators who have assets they are free to bet, and that some extra benefits consistently accrue to those who win their bets. These benefits need not be large, however, nor need the community of speculators be very large.

For example, market speculators who were rich and selfish could easily approve policies that greatly hurt the rich. If such speculators believed that such policies would best achieve national welfare as defined, then betting for these policies would be the best way for each speculator to be as rich as possible, given whatever policies are approved. Each speculator typically has little influence over policy in general, but has much more influence over his betting wins or losses. This proposed form of government should thus appeal to those who can accept the values democracy would favor, and who think that speculators would agree with their assessment of how to best promote such values.

People Prefer Their Comfortable Illusions

If many people's lives are made more enjoyable by the illusions they have about politics and policy, then we might hurt them by forcing them to forgo such illusions via better information aggregation. Fortunately, voters need not be directly confronted with speculator beliefs. The prices that determine policy need not directly explain speculators' reasoning, and news media that catered to viewers with cherished illusions could avoid explaining this reasoning. Even today, media often avoid telling viewers distasteful details about how legislative sausage is made.

People Would Reveal Less And Lie More

Perhaps many people now often reveal their politically relevant information, and refrain from lying about such topics, because they feel it is their civic duty to do so. If related betting markets became available, and if civic duty were fragile, then such people might be tempted to keep quiet and lie about their information, in order to benefit from related bets.

Those who feel that civic duty makes them honest on politics are often self-deceived, however. Not only do betting markets discourage such self-deception, but once people run out of ways to bet on their secrets, they should want to reveal those secrets and persuade other speculators to believe them, so that they can reverse their earlier trades for a profit. If secret-holders never think they have run out of ways to bet on their secrets, this may be a problem. (Laboratory experiments should be able to help clarify this.) But even so, the studies mentioned earlier showing speculative markets beating other institutions suggest that other institutions often have worse problems.

Maybe Low Information Is Not Democracy's Major Failing

What if democracy's biggest problem were not its ability to aggregate information, but some other problem, such as a coordination or commitment failure, or preventing the government from being overthrown? If so, this new form of government might still be attractive if it did not make this bigger problem much worse, and if it were compatible with whatever reforms could reduce this bigger problem. We would still "vote on values," and so we could change this democratic component to adjust for other problems. For example, some governments might

face the problem of paying off powerful groups who could otherwise overthrow the government. Instead of paying them off via direct financial payments or pork barrel programs, we might pay them off by raising the welfare weight on outcomes they favor.

Democracy Might Become Unstable

In theory, democracies seem subject to policy instability, or “cycling,” since for any policy there is typically another policy that some majority favors. This does not seem to be a large problem in practice (Tullock, 1981), but this may be in part due to voter ignorance, as some theories suggest (Hanson, 1997). If so, this proposal might make instability worse, by better informing voters.

This might be a reason to lean toward more stable democratic institutions. We might prefer one or more large decentralized legislatures whose members have staggered terms, and we might shy away from powerful presidents or proportional representation systems in which coalitions rule as a group. If values change more slowly than beliefs about policy consequences, and if less expertise is required to make value judgments, then the democratic part of this form of government might reasonably be allowed to be slower and less expert than today.

Time-Inconsistency Might Be A Problem

The inability to commit has been identified as a major reason, in theory and some practice, for government failures (Levy & Spiller, 1994; Besley & Coate, 1998). The basic rule of government described above does not overcome this problem, but it also does not obviously make this problem any worse. So perhaps we should continue with the current approach, which is to mostly only allow governments to commit if they can arrange to do so themselves, such as via transaction costs, posting bonds, external reputation, or other external institutions. And any advantages from avoiding time inconsistency problems must be weighed against the problem of allowing earlier generations to take advantage of later generations.

Expressive Voting Could Still Cause Problems

Voters often seem to vote expressively, i.e., to care less about the policies their votes may influence than about how their votes will make them look and feel (Brennan & Lomasky, 1993). Voters may, for example, want to show they are tough or that they care, and they may want to have people they like represent them. These may be worthwhile goals, but policy choices can suffer as a result. By limiting democracy primarily to values, we would presumably focus voters more on expressing their values, rather than their beliefs. It is not clear that this makes expressive voting any more of a problem overall.

Markets Might Be Too Thin To Make Good Estimates

The proposal is to use market prices to change the status quo. So if some markets fail to exist, we can at worst fail to change the status quo when the status quo should change. However, very “thin” markets, i.e., markets that exist but have few traders and noisy prices, might cause great harm via accidental decisions. A market that influences important policies, however,

simply cannot be very thin. After all, if a very thin market were to influence policy, interested parties could pay very little to move the price and favorably influence policy. If interested parties on both sides were similarly funded, their combined trades would thicken the market. Alternatively, if one side were willing to spend much more, then speculators who knew this fact could make easy profits by trading against that better funded side, again thickening the market. So either way, the market would not end up thin.

