

Cost-Benefit Analysis and Prediction Markets  
and the Proposal for University of Oregon Prediction Markets

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# Cost-Benefit Analysis and Prediction Markets and the Proposal for University of Oregon Prediction Markets

## **Abstract:**

This paper is broken into two sections. The first section presents the problems with traditional cost-benefit analysis and then introduces and defends “the welfare question” as an alternative public policy decision tool. The welfare question uses a winner-take-all prediction market that asks if a representative entity of society will vote a project welfare enhancing X years from now. The price is interpreted as the probability the project enhances welfare. We find that the welfare question provides a relatively low transaction cost and accurate tool for public decision-making. We also determine how prediction markets can be used as a control on traditional cost-benefit analyses by providing parameter estimates.

The second section discusses a practical case study where a prediction market is used to gather information about the expected day the first basketball game will be played in a new arena. Additionally, a practical example of an idea introduced in section one is discussed. Prediction markets are used to create parameter estimates to be used to act as a control on and improve upon the conclusions of an economic impact analysis. We use our experience from the case study to offer recommendations for the future creation of the Oregon Prediction Markets, a university-ran set of prediction markets similar to the Iowa Electronic Markets.

**Approved:**

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Prof. [Bill or Bruce]

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Date

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This paper is broken into two distinct sections. The first section introduces and defends an alternative public policy decision tool to cost-benefit analysis. The second section discusses a practical case study where a prediction market is used to gather information about the expected day the first basketball game will be played in a new proposed arena not yet under construction. Additionally, a practical example of an idea introduced in section one is discussed, where prediction markets are used to create parameter estimates to be used to act as a control and improve upon the conclusions of an economic impact analysis.

## **Cost-Benefit Analysis and Prediction Markets**

### ***Introduction to Section 1***

Cost-benefit analysis (CBA) is a well-established technique for evaluating government projects. All of a project's costs and benefits are converted into dollar amounts, and if the dollar amount of benefits exceeds the dollar amount of costs, the project should be undertaken. If the costs exceed the benefits, then it should not be undertaken. While long established and widely used, CBA suffers from many problems that make its recommendations subject to scrutiny. In this paper we explain how prediction markets can help solve the pitfalls of CBA.

Prediction markets function much like current financial markets or betting markets. Assets are created with a final payout tied to a particular event or parameter. Market prices can then be interpreted as predictions of the probability of the event or the expected value of the parameter.

Abramowicz has proposed combining prediction markets with a retrospective CBA in order to aid in information aggregation important for CBA. Abramowicz believes that if the identity of the future decision maker conducting the CBA is unknown, then his “predictive CBA” will estimate how an average decision maker would evaluate the policy. This paper provides a critique of Abramowicz’s predictive CBA and offers two alternative decision-making tools. First, CBA can be foregone altogether by utilizing a carefully designed prediction market to estimate the effects a project has on welfare versus the status quo. For instance, when proposing to build a new town bridge, a prediction market would be created that asks, “Will 10 years from now a representative entity deem this project welfare enhancing?” If the market predicts the project to be welfare enhancing, the project should be undertaken. This paper also addresses the problems associated with this proposed method including: Whom is the representative entity and whether or not a project is welfare maximizing. We conclude it has the potential be a low-cost and accurate alternative to traditional CBA and predictive CBA.

The second is to use prediction markets as a control on CBA. At times, skillful analysts can manipulate CBA. A small change in the discount rate used to discount future cash flows can have a large impact on the result of the analysis. Prediction markets can offer a way to control this manipulation by estimating the accuracy of key factors in a given CBA.

### ***Literature Review***

The literature review starts with an analysis of the state of CBA and the problems with its implementation. Then, prediction markets are introduced and discussed. Finally, a theory combining prediction markets with CBA is introduced. This review serves both

as a context in which to view our proposals and as a guide for the creation of the Oregon Prediction Markets.

### ***Cost-Benefit Analysis***

Adler and Posner summarize the current state of CBA well with the statement, “The reputation of cost-benefit analysis among American academics has never been as poor as it is today, while its popularity among agencies in the United States government has never been greater.”<sup>1</sup> Indeed, much of the current academic literature surrounding CBA has been negative.

Conversely, during the 1980s, the Reagan Administration declared any major governmental project must be subjected to a cost-benefit analysis before implementation. The Clinton administration reaffirmed this during the 90s and it continues today. The Office of Management and Budgets (OMB) oversees governmental CBA.<sup>2</sup>

### ***Defenses of CBA as a Moral Decision Criterion***

#### **Pareto Defense**

The Pareto Defense says CBA sufficiently approximates the Pareto principle. The Pareto principle declares any project should be accepted if it makes at least one person better off without making anyone else worse off. In theory, the Pareto principle is difficult to argue with; however, in practice many believe CBA does not approximate the Pareto principle. The reasons behind this include the diminishing marginal value of money, incommensurability, etc. These problems with CBA are outlined below.

However, the main problem with CBA approximating the Pareto principle is that the

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<sup>1</sup> Adler, Posner, “Rethinking Cost-Benefit Analysis”

<sup>2</sup> Office of Management and Budget, Circular No. A-94, “Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs.”

Pareto principle is too restrictive. Very few projects are proposed that make some people better off without making anyone else worse off. Even if the flaws of CBA were fixed such that it perfectly approximated the Pareto principle, many welfare enhancing projects would not be undertaken.

### **Kaldor-Hicks Defense**

The Kaldor-Hicks standard is a variation of the Pareto principle. The Kaldor-Hicks standard states that if a project makes some people sufficiently better off such that they could compensate those who are worse off due to the project without having to do so, then the project should be undertaken. Some mention that if this standard was applied and the government actually stepped in and redistributed gains to those who were worse off, then the project could be Pareto efficient as well. However, the costs associated just with determining the winners and losers from the project and then distributing them would often be too great to warrant the redistribution.<sup>3</sup> Therefore, the problems associated with CBA acting as an approximation of the Pareto defense apply equally to the Kaldor-Hicks defense.

### ***Problems with CBA***

Why is there a discrepancy between current political practice and the academic literature? The answer stems partly from the fact that CBA became required at the governmental level. During the twentieth century, the rise of the progressivists in government brought about a belief that government decisions could be based on objective and tangible scientific principles.<sup>4</sup> Because of this, CBA at times (for a brief period in

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<sup>3</sup> Adler, Posner, "Rethinking Cost-Benefit Analysis"

<sup>4</sup> Richard H. Nelson, *The Economics Profession and the Making of Public Policy*, 25 J. ECON. LIT. 49, 52-54 (1987).

the 60s and again in the 80s) has been popular among administrators. However, Adler and Posner suggest that perhaps the simple reason behind CBA's cyclic popularity is CBA tends to lead to less regulation. Therefore, administrators trying to regulate more are less supportive of CBA and those that are trying to regulate less are more supportive of it.<sup>5</sup> However, as CBA became a prominent fixture in administrative policy-making, the academic world questioned its validity. After all, CBA is used by governmental policy makers who should ensure society's welfare is maximized, and CBA is a tool that is supposed to help do this. If it could be proven that CBA's costs were not worth its own benefits, then it should not be used. The following section outlines what some of these costs are. In future sections, we discuss ways our proposed welfare question fixes these problems of CBA.

### **Diminishing Marginal Value of Money**

One of the primary problems of using money in a decision procedure that is supposed to maximize social welfare is that the more money one has, the less an additional dollar is worth. This leads to distributional issues with CBA. For instance, a project that benefits only a handful of rich people at the expense of many poor people can be accepted. This is related to the willingness to pay versus willingness to accept dilemma. All else equal, due to the diminishing marginal value of money a rich person can pay more for the benefits from a project than a poor person can pay to avoid the costs.

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<sup>5</sup> Adler, Posner, "Rethinking Cost-Benefit Analysis"

## **Incommensurability**

Some argue certain things are incapable of having a monetary value associated with them. A typical example of this is human life. The argument is that by assigning monetary values to things that cannot be monetized those things are cheapened. For instance, there was outrage in 1968 when it was revealed that Ford had used a cost-benefit analysis valuing a human life lost due to a safety malfunction of its Pinto line of cars at only \$200,000. This low value of human life led Ford to the decision to keep producing the cars without safety modifications. Other studies have value human lives at over \$3 million but some believe that human lives cannot truly be monetized.

## **Willingness to Pay Does Not Always Equal Willingness to Accept**

A large problem arises when the amount someone would be willing to pay to keep the status quo does not equal that person's amount he/she would be willing to accept to change the status quo. This problem arises often with benefits that do not have readily active markets, and therefore CBA is often at the forefront of environmental studies. For instance, one study asked people their willingness-to-pay to ensure a tree would not be bulldozed and their willingness-to-accept to have the tree bulldozed. The two values were vastly different and the magnitude of the differences depended on whether the tree was to be bulldozed because it was diseased or whether it was to make room for a wider street. This suggests that the WTP vs. WTA differences do not conform to traditional economic theory which says the two should be equal.<sup>6</sup>

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<sup>6</sup> Disparate WTA-WTP disparities: the influence of human versus natural causes. Michael E. Walker, Osvaldo F. Morera, Joanne Vining, Brian Orland

## **Distorted Preferences**

It is often argued that cost-benefit analysis can be distorted by people's preferences. For instance, should a drug addict be allowed to take illegal drugs? This may be welfare maximizing for the addict in the short-term, but few would say that the drug addict would actually be better off.

