

# **Technology: Prediction Markets**

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## **Abstract**

Prediction markets are electronic marketplaces in which registered traders buy and sell shares in predictions about real-world outcomes. Based on the idea that most people hold at least a little genuine information and that the right technology can aggregate that information in a useful way, prediction markets have proven to be accurate forecasting tools in corporate and political domains. Prediction markets could revolutionise both politics and policymaking, but several important ethical issues stand in the way, not least of which that prediction markets in some domains are seen as repugnant.

**Keywords:** Prediction markets, Ethical issues, Terrorism, Gambling, Policy Analysis Market, ICT

## **What Prediction Markets are and how they work**

Prediction Markets (also known as Ideas Futures and Information Markets) are electronic<sup>i</sup> marketplaces in which registered traders buy and sell shares in predictions about real-world outcomes. Modern Prediction Markets (PMs) crucially rely on ICT for their effectiveness because the success of PMs relies on their ability to automatically receive, aggregate, and display information from a widely dispersed group of traders.

PMs require a currency to trade with. Some PMs use real money and others use status points, play money, or some kind of special credit. The predictions are usually of the form ‘Event X will happen’. In these kinds of predictions, traders can buy shares in the prediction if they think X will happen or ‘short’/sell shares in the prediction if they think that X won’t happen. These kinds of predictions have set payoffs, usually \$1 or \$10 per share for traders who were right and \$0 for traders who invested in the wrong outcome. In the same way as traders in traditional stock markets, PM traders can also post buy and sell prices instead of accepting the buy and sell prices of other traders or automated market makers (Hanson 2007a).

The most recent buy/sell price of a prediction is a measure of the market’s current collective opinion about the likelihood of the prediction being true (the event occurring). If the most recent buy/sell price of a prediction, such as ‘Obama will win the 2008 US election’, was \$5.50 in a PM that returned \$10 for correct shares, then we can say that the market suggests Obama has a 55% chance of winning the US election in 2008. If a well-resourced trader, Trevor, thought that there was a 70% chance of Obama winning in 2008, then Trevor would buy all of the posted share offers in that prediction up to the value of \$7. If other traders kept buying shares in that prediction until that the current buy/sell price became \$8, then Trevor might want to post a sell price for his shares at \$8 (making \$1+ guaranteed profit on each sale) or hang on to them and take the risk that Obama wins (making either a \$3+ profit on each share or up to a \$7 loss on each share).

## **History of Prediction Markets**

The longest-running electronic prediction market, the Iowa Electronic Market (IEM), has made a name for itself by producing predictions about US election winners from 1988 onwards that regularly outperform political polls (Berg *et al.* 2008). The IEM effectively digitised the large public betting markets on presidential election results

that were run (often illegally but without interference) between 1868 and 1940 (Rhode & Strumpf 2004). Like the IEM, these betting markets were surprisingly reliable, at one point being described as “never wrong” (see Rhode & Strumpf 2004, pp. 129-132). The accuracy of these early PMs is remarkable because they operated at a time in which political polling was non-existent. Collectively, the traders in these markets were very good at predicting who would win the elections.

The idea that aggregating the judgments of non-expert groups of people is a good method for creating accurate predictions also gets support from a simple experiment conducted by Francis Galton and since replicated in many different domains by others (Surowiecki 2004). At the International Exhibition of 1884 in London, Galton analysed nearly 800 attendees’ guesses about how much a live ox would weigh after being butchered. Hoping to make a point about the ignorance of regular folk, Galton was surprised to find that the average of the guesses was nearly exactly correct—just 1 pound off the actual weight of 1,198 pounds (Galton 1908, pp. 280-281). While this might seem like a miracle, the same principle underpins the success of the IEM and its predecessors. Most of us have some genuine information about the topics in question as well as some randomly incorrect information. When all of this information is aggregated in the right way, the random incorrectness tends to cancel out (because it’s random) and the genuine information accumulates into the basis of an accurate prediction (Mauboussin; c.f. Nocera 2006).<sup>ii</sup>

