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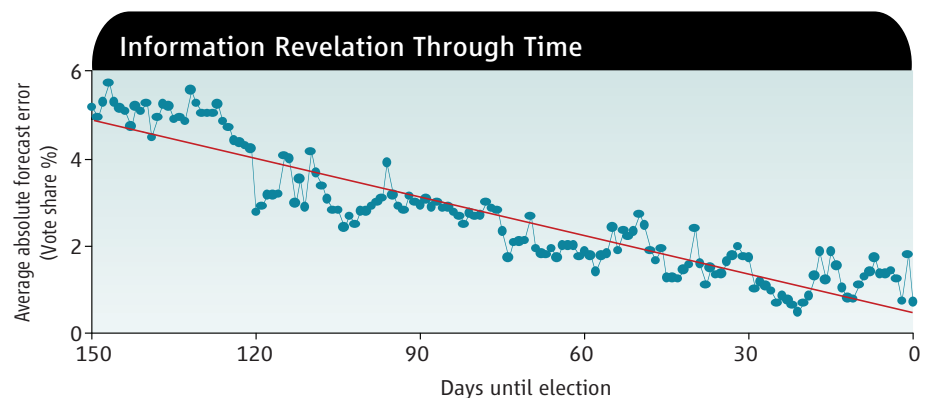
The Promise of Prediction Markets

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Prediction markets are forums for trading contracts that yield payments based on the outcome of uncertain events. There is mounting evidence that such markets can help to produce forecasts of event outcomes with a lower prediction error than conventional forecasting methods. For example, prediction market prices can be used to increase the accuracy of poll-based forecasts of election outcomes (*1*) (see the figure), official corporate experts' forecasts of printer sales, and statistical weather forecasts used by the National Weather Service.

Several researchers emphasize the potential of prediction markets to improve decisions (2–5). The range of applications is virtually limitless—from helping businesses make better investment decisions to helping governments make better fiscal and monetary policy decisions.

Prediction markets have been used by decision-makers in the U.S. Department of Defense (6), the health care industry (7), and multibillion-dollar corporations such as Eli Lilly, General Electric, Google, France Telecom, Hewlett-Packard, IBM, Intel, Microsoft, Siemens, and Yahoo (8). The prices in



Information revelation through time. Data are from the Iowa Electronic Markets for markets predicting the two-party vote shares from the 1988, 1992, 1996, and 2000 presidential elections (19). The vertical axis plots the average absolute difference between the market prediction and the actual vote share. In the week immediately before the election, the market erred by an average of 1.5 percentage points compared with an average error of 2.1 percentage points for the final Gallup poll. The longer-run forecasting performance of the market is also impressive, with an average error of only 5 percentage points 150 days before the election, a time when polls have much larger errors when interpreted as predictions. Calculations are based on data available at www.biz.uiowa.edu/iem.

these markets reflect employees' expectations about the likelihood of a homeland security threat, the nationwide extent of a flu outbreak, the success of a new drug treatment, the sales revenue from an existing product, the timing of a new product launch, and the quality of a recently introduced software program.

These markets could assist private firms and public institutions in managing economic risks, such as declines in consumer demand, and social risks, such as flu outbreaks and environmental disasters, more efficiently.

Unfortunately, however, current federal and state laws limiting gambling create significant barriers to the establishment of vibrant, liquid prediction markets in the United States. We believe that regulators should lower these barriers by creating a legal safe harbor for specified types of small-stakes markets, stimulating innovation in both their design and their use (9).

How and Why Prediction Markets Work

An example will help to clarify the prediction market concept. Consider a contract that pays \$1 if Candidate X wins the presidential elec-

The ability of groups of people to make predictions is a potent research tool that should be freed of unnecessary government restrictions.

tion in 2008. If the market price of an X contract is currently 53 cents, an interpretation is that the market “believes” X has a 53% chance of winning. Prediction markets reflect a fundamental principle underlying the value of market-based pricing: Because information is often widely dispersed among economic actors, it is highly desirable to find a mechanism to collect and aggregate that information. Free markets usually manage this process well because almost anyone can participate, and the potential for profit (and loss) creates strong incentives to search for better information. To be sure, a lively debate has arisen about whether prediction market prices are subject to various biases, which might diminish their accuracy as an aggregation mechanism (10–14). However, prediction markets have been used with success in a variety of contexts.