## **Time and Discounting**

The time-value of money is well established in finance theory. This is demonstrated with the simple example: a dollar today is worth less than a dollar one year from now. Because of this, dollars expected in the future are discounted by a certain rate to put them in present value. Usually in finance, this discount rate is readily apparent. However, this is not so for CBA. This is because it is difficult to compare costs and benefits today with costs and benefits in the future. In some cases, small changes in the discount rate used can change the outcome of the CBA. Determining this discount rate is difficult with traditional CBA and has led the Office of Management and Budgets to issue guidelines on the issue.

## **Should CBA Be Used At All?**

Despite CBA's shortcomings, Adler and Posner propose that CBA should still be used because of its relative accuracy and its transparency. Policy makers should be wary of some of the downfalls of CBA, but overall the procedure offers sufficient benefits for continued use.<sup>7</sup>

## ***Prediction Markets***

The following information only presents background to understand what a prediction market is, what types of prediction markets already exist, and some problems

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<sup>7</sup> Adler, Posner, "Rethinking Cost-Benefit Analysis"

with prediction markets. Later, we present Abramowicz's predictive cost-benefit analysis as the first combination of prediction markets and CBA. We then critique Abramowicz's view and offer our own suggestions for combining prediction markets and CBA for government decision-making.

### **What is a Prediction Market?**

A prediction market is a speculative market created for making predictions by aggregating information. Prediction markets' theoretical foundations lie with the efficient market hypothesis. This says a sufficient number of marginal traders with rational expectations who maximize utility through maximizing profits will set prices such that no arbitrage can occur. Indeed, prediction markets are designed so that marginal traders of information react in a way that the current price reflects all relevant information--sufficient to create a no arbitrage condition for the prediction market's price.

### **History of Prediction Markets**

Prediction markets have a history characterized by both skepticism and acceptance. Charles Mackay's 1841 book, Extraordinary Popular Delusions and the Madness of Crowds, told how group information aggregation with markets led at times to speculative bubbles with incorrect prices. However, the use of markets has not waned and prediction markets have enjoyed increasing popularity recently. This is evidenced by James Surowiecki's 2003 book, The Wisdom of Crowds, its name chosen as an ironic allusion to Mackay's book. Surowiecki's book highlights some of the benefits of information aggregation with prediction markets.

## **Iowa Electronic Markets**

Developed in 1988 at the University of Iowa, the Iowa Electronic Market is the most well known and most well studied prediction market. The market allows betting on a wide range of issues with its most popular bets being on politics and economic indicators. The market uses real money, but places a cap on bets at \$500.

## **Policy Analysis Market (PAM)**

The most infamous of prediction markets, this market was developed in 2003 by the United States Defense Advanced Research Projects Agency (DARPA) with the intent to provide better foreign intelligence. Participants would try to bet on securities where the payoffs hinged on such events as political assassinations, changes in power, and more. The prediction market met with immediate political disapproval, with some politicians declaring the markets were a “betting parlor on atrocities and terrorism.” The plan was canceled within a day by the Pentagon.

## **Three Main Types of Prediction Markets**

The three main types of prediction markets are 1) winner-take-all, 2) index, and 3) spread markets.<sup>8</sup> The winner-take-all market asks a question such as, “Will the Democrats win the popular vote in 2008?” The contract pays only if the Democrats win the popular vote. In this case, the price is interpreted as the probability the event occurs. For index markets, the contract would pay a certain amount for each incremental gain of the underlying asset. For example, an index contract could pay \$1 for every percentage point of popular vote share won by the Democrats in 2008. In this instance, the price of the market would be interpreted as the expected value of the vote share. Finally, a spread

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<sup>8</sup> Wolfers, Justin and Eric Zitzewitz (2004a), “Prediction Markets,” *Journal of Economic Perspectives*, 18(2).

contract has participants bet on the cutoff determining whether an event will occur. This is similar to a point spread in sports betting. When this is combined with an even-money bet where losers get nothing and winners double their earnings, the price can be interpreted as the market's expectations of the median outcome.

### **Thick vs. Thin**

With thin markets, there is low activity, volume and liquidity. This makes it harder to match buyers and sellers. Small changes in supply or demand could substantially affect the price in thin markets. However, if a sufficient number of marginal traders exist, then thin markets are not a problem. All else equal the thinner a market is the more likely it is to suffer from price manipulation.

Low interest issues are more likely to result in thin market trading. However, a low interest betting market on the Australian district level races yielded remarkably accurate results.<sup>9</sup> In fact, in 43 out of 47 cases, the prediction market correctly predicted the election. Thick or thin, the prices of the market should reflect the mean belief with a sufficient number of marginal traders.<sup>10</sup>

### **Prediction Markets vs. Deliberation and Expert Opinions**

Several methods are used for making public decisions. Most are made by using "expert" opinions and through deliberations. Opinion polls are used to collect the public's input. Experts are not able to gather all relevant information and produce the best decisions relative to the aggregation potential of predictive markets. Expert opinion and the use of deliberation have several pitfalls. The pitfalls include amplification of

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<sup>9</sup> Wolfers, Justin and Andrew Leigh. 2002. "Three Tools for Forecasting Federal Elections: Lessons from 2001." *Australian Journal of Political Science*. 37:2, pp. 223–40.

<sup>10</sup> Gjerstad, 2005. "Risk Aversion, Beliefs, and Prediction Market Equilibrium."

cognitive error, hidden profiles and common knowledge, information and reputation cascades, and polarization.<sup>11</sup>

Deliberators tend to converge on a truth if the truth was initially supported amongst them. Groupthink is prevalent in deliberations leading to homogeneity and suppression of ideas.<sup>12</sup> When groupthink develops, selective information is gathered and few alternatives are considered. The reduction in variance of opinions held and the confidence within the group lead to suboptimal decisions.

Some corporations have pitted their experts against predictive markets. Hewlett-Packard's internal prediction markets beat official forecasts six times out of eight at predicting printer sales.<sup>13</sup> Moreover, the prediction market at Siemens accurately predicted that a deadline was not going to be met while traditional methods showed otherwise.<sup>14</sup>

The Iowa Electronic Markets has produced extremely accurate predictions as well as outperformed national polls. Iowa's market beat national opinion polls 451 out of 596 times in predicting presidential election results.<sup>15, 16</sup> Opinion polls tend to state more of what people want and not what they think will happen.

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<sup>11</sup> Sunstein 2004. "Deliberation and Information Markets."

<sup>12</sup> Irving L Janis, "Groupthink", 2d ed. (Boston: Houghton Mifflin, 1982) 7-9

<sup>13</sup> Chen and Plott, 2002. "Information Aggregation Mechanisms; Concept, Design and Implementation for a Sales Forecasting Problem."

<sup>14</sup> Ortner 1998. "Forecasting Markets – An Industrial Application."

<sup>15</sup> Berg, Joyce, Robert Forsythe, Forrest Nelson and Thomas Rietz. 2001. "Results from a Dozen Years of Election Futures Markets Research," in *Handbook of Experimental Economic Results*. Charles Plott and Vernon Smith, eds. Amsterdam: Elsevier, forthcoming.

<sup>16</sup> Berg, Forsythe, and Reitz, "Iowa Electronic Market." 1997, 2001.

## Real vs. Play Money

An important factor to consider is the use of real vs. play money. Currently, using real money has legality problems, and is classified as gambling. The government could change laws to allow for use of real money for public policy purposes; currently there is a push to allow information markets used for education purposes (such as the Iowa Electronic Markets) to use real money. As stated, the Iowa Electronic Markets is already granted an exemption from regulation since it limits the maximum investment per participant to \$500.

Is real money needed to produce accurate information aggregation? The Hollywood Stock Exchange (HSE) is a popular play money prediction market taking bets on movie and actor related securities. The HSE has accurately predicted US box office movie ticket sales and is as successful as experts at picking Oscar nominees.<sup>17</sup>

Some have proposed that play money may outperform real money because it can only be accumulated through proven predictions. Play money could also be effective if it is tied to reputation. The results of a market could be publicized to accomplish this. Reputation could be a powerful mechanism that could ensure marginal trading occurs.

A study comparing prices from real money and play money exchanges found that both yielded similarly accurate predictions for the 2003 NFL season. Both outperformed almost all of the 3,000 participants in an online contest.<sup>18</sup> Exchange markets have an easier time attracting people with play money when they pertain to high interest events such as sports. Additionally, an advantage of play money over real money comes with the amount of risk the market maker is subject to. In some cases, the market maker may

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<sup>17</sup> Pennock, Lawrence, Giles and Nielsen, 2001. "The Real Power of Artificial Markets."

<sup>18</sup> Servan-Schreiber, Wolfers, Pennock and Galebach, 2004. "Prediction Markets: Does Money Matter?"

have to make substantial payments to participants exceeding receipts. This situation is further discussed later in the section on setting up the market.