Since at least 1989, when he set up an internal PM at Xanadu to gauge the likelihood of their key product being completed in a timely manner, Robin Hanson has steered the course of PMs.<sup>iii</sup> Hanson has been involved with several commercial, not-for-profit, and governmental PM-based initiatives and has published many scholarly articles on the topic (e.g. Hanson 1995; 1999; 2003; 2006a; 2007a; 2007b).<sup>iv</sup>

### **Modern uses of Prediction Markets**

More recently, many PMs have been set up, most with the purpose of making money and a couple designed to produce knowledge that could be useful for research or for informing public policy and other endeavours. As a result, a surprisingly broad range of predictions have been available to invest in over the last 10 years; from whether Israel or the US will conduct an airstrike on Iran<sup>v</sup> to who will win the next season of the television show *Survivor*.<sup>vi</sup>

PMs designed to make profits through transaction fees, monthly service fees, or advertising revenues set up predictions on whatever will draw attention to the website or encourage traders to place bets.<sup>vii</sup> The result is a mix of predictions concerning the diverse range of topics covered by mainstream news media; important local and international political events, certain commodity prices, sports events, and anything else that might make a good headline.

Other PMs aim to make money for businesses by helping them to make more accurate predictions about what the launch date of their new products will be or what their quarterly sales figures will amount to. Over the last few years, many of the biggest businesses have been successfully using PMs in this way, but none as extensively as Google (Cowgill, Wolfers, & Zitzewitz 2009).<sup>viii</sup> Since 2005, Google has run a company-wide play money PM with 25-30 different predictions each quarter and end-of-quarter raffles at which the play money—Goobles—could be used to win prizes up to the value of \$10,000 (Cowgill, Wolfers, & Zitzewitz 2009). The predictions are on many topics, including product launch dates, new office opening dates, and numbers of product users and have proven to be well-calibrated—meaning that the predictions that were deemed to have a 50% chance of occurring happened about half of the time and predictions that were deemed to have an 80% chance happened approximately 80% of the time (Cowgill 2005). Running PMs for businesses is now a big business in itself, with the first dedicated PM consulting company, Lumenogic,<sup>ix</sup> being joined by many more over the last few years.<sup>x</sup>

Apart from the IEM, there are few, if any, major PMs with the express aim of producing predictions in order to stimulate research or promote some other greater good.<sup>xi</sup> Government funded PMs, with the purpose of creating knowledge for the public good, deserve more consideration and could become a ubiquitous and highly beneficial use of this technology in the future. Unfortunately, the only historical attempt to use PMs in this way resulted in a huge public controversy.

### **A Prediction Market Controversy: Policy Analysis Market**

Given the success of PMs' in the domains mentioned above, the Defense Advanced Research Projects Agency (DARPA)<sup>xii</sup> funded the development of a prediction market with the aim of forecasting “military and political instability around the world, how US policies would effect such instability, and how such instability would impact US and global aggregates of interest” (Hanson 2006a, p. 259). The PM project, named

Policy Analysis Market (PAM), seemed worthy of investigation because, as one of the creators, Robin Hanson, puts it: “what could be more valuable than to inform the largest defense policy decisions?” (Hanson 2006a, p. 259).

PAM would have enabled a broad range of people from around the world to invest in predictions both specifically about, and related to, terrorist attacks, thereby allowing the markets to aggregate disparate pockets of knowledge. Considering that an acquaintance of a terrorist might bet on an anonymous prediction market, but would be very unlikely to contact the relevant security or intelligence forces (especially if they lived in the Middle East), PAM might have been able to gather information unavailable through traditional intelligence-gathering methods. Furthermore, the cost of setting up and running a prediction market like PAM would be less than the cost of training, equipping, deploying, and logistically supporting one additional spy.

