April 15, 2003

Federal Reserve Bank of Cleveland

Iowa Electronic Markets

by Paul Gomme

In 1998, University of Iowa faculty members created their own futures markets. These experimental markets, designed to provide insights into the behavior of traders and naturally occurring markets, are still going strong. Their clever design gives them another practical use: They can be used to predict future events such as election outcomes and Federal Open Market Committee voting.

When making comparisons with the so-called hard sciences, economics is often likened to astronomy. Both fields begin with a set of observations, and theories are evaluated on how well they fit these observations. Of course, theory often guides what is observed, and improved measurement can overturn previously accepted wisdom. By way of contrast, physics is characterized by experiments that can, in principle, be replicated by anyone.

Co-winner of the 2002 Nobel Prize in economics, Vernon Smith, was recognized for his pioneering contributions to experimental economics, a field that resembles physics more than astronomy. Today, experimental economics is often conducted in laboratories, where researchers control various aspects of the economic environment in which the subjects (typically university students) interact. Many experiments are conducted electronically over networked computers. In fact, there is nothing that requires that the subjects be on the same campus—or even the same continent.

The Iowa Electronic Markets (IEM) are a set of experimental markets that allow for very wide participation. They were created in 1988 by University of Iowa faculty as a tool for studying the behavior of individual traders and markets as a whole. The IEM are futures markets—markets that trade assets whose ultimate value depends on the outcome of some future event. A variety of markets are operated. Some are based on upcoming political events such as elections, some on the future decisions of policymakers, and some even on the box-office receipts of soon-to-be-released movies. Stakes are fairly modest: An account can be opened for as little as $5 and no more than $500.

The IEM's usefulness extends beyond the purely academic interests of economists. Political markets are very popular at the IEM, and the prices in these markets are typically good indicators of eventual election results. In fact, the prices from the IEM are often better at predicting election outcomes than public opinion polls. The university claims that the IEM predict election outcomes with a prediction error of only 1.37 percentage points.

This *Commentary* explains how the IEM are designed to predict public opinion and looks at two of the Iowa Electronic Markets. The first is a political market in which participants speculated on which party would gain control of the U.S. Senate and House following the November 2002 elections. The second market lets traders predict upcoming decisions of the Federal Open Market Committee (FOMC).

Designed to Tap Public Opinion

One of the clever—and perhaps unique—features of the IEM is the discrete nature of the payoffs. Contracts are written to pay $1 at maturity if some event occurs (for example, if the Democratic Party candidate receives the most popular votes). Tying a $1 payoff to the occurrence of a future event means that contract prices reflect the probabilities that the marginal trader attaches to each of two events. One is the event happening; the other is it *not* happening. Of course, prices and probabilities might change as the contracts are traded over time.

To see why the prices correspond to probabilities, consider a trader, Wendy, who decides to participate in the 2004 U.S. Presidential "Winner-Takes-All" Market. Suppose that in this market, two assets trade. The first, *Dem,* pays $1 if the Democratic Party receives the most popular votes, and $0 otherwise. The other, *Rep*, pays $1 if the Republican Party receives the most popular votes, and nothing otherwise.

Wendy thinks that the probability the Democrats will win the most votes in the 2004 presidential election is 55 percent. For Wendy, the expected value of holding the *Dem* contract to maturity is $0.55—the probability that she attaches to a Democrat winning the most votes (55 percent) times the payoff ($1.00). If some other trader were offering the *Dem* contract at a price below $0.55, Wendy should be willing to buy the contract. By way of example, suppose that another trader were offering the *Dem* contract at a price of $0.40. Wendy should buy the contract at this price since she would earn an expected profit of $0.15: The expected value of the contract ($0.55) less the price paid ($0.40).

By the same token, Wendy should be willing to sell the *Dem* contract (if she holds it in her portfolio) at a price above $0.55. If another trader was willing to pay, say, $0.66 for this contract, then Wendy earns an expected profit of

ISSN 0428-1276

$0.11 by selling it to this trader: the $0.66 that she receives for the contract, less the $0.55 expected value that she associates with this contract.