There are various ways real money can be incorporated. It could be subsidized by the government, taxes could be reduced, giving people more money to participate with, or a pure money exchange between participants could be used, where the losers compensate the winners and the result is a zero-sum game. Play money could be converted into real money by having the government pay participants for accurate predictions. If the government does not wish to get involved in providing capital, then the simplest way to ensure everyone would have an equal standing in the market is to limit the investment. Perhaps it can set a maximum of \$500 per calendar year per person (not account). This would allow an “ownership” feeling. Play money could also be used with people wishing to shape public policy with interest in welfare, community, and public policy being the driving force for accumulation of play money.

## ***Problems Related to Prediction Markets***

### **Long-Shot Bias**

The long shot bias refers to undervaluing near certainties and overvaluing of unlikely events. This phenomenon is well documented in many situations from horse racing to derivatives options. The most famous study is by Thaler and Ziemba on favorite-longshot bias in horseracing.<sup>19</sup> For decision-making, this bias would not be a significant problem. For instance, logically it makes no difference if the expected benefits of a project are zero or near zero if the costs are prohibitively high.

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<sup>19</sup> Thaler, Richard H., and William T. Ziemba (1988), “Anomalies: Parimutuel Betting Markets: Racetracks and Lotteries,” *Journal of Economic Perspectives*, Vol. 2, No. 2.

## **First Bidder Advantage**

The first person buying shares has a clear advantage if he/she has knowledge that the initial offering price is incorrect. This initial purchase allows buyers to make an easy profit if the security is offered at 50 percent probability. The solution to this is to auction off the right to be the first bidder.

## **Manipulation**

Absence of manipulation is paramount for ensuring prediction markets provide accurate information. Interested parties may have desires or incentives to manipulate markets by shifting prices to support policies they should not and vice versa. The danger of manipulation is less with prediction markets with CBA. With CBA, manipulation comes from parties involved with creating the CBA. However, prediction markets are more transparent. As mentioned earlier, marginal traders would spot such a discrepancy between price and information and correct any attempt to manipulate prices.

Strumpf randomly placed \$500 trades on the Iowa Electronic Markets to observe the effect of his manipulation, finding that prices were shortly corrected.<sup>20</sup> Camerer's attempts to manipulate horse racing payouts when he discovered his attempts to manipulate markets had little effect.<sup>21</sup>

## **Objectivity & Clarity**

Markets need to be objectively measurable and clearly explained. Results require minimization of disputability along with a consensus. The more objective the measures, the less problematic it is to determine winners. Clarity is also important. Several

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<sup>20</sup> Strumpf, Koleman (2004), "Manipulating the Iowa Political Stock Market", *mimeo*, University of North Carolina.

<sup>21</sup> Camerer 1998. "Can Asset Markets Be Manipulated? A Field Experiment With Racetrack Betting."

prediction markets had to be “ruled” on the exact meaning of the contracts, leading to dissatisfaction among participants. For instance, Tradesports.com created a prediction market that asked whether Yasser Arafat would leave Palestine by 2005. In 2004, he became ill. There was confusion as to whether Arafat leaving the country to seek medical attention in France constituted him leaving Palestine.<sup>22</sup>

## **Futarchy**

Robin Hanson suggested a government run by prediction markets. This type of government was coined “futarchy.”<sup>23</sup> In this type of government, a measurement known as GDP+ would be used to predict success of the security. This GDP+ would be a customizable measure encompassing indicators such as GDP growth and unemployment. Hence, if people believe that GDP+ would rise above a certain level provided, the policy would automatically be implemented.

Futarchy suffers from the correlation vs. causation dilemma. Different policies with identical measurements of success would all be automatically deemed successful if the indicators rise. That would make it impossible to know whether a policy was the cause of the success.

## **Market Mechanisms**

In most prediction markets, a continuous double auction is used to match buyers and sellers.<sup>24</sup> Buyers submit bids and sellers submit asking prices simultaneously. A trade occurs when the two sides reach a mutually agreeable price. However, some new

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<sup>22</sup> Wolfers, Zitzewitz. “Five Open Questions About Prediction Markets.”

<sup>23</sup> Hanson, Robin (2003), “Shall We Vote on Values, But Bet on Beliefs?” *mimeo*, George Mason University.

<sup>24</sup> Wolfers, Justin and Eric Zitzewitz (2004a), “Prediction Markets,” *Journal of Economic Perspectives*, 18(2).

markets operate like the pari-mutuel systems common in horse-race betting. In a pari-mutuel system, all betting money goes into a common pot that is divided among the winners. Additionally, market makers themselves can choose to facilitate buying and selling. Finally, algorithms can be created that allow the market to update automatically by facilitating trades itself. There are two commonly used algorithms: the first is the Market Scoring Rules developed by Robin Hanson. These rules allow for simultaneous predictions over many combinations of outcomes. Traders effectively bet that the sum of their errors over all predictions will be lower.<sup>25</sup> The second is the David Pennock's Dynamic Pari-Mutuel Market. These algorithms offer infinite liquidity to traders.<sup>26</sup> This makes them ideally suited for small or thin market because trades can occur instantly.

There is market risk for information markets that facilitate buying and selling themselves. Take for example an index market based on the democratic vote share in an election. The contract may be set up to pay \$1 for every percentage point won by the democrats. If the price the contract is trading for exactly equals the percentage vote share the Democratic Party receives, then the number of dollars invested to purchase securities exactly equals the amount paid out. However, suppose the price is trading at 25 cents but the democrats win 50 percent of the popular vote. In this case, the market must pay out twice as much as it received on those purchasing contracts.

The market may choose to take a slight margin on trades so that its expected value of any given market is positive and use the surplus over time to fund its existence. Such a strategy could be structured so that over time the expected surplus of the market is zero.

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<sup>25</sup> Hanson, 2003. "Combinatorial Information Market Design."

<sup>26</sup> Christiansen, Jed. Structuring Your Market. <http://blog.mercury-rac.com/2007/03/11/structuring-your-market/>

This means the market would be expected to earn money on any given security, but in aggregate the risk associated with high payoffs as described above would push market profits to zero. Additionally, outside sources may guarantee the contract, such as the government or a private party. As stated, this problem only exists for real money information markets.

No matter what type of market is set up, it is important that it is clear how payouts will be determined when the market is cleared. The Iowa Electronic Market's contracts feature multi-page prospectuses outlining how the market settles under a number of contingencies. On *Tradesports.com* this is often limited to a single sentence.

### ***Abramowicz's Predictive CBA***

Abramowicz presented an improvement on how prediction markets could be used for public policy.<sup>27</sup> He suggested combining prediction markets with cost-benefit analysis. An information market would be created that predicts the outcome of a future cost-benefit analysis. At a set time before the decision to implement the project is conducted, the final prediction is determined from the market. In the future, a cost-benefit analysis is conducted whether or not the project was implemented. This determines the final liquidation amount of the securities. This essentially means that the CBA is being delayed when information that is more accurate (the future CBA uses actual historical measures whereas traditional CBA uses forecast estimates) can be used and the prediction market serves as the decision helper. This means the accuracy of the prediction markets is important and there is a trade-off between performing the CBA at the time the project is being proposed and later. For instance, one reason traditional CBA

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<sup>27</sup> Abramowicz, Michael (2004), "Information Markets, Administrative Decisionmaking, and Predictive Cost-Benefit Analysis," *University of Chicago Law Review*, 71(3).

has been accepted is its transparency. Therefore, the objectivity of the prediction market must be sufficiently high that the results can be trusted. Abramowicz also proposes that standard enhancements needed to extract a better prediction with the most fairness for each of the participants be applied. For instance, the first bid should be auctioned off to prevent first bidder advantages.

### **Problems with Abramowicz's Predictive CBA**

The primary problems with Abramowicz's predictive CBA stem from the fact that it still relies on a traditional CBA to be conducted at some point. Predictive CBA is proposed in a way where the traditional problems with CBA as outlined above are still applicable. For instance, just because the information market correctly predicts a project will produce a cost-benefit analysis in the future, displaying benefits that outweigh its costs does not mean that the project was welfare enhancing. Indeed, the problems of distorted preferences, the diminishing marginal value of money, etc. still are applicable.

### ***Our Proposal: The Welfare Question***

#### **Our Proposed Alternative to Abramowicz's Predictive CBA**

We propose an alternative to Abramowicz's predictive CBA. Instead of asking participants to bid on the likelihood that a future CBA will deem the project a good one, we propose that the question should be asked as follows: "Will a representative entity X years from today judge that the project was welfare enhancing?" This means we are advocating a winner-take-all market where payoffs are determined by an entity that represents society's welfare. If the entity deems the project successful (welfare enhancing), the contract would pay the amount specified during contract formation. If the entity deems the project unsuccessful then the contract pays nothing. Thus, the price

would be the probability that the project will be welfare enhancing. This question improves on Abramowicz's predictive CBA in the following ways. First, it eliminates the problems with CBA. If the representative entity, as an agent for the general public, acts in a way to maximize social welfare and would thus properly judge the project, then essentially the information market is trying to predict whether the project will be welfare enhancing or not. For instance, suppose a project in a community is being proposed that hurts thousands of poor people and homeless but that benefits a handful of wealthy people. Traditional CBA could show the project to have benefits outweighing costs because rich people would be willing to pay a sufficient amount to compensate the losers. However, it is debatable as to whether the project would actually be welfare enhancing. Abramowicz's predictive CBA would likely produce the same result as traditional CBA because participants would be betting on how likely a future CBA is to say the project's benefits outweighed its costs. If these participants are sufficiently taking into account the flaws with CBA, then they will produce the same result as a traditional CBA. Our proposal forces marginal traders to take into account what a representative entity whose job it is to maximize social welfare will think of the project. This means if the representative entity takes into account all the problems of traditional CBA when making its decisions, then market betters do as well.