In 2003, the development of the PAM project was nearly complete and the team behind it had set up a website and started to present information about what they were planning to various audiences. The example graphics used by the PAM team included these specific terrorism-related predictions: the assassination of Yasser Arafat and a North Korean missile attack (Hanson 2006b). These example predictions were taken very seriously, resulting in PAM being relabelled ‘terrorism futures’ and derided as being ‘repugnant’, first by morally outraged senators Byron Dorgan and Ron Wyden<sup>xiii</sup> and then by journalists and other politicians (Hanson 2006a, p. 261).<sup>xiv</sup>

Amidst the many criticisms of PAM, there were some clearly articulated moral concerns that appear to apply to most plausible versions of anti-terrorism PMs. The most important of these moral concerns are as follows: 1) that the money people could make from anti-terrorism PMs would be “an incentive... to commit acts of terrorism” (Daschle; c.f. Schoen 2003, no page), 2) that purposefully making money from the terrorist acts of others is repugnant because “none of us should intend to benefit when some of them hurt some of us” (Hanson 2006, p. 291), and 3) that terrorist cells could fund their campaigns of terror by “driv[ing] up the market for an event they are planning (so they can] profit from an attack” (Wyden & Dorgan 2003, no page).

The widely publicised outrage and, perhaps, especially these three moral concerns appear to be the main causes of DARPA immediately cancelling the PAM project. Although PAM was widely criticised around the time of its demise, subsequent academic and media discussions of PAM were both more sanguine about

what its chances of success would have been and generally less outraged about the perceived moral problems with it (see Hanson 2005 for analysis and, for examples, see Hanson 2006a; Looney 2004; Surowiecki 2005; Yeh 2006).

While this controversy is already 10 years old, it seems inevitable that the debate about government-funded PMs on terrorist activity will come up again in the near future. Several factors support this conclusion:

- Because the on-going risk of terrorist attacks causes psychological and economic unease, governments should take steps to increase general awareness about potential current and future terrorist activity (White, Porter, & Mazerolle 2012, p. 2).
- Even more importantly, because successful terrorist attacks can be devastating, governments should do all that they can to prevent them.
- Terrorist attacks, including those that affect large numbers of people, and for which relevant information to thwart them was in circulation, occur frequently. For example, just like the airplane-based attacks of 11 September 2001, the Boston Marathon Bombing on 15 April 2013 affected a large number of people and was foreshadowed by information that could have been used to predict the attack (Memmott 2013).
- In these difficult economic times defense spending is being cut. This makes PMs on terrorist attacks and other homeland and international security events much more attractive because they would be a much cheaper method of intelligence gathering than the labour intensive methods currently employed.
- It's plausible that PMs on terrorist attacks and other homeland and international security events could collect information that might never have been gathered using the traditional intelligence gathering methods.
- At least two security officials have published articles in support of testing PMs since the controversy (e.g. Weigle 2007; Yeh 2006).

However, because of the controversy 10 years ago, policymakers cannot be sure that PMs on terrorist attacks would actually work. Therefore, it seems likely that security officials will recommend a trial of PAM, or something like it but with a very different name, in the future. And, if government-funded testing of PMs on terrorist attacks is proposed again, politicians or journalists will hear about 'the reincarnation of PAM' and the controversy will arise again.

### **Specific Ethical Issues Raised by Prediction Markets**

*Online gambling* – In the public furore over PAM, many of the criticisms seemed to target the fact that PMs are a form of gambling, which is illegal, or at least considered to be immoral, in some places. Due to their online presence, PMs could enable gambling in places where it is illegal. Indeed, despite many US residents trading on Intrade, it is illegal for them to do so because of anti-gambling laws. Following the widespread media attention Intrade attracted from its predictions on the 2012 US election, the United States Commodity Futures Trading Commission has pressured Intrade to ensure that US residents do not trade on its site.<sup>xv</sup>

*Profiting from tragedy* – PAM was also accused of being an immoral system because it allowed and encouraged traders to profit from tragedy (such as a missile attack by North Korea). But (at least) Intrade, Foresight Exchange, and iPredict regularly run markets on predictions that allow or encourage traders to profit from tragedy (such as an attack using weapons of mass destruction).<sup>xvi</sup> Any PM that enables and encourages trading on tragic predictions like this, may be accused of a trifecta of moral wrongs: creating character-affecting perverse incentives, desensitising society to tragedy, and disrespecting important ideals.

