



## Macro-markets and Environmental Futures

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### Abstract

*Prediction markets offer a new forecasting method whereby people trade future outcomes as on a stock exchange. This results in dynamic consensus probability estimations of future events whose superior accuracy has been documented in numerous domains including box-office, product sales, political elections, sports, regulatory forecasting, etc. Applied to the forecasting of important environmental outcomes, prediction markets could help deepen public awareness of the problems and possible solutions, cut through the fog of ambiguous scientific discourse, evaluate alternative scenarios of doom or salvation, and identify the more trustworthy experts.*

### Futures Markets as Forecasting Tools

One of the most intriguing properties of financial markets is their ability to aggregate widely dispersed information and various beliefs into dynamic, quantifiable consensus: a trading price. Futures markets are particularly interesting in this respect because they project this collective intelligence onto the future, thereby generating valuable predictions.

Prediction markets—also called idea futures markets or information markets—are a special class of futures markets designed to aggregate information and produce predictions about future events: for example, a political candidate's election, or a box-office take, or the probability that the Federal Reserve will increase interest rates at its next meeting. To elicit such predictions, contract payoffs are tied to unknown future events. For example, a contract might pay \$100 if George Bush is re-elected in 2004, or nothing if he is not. Thus, until the outcome is decided, the trading price reflects the traders' collective consensus about the expected value of the contract, which in this case is exactly proportional to the probability of Bush's re-election (see Figure 1).

Such markets have been available on-line to the general public since the mid-1990's, in both real-money (gambling) and play-money (game) formats, and a few have developed large communities of regular traders. Popular play-money markets include the Hollywood Stock Exchange (<http://www.hsx.com>), which focuses on movie box-office returns, NewsFutures' World News Exchange (<http://us.newsfutures.com>), which covers current events, politics, financial markets, sports and entertainment, the Foresight Exchange (<http://www.ideosphere.com>), which focuses on science and politics, and MIT Technology Review's Innovation Futures (<http://trif.technologyreview.com/bk/index.html>), which covers technology and the business of technology. Real-money exchanges that are popular with the American public include the Iowa Electronic Markets (<http://www.biz.uiowa.edu/iem>), which focuses on political election returns (under a special no-action agreement with the CFTC, in part due to its university affiliation and individual investment limit of US\$500), and Tradesports (<http://www.tradesports.com>), a sports betting exchange based in Ireland.

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## Trading Price for: "George W. Bush elected in 2004"



**Figure 1:** What is the probability that George W. Bush will be re-elected in 2004? On May 8th, Bush victory contracts were trading at \$49. If he wins, then each contract will be worth \$100, otherwise they will be worthless. While the outcome is uncertain, the trading price is decided collectively by the participants themselves through the dynamics of supply and demand. Because the price is constrained between \$0-\$100, it can also be read as a probability estimation from 0% to 100%. Accordingly, the \$49 market price on May 8<sup>th</sup> indicates that the traders' consensus on that date was that Bush has a 49% chance of being re-elected.

In the last few years, researchers have closely studied the predictions implied by prices in these markets, and found them to be remarkably accurate, outperforming most individual experts whether they operate with real-money or play-money (Servan-Schreiber et al., in press). The operators of the Iowa Electronic Market have found that their markets routinely outperform opinion polls in predicting the ultimate result of political elections in the U.S. and abroad (Berg et al. 2000; Forsythe et al. 1999). Pennock et al. (2001a; 2001b) looked at the trading prices from the Foresight Exchange and the Hollywood Stock Exchange, showing them to be closely correlated with actual outcome frequencies in the real world. Financial derivatives prices have been shown as good forecasts of the fate of their underlying instruments (Roll 1984). In a series of experiments, researchers at Hewlett-Packard have enrolled some of the company's employees as prediction traders, and found that their forecasts of product sales systematically outperform the official ones (Chen et al. 2002). Other controlled laboratory experiments have verified the power of prediction markets to aggregate information diffused across a trading population (Plott and Sunder 1988). Wolfers and Zitzewitz (2004) provide a survey of the performance of prediction markets across these and other contexts.