### **Who Should be the Representative Entity?**

Several considerations must be taken into account with our proposed alternative. First, who should be the person(s) representing society's best interests? That person(s) could be elected or appointed. We believe that direct referendum voting should not be used to clear a market, as perverse incentives could result. Voters would find themselves

with a profit maximizing incentive to vote for whether the project would be welfare enhancing or not based on whether they own the security or not. In this scenario, the price may not reflect the general population's true beliefs.

Then representative entity should be elected because the gap between what maximizes society's welfare and the ability to recognize what maximizes society's welfare could increase when moving from an elected official to an appointee of an elected official. In this case, the representative entity becomes the same as the median voter identity. We choose not to use this term because the median voter identity may not necessarily be representative of society's aggregate preferences.

The representative entity implicitly assumes that distorted preferences among society members are not sufficiently large to create situations where the elected official believes he/she is maximizing society's welfare but is not. If the elected official does not close the market according to what society demands, then we should expect the next election to correct for this by removing the incumbent from office. Additionally, the threat of public ridicule could serve as a way to keep the elected official(s) acting in society's best interest. Once again, for this argument, we assume that society knows what is best itself, in that distorted preferences are insignificant. Alternatively, the market clearer could be an objective observer(s) similar to the Supreme Court of the United States. Instead of being subject to periodic elections, the group would serve lifelong terms. In addition, there is the issue of whether it should be one individual or a group serving as the market clearer. Further research to determine the optimal make-up of the representative entity is necessary.

## **Reduced Transaction Costs**

One of the primary benefits of the welfare question is its ability to reduce the transaction costs of decision-making relative to traditional CBA and predictive CBA. A large amount of work must be done to complete a cost-benefit analysis. However, with one representative entity using intuitive balancing to make decisions the costs associated with analyzing a cost-benefit analysis are reduced. However, CBA is relatively more transparent because it is impossible to see exactly how the representative entity arrived at his/her conclusion. However, we believe the incentives to remain in office and avoid public ridicule are sufficiently strong to minimize corruption by the representative entity.

## **Requires Intuitive Balancing**

The social welfare question must be answered whether or not the project was adopted. For instance, if a project's effect on welfare was evaluated ten years from the date of issue, but was not implemented, then the market-clearer would have to use intuitive balancing to estimate the projects effects had it actually been implemented. The disadvantage to this is the lack of transparency where outsiders cannot see exactly how the representative entity makes his/her decision as to whether the project was welfare enhancing or not. However, research has shown that intuitive balancing is an effective decision-making tool.

To see this, we first define exactly what intuitive balancing entails. In traditional psychological theory, intuitive balancing involves not only the use of intuition, but emotion as well. Those that support the use of intuition and emotion as valid decision tools are typically called institutionists and those that favor rules-based decision tools are

called reasonists.<sup>28</sup> The contrast between intuitive balancing and a rules-based decision procedure has been studied in a wide range of psychological contexts. Cowan, Etzioni, Mellers et al., and De Souza each argued that emotion was essential for reasoned argument.<sup>29,30,31,32</sup> This distinction is often seen in the study of law, where there is constant debate between the merits of an intuition-based sense of justice (natural law) and a reason-based sense of justice (positive law).<sup>33</sup> Hume posits the “naturalistic fallacy” where moral sentiments cannot be readily reduced to facts.<sup>34</sup> This parallels our argument against traditional CBA, which tries to reduce all costs and benefits of a project to facts, even when some of those costs and benefits are moral sentiments.

New advances in technology have contributed to the understanding of intuitive balancing. Current work applying neuroscience to normative thinking has largely rejected the rules-based conception of normative judgment. Rather, models emphasizing the role of emotion and intuition in moral judgment have been developed.<sup>35,36,37,38,39</sup>

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<sup>28</sup> Goodenough, Prehn. 2004. “A Neuroscientific Approach to Normative Judgment In Law and Justice.”

<sup>29</sup> Cowan 1965. “Non-rationality in Decision Theory.”

<sup>30</sup> Etzioni, 1988. “Normative-Effective Factors: Toward a New Decision-Making Model.”

<sup>31</sup> Mellers, et al. 1998. “Judgment and Decision Making.”

<sup>32</sup> De Souza 1987. “The Rationality of Emotion.”

<sup>33</sup> Austin 1832. “The Province of Jurisprudence Determined.”; Holmes 1881. “The Common Law.”; Kelsen 1934. “Introduction to the Problems of Legal Theory.”; Hart 1961. “The Concept of Law.”; Weinreb 1987. “Natural Law and Justice.”; Gruter 1992. “An Ethological Perspective on Law and Biology.”; also see Goodenough 1997. “Retheorizing Privacy and Publicity.”).

<sup>34</sup> Hume, 1739. “A Treatise of Human Nature.”

<sup>35</sup> Damasio, 1996. “The Somatic Marker Hypothesis and the Possible Functions of the Prefrontal Cortex.”

<sup>36</sup> Pizarro, 2000. “Nothing More Than Feelings? The Role of Emotions in Moral Judgment.”

<sup>37</sup> Haidt, 2001, 2003. “The Emotional Dog and Its Rational Tail: A Social Intuitionist Approach to Moral Judgment.”, “The Moral Emotions.”

It is our belief that in the complicated world of public policy decision-making, intuitive balancing is more appropriate than a completely rationalized approach. It is the nature of intuitive balancing that we allows it to fix the problems associated with traditional CBA and predictive CBA.

### **How Does the Welfare Question Fix CBA?**

As stated earlier, CBA suffers from problems due to the diminishing marginal value of money, incommensurability of some objects, etc. One of the primary advantages of the welfare question is the use of intuitive balancing by the representative entity. This allows the representative entity to take into account those effects of traditional CBA that would lead to sub-optimal decisions. Take for instance a hypothetical project that would bulldoze a public park with rare trees and several hundred low-income houses to make room for one a dam that would supply power to a handful of mansions. Several problems arise with evaluating this project if only a traditional CBA is used. The rich people benefiting from the project are likely sufficiently better off in dollar terms such that they could compensate the losers and still be better off. Additionally, there is the problem of assigning dollar values to the rare trees based on their worth to people who did not directly view the park, but took pleasure in knowing the trees existed. With the welfare question, these problems can be intuitively balanced by the representative entity to arrive at the optimal result.

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<sup>38</sup> Nichols, 2002. "Norms With Feelings: Towards a Psychological Account of Moral Judgment."

<sup>39</sup> Casebeer & Churchland, 2003. "The Neuromechanisms of Moral Cognition: A Multiple-Aspect Approach to Moral Judgment and Decision-Making."

## **Comparisons Between Projects**

Ideally, the way to compare projects would be to choose the optimal number of projects that maximizes welfare gains relative to costs subject to any relevant constraints. Unfortunately, the welfare question we propose does not provide a measure of welfare itself. For instance, it cannot be said that undergoing a certain project will improve net utility by 30 utils, in the style of Jeremy Bentham. However, it is our feeling that since the welfare question provides a transparent and sufficiently accurate way of determining if a change from the status quo improves or decreases welfare, then the intuitive balancing done by policy makers should be enough to closely approximate the optimal bundle of projects defined above. Other methods can be used in conjunction with the welfare question to aid in decision-making. For instance, if two projects are deemed likely to be welfare enhancing by a welfare question prediction market and only one project may be chosen, then traditional CBA could help a policy-maker decide which project may have the higher benefits relative to its costs.

Other practical methods could include choosing the project that improves welfare to the most amount of people. Additionally, a ranking system could be built into the social welfare question where betters quickly indicate on a scale of 1-10 how important a project being implemented or not is.

## **Prediction Markets as an Investment Vehicle**

Prediction markets are used to gather information, and marginal traders are an important part of the process. We have repeatedly assumed a sufficient number of marginal traders are present in thick prediction markets to declare the price of the security accurately reflects all available information. However, these marginal traders must have a reason to trade. Typically, the profit motive is the underlying reason for this. Think of

prediction markets for these marginal traders as an investment vehicle. An investor has to determine whether to invest his/her money in a prediction market or some other investment vehicle such as a mutual fund. Even if the marginal trader could assuredly make money, would the return be enough to justify the opportunity cost of time spent not investing elsewhere? Because of this, the farther off into the future the prediction market is settled the more marginal traders will believe their time and money is better spent elsewhere and information aggregation will suffer as a result. However, there appears to be two other reasons traders enter markets. As previously discussed, the Hollywood Stock Exchange uses play money but still beats experts at predicting movie ticket sales. It seems there is an enjoyment motive that causes marginal traders to trade. Additionally, we propose that if the results of betting are published or at least accessible then a prestige motive may also exist. However, it is unclear as to how the enjoyment and prestige motive could be affected by having a market settled far into the future. Perhaps incentives to market participants could be offered, such as paying the risk-free rate of interest on the dollar amount invested. Additionally, an optimal timeframe for a given market may exist. Further research into this possibility is needed. Finally, we believe there is a public welfare motive for trading. This motive is similar to the motive some exhibit when voting, where the act is seen as one's duty to society.