The Rich Would Get More Influence

The rich have more influence in most every area of life, including politics in every known political system. After all, the point of being rich is to be able to get more of whatever it is you want. If we do not want the rich to get as much as they do, let us tax them more, and they will not be as rich. Perhaps the concern here is that the rich should have proportionally less influence in politics than they do in other areas of life. But in this new form of government the rich would have proportionally less influence in politics, if their relevant information were proportionally less, as seems plausible. Betting markets are not opinion polls where the rich get more votes. The rich have more *potential* votes, but they will lose those votes if they use them without having proportionally more information. And the rich do not tend to throw their money away easily; those who do, do not stay rich very long. Also, there is the option to limit how much money each person can bring to trade on policy proposals.

One Profits Little By Supporting Unlikely Proposals

Imagine that you thought well of some policy proposal, but that few people agreed with you. Because your opponents have consistently held down the market estimate of national welfare given your proposal, your proposal has never been tried. In your eyes it seems terribly unfair that you have never been rewarded, and they have never been punished, for your being right. Of course from each trader's point of view there should always be some chance each proposal will be adopted, since other traders might jump in and support it before the deadline. (And the smaller the market odds were of the proposal passing, the cheaper it would be to try this.) So there is always some possible reward from trading on unlikely proposals, though with finite transaction costs this incentive might not be enough.

Alas, every known political system has a similar problem. Supporters of contrarian proposals might first try them out on smaller scales, and speculators might be persuaded to carve out local regimes where such proposals can be tried. Also, the insights that tell you why your proposal is good might also be useful in predicting the consequences of proposals that are actually adopted. If so, you might first bet to convince others of your insights, then convince them to support your proposal.

People Could Buy Policy Via The Markets

Imagine that speculators know that a certain interested party, a manipulator, wants to move some price in a certain direction. If speculators know this manipulator has no special information about this topic, then if he began trading large amounts in order to move the price, speculators would see easy profits in moving the price right back. The same result follows if

this manipulator has relevant information, as long as the speculators know just how badly he wants to move the price, and how much money he has to spend on this. If speculators can predict a bias, they can and will correct for it.

A manipulator can thus only influence the price if speculators both think he (or those who trade for him) might have relevant information, *and* are unsure about how badly he wants to move the price. This implies that on average interested parties cannot bias the price; they can at worst only add noise. A manipulator may sometimes raise the price when observers under-estimate how badly he wants to raise the price, but such cases are balanced by other cases where the price is lowered because observers over-estimate how badly he wants to raise the price. Furthermore, the fact that interested parties lose their bets on average will attract more speculators to study this topic. The added information from such efforts may more than compensate for the noise from manipulator trading.⁹

For example, interested insiders who happen to have an unusually strong desire to raise the market estimate of a certain proposed stadium's profitability might succeed, but then some other possible stadium's estimate would be reduced because their insiders happen to have an unusually weak desire to raise that stadium's profitability estimate. And the existence of such insiders would attract more speculators to study stadium profitability.

Bad Guys Might Pay To Add Noise

Some of our policies effect foreign nations, and so the markets that estimate the consequences of such policies might be tempting targets for foreign agents. Even if they couldn't bias the estimates in their favor on average, couldn't foreign agents just trade randomly and so reduce our ability to estimate the consequences of our policies? The thicker such markets were, the more it would this strategy would cost. And while such trades would directly add noise to market estimates, indirectly they would entice more speculators to study the topic, improving market estimates. Also, we might try to limit which foreigners can trade in these markets.

One Rich Fool Could Do Great Damage

Even Bill Gates, the richest person alive today, has only a small amount of wealth compared to that available to all market speculators. So if most speculators were confident that Bill Gates were wrong about some market estimate, even Bill Gates could not substantially change that estimate. If Gates pushed the price one way, all those speculators would, by trading, push it right back. More likely, however, speculators would allow Gates to move the price some because they reasonably suspected that he had access to relevant information. Given his successes, this would not be an unreasonable assumption.

We Need To Verify If A Proposal Was Implemented

To implement a rule requiring market-approved proposals to be implemented, we want it to be clear whether approved proposals have in fact been adopted. This includes being clear

⁹Recent laboratory experiments found no reduction in market information from traders with incentives to manipulate market prices (Hanson, Porter, & Oprea, 2003).

about what old policies each new policy would invalidate. After all, it is hard to enforce ambiguous laws. It seems sufficient, however, to treat proposals like contracts, in the sense of being responsible for saying how to resolve such ambiguities. A contract can specify its rules of interpretation or the arbitrator who should do the interpretation, and contract law can lie in the background to fill in remaining ambiguities. Similarly, official policy proposals could specify their interpretation regime as well as who would do the interpreting.

If it were not clear to speculators how a proposal would be interpreted, such speculators would have to average over likely interpretations in estimating the consequences of such policies. An unclear proposal might be a sloppy but sincere attempt to improve national welfare, or it could be an insincere attempt to slip in policies that would not be approved if proposed clearly.