What if Wendy doesn't have any of the *Dem* contract in her portfolio? On Wall Street, Wendy would sell the *Dem* contract short—in essence, sell a contract that she doesn't currently own. While the IEM do not allow for short sales (to ensure that the IEM neither make nor lose money owing to a trader defaulting on a short sale), they do allow traders to buy for $1 a "contract bundle" consisting of one unit of each contract. In this case, traders can purchase a bundle consisting of one unit of *Dem* and one unit of *Rep.* Notice that if a trader buys this bundle and holds it to maturity, she simply gets her dollar back since one of these events will occur.

So, if some other trader is offering to buy the *Dem* contract at a price above Wendy's expected value of $0.55, all she needs to do is to buy a contract bundle and sell off the *Dem* contract. To figure out Wendy's expected profit on such a transaction, notice that if Wendy places a probability of 55 percent on *Dem*, she must place a probability of 45 percent on *Rep* (assuming that no other party stands a chance of winning a plurality of the popular vote). Consequently, the expected value of holding one *Rep* contract is $0.45 (again, the probability of a Republican winning the popular vote, 45 percent, times the payoff, $1.00). So if Wendy can sell the *Dem* contract for $0.66, she earns an expected profit of $0.11: the $0.66 from the sale of *Dem* plus the $0.45 expected value of *Rep*, less the $1.00 that she paid for the contract bundle.

What will happen for the market as a whole? In particular, suppose that Randy thinks the likelihood that the Democrats will win the popular vote is 60 percent while Wendy's probability is 55 percent. Presumably, Wendy will sell *Dem* contracts to Randy, buying up contract bundles if necessary. In this case, two outcomes are likely. The first is that either Wendy or Randy will run out of funds: Recall that the maximum investment the IEM will accept is $500. We would expect the price of *Dem* to be somewhere between $0.55 and $0.60, with both Randy and Wendy earning what they perceive to be expected profits from these transactions.

A second possibility is that Wendy, Randy, or both will revise the probabilities they attach to the Democrats winning the most votes. Why might this happen? Wendy might think other traders have information she does not have—after all, she has to figure these other traders are not taking expected losses when they trade with her. So, Wendy can be expected to revise up the probability she associates with the Democrats winning the popular vote. Likewise, traders like Randy can be expected to revise down the probability they attach to the Democrats winning the most votes. As these probabilities converge, so will the prices at which traders are willing to buy and sell the *Dem* contract. In the end, the price will end up somewhere between $0.55 and $0.60.

The key insight is that the price paid for *Dem* will end up reflecting the probability the marginal investor places on the Democrats winning the popular vote in the 2004 U.S. presidential election. Similarly, the price of *Rep* will reflect the probability traders attach to the Republicans winning the popular vote.

The 2002 U.S. Congressional Control Market

The 2002 Congressional Control Market opened on July 19, 2002, and closed on November 7, 2002 (two days *after* election day). Four contracts traded in this market, with the payoffs depending on whether Republicans gained control of the House, the Senate, both, or neither. For example, the contract *RH NS* (Republican House/Non-Republican Senate) promised to pay $1 if, following the 2002 elections, the Republicans controlled the House but not the Senate. The payoffs for the other contracts (*NH RS, RH RS,* and *NH NS*) were similarly defined.

As above, the prices of these assets reflect the probabilities that market participants placed on the various events to which the contracts correspond. Furthermore, we can compute the probability participants placed on events that aren't directly represented by the contracts. For example, we can find the probability placed on Republican control of the House, independent of whether they also controlled the Senate. In this case, we would add the price of the contracts *RH RS* and *RH NS.* Similarly, the probability of a Republican Senate independent of the outcome for the House is obtained as the sum of the prices of the contracts *RH RS* and *NH RS.*

Figure 1 gives the prices (or probabilities) of either a Republican-controlled House or a Republican-controlled Senate for the period over which this market operated. Until September, Republican control of the House was seen as a 50–50 proposition, while their control of the Senate received a probability of around 20 percent. In October, the likelihood of a Republican-controlled House fluctuated between 65 percent and 90 percent while the likelihood of a Republican Senate fluctuated around 40 percent. It was not until election day results came in that market participants locked in on the eventual outcome: Republican control of both the House and Senate. Of course, this outcome was generally a surprise: Neither pollsters nor political commentators called the Republican win in the Senate.