### **Accounting for Preference Changes**

Our proposal so far does not account for societal preference changes. If people's preferences change, then a project considered welfare enhancing on one date may not be welfare enhancing on another. Take for instance the decision to invest public funds toward the development of a specific type of alternative energy source in a state where it

is welfare maximizing to do so. The security would ask, “Will investing public funds be considered welfare enhancing by the representative entity five years from now?” Then in five years, the market is settled and it is declared the project was indeed welfare enhancing. However, six years from the date of the market creation it is determined the alternative energy source causes cancer. Let us assume that nobody could have suspected this. This unforeseen information would have resulted in a different decision as to whether to invest funds had it been known. To combat this we propose that multiple settlement dates be used.

### **Multiple Settlement Dates**

In traditional finance theory, the dividend growth model combined with the efficient market hypothesis declares the sole reason for holding a security is to earn dividends. While there are problems with this, it is generally accepted to be true when the timeframe in question is extended to the limit. As noted above, prediction markets must be compared to other investment vehicles due to the opportunity cost of investing if the profit motive is the primary driver of investment behavior. In this case, a single prediction market that pays off at a specified time in the future would be akin to a stock paying one single dividend in the future. All else equal, this dividend payment will be further discounted the farther into the future the market is settled. The willingness to invest money in a prediction market diminishes as the settlement date is farther off. We have devised a potential remedy for this. We recommend that a market maker could simply create several different prediction markets with the same basic question but different settlement dates are offered. For instance, a question could be proposed as to whether a sales tax will be welfare enhancing could be settled 1, 2, 3, 5, 7 and 10 years

from the date of issue. This method has two distinct advantages. First, the shorter-term settlement dates lower the opportunity cost of investing in prediction markets rather than other investment vehicles. This could lead to thicker markets and better information aggregation. Second, if the market-clearers are elected for terms wholly encompassed by the earliest and latest settled prediction markets then the potential for bias is minimized or at least made transparent. Take for example the same sales tax discussed above. If the current elected market-clearer is more likely to vote in favor of the tax being welfare enhancing but people's tax preferences reverse during current market-clearer's term then the longer term securities should reflect the fact that voters would likely elect someone who shares these new preferences.

This method also allows a way to observe how society weights welfare received at different times. If short-term welfare securities of a project are trading at a high premium relative to long-term welfare securities, all else equal this would indicate society's willingness to discount future welfare.

### **Transparency of the Accounting Stance**

Additionally, there is the possibility of market maker bias, where the market maker sets up the question in such a way as to maximize welfare for a given location or entity, but not society in general. There are certain cases where asking if a project maximizes welfare in only a certain location is recommended, since it can increase interest in the market and thus possibly entice more marginal traders to trade, improving the market's accuracy. For instance, if a market asks whether repaving a local city road is welfare maximizing to society, the interest level it generates among marginal traders (who are likely to be local in this case) may not be as large as if the market asks if the

project would be welfare enhancing to the city. Therefore, in these cases, maximizing welfare to the city serves as a good representation of maximizing welfare to society. However, take the case where a market asks if welfare would be maximized in a city if all the inmates in a city jail were shipped to another nearby city. Such a project may free up jail space in one city but the other city's jail may have to run at above capacity. Society's welfare may be decreased as a result, but the local city implementing the prediction market biases the question. Thus, it is our recommendation that who creates the market be published and readily available to market participants. This would create an incentive for market creators to ask proper questions, to avoid the threat of ridicule one would suffer by asking a biased question.

### ***The Comparison Question***

#### **Comparing Projects with the Social Welfare Question**

The social welfare question determines how likely a project is to be welfare *enhancing*, but this does not indicate whether that project is welfare *maximizing* given budget constraints. For this to be an issue, competing projects must exist. If only one project is possible and it is deemed to be welfare enhancing, then it should be undertaken. There are several ways to determine if the results of the social welfare question should lead to a project being accepted over other competing projects. First, intuitive balancing may be used by decision-makers. Decision-makers may be able to use only “gut-feel” to determine if one project will generate more welfare than another relative to project costs. Alternatively, we propose a welfare comparison question. A prediction market is created that asks the question, “What is the likelihood a representative entity X years from now declares a project social welfare maximizing?” The danger with this question is that the

representative entity would be overwhelmed having to choose between the project in question and an infinite number of other potential projects. Likely, this question is ideal for situations where the possible welfare enhancing projects are readily identifiable. However, this is true for CBA as well. Further study would be needed to assess these concerns.

### ***Using Prediction Markets as a Control on Traditional CBA***

#### **Using Prediction Markets as a Control on Traditional CBA**

Bypassing CBA and using the type of question we proposed above is a significant departure from current analyses. Even if further study confirmed our proposal's merit, the switching costs from switching directly from CBA to our method could be prohibitively high. An infrastructure of professionals who are familiar with CBA and unfamiliar with prediction markets may resist the change. For this reason, we also propose an alternative way of combining prediction markets with CBA than what Abramowicz proposed rather than just a bypass.

It is our proposal that a winner-take-all market's price can act as a deflator of estimated costs or benefits in a traditional CBA. For instance, a traditional CBA for the building of a new form of public transportation may include estimates for future ridership and revenues. Let us suppose future revenues from this project are estimated at \$10 million. A winner-take-all prediction market is then created that asks the question how likely is the project to produce those \$10 million in revenues. Since the interpretation of the price is the probability the event will occur, it can be used to directly deflate the \$10 million to the proper estimated level assuming full aggregation of information. For instance, if the price of the security traded at 20, then we would say there is a 20 percent

chance the \$10 million will be realized. Thus, the correct estimate to be used would be \$10 million \* .2 = \$2 million. This would work in a similar way if an index market was created since the price is interpreted as the expected value. Using index markets as controls would also have the added benefit of being able to determine if the estimate was actually too low, whereas a winner-take-all market is capped at 100%.

This method can be used with our overarching proposal of the welfare question for decision-making. Just as we showed how prediction markets can serve as a control on traditional CBA, the opposite is true as well and can be improved with prediction markets as outlined above. For instance, a project may be deemed welfare enhancing by the market-clearer at the time of settlement, but a traditional CBA showed the project to have costs exceeding its benefits. If released to the public, this may create a sort of publicity effect acting as a control on the market-clearer. The potential for corruption would be minimized.

### **Using Prediction Markets to Estimate Parameters for Traditional CBA**

Prediction markets can also be used in conjunction with traditional CBA by estimating parameters that serve as inputs into a traditional CBA. One could create a prediction market for every single cost and benefit used as an input into traditional CBA. However, there are costs associated with this. For instance, more markets could overwhelm traders and lead to thinner markets. It is our belief that there is an optimal ratio of predictive markets to be used with any given traditional CBA. Indeed, we propose that only the key inputs most significant to the traditional CBA's results be estimated using prediction markets.

This use of prediction markets with traditional CBA may be especially useful for measuring the values of hard to measure parameters, such as environmental contingent valuations. Contingent valuation is a survey-based technique used to estimate the value of goods that are not traded on markets and is subject to much scrutiny.<sup>40</sup> Primarily, this scrutiny comes from contingent valuation using willingness-to-pay vs. willingness-to-accept questions. Thus, contingent valuation is subject to the same problems as WTP and WTA valuations outlined earlier. Prediction markets should improve the parameter estimates of contingent valuations because marginal traders should drive the price to its proper valuation. However, attempts to use prediction markets to determine inputs for contingent valuation have been mixed.<sup>41,42</sup> Participants are asked to predict the results of a contingent valuation survey. The research suggests that the bias exhibited by WTP and WTA contingent valuation is transferred to prediction markets because participants have an incentive to properly guess what the actual results of the contingent valuation survey will be. In this regard, prediction markets have performed admirably. It may be that the best way prediction markets can aid in contingent valuation techniques is by offering a quick way of forming the estimates a contingent valuation survey would offer.

### **Realism of Implementation**

We have presented our case outlining that if certain assumptions are held, the welfare question provides a relatively low-cost and accurate alternative to traditional CBA or predictive CBA. However, how realistic is that these assumptions hold? The

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<sup>40</sup> The Contingent Valuation Debate: Why Economists Should Care. Paul R. Portney, *The Journal of Economic Perspectives*, Vol. 8, No. 4 (Autumn, 1994), pp. 3-17.

<sup>41</sup> Do Your Neighbors Know You Better Than Themselves? A Prediction-Based Non-Market Valuation Method. Jayson L. Lusk and F. Bailey Norwood.

<sup>42</sup> A Comparison between the Traditional Contingent Valuation Methodology and Prediction Mechanism Lava P. Yadav, Thomas H. Stevens, and James J. Murphy

primary assumption that must hold is that the representative entity be truly representative of society's welfare. We believe this assumption is similar to the current process of electing officials into office. If an elected official does not perform to voters' satisfaction, then he/she is not elected to another term. In the same way, if the representative entity does not perform to voters' satisfaction, he/she will not be reelected either. Further, our proposal to publicize the representative entity's decisions ensures an incentive is in place for him/her to vote properly.

The short-term viability of the welfare question is harmed by the upfront costs associated with requiring the election of the representative entity and the costs associated with creating the prediction market itself. Traditional CBA's analyses can be implemented by anyone who can estimate the costs and benefits of a project. However, the welfare question can be implemented simultaneously as CBA still exists. Some government agencies can operate with traditional CBA, some with the welfare question, and some using a combination of the two. We believe in the long run the welfare question can become an effective low-cost accurate replacement for traditional CBA.