A Policy Might Influence How Welfare Is Measured

If speculators expected a policy to raise estimates of national welfare by influencing how welfare is measured, rather than by influencing real welfare, they still would approve that policy. It is therefore important that welfare measurement be a relatively independent process. Markets should therefore not be allowed to approve proposals that substantially change how welfare is measured. Similarly, we should be wary of allowing markets to change policies that change the political process that leads to changes in the welfare definition, since otherwise market estimates might tend to prevent changes to the current welfare definition.

People Could Do Harm to Win Bets

Insurance companies worry about people deliberately setting fires to collect fire insurance, or killing their spouses to collect life insurance. In principle, public corporations should also worry about people selling their stock short and then damaging their factory or delivered product. This latter scenario seems to be much less of a problem, however. It is hard for most people to substantially damage an entire company, and easier to monitor the few people who can. While this sell-then-harm strategy might seem attractive to criminals, there are in fact no known cases of this; suspicions about the Tylenol poisonings case and the World Trade Center attacks have never been substantiated. Criminals with an ability to harm seem to prefer simple extortion, as in protection rackets.

Not only is the ability to damage national welfare even rarer than the ability to damage a corporation, there are already many speculative markets where people could profit enormously from such an ability. Furthermore, damaging actions should only favor market evaluations of a particular policy proposal if speculators expect that such damaging actions are more likely if the proposal is not implemented. Thus in order to bias a decision via such damaging actions, one has to commit to substantially harming national welfare if the decision goes one way, but not if the decision goes another way, and either have deep financial pockets to bet on this, or credibly convince deep-pocket speculators that you had so committed yourself. This seems an unlikely scenario.

Welfare Measurement Might Be Corrupted

As is familiar in business, the more that rides on a measurement the more one must work to avoid measurement corruption. If you're going to reward your sales staff based on how happy customers say they are, for example, it is best not to have the sales staff manage the customer happiness survey. The former Soviet Union was full of examples of bad business measures, such as the proverbial factory that was rewarded for the tons of nails it produced, which then produced a few enormous nails. However, a great deal now rides on GDP measurements, yet most rich countries seem to have limited corruption in long-term GDP measurements to tolerable levels. Also, many businesses seem to have found ways to limit corruption in measuring many important business statistics. One robust approach is redundancy; several different agencies could collect similar data and process it in similar ways, with the official estimate being the median agency estimate.

The straightforward way to profit from an ability to change a measurement would be to artificially raise or lower that measurement, after one had bet that this change would happen. In order to bias a decision, however, you would have to also commit to substantially changing an important contribution to measured national welfare if a decision went one way, but not if a decision went another way, and either have deep financial pockets or convince deep-pocket speculators that you had so committed, without revealing your corruption to enforcers. This seems an unlikely scenario.

Policies Might Be Encoded In The Welfare Definition

Elected representatives could in principle directly get whatever decisions they wanted by encoding them in the definition of welfare. For example, if they wanted a certain road built, they might put a term in the welfare definition that takes on a large positive value if the road is built as specified, and zero otherwise. Speculators would then have to agree that building the road as specified would raise expected national welfare. To avoid this, courts might be empowered to enforce a rule against such rigged welfare definitions, just as courts now enforce the rule that laws cannot too directly single out a particular person for higher taxes. But more generally we might have to rely on the public to consider such welfare terms as scandalous. And in the worst case, this new form of government would just have reverted to our something like ordinary democracy.

Most Decisions Can Not Detectably Impact Welfare

Speculative markets do not create infinitely precise prices, since many random contingencies influence exactly who trades what when. To avoid letting such factors excessively influence policy, we could require that markets "clearly" favor a proposal over the status quo, via consistently higher prices over a substantial period of time. But then how could small changes ever be approved? One answer is that many small changes added together can have large impact. So a proposal that influences many small decisions may have a detectable impact on national welfare. For example, instead of proposing to build a particular stadium, one could propose a general policy saying how all stadium decisions will be built.

This approach to making laws could also “recurse,” if these general policies authorized similar localized regimes with more focused welfare measures. For example, a general stadium policy might say to approve a stadium whenever markets estimated that it would increase some measure of regional welfare, or of stadium profitability, or be favored by an ex post cost-benefit calculation (Abramowicz, 2003). Similarly, a general school policy might base school decisions on market estimates of improved student test scores, and a general defense policy might base defense decisions on the chances of deterring or winning a war.

The Military Needs Secrecy, While Markets Are Public

This form of government allows public decisions, but does not require them. The general rule of government could be used to approve as a policy a regime in which military decisions are made in private. That private regime could be a recursion where only certain people could see prices and trade, or it could be any other institution that speculators expect to produce good military policy. We would still allow ordinary speculators to override general military policy in any specific case where they estimate that doing so would substantially raise national welfare. In such cases, speculators would take into account the fact that such overrides would be public, and therefore known to potential enemies. If they still approved the policy, it would be because they estimated the secrecy loss to be outweighed by some greater gain.