- PMs on tragic events will most likely encourage some traders to hope that the tragic event occurs so that they can reap the financial (or other) rewards, thereby encouraging these traders to develop a cruel streak and become worse people.
- PMs on tragic events are also likely to desensitise everyone systematically exposed to them, especially traders, to tragic events by making the events the subject of a game. This is likely to result in a society that is more callous about tragedies.
- PMs on tragic events also disrespect important ideals, such as the ideals of life and freedom, by making a game out of tragic assaults on these ideals.

Since PAM was thoroughly chastised for reasons similar to these, more ethical analysis needs to be conducted on these issues to see whether Intrade and other PMs should receive similar rebukes.

*Incentivising unethical behaviour* – Gambling has always provided incentives to alter real-world events, perhaps especially in sporting events. PMs escalate this concern to new levels when they include predictions on events that are matters of life and death. Such PMs create situations in which traders could profit from deadly events occurring, thereby creating an incentive for them to try and make those events happen. For example, a high-level military commander could cause there to be an airstrike on Iran, or just about anyone could attempt to assassinate a famous person, just to profit from a related PM. More research is needed on this issue, but it's not obvious that the limited benefits of these kinds of PMs outweigh the very slight chance of them turning a non-killer into a killer.

*Rewarding unethical people* – While the above ethical issue concerns encouraging people to perform immoral actions when they otherwise wouldn't have, this ethical issue concerns enabling people to profit from the immoral actions that they intended to carry out anyway. Terrorists who were already planning a Weapons of Mass Destruction (WMD) attack could profit from buying up as many shares as possible in Intrade's PM on WMDs.<sup>xvii</sup> Terrorists could only make a few thousand dollars (at the very most) from PMs in this way and so it's not clear why they would choose to make money from PMs instead of through traditional stock markets, which react in predictable ways to major attacks (Hanson 2006a, pp. 268-270). Nevertheless, some people likely find the mere possibility of terrorists profiting from PMs a thoroughly repugnant notion.

*Prediction Markets in public policy* – Perhaps the most important ethical issue about PMs is the possibility that they will be used to inform policy decisions in many domains and possibly also voter preferences. Combinatorial PMs—which depend on results in more than one normal PM—can be used to gauge the perceived effects of various events on important outcome events (Hanson 2003). For example, whether Bashar al-Assad is still in power in 2014 might be perceived to impact future oil prices. Noting this, US government officials might choose to be more involved with Assad's chances of maintaining power in Syria. Similarly, whether the next US president is a Republican might be perceived to impact whether the US will be involved in a major internal war in the future. Noting results like this, US citizens could cast their presidential votes with that information in mind (in addition to the



candidates campaign promises etc.). Combinatorial PMs appear to have many potentially beneficial uses, including more transparent politics, but their potential use raises several ethical concerns.

PMs are notoriously robust against manipulation in theory (e.g. Hanson, Oprea, & Porter 2006), but several important domains have not been tested in practice (most notably, PMs on terrorist attacks and other tragic events). If PMs are to have major impacts on policy and electoral voting, then thorough testing of all domains is necessary to prevent unethical manipulation of these markets.

Another potential ethical concern is that, while the use of combinatorial PMs in politics might make politician's claims more transparent, it might also make politics less democratic because large subsets of the population might not want to or be able to participate with the PM process because of its complexity and the need for computer and internet access and proficiency. Most of these factors will likely diminish with time, mainly driven by technophobic generations dying off and the recent boom in mobile internet technologies, such as smart phones. Nevertheless, if PMs are used in this way, then there will likely be a transition period in which the predictions of several subgroups of the population will not be heard and the members of those subgroups may feel politically isolated.

### **Methods for Addressing the Ethical Issues Raised by Prediction Markets**

At least two promising methods for addressing the ethical issues raised by prediction markets are available and should be used to help inform whether and how PMs should be used. Both of these methods are apt for applied ethical analysis because they avoid forcing particular moral theories on the issue, which might alienate people who do not adhere to that moral theory and might also fail to take into account the particular details and context specific to the issue (Arras 2013; Fieser 2009).