### ***Conclusion***

We advocate the use of the welfare question as a low cost and accurate replacement for traditional cost-benefit analysis and predictive cost-benefit analysis. By using intuitive balancing, a representative entity is able to adjust for problems that negatively impact traditional CBA's effectiveness as a decision-tool. The welfare question requires initial setup costs to vote in the representative entity and create the welfare question prediction market, but it is our belief that the long-run benefits of the welfare question will be sufficiently great. Alternatively, prediction markets can be used

to act as a control on traditional CBA by deflating or inflating traditional CBA parameter estimates to their proper amounts.

# Proposal to Create the Oregon Prediction Markets

## *Introduction to Section 2*

We propose the University of Oregon establish and run a university-funded prediction market. This would be a faculty-run operation by the economics department. We recommend it focus on issues of public policy and begin by looking at university and community related issues. We can foresee the university becoming a leading researcher in using prediction markets to aid environmental research. The markets would serve as a research tool to study prediction markets while providing the university with notoriety similar to that received by the Iowa Electronic Markets.

In the prior section of this paper, we discussed using prediction markets to provide parameter estimates for inputs into traditional CBA. Sunstein tells how government agencies might declare a certain regulation will save as many as 80 lives each year and as few as 0 with a preferred estimate of 25. These numbers inevitably involve a degree of guesswork.<sup>43</sup> In this paper we use the construction of the aforementioned University of Oregon basketball arena as a practical example of how prediction markets can minimize the guesswork and act as a control on the economic impact analysis conducted on behalf of the project.

To test the viability of a university-run prediction market, we set up a test market with [inklingmarkets.com](http://inklingmarkets.com). Although [inklingmarkets.com](http://inklingmarkets.com) does not provide features we deem necessary for the Oregon Prediction Markets, we were able to achieve edifying and promising results from our experiment. The market asked participants to estimate the likelihood a new University of Oregon basketball arena will be completed by a certain

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<sup>43</sup> Cass Sunstein. "The arithmetic of arsenic in risk and reason."

date. In under a week, ten participants had actively participated in the market, driving the price to what we intuitively believe is close to a reasonable probability. Additionally, even with only ten traders the data suggested several of those traders acted as marginal traders keeping the price in check. However, the problems with [inklingmarkets.com](http://inklingmarkets.com) persuaded us to research other possible platforms for the Oregon Prediction Markets. We recommend the Oregon Prediction Markets use [newsfutures.com](http://newsfutures.com). We also recommend the Oregon Prediction Markets use play money to begin with, and then explore real money markets as the project matures.

### ***Oregon Prediction Markets***

The University of Oregon has a large pool of potential participants to draw from to participate in the Oregon Prediction Markets (OPM). We recommend that in order to draw a sufficient number of participants ensuring thick and accurate markets the OPM should focus on issues affecting the university and local community. Eugene has a reputation of being environmentally conscious and the University of Oregon has a reputation for being a leader in academic environmental research. Focusing on environmental issues as the first major markets may help build interest in the OPM and position the university in a desirable niche position. As the OPM gathers a steady stream of participants, other markets can then be created.

We recommend a board and chairperson be appointed to oversee the program. We leave the exact method of how this is accomplished to relevant parties. The board would act as a gatekeeper, having the authority to give approval to or reject proposed markets. We also propose the creation of a representative entity voted on by the local community to facilitate future research related to our proposed “welfare question.” We

intuitively recommend the representative entity serve four-year renewable terms, but future experience may indicate a more desirable setup.

A setup fee of \$1-5 dollars would be charged to open an account. This is similar to what the Iowa Electronic Markets charge. Once the account is opened, participants receive a specific amount of play money. We recommend a large amount of play money be given to encourage trading. We choose to denote this play money as “duck bucks” for this paper. We envision several research possibilities for the duck bucks themselves. For instance, the implications of assigning a random number of duck bucks upon account creation could be tested.

Expenditures for promoting the OPM would likely be necessary at its inception. Integrating the prediction markets into economics and finance classes could help improve student involvement. This is done at the University of Iowa successfully. In fact, the University of Iowa has posted course materials to aid in integrating prediction market material into existing curriculum. The University of Iowa calls these “course modules” and it has created modules for such topics as the Capital Asset Pricing Model, Federal Reserve Monetary Policy, and Financial Statement Analysis.<sup>44</sup>

### ***An Example of Using Prediction Markets to Obtain Parameter Estimates: The University of Oregon Basketball Arena***

This example illustrates how the OPM would be used in conjunction with traditional CBA. As of this writing, the University of Oregon plans to build a new basketball arena to replace an aging McArthur Court. Attempts have been made to build the arena since 2003. Issues with fundraising and increased building costs have stymied efforts thus far. The original estimated cost in 2003 to build the arena was between \$90

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<sup>44</sup> <http://www.biz.uiowa.edu/iem/modules/>

million and \$130 million and would be entirely funded by private donors. Now in June of 2007, the estimated arena cost is over \$250 million and may be funded by a mix of private donations and university issued bonds.

There are several parameters important to the decision of whether to build the new arena or not. Typically, a third party conducts an economic impact analysis that attempts to estimate the overall benefits and economic impact the project would have on the University and surrounding city. It is well known that at times the results of these economic impact analyses are suspect.<sup>45</sup> We analyzed the 2002 economic impact analysis corresponding to the original design for the arena approved in 2003 and identified the key parameters the analysis focused on. The following presents those parameters:

BENEFIT PARAMETERS	COST PARAMETERS
University Event Demand (Revenues) <ul style="list-style-type: none"> <li>• men’s basketball</li> <li>• women’s basketball</li> <li>• women’s volleyball</li> <li>• men’s wrestling</li> <li>• commencements</li> </ul> Non-University Events Demand <ul style="list-style-type: none"> <li>• concerts, family shows, other sporting events, high school sports, high school graduations, other events</li> </ul> Preferences for seating types Community multiplier effects <ul style="list-style-type: none"> <li>• direct effects, indirect effects, and leakage</li> </ul>	All project costs (the economic impact analysis lists these in one aggregate measure) – these include operating and building costs...

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<sup>45</sup> Johnson, Thomas. 2000 “The Economic Impact of Museums A Critique.”

## Using Prediction Markets to Improve the Economic Impact Analysis

We believe prediction markets can provide better estimates of the relevant parameters. Theoretically, a security could be created for each cost and benefit imaginable. However, in practice this could lead to thin markets by overburdening participants. We recommend that two securities be created. One focuses on the economic benefits and the other on the costs. The multiplier cannot be measured using a prediction market as it is impossible to have an objective valuation in the end. For instance, suppose the predicted multiplier is 1.2, meaning that for every dollar the arena generates, the local community sees its wealth increase by \$1.20. When it comes time to clear the market, the actual multiplier would have to be calculated to award winners and losers. However, a city's wealth constantly fluctuates. Allocating those fluctuations to one specific problem presents a daunting task. This is a type of the causation/correlation dilemma presented earlier in this paper.

With the above thoughts in mind, we recommend index markets for both revenues and costs. For revenues, an example security may pay 100 duck bucks for every \$10 million in real revenues the arena is expected to generate in its lifetime. The 2002 economic impact analysis we studied used a simple discount rate of 10 percent. The discount rate plays an important role in the valuation of a project and its improper estimate is one of the primary problems the academic literature finds with economic impact analyses.<sup>46</sup> By asking for revenues in real terms, the prediction market effectively asks market participants to factor into their prediction what they believe the proper discount rate for the project to be. The same method would be done for project costs. The difference between expected real revenues and expected real costs would thus be the

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<sup>46</sup> Johnson, Thomas. 2000 "The Economic Impact of Museums A Critique."