We Must Define When A Market “Clearly” Estimates

There are many detail questions about how exactly to implement the betting markets. Who can issue assets? What are the maximum and minimum national welfare values? What marketplaces count for setting prices? What information about offers is public? Who can trade in these markets? Who can make proposals? Is there a proposal fee? How large a price difference lasting for how long is a “clear” price difference? Are markets taxed or subsidized?

The recursion approach mentioned above can deal with many of these detail questions. The most basic rule of government could be very conservative, only approving changes that get very clear support from very trusted participants. Then within that framework, people could propose as policies particular less conservative regimes. So, for example, if the basic rule required that price differences must last a year to be “clear,” under that rule speculators could approve a policy which said that all policies chosen by a certain new regime should be approved. And in this new regime differences need only last one week. Once a year had passed, so the basic regime could approve the new policy, from then on only a week would be needed to approve new policies. If there ends up being a clearly best way to answer these questions, different fundamental conservative rules might result in nearly the same in-practice rules.

This Ignores The Cost of Considering Proposals

If one always adopts proposals that would raise welfare conditional on adopting them, one ignores the cost of evaluating proposals. Whenever policy change is possible, people must continually pay attention to new proposals that might be approved, looking for proposals that threaten their interests. And when speculators estimate the benefits of a proposal conditional on adopting it, versus not adopting it, they ignore this cost of evaluating the proposal, since

this cost will have already been incurred either way. If it were easy for anyone to create a market that proposed a policy change, more good changes might result, but we would also all have to pay more attention to the proposal process.

To adjust the rate at which proposals are made, we could choose a fee that people must pay to make a proposal official. (This fee might be refunded, perhaps even at a multiple, if the proposal were accepted.) As described above, legal recursion could set this fee by having a high fee at the base level, and inviting the creation of regimes at other levels with lower fees. If the basic rule required a \$10 million fee for making a proposal official, then within this regime speculators might estimate that the additional changes that would result from lowering this fee to \$10 thousand would on average raise national welfare. In this case, speculators would approve as a policy a new regime which authorized decisions using this lower fee.

You Might Not Catch Buggy Decisions Quickly Enough

If a bad decision were made due to bad information, then the market decision advice should be reversed the moment speculators became aware of this fact, giving legal authority to reverse the bad decision. But what if a bad decision were instead due to a bug in the welfare function, i.e., an unintended consequence of oversimplifying some aspect of our values? To fix this kind of problem, the democratic part of this form of government would have to vote to change the welfare function. But this process might be too slow to avoid great harm from bad decisions that are expensive to undo.

So far we have suggested that a proposal would be approved today if a market clearly estimated good consequences for welfare as it is defined today. To deal with this welfare bug problem, we could also allow such proposals to be vetoed if another market clearly estimated bad consequences for welfare as it will be defined in the future, say in one year. If someone then spotted a bug, they could bet that elected representatives would agree with it being a bug and fix it within one year. If speculators agreed, the proposal would not be implemented. This system might give more veto power to representatives who have private information about likely welfare definition changes. But this may be a reasonable price to pay to avoid bad decisions due to welfare definition bugs.

This Is Too Big A Change All At Once

Speculators should take into account the negative costs of too quickly disrupting established processes when they estimate the consequences of each proposed policy change. This form of government sets up a rule for changing the status quo, but allows for any status quo and any rate of change. Thus a nation might keep its current political system and modify its constitution only to allow policy to change via speculative markets. Once a bill were passed declaring the first definition of welfare and the agencies responsible for measuring it, policy would change only as fast as speculators deemed appropriate for achieving welfare as so defined.

Basic Rights and Freedoms Are Not Guaranteed

Rights and freedoms could be preserved by putting them directly into the welfare function. That is, the government might collect statistics regarding the number and types of violations

of basic rights and freedoms, and the definition of national welfare might give a large negative weight to such outcomes. Alternatively, the constitution might require all approved policies to respect certain stated rights.

It Seems Hard To Make One Measure Encode All Our Values

The democracy part of this government could build a welfare measure incrementally. It would start with say GDP, and then entertain proposals to change it. Those in favor of a change would point to choices, real or hypothetical, where the proposed definition seems to choose better the current definition. Those opposed would then point to choices where the old definition seems to choose better. Representatives would then decide which errors seemed the most tolerable.¹⁰

Decisions Would Magnify Measurement Errors

Under this form of government, speculators should raise measured welfare as much as possible. This can be done not only by raising real welfare, but also by raising the positive error between measured and real welfare. The easier it is for policies to move those errors in a consistent direction, the more harm might be done by a crude welfare measure. Businesses and other institutions have long had to deal with related problems, however, including what incentives to give a CEO, a plant manager, a salesperson, a teacher, or a student. Measured performance always differs from real performance in some ways, and that difference can cause problems. But those problems do also often seem to be manageable. Note also that a similar problem occurs with *any* way in which things learned from looking at crude welfare measures are allowed to influence policy. Any such influence on policy is also at risk of responding to, and increasing, welfare measurement error rather than real welfare. When you take action, you risk making a mistake.