The Federal Reserve Monetary Policy Market B

The Federal Reserve Monetary Policy Market B has operated since October 3, 2001 (the day following an FOMC meeting). Prices in this market give the probabilities that the market's participants place on what the FOMC will do to the federal funds rate at its next meeting.

For most meetings, three contracts have traded. For example, before the November 2002 FOMC meeting, the contracts were: *FRup1102*, *FRsame1102*, and *FRdown1102*, which corresponded to whether the FOMC raised the federal funds rate target at the November meeting, kept it the same, or lowered it.

Figure 2 plots the last price for each day of trading since the Federal Reserve Monetary Policy Market B opened. The prices do not necessarily sum to one in the figure, whereas the underlying probabilities must, but this is just an unfortunate consequence of using the last price of the day. Preceding the November 2001 FOMC meeting, the market prices tell us that market participants initially placed fairly equal probability of the FOMC either leaving the target unchanged or lowering it. However, as the month progressed, participants ended up placing a high likelihood on a reduction. In fact, the FOMC lowered its target 50 basis points.

FIGURE 1 2002 CONGRESSIONAL CONTROL MARKET

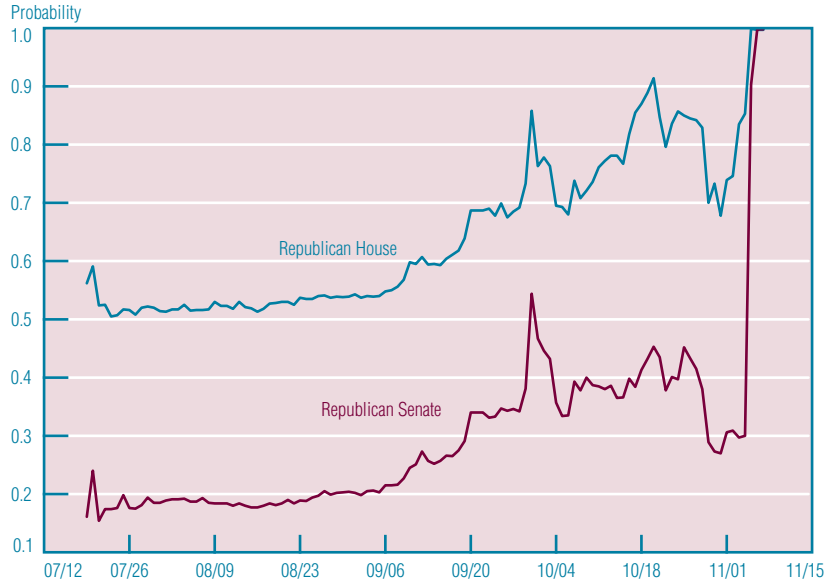
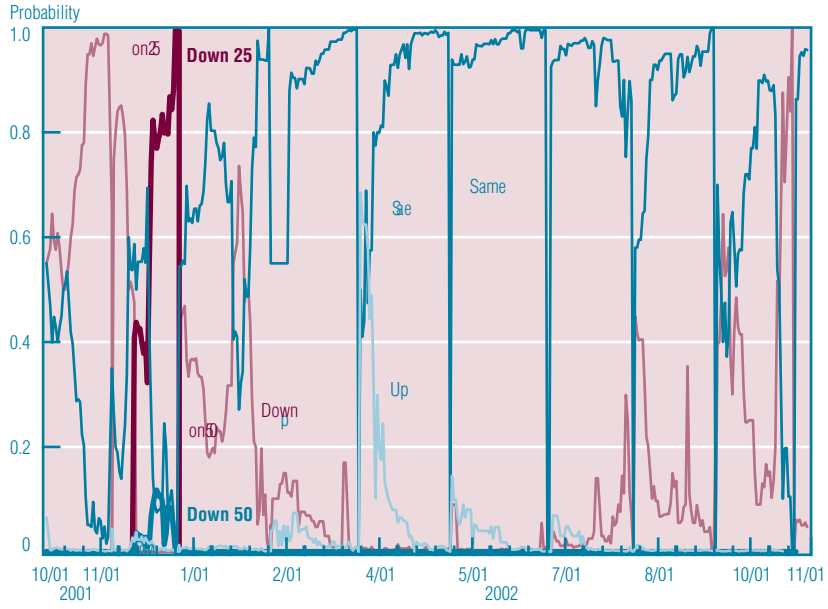


FIGURE 2 FEDERAL RESERVE MONETARY POLICY MARKET B CONTRACT PRICES



Before trading began for the December 2001 FOMC meeting, the directors of the IEM introduced two "spin-off" contracts, which split the *FRdown1201* contract. Specifically, they introduced *FR25dn1201*, which paid $1.00 if the fed funds rate target was decreased at the December 2001 meeting by fewer than 50 basis points, and *FR50dn1201,* which paid $1.00 if the target was reduced 50 basis points or more.