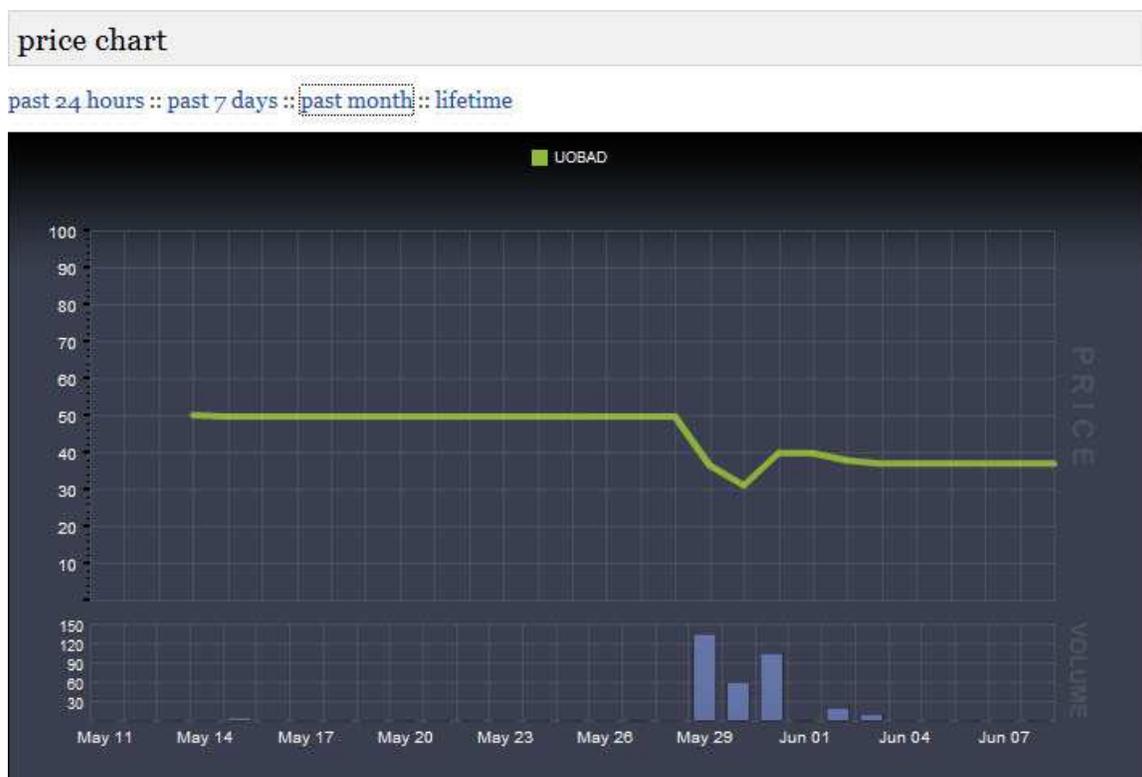
expected net present value of the project, net of any additional multiplier effects. The 2002 economic impact analysis we studied valued the net present value of the stadium at between \$194 million and \$258 million.

### ***Inklingmarkets.com: A Practical Case Study***

We wished to conduct an experiment to determine the extent interest could be raised for a prediction market sponsored by the University of Oregon. We chose to do a simple winner-take-all market asking participants to vote on the date the first men's basketball game would be played at the aforementioned new arena. We created this security because the level of interest in the new arena is currently elevated. This is due to a new athletic director whose sole purpose in replacing the previous athletic director may be to generate the necessary financial support from key donors to jumpstart arena construction. In a meeting with a representative of the athletic department, we learned the project "break ground" date is scheduled for September 2007 and that it typically took three years to complete similar arenas. The goal is to have the arena ready to accommodate fall sport practices in 2010. The representative further revealed that two separate proposals for the arena exist. A larger, more extravagant model would be built if the necessary financial support discussed above is realized. A more cost-effective arena would be built if the athletic department had to fund the project with bonds.

Using the above information, we constructed the market as a winner-take-all market that pays \$100 for every share if the first men's NCAA Division 1 basketball game is played in the arena before December 1, 2010 and nothing if it is not. In a week's trading time, ten participants had driven the market price down to \$36.82. This means market participants estimated the probability the game would be played before the stated

date at roughly 36.82 percent. Even with only ten participants, the movement of the share price over the course of the week suggests that several of the participants acted as marginal traders. This is evidenced as the price fell to as low as \$30 before being bid back up. Intuitively the price seems to make sense when weighing the fact that a new athletic director was hired to procure funds for the arena with the fact that delays in construction are common. The following screenshot illustrates the price path we believe indicates the presence of marginal traders.



Our experience with [inklingmarkets.com](http://inklingmarkets.com) leads us to recommend using an alternative platform for the Oregon Prediction Markets. Although the platform provided us with an edifying starting point for analysis, there are several aspects of its service we do not condone. First, as stated, [inklingmarkets.com](http://inklingmarkets.com) does not operate using a continuous double auction mechanism. After emailing the company, we discovered

Inklingmarkets.com uses market scoring rules to automatically clear trades and set prices. However, this is undisclosed on the website. Participants see how the price changes after a trade is made, but the transparency of this process is low.

The following is a screenshot that shows what users see when they place a bet:

Will the first men's collegiate basketball game in a new U. of Oregon basketball arena occur before Dec 1, 2010?

**Trading Assistant**

You selected: Chances are higher than 36.82%

Current odds of 36% are:	Recommended	Funds Spent	Estimated New Price
<input type="radio"/> Way too low	Buy 50 shares	\$1,959.13	41.6%
<input type="radio"/> Low	Buy 20 shares	\$755.11	38.7%
<input type="radio"/> Just below	Buy 5 shares	\$185.25	37.3%
<input type="radio"/> I'll define my own amount	Buy <input type="text"/>		

current price  
**\$36.82**  
available balance  
**\$867.08**

[back](#) | [confirm trade](#)

You currently own -15 shares worth \$-552.30.  
A total of 335 shares have been traded. The last trade was at: Jun 03, 2007 21:08:03 PDT

As seen, users specify how many shares they wish to purchase (or sell) and what the new price will be after the purchase.

Our second problem is related to the first. Participants cannot buy blocks of shares at a certain price. Due to the automatic price setting mechanism, when purchasing a block of shares the price rises for each individual share purchased. The same is true when shorting, where each share of the block purchased is worth less than the previous. This creates confusion because there is no way to determine how much buying or selling a block of shares will cost until after the participant inputs a potential order. If a participant has only a limited amount of funds left and wishes to use up all available funds on a transaction, it becomes a game of trial and error to determine the proper block of shares to buy or sell.

Finally, the site puts a limit on the amount a participant can short. In traditional finance theory, brokers place limits on the amount of shorting because credit risk is involved. There exists the possibility a trader may not be able to purchase shares at the obligated price if it rises too high. However, with play money such a problem does not exist and constraining shorting only limits the ability for marginal traders to adjust the price to be properly reflective of the probability the event occurs.

### **Additional Lessons Learned**

Our experience indicated the importance of having a clearly defined security. Even though [inklingmarkets.com](http://inklingmarkets.com) allows the security to be modified post-conception, such changes can create confusion and dissatisfaction amongst participants. When we first created the security for the date of the first game in the arena we did not specify the game. Such a mistake would have led to confusion and dissatisfaction amongst participants.

We also identified that the future platform for the Oregon Prediction Markets needs to have the capability of auctioning off the right to bid first. In our test market, the first bidder advantages were large. As of this writing, the first two bidders outperformed the other eight bidders by an average of \$190.00, solely from capital gains/losses.

We posted our email addresses for participants to offer voluntary comments about their experiences. We received emails from two of the ten participants declaring that they did not have enough funds allocated by [inklingmarkets.com](http://inklingmarkets.com) to bid as much as they would have liked. While it was encouraging that the participants had enjoyed the markets enough to become interested in trading other securities on [inklingmarkets.com](http://inklingmarkets.com), we recommend that more funds be allocated than [inklingmarkets.com](http://inklingmarkets.com)' default amount.

Finally, [inklingmarkets.com](http://inklingmarkets.com) did not provide a way for us to view individual participants' data. We could not see what price the participants purchased shares at nor could we see how many shares they purchased. [Inklingmarkets.com](http://Inklingmarkets.com) only provides market-makers with an aggregate list of participants, ranked by their relative capital gains/losses. We recommend the future platform of the Oregon Prediction Markets allow access to detailed individual participant data.

### ***Other Platform Possibilities***

#### **Newsfutures**

We opened an account with [newsfutures.com](http://newsfutures.com) to see how well it could accommodate the university's market. The layout of the website is intuitive and attractive. The site operates as a continuous double auction. Participants specify the numbers of contracts and the price at which they are willing to buy or sell. Additionally, [newsfutures.com](http://newsfutures.com) offers customized solutions for companies.

[Newfutures.com](http://Newfutures.com) allows markets to be set up as a winner-take-all or index markets. For each question, there are two securities that are opposites of each other. For example, one security would be "the Ducks will beat the Beavers" and the opposite would be "the Beavers will beat the Ducks." This facilitates the company's approach to short selling. Instead of directly shorting a security, participants buy shares of the opposite outcome. The prices of the opposing contracts are linked such that if one's price is  $P$ , the opposite's is  $100-P$ . The sum of both the contracts will always equal 100. The site does not allow regular users to create the markets so we were unable to test it out fully. However, [newsfutures.com](http://newsfutures.com) offers customized enterprise solutions that can be

either run by the company or installed at and run by the university. It also offers full technical support.

We recommend Newsfutures.com be used primarily because it uses a transparent double auction. Additionally, the ability to customize markets would allow the Oregon Prediction Markets the flexibility to change its setup as it deems necessary. For instance, we recommend that the right to bid first be auctioned off to avoid the first bidder advantages we identified with inklingmarkets.com. Newsfutures.com has current clients such as arcelor Mittal, Pfizer, Thomson, and Yahoo!, which indicates the company has experience working with large clients. The company does not release enterprise cost information on its website, so future research would be needed to determine if a newsfutures.com solution is financially feasible.

The following screenshot illustrates the intuitive nature of the company's interface. Also note that another market exactly opposite to trades concurrently that asks if the avian flu will reach the U.S. before the EU. Newsfutures.com also sells ad space.

### Avian flu will reach the EU before the US

Each AFLUINEU contract will be worth x\$100 if a human case of H5N1 influenza is reported (by the WHO) in an EU country before such a case is reported in the US. Otherwise, this contract will be worth **nothing**.  
 Ref: [http://www.who.int/csr/disease/avian\\_influenza/country/en/index.html](http://www.who.int/csr/disease/avian_influenza/country/en/index.html)

You might also want to check out the market for the [opposite outcome](#) (Avian flu will reach the US before the EU).