Easy to Measure Values Would Be Over-Emphasized

A teacher who is rewarded only on the basis of student test scores may neglect aspects of teaching that do not much influence test scores. If other outcomes of teaching are important and hard to measure, it can be better to pay teachers a flat salary than to pay them only for outcomes that can be easily measured (Holmstrom & Milgrom, 1991). This new form of government might similarly cause harm if important things we valued did not contribute to national welfare as formally measured. And some things we value are certainly much harder to measure than others.

The similarly with the case of the teacher ends there however. It is risk-aversion, together with exerting hidden effort, that makes teachers reluctant to be paid based on very noisy measures of the real outcomes of interest. Market speculators, in contrast, are to a good

¹⁰A different approach would be for elected representatives to pick a distribution over hypothetical test choices between national outcomes, instead of directly choosing a welfare function. Juries or the legislature would later have to make choices for a random subset of these hypothetical cases. Before this, private groups could then propose welfare functions, and the official welfare function at any one time would be the one that speculators estimated would give the smallest error rate on test choices. (This general approach was suggested by Peter McCluskey.)

approximation risk-neutral, and exert no relevant hidden effort when making estimates. There is therefore no reason for a national welfare measure not to include every factor that contributes substantially to real welfare, even if the best available measures of those factors are very noisy.

There Is A Decision Selection Bias

When you are in full control of a decision, standard decision theory tells you to make the choice that, according to your values and information, gives the best expected outcome conditional on your making that choice. If other people are watching you, however, then even if they exactly share your values they do *not* necessarily want you to make the choice that they estimate will give the best outcome conditional on your making that choice. This is because they have to worry that the fact you make a particular choice could tell them something about things you know that they do not.

For example, imagine a company's board of directors were going to keep or dump their CEO based on their estimate of the expected value of the stock conditional on keeping or dumping the CEO. Imagine further that speculators who knew less than the board also estimated the value of the stock conditional on keeping or dumping the CEO. There are some possible distributions over outcomes where speculators will estimate a higher stock value conditional on keeping the CEO than on dumping him, even though the information speculators have says to dump him.

This sort of effect can distort betting market decision advice when the market speculators are not as well informed as the agents who are making the decision. To avoid this distortion, we can allow informed insiders to trade in the markets, or we can put market estimates directly in control of decisions, rather than making such estimates advisory. We can also make the time at which markets will make the decision clear, by specifying a short time duration during which they can be considered. This helps because if market speculators are making a decision now, but think that the decision may actually be made later, then they have to worry about they will know in the future that they do not know now.

A Specific Proposal

We have now considered thirty design concerns about using the information power of speculative markets to fix the information problems with democracy. Upon further examination, some of these issues seem more serious than others, and we have identified approaches that might mitigate some of these problems. Let us now collect these various fixes together into a modified design concept for "futarchy," a form of government where we vote on values, but bet on beliefs.

This form of government would have a democratic component capable of approving bills, either by electing representatives who approve bills, or via some more direct democracy. This democratic component need not be as expert or responsive as existing democracies, and should instead try to be more robust to other problems, such as revolution or cycling. The bills approved would primarily define what national welfare is, how to measure it after the fact, and who is to measure what parts of it. At any one time there would be a current official definition of national welfare, and while new bills would be allowed to change that definition, they must commit to eventually publishing values for all past official definitions of national welfare.

The agencies that are charged with measuring welfare would ideally have enough redundancy and monitoring to deter most corruption in measurement, and be independent enough from other social institutions so that changes in other institutions would not systematically change what values they eventually declare.

National welfare is to be defined primarily in terms of outcomes desired. Some exceptions can be allowed to embody ethical judgments about actions which are not desired no matter what outcomes they lead to. Perhaps the courts should declare a national welfare definition change invalid if it seemed too directly an attempt to implement specific policy.

There would at any one time be a set of nested status quo policies, with more fundamental policies authorizing less fundamental policies. This is similar to the way that today a law authorizing the creation of some government agency implicitly authorizes whatever regulatory rules that agency creates. This new form of government would begin with the previous set of laws and regulations as the status quo policies, except that the most fundamental policy would be this rule:

Futarchy's Basic Rule: *When* a valid market clearly estimates that, conditional on approving a certain valid proposed policy versus not approving it, national welfare as defined today would be higher, *and* if no valid market clearly vetoes this by estimating that, conditional on approving this policy versus not approving it, national welfare as defined a certain delay later (e.g., a year) would be lower, *then* that proposal immediately becomes law, at one level removed from this basic rule, and overrides any conflicting non-constitutional laws.

Each valid proposed policy declares a short time window during which it can be approved, and says, directly or indirectly, what people must do to comply with it, what happens if they do not comply, and what previous policies it invalidates. Such a proposed policy should specify how and by whom it is to be interpreted. Thus the official court need only fill in any remaining ambiguities, and rule on whether the policy is valid. Valid policies do not violate any constitutional guarantees, such as a bill of rights, and may not substantially and systematically influence how welfare is defined or measured.