The directors reserve the right to introduce such "spin-off" contracts at any time in the Federal Reserve Monetary Policy Market B. Had there been trading in *FRdown1201* prior to the spin off, a trader holding an *FRdown1201* contract would receive one *FR25dn1201* contract and one *FR50dn1201* contract. Thus, the liquidation value of the spun-off contracts is the same as the liquidation value of the original contract. As can be seen in figure 2, market participants never placed much likelihood on a 50 basis point cut and ended up placing considerable probability on a 25 basis point cut (the outcome announced by the FOMC).

From December 2001 to November 2002, the FOMC left the target fed funds rate unchanged. With a few notable exceptions, participants in the IEM have placed very high probability on no change. The first exception occurred leading up to the January 2002 FOMC meeting. Participants placed a sizeable likelihood on a further cut, with this probability peaking at around 74 percent in the middle of January. Subsequently, the bulk of the probability was placed on no change. The second exception occurred in early trading on the May 2002 contract, when participants placed considerable likelihood on an increase in the target. Finally, just prior to the August 2002 FOMC meeting, the market placed a small but nonnegligible weight on a cut. A small probability of a cut is also evident in trading for the September 2002 FOMC meeting. Following this meeting, market participants placed roughly even odds on either a cut or no change in the fed funds rate target. The market was no doubt sorting out the significance of the dissents by Federal Reserve Board Governor Gramlich and Federal Reserve Bank of Dallas President McTeer, both of whom preferred a reduction in the fed funds rate target.

By mid-October, IEM participants evidently placed a low probability (10–20 percent) on a cut. But on October 29—more than a week before the FOMC meeting—the probability of a cut broke above 50 percent, and in the days just prior to the FOMC meeting, the market placed the chance of a cut at 90 percent. On November 6, the FOMC did in fact cut by 50 basis points. The cut—if not the size—was widely anticipated in the financial press.

■ Better than Gallup?

The IEM political markets have a couple of advantages over their closest "competitor," the public opinion poll. One advantage is that data from the IEM are available virtually instantaneously and almost continuously. Results from polls are typically several days old when they are reported and are taken at discrete intervals. Consequently, data from the IEM are more amenable to studying events like the untimely death of a Senate candidate.

A further advantage of the IEM is that contracts can be written based on intrinsically interesting events, such as

who controls the House or Senate. Poll results require more massaging to answer such questions.

In trying to predict FOMC interest rate changes, Wall Street commentators often infer probabilities from fed funds rate futures. The payoffs from fed funds rate futures are constructed in such a way, though, that they can only tell us about the expected value of the fed funds rate in some future month and not the underlying probabilities. To tease out probabilities from fed funds rate futures, commentators need to make reasonable assumptions regarding the likely size of the change in the fed funds rate target. At the very least, the IEM provides useful supplemental information regarding these probabilities.

Paul Gomme is an economic advisor at the Federal Reserve Bank of Cleveland.

Economic Commentary *is published by the Research Department of the Federal Reserve Bank of Cleveland. To receive copies or to be placed on the mailing list, e-mail your request to* 4d.subscriptions@clev.frb.org *or fax it to* 216-579-3050. Economic Commentary *is also available at the Cleveland Fed's site on the World Wide Web:* www.clev.frb.org/research, *where glossaries of terms are provided.*

We invite comments, questions, and suggestions. E-mail us at editor@clev.frb.org.

Federal Reserve Bank of Cleveland
Research Department
P.O. Box 6387
Cleveland, OH 44101

Return Service Requested:
Please send corrected mailing label to the above address.

PRSRT STD
U.S. Postage Paid
Cleveland, OH
Permit No. 385