#### Trading price for outcome: AFLUINEU

Time Scale: [24h] . [week] . [month] . [history]

Trading Price: 87

Volume: 6K, 4K, 2K

Feb06 May06 Aug06 Nov06 Feb07 May07

Copy this chart into your blog or website

Total contracts held by players: 12,444 Last Trade at: XS87

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#### Avian flu will reach the EU before the US

Sellers		TIP: If you don't believe in this outcome, you should <a href="#">invest in the opposite outcome</a> .	My Position		
jelloyeti	5 contracts at XS88		number of contracts: <input type="text"/> unit price: <input type="text"/>	Available Cash	2,000
---	189 contracts at XS88			My Contracts	0
c13	32 contracts at XS87			Holding Value	0
---	64 contracts at XS87		Performance	0%	
Buyers		BUY HERE		Gain	0
---	40 contracts at XS81	<input type="button" value="Buy"/>		<a href="#">My Transactions</a>	
oivvt	33 contracts at XS80				
>foakabb	466 contracts at XS79				
---	200 contracts at XS75				

[All Orders](#) | [Opposite Outcome](#) | [I Need Help!](#)

## Consensus Point

Consensuspoint.com offers predictive market solutions to enterprises. While it serves several of its clients it provides little description as to what its platform looks like and what features it offers. We discovered the company's software powers a prediction market called the Foresight Exchange. The Foresight Exchange is located at [www.ideosphere.com](http://www.ideosphere.com) and at [www.idea futures.com](http://www.idea futures.com). The website uses play money and asks users to "sign up free and bet your reputation on the future." This parallels our earlier stated belief that one of the motives to trade in prediction markets is the prestige motive.

We question the user-friendliness of Consensus Point's offerings based on our experience with [www.ideosphere.com](http://www.ideosphere.com). The interface is difficult and confusing to

navigate and we believe potential casual traders may become disheartened and choose not to trade. It is difficult to understand how to buy and sell and it forces users to log in at every screen. The following screenshot illustrates these negative features.

**Your Buy YES Orders    Players Buying YES Coupons**

**Erase    Quantity    Price**

<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	1000 @ 1	yogidog98 ( <a href="#">8962</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	100 @ 10	SMWinnie ( <a href="#">306</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>		

**Price Plot for life of XMSIRI**

Date	Price
Mar 2007	50
Mar 2007	50
Apr 2007	35
Apr 2007	40
May 2007	45
May 2007	30

Last trade price: **30**  
Current ask price: **45**  
Current bid price: **10**  
Pairs outstanding: **328**  
Players participating: **6**  
[View the ticker for this Claim.](#)

Your cash balance: **50.00**  
Your holdings in this Claim: **0**  
Your UID:   
Your password:

**Your Sell YES Orders    Players Selling YES Coupons**

**Erase    Quantity    Price**

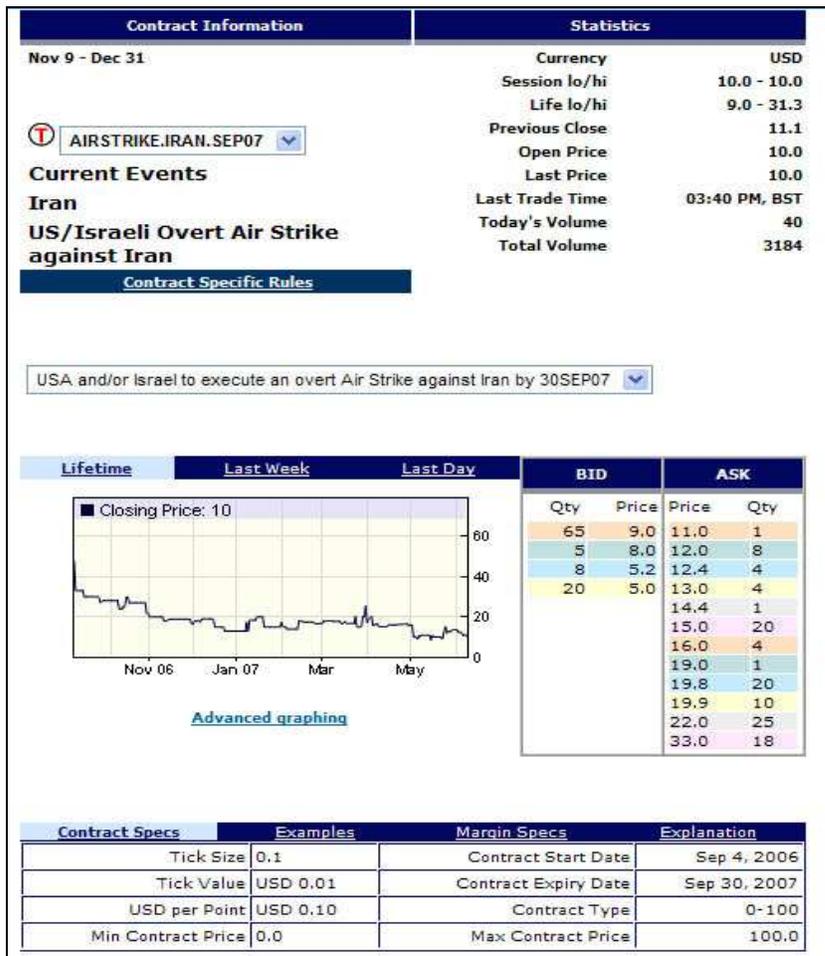
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	50 @ 45	Luscious ( <a href="#">2488</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	1 @ 51	VirtualVolition ( <a href="#">4007</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	1000 @ 98	Luscious ( <a href="#">2488</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	1000 @ 99	yogidog98 ( <a href="#">8962</a> )
<input type="checkbox"/>	<input type="text"/>	<input type="text"/>	1 @ 99	Jonathan Kaplan ( <a href="#">4493</a> )

If this prediction market is indicative of all Consensus Point's offerings, we recommend avoiding its use. However, the company does serve several large clients including General Electric and the market maker tools on [www.ideosphere.com](http://www.ideosphere.com) allow individual data to be viewed, unlike [inklingmarkets.com](http://inklingmarkets.com).

## Intrade

Intrade offers real money or play money options. It uses an ideal continuous double auction mechanism for matching orders. Additionally, it allows short-selling. We like that the website has an attractive user interface with a section answering frequently

asked questions novice users are likely to have. For instance, it tells what the prices mean, offers tutorials on how to place an order, and for real money markets it tells participants how to add money to their accounts. The following screenshot illustrates the well functioning interface and how the continuous double auction is ran.



The markets do not charge a commission on “price-maker orders,” which are orders that are not immediately matched up with a corresponding order. It charges 3, 5 or 10 cents on “price-taker orders” depending on whether the price is extreme or not (0-5 and 95-100) or if the price is in or out of the money. We like the fact that the market incentivizes people to bid when the price is at an extreme level because this helps

eliminate the long-shot bias discussed earlier. We recommend this website if newsfutures.com's customizable solutions are deemed prohibitively expensive.

## **Zocalo**

Zocalo is found at <http://zocalo.sourceforge.net>. Zocalo differs from the other the other platforms presented thus far because it is downloadable software that must be ran from a server procured by the market manager. The software is set up to allow the conduction of controlled prediction market experiments. The program is open source, but its default features are not robust enough to handle the scale of prediction markets the OPM would eventually see. However, since the program is open source, if the Oregon Prediction Markets procured capable programmers, it could customize Zocalo to include some of the features we recommend. We recommend the software could be used for future experiments with prediction markets, but not for the OPM unless capable programmers can customize the program. The following screenshot illustrates what an experimenter sees while conducting an experiment.



## Create and Manage Proprietary Market

The Oregon Prediction Markets may wish to create and manage its own proprietary prediction market software. Such a decision would require the same capable programmers Zocalo requires, with the added complexity of building the program from scratch. Unless an ambitious group of computer science majors becomes passionately interested in the product, it is our recommendation that another method be used.

## Other Practical Issues With Prediction Markets

When using an index market with play money, scaling becomes an issue. For instance, suppose two securities were created based on the real dollar amount of revenues generated by a project. If one security pays 100 play dollars for every 1 million real dollars in revenue the project generates and the other pays 1 million play dollars for every 1 million real dollars in revenue, the interpretation of the price is the same. However, amount it costs investors to enter the market is significantly different for the two

securities. Securities pay-off schedules should be balanced to ensure one security does not take unfair precedence over another.

### ***Conclusion***

We recommend the OPM first focus on prediction markets pertinent to environmental issues. Our experience with [inklingmarkets.com](http://inklingmarkets.com) helped us determine what desirable characteristics the Oregon Prediction Markets should possess and suggested that we were able to draw marginal traders to bid in a market in a short time. Subject to a feasibility study, we recommend that the OPM use [newsfutures.com](http://newsfutures.com) as its future platform. The platform should allow the ability to auction off the right to the first bid to prevent unfair first bidder advantages. In addition, it should provide access to detailed individual level bidding data. We also discussed other potential platforms for the OPM, outlining their strengths and weaknesses. We identify several other factors to consider when creating a prediction market, such as to ensure that the payoff schedules of multiple securities are approximately balanced and that the market is clearly defined.