At the basic level there are some very conservative rules regarding what is a valid market, when such a market clearly estimates something, and how long the veto delay is. These rules say who can propose policies, who can bet on them, what assets and market places count for determining prices, and how long and distinctly prices must differ in order to say that one price is “clearly” above another.¹¹ Futarchy's basic rule is allowed to approve other policies which look like the basic rule one level removed, except that they have less conservative answers to these questions.

While not yet specific enough to officially propose, this proposal may be specific enough to more critically evaluate.

¹¹For example, these conservative rules might let anyone bet, let anyone propose a policy if they pay a \$100,000 fee, require for approval a difference in CFTC-market-approved prices of at least twice both bid ask spreads averaged over each of two consecutive weeks, and have a veto delay of one year.

Conclusion

This paper has explored the idea of using the successes of speculative markets as information aggregation mechanisms to help reduce the failures of democracies as information aggregation mechanisms. In a new form of government, we could formally deferring to betting markets on matters of fact, while retaining democracy on matters of value. We could vote on values but bet on beliefs. This paper has taken an engineering-style approach to this concept. After reviewing democratic failures, speculative market successes, and the measurement of welfare, we considered thirty design issues with this concept, and finally sketched a more specific proposal to deal with some of these issues.

If, after this examination, the concept passes the low engineering threshold of “promising,” then the next appropriate engineering-style step would be to test simple prototypes in simple test environments. Laboratory experiments, for example, can compare a simple version of this concept to a simple version of more familiar democracy in some simple but non-trivial information environment. Laboratory successes might then prompt larger trials, such as making important decisions in a corporation or other large organization. Eventually, we might consider trying agency-level decision making, such as with monetary policy, and later still, we might even be ready to consider changing our form of government. Perhaps, at such a moment, we might even consider what a betting market has to say about how making this change would impact future GDP and other welfare measures.

References

- Abramowicz, M. (2003). Information Markets, Administrative Decisionmaking, and Predictive Cost-Benefit Analysis..
- Ascher, W. (1999). *Why Governments Waste Natural Resources: Policy Failures in Developing Countries*. Johns Hopkins University Press, Baltimore.
- Aumann, R. (1976). Agreeing to Disagree. *The Annals of Statistics*, 4(6), 1236–1239.
- Barker, A., & Peters, B. G. (1993). *The Politics of Expert Advice*. University of Pittsburgh Press, Pittsburgh.
- Barsky, R. B., & De Long, J. B. (1993). Why Does the Stock Market Fluctuate?. *Quarterly Journal of Economics*, 108(2), 291–311.
- Bell, T. (1997). Idea Futures: Making the Marketplace of Ideas Work. Tech. rep., Chapman University School of Law.
- Berg, J. E., & Rietz, T. A. (2003). Prediction Markets as Decision Support Systems. *Information Systems Frontiers*, 5(1), 79–93.
- Besley, T., & Coate, S. (1998). Sources of Inefficiency in a Representative Democracy: A Dynamic Analysis. *American Economic Review*, 88(1), 139–56.

- Boskin, M. J. (2000). Economic Measurement: Progress and Challenges. *American Economic Review*, 90(2), 247–252.
- Brennan, G., & Lomasky, L. (1993). *Democracy and Decision: The Pure Theory of Electoral Preference*. Cambridge University Press, Cambridge.
- Brenner, R., & Brenner, G. A. (1990). *Gambling and Speculation*. Cambridge University Press, Cambridge.
- Brunner, J. (1975). *The Shockwave Rider*. Harper & Row, New York.
- Buchanan, J. M. (1988). Contractarian Political Economy and Constitutional Interpretation. *American Economic Review*, 78(2), 135–139.
- Caplan, B. (2001). Rational Irrationality and the Microfoundations of Political Failure. *Public Choice*, 107(3/4), 311–331.
- Caplan, B. (2002). Systematically Biased Beliefs about Economics: Robust Evidence of Judgmental Anomalies from the Survey of Americans and Economists on the Economy. *Economic Journal*, 112, 433–458.
- Carlton, D. W. (1984). Futures Markets: Their Purpos, Their History, Their Growth, Their Successes and Failures. *The Journal of Futures Markets*, 4(3), 237–271.
- Carson, L., & Martin, B. (1999). *Random Selection in Politics*. Praeger.
- Ceci, S. J., & Liker, J. K. (1986). A day at the races: a study of IQ, expertise, and cognitive complexity. *Journal of Experimental Psychology: General*, 115, 255–266.
- Chen, K.-Y., & Plott, C. R. (1998). Prediction markets and information aggregation mechanism: Experiments and application. Tech. rep., California Institute of Technology.
- Chubin, D. E., & Hackett, E. J. (1990). *Peerless Science: Peer Review and U.S. Science Policy*. SUNY Press, Albany.
- CNN (1997). Poll: U.S. hiding knowledge of aliens.. <http://www.cnn.com/US/9706/15/ufo.poll/>.
- Cowen, T., & Hanson, R. (2002). Are Disagreements Honest?. Tech. rep., George Mason University Economics.
- Davis, J. A., Smith, T. W., & Marsden, P. V. (1996). General Social Survey.. <http://www.icpsr.umich.edu/GSS/>.
- De Long, J. B., & Lang, K. (1992). Are all Economic Hypotheses False?. *The Journal of Political Economy*, 100(6), 1257–1272.
- De Long, J. B., Shleifer, A., Summers, L. H., & Waldmann, R. J. (1990). Noise Trader Risk in Financial Markets. *Journal of Political Economy*, 98(4), 703–738.