Legal Impediments

The use of prediction markets has been greatly deterred by state and federal laws restricting Internet gambling because at least some of these laws are plausibly understood to cast serious doubts on prediction

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markets. Currently, eight states bar Internet gambling outright. In 2006, President Bush signed the Unlawful Internet Gambling Enforcement Act, designed to crack down on such gambling.

The legal questions here are complex, but to create a prediction market in the United States that is unambiguously legal, one must run a regulatory gauntlet (15). In principle, these difficulties could be avoided by creating prediction markets outside the United States, but this approach could suppress innovation and reduce opportunities to aggregate information and improve decisions. It would be better for U.S. authorities to clarify the circumstances under which prediction markets are plainly legal.

Breaking the Legal Impasse

We suggest that two steps should be taken to facilitate the use of prediction markets while still meeting the legitimate concerns of lawmakers and regulators.

(i) The Commodity Futures Trading Commission (CFTC), the federal regulatory agency that oversees futures market activity, should establish safe-harbor rules for selected small-stakes markets. One limited safe harbor is the no-action letter, in which the CFTC market oversight staff confirms in writing that it will not recommend enforcement action if the recipient acts in specified ways. The only prediction market to receive a no-action letter (in 1992) is the Iowa Electronic Markets (16), which is run by professors at the University of Iowa and which initially focused on presidential elections. Although such no-action letters reduce the chances of legal action under other state and federal laws, they may not be adequate. We would therefore urge the CFTC to explore other approaches to ensuring safe harbors, for example, formal rules or guidance approved by the commission.

We suggest that three types of entities be eligible for safe harbor treatment. The first would be not-for-profit research institutions, including universities, colleges, and think tanks wishing to operate exchanges similar to the Iowa Electronic Markets. The second would be government agencies seeking to do research similar to that of nongovernmental research institutions. The third group would consist of private businesses and not-for-profits that are not primarily engaged in research, which would only be allowed to operate internal prediction markets with their employees or contractors.

In all cases, markets would be limited to small-stakes contracts. Although the definition of small stakes is somewhat arbitrary, we use the term to mean an exchange in which

the total amount of capital deposited by any one participant may not exceed some modest sum, perhaps something like \$2000 per year.

The exchanges themselves would be not-for-profit but would be allowed to charge modest fees to recoup administrative and regulatory costs. Brokers and paid advisers would be barred, reducing the risks that contracts would be sold to inappropriate or vulnerable customers or that customers would be charged fees above the amounts needed to maintain the markets. Exchanges would be self-regulated, leaving them with the responsibility to make reasonable efforts to keep markets free from fraud and manipulation.

For its part, the CFTC should allow contracts that price any economically meaningful event. This definition could allow for contracts on political events, environmental risks, or economic indicators, such as those offered by the Iowa Electronic Markets, but would presumably not include contracts on the outcomes of sports events.

The contracts qualifying under this safe harbor would also create opportunities for more efficient risk allocation (17). Although the small-stakes nature of these markets would necessarily limit their usefulness for hedging risk, they could serve as proofs of concept for larger-scale markets that could be developed under alternative regulatory arrangements.

The CFTC should allow researchers to experiment with several aspects of prediction markets—fee structures, incentives against manipulation, liquidity requirements and the like—with the goal of improving their design. Prediction markets are in an early stage, and if their promise is to be realized, researchers should be given flexibility to learn what kinds of design are most likely to produce accurate predictions. Of course, exchanges would need to inform their customers so that they are aware of the risks and benefits of participating in these markets.