Early successes have attracted the attention of corporations and policymakers, and most famously, the Pentagon, eager to improve their forecasting methods by leveraging a wider base of knowledge and analysis. For example, the Pentagon agency DARPA had backed a project called the Policy Analysis Market (PAM), a futures market in Middle East related outcomes (Polk et al. 2003), until a political firestorm killed the project. Academic and policy interest in these markets remains robust, and it appears likely that private-sector firms will step into this void. Part of the allure is that whereas only so many people can be practically gathered into the same room at the same time for a coherent discussion, on-line prediction markets can easily aggregate the insights of an unlimited number of potentially knowledgeable people asynchronously.

## Environmental Futures

There is no shortage of issues in the environmental and sustainable development domains to which prediction markets can be applied. Here are some examples<sup>2</sup>:

- Will the world's Ecological Footprint go up or down this year?
- Will the risks and costs associated with environmental change increase this year?
- Will the insurance industry payments due to natural disasters increase this year?
- Will Kyoto become effective this year?
- Will there be more forest fires in the Amazon this year?
- Will environmentally induced migration increase this year?
- Will there be a significant oil spill this year?
- Will the hole in the Ozone Layer over Antarctica increase this year?
- Will the average global temperature fall this year?
- When will China become a net importer of food?

The trading prices in such markets would serve as real-time signals of the estimated probabilities of various important environmental outcomes. Together, they would deliver the ultimate dynamic monitoring dashboard, aggregating the latest available information and various beliefs into easily understood numbers.

One could use it not only to learn about current probability estimations, but also to measure how those estimations vary in response to various developments in the real-world. For instance, come November, observers could readily measure the effect, if any, of Bush's re-election (or not) on the price of the contract tracking the evolution of the world ecological footprint.

Going one step further, we could also design markets to predict ahead of time the effects of particular events on some other events: so called "decision markets" (Hanson, 1999; Varian, 2003). These could be used, for instance, to evaluate the relative impacts on the world's ecological footprint of a Bush victory or a Kerry victory. Presumably, a Kerry victory would be more beneficial to the environment, but by how much? Markets would know... Then American voters can use this objective answer as one more data point to help them *decide* whether or not it's worth it to re-elect Bush. That's why such markets are called *decision* markets. Another perhaps less trivial example would be a decision market to evaluate the impact on global warming of the U.S. ratifying the Kyoto protocol. It would help make explicit the consensus on the relative environmental cost of the U.S. decision not to take part.

Such markets could serve several different purposes, depending on who the participants are. One implementation might be targeted at the general public, perhaps in association with environmentally conscious mass media. Another might enrol hundreds or thousands of experts or stakeholders in the scientific debate. A third might be specifically designed to offer hedging opportunities for business interests.

Offering to the general public the opportunity to trade on Environmental Futures would be an entertaining way to deepen its awareness of the problems, of the possible solutions, and of the progress made or unmade. People would become stakeholders in the environmental outcomes they chose to invest in. The environmental debate, which can often sound very abstract or remote to the uninitiated, would suddenly become a *personal* matter.

A market reserved for self-declared environmental experts or professionals might serve other purposes altogether. First of all, it would generate clear, easily understood consensus estimates that cut through the fog of the scientific debate. These might be very valuable for policy makers. Secondly, a well designed set of decision markets would allow the community of experts to rapidly estimate the outcomes of various scenarios or interventions. Thirdly, by

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<sup>2</sup> Graciously provided by Steven Lovink of TransGlobal Ventures.

holding participants accountable to their successful or failed predictions, it would help progressively identify those who best know what they are talking about.

Finally, such markets could also be used to let businesses, insurers, environmental organizations, hedge publicly against environmental-impact outcomes. These might generate intriguing signals. For instance, the price of the “oil spill this year” contract would reveal the insiders’ current calculations of risks to oil tankers.

The promise of Environmental Futures is better forecasting for a better world.

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