- Delli-Carpini, M. X., & Keeter, S. (1989). *What Americans Know about Politics and Why It Matters*. Yale University Press, New Haven.
- Dewald, W. G., Thursby, J. G., & Anderson, R. G. (1986). Replication in Empirical Economics: The *Journal of Money, Credit and Banking* Project. *The American Economic Review*, 76(4), 587–603.
- Dixit, A. K. (1997). *The Making of Economic Policy: A Transaction-Cost Perspective*. MIT Press, Cambridge, Massachusetts.
- Figlewski, S. (1979). Subjective Information and Market Efficiency in a Betting Market. *Journal of Political Economy*, 87(1), 75–88.
- Forsythe, R., & Lundholm, R. (1990). Information Aggregation in an Experimental Market. *Econometrica*, 58(2), 309–347.
- Forsythe, R., Nelson, F., Neumann, G. R., & Wright, J. (1992). Anatomy of an Experimental Political Stock Market. *American Economic Review*, 82(5), 1142–1161.
- Forsythe, R., Rietz, T. A., & Ross, T. W. (1999). Wishes, Expectations and Actions: A Survey on Price Formation in Election Stock Markets. *The Journal of Economic Behavior and Organization*, 39(1), 83–110.
- Friedman, D. (1989). *The Machinery of Freedom* (2nd edition). Open Court, La Salle, Ill.
- Fuller, S. (2000). *The Governance of Science*. Open University Press, Buckingham.
- Gallup (1998). Gallup UFO Poll: Some Want to Believe, Some Don't.. <http://www.parascope.com/articles/0597/gallup.htm>.
- Gallup (1999). Americans Support Teaching Creationism as Well as Evolution in Public Schools..
- Group, B. R. (1994). Barna Research Online Archives.. <http://www.barna.org/cgi-bin/PageCategory.asp?CategoryID=6>.
- Hanson, R. (1995a). Comparing Peer Review to Information Prizes – A Possible Economics Experiment. *Social Epistemology*, 9(1), 49–55.
- Hanson, R. (1995b). Could Gambling Save Science? Encouraging an Honest Consensus. *Social Epistemology*, 9(1), 3–33.
- Hanson, R. (1999). Decision Markets. *IEEE Intelligent Systems*, 14(3), 16–19.
- Hanson, R. (2002). Disagreement is Unpredictable. *Economics Letters*, 77, 365–369.
- Hanson, R., Porter, D., & Oprea, R. (2003). An Experimental Test of Incentives to Manipulate Information Markets. Tech. rep., George Mason University.

- Hanson, R. D. (1997). *Four Puzzles in Information and Politics: Product Bans, Informed Voters, Social Insurance, and Persistent Disagreement*. Ph.D. thesis, California Institute of Technology.
- Hausch, D. B., Lo, V. S., & Ziemba, W. T. (1994). *Efficiency of Racetrack Betting Markets*. Academic Press, San Diego.
- Henrion, M., & Fischhoff, B. (1986). Assessing uncertainty in physical constants. *American Journal of Physics*, *54*(9), 791–798.
- Hirshleifer, J. (1971). The Private and Social Value of Information and the Reward to Inventive Activity. *American Economics Review*, *61*(4), 561–74.
- Holcombe, R. (1985). *An Economic Analysis of Democracy*. Southern Illinois University Press, Carbondale.
- Holmstrom, B., & Milgrom, P. (1991). Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design. *Journal of Law, Economics, and Organization*, *7*(0), 24–52.
- Jorion, P., & Goetzmann, W. N. (2000). A Century of Global Stock Returns. Tech. rep. 7565, NBER.
- Kadane, J., & Winkler, R. (1988). Separating Probability Elicitation from Utilities. *Journal of the American Statistical Association*, *83*(402), 357–363.
- Kindleberger, C. P. (1984). *A Financial History of Western Europe*. George, Allen, & Unwin, London.
- Kittlitz, K. (1999). Experiences with the Foresight Exchange. *Entropy Online*.
- Kraus, N., Malmfors, T., & Slovic, P. (1995). Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks. *Risk Analysis*, *12*(2), 215–32.
- Kruglanski, A. W., & Freund, T. (1983). The Freezing and Unfreezing of Lay-Inferences: Effects on Impressional Primacy, Ethnic Stereotyping, and Numerical Anchoring. *Journal of Experimental Social Psychology*, *19*, 448–468.
- Leamer, E. E. (1986). Bid-Ask Spreads For Subjective Probabilities. In Goel, P., & Zellner, A. (Eds.), *Bayesian Inference and Decision Techniques*, pp. 217–232. Elsevier Science Publications.
- Levy, B., & Spiller, P. T. (1994). The Institutional Foundations of Regulatory Commitment: A Comparative Analysis of Telecommunications Regulation. *Journal of Law, Economics, and Organization*, *10*(2), 201–46.
- Lichtenstein, D. R., Kaufmann, P. J., & Bhagat, S. (1999). Why Consumers Choose Managed Mutual Funds over Index Funds: Hypotheses from Consumer Behavior. *Journal of Consumer Affairs*, *33*(1), 187–205.