(ii) Congress should support the CFTC's efforts to develop prediction markets (18). To the extent that the CFTC incurs costs in promoting innovation, Congress should provide the necessary funding. More fundamentally, Congress should explore alternative ways of securing a legal framework for prediction markets if the CFTC's existing authority proves inadequate. In particular, Congress should specify that a no-action letter, or similar mechanism, preempts overlapping state and federal antigambling laws. Because Congress did not intend the CFTC to regulate gambling, it is important to design new regulations so that socially valuable prediction markets easily qualify for the safe harbor but

gambling markets do not.

Conclusion

We have suggested some modest reforms at the federal level that we hope will facilitate the development of prediction markets. These markets have great potential for improving social welfare in many domains. American leadership in this area is likely to encourage parallel efforts in other countries, speeding the development of this tool. The first step in helping prediction markets deliver on their promise is to clear away regulatory barriers that were never intended to inhibit socially productive innovation.

References and Notes

1. J. Berg, F. Nelson, T. Rietz, *Int. J. Forecast.*, in press.
2. R. Hanson, *IEEE Intell. Syst.* **14**, 16 (1999).
3. R. Hahn, P. Tetlock, *Harvard J. Law Pub. Pol.* **28**, 213 (2005).
4. C. Sunstein, *Infotopia: How Many Minds Produce Knowledge* (Oxford Univ. Press, New York, 2006).
5. E. Snowberg, J. Wolfers, E. Zitzewitz, *Q. J. Econ.*, **122**, 807 (2007).
6. R. Hanson, T. Ishikida, J. Ledyard, C. Polk, *Proceedings of the ACM International Conference on Electronic Commerce*, Pittsburgh, PA, 30 September to 3 October 2003 [Association for Computing Machinery (ACM), New York, 2003], p. 272.
7. P. M. Polgreen, F. Nelson, G. Neumann, *Clin. Infect. Dis.* **44**, 272 (2007).
8. B. Cowgill, J. Wolfers, E. Zitzewitz, "Using prediction markets to track information flows: Evidence from Google," Dartmouth College (2008); www.bocowgill.com/GooglePredictionMarketPaper.pdf.
9. K. Arrow *et al.*, "Statement on prediction markets," AEI-Brookings Joint Center Related Publication No. 07-11 (May 2007); available at Social Science Research Network (SSRN), <http://ssrn.com/abstract=984584>.
10. J. Wolfers, E. Zitzewitz, "Interpreting prediction market prices as probabilities," Stanford Graduate School of Business (2005).
11. C. Manski, *Econ. Lett.* **91**, 425 (2006).
12. C. Sunstein, *Infotopia: How Many Minds Produce Knowledge* (Oxford Univ. Press, New York, 2006).
13. M. Ottaviani, P. N. Sørensen, *J. Eur. Econ. Assoc.* **5**, 554 (2007).
14. P. Tetlock, "Liquidity and prediction market efficiency" (March 2008); available at SSRN: <http://ssrn.com/abstract=929916>.
15. R. Hahn, P. Tetlock, *J. Regul. Econ.* **29**, 265 (2006).
16. No-action letter from Andrea M. Corcoran, Director, Commodity Futures Trading Commission (CFTC) Division of Trading and Markets, to George R. Neumann, Professor of Economics, University of Iowa (5 February 1992); www.cftc.gov/files/foia/repfoia/foirf0503b002.pdf.
17. R. Shiller, *Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks* (Oxford Univ. Press, Oxford, 1993).
18. On May 1, 2008, the CFTC requested public comment on the appropriate regulatory treatment of prediction markets. "Commodity Futures Trading Commission, Concept release on the appropriate regulatory treatment of event contracts" (May 2008); www.cftc.gov/stellent/groups/public/@lrfederalregister/documents/file/e8-9981a.pdf.
19. J. Wolfers, E. Zitzewitz, *J. Econ. Perspect.* **18**, 107 (2004).
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