- Lo, A. W. (1997). *Market efficiency: Stock market behaviour in theory and practice*. Elgar, Lyme.
- Maddison, A. (1995). *Monitoring the World Economy 1820-1992*. OECD, Paris.
- Mahoney, M. J. (1977). Publication Prejudices: An Experimental Study of Confirmation Bias in the Peer Review System. *Cognitive Therapy and Research*, 1.
- Metzger, M. A. (1985). Biases in Betting: An Application of Laboratory Findings. *Psychological Reports*, 56, 883–888.
- Noeth, M., Camerer, C. F., Plott, C. R., & Webber, M. (1999). Information Aggregation in Experimental Asset Markets: Traps and Misaligned Beliefs. Tech. rep. 1060, California Institute of Technology.
- Nordhaus, W. D. (2000). New Directions in National Economic Accounting. *American Economic Review*, 90(2), 259–263.
- Olson, M. (1996). Big Bills Left on the Sidewalk: Why Some Nations are Rich and Others are Poor. *Journal of Economic Perspectives*, 10, 3–24.
- Ortner, G. (1998). Forecasting Markets - An Industrial Application. Tech. rep., University of Technoloy Vienna. <http://ebweb.tuwien.ac.at/apsm/fmaia2.pdf>.
- Oswald, A. (1997). Happiness and Economic Performance. *Economic Journal*, 107, 1815–1831.
- Pagano, M. (1989). Endogenous Market Thinness and Stock Price Volatility. *The Review of Economic Studies*, 56(2), 269–287.
- Page, B. I., & Shapiro, R. Y. (1992). *The Rational Public: Fifty Years of Trends in America's Policy Preferences*. University of Chicago Press, Chicago.
- Pennock, D. M., Giles, C., & Nielsen, F. (2001). The Real Power of Artificial Markets. *Science*, 291, 987–988.
- Peters, D., & Ceci, S. (1982). Peer Review Practices of Psychological Journals: The Fate of Published Articles, Submitted Again. *The Behavioral and Brain Sciences*, 165, 187–195.
- Plott, C. R. (2000). Markets as Information Gathering Tools. *Southern Economic Journal*, 67(1), 2–15.
- Redner, H. (1987). Pathologies of Science. *Social Epistemology*, 1(3), 215–247.
- Roll, R. (1984). Orange Juice and Weather. *The American Economic Review*, 74(5), 861–880.
- Sachs, J. D., & Warner, A. M. (1995). Economic Convergence and Economic Policies. Tech. rep. 5039, NBER.
- Sears, D., & Funk, C. (1990). Self-Interest in Americans' Political Opinions. In Mansbridge, J. (Ed.), *Beyond Self-Interest*, pp. 147–170. University of Chicago Press, Chicago.

- Shiller, R. J. (1993). *Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks*. Clarendon Press, Oxford.
- Shiller, R. J. (2000). *Irrational Exuberance*. Princeton University Press.
- Sobel, R. S., & Raines, S. T. (2003). An examination of the empirical derivatives of the favorite-longshot bias in racetrack betting. *Applied Economics*, 35(4), 371–385.
- Stiegler, M. (1999). *Earthweb*. Baen Books, New York.
- Stiglitz, J. (1998). The Private Uses of Public Interests: Incentives and Institutions. *Journal of Economic Perspectives*, 12(2), 3–22.
- Sunder, S. (1995). Experimental Asset Markets. In Kagel, J. H., & Roth, A. E. (Eds.), *The Handbook of Experimental Economics*, pp. 445–500. Princeton University Press, Princeton New Jersey.
- Taylor, J. B. (Ed.). (1999). *Monetary Policy Rules*. University of Chicago Press, Chicago.
- Tullock, G. (1981). Why So Much Stability. *Public Choice*, 37(2), 189–202.
- Varian, H. R. (1998). Effect of the Internet on Financial Markets. Tech. rep., University of California, Berkeley.
- Wittman, D. (1995). *The Myth of Democratic Failure*. University of Chicago Press, Chicago.
- Zeckhauser, R. J., & Viscusi, W. K. (1990). Risk Within Reason. *Science*, 248, 559–564.