The first promising methodology (practical consistency) compares the ethical concerns with PMs to the ethical concerns about other technologies that play similar roles in similar contexts, especially if they raise similar moral concerns. The aim of this framework is not to pass a verdict on whether a particular use of a PM is moral, rather it is to provide a verdict about whether PMs are more or less moral than other practices/technologies that play similar roles in similar contexts. For example, if the purpose of a PM on terrorist attacks was purely entertainment and the ethical issues involved were deemed to be about gambling and offence, then we might want to

compare it to online gambling, computer games in which players take the role of terrorists, and death pools (betting pools on whether certain celebrities will die in the next year). These kinds of comparisons enable the discernment of where and why people in a society draw the “moral line” and whether PMs are on the right side of that line. The end result of such a comparison might be that PMs on terrorism for entertainment are deemed morally worse than two mainly accepted practices/technologies (gambling and computer games in which players take the role of terrorists) and morally equivalent to a practice/technology that is widely viewed as immoral (death pools) because of how it trivialises the deaths of real people; in sum PMs on terrorism for entertainment purposes seem to be morally unacceptable based on current beliefs and practices. Any decision about whether such PMs should be permitted could be informed by this verdict.

But for some new technologies, good comparitors are not readily available. Furthermore, using the practical consistency method may not help us decide whether a particular use of PMs should be permitted. Consider cases in which a particular use of PMs is less morally acceptable than the most similar current practices, but these most similar current practices are considered morally acceptable (not *only just* morally acceptable), so there is not enough information to work out if that use of the PM is morally *unacceptable*.

This brings us to the second promising methodology, principle-based consistency, which would assess whether the particular use of PMs was in adherence to the relevant moral principles that most dominant moral theories would agree to. The principles might include: don’t cause unnecessary harm, treat others fairly, and be benevolent when the benefits to others far outweigh the costs to yourself (Fieser 2009). If we were to assess PMs on terrorism with these criteria, it seems like only the harm-related principle would play a major role. The analysis would focus on comparing the potential harms and benefits of PMs on terrorism to inform a decision on whether the benefits outweigh the harms to the extent that the harm can be viewed as “necessary”. For example, the potential to save hundreds or thousands of lives and to prevent the associated misery, would have to be weighed up against the likely offence, possible desensitisation to violence, and potential for terrorists to profit that PMs on terrorism would bring about. Since such an analysis is complex and deserves much discussion, I will not attempt to complete it here.

Suffice it to say, there are promising methods to further analyse the ethical issues that various uses of PMs arouse and that these issues deserve greater attention.

### **Attribution**

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## Endnotes

<sup>i</sup> Prediction Markets need not necessarily be electronic, but contemporary non-electronic PMs would be so much more cumbersome, and harder to attract investors to, than electronic PMs that they would not be viable.

<sup>ii</sup> Note that, if misinformation is structurally biased, rather than randomly biased, then PMs will not be as accurate (at least initially).

<sup>iii</sup> See here for a PM timeline: <http://www.midasoracle.org/2007/07/17/history-prediction-markets-timeline/> (accessed on 28 February 2013). More details on Hason's PM at Xanadu can be found here: [http://www.overcomingbias.com/2006/11/first\\_known\\_bus.html](http://www.overcomingbias.com/2006/11/first_known_bus.html), (accessed 28 February 2013).

<sup>iv</sup> See Hanson's website for more information on PMs and his publications: <http://hanson.gmu.edu/ideafutures.html> (accessed on 28 February 2013).

<sup>v</sup> See the prediction here: <http://www.intrade.com/v4/markets/contract/?contractId=763547> (accessed 28 February 2013, note that this link will probably stop working on about 1 January 2014).

<sup>vi</sup> See the prediction here: <http://www.ideosphere.com/fx-bin/Claim?claim=SVrudy> (accessed 28 February 2013).

<sup>vii</sup> E.g. InTrade (<http://www.intrade.com/v4/home/>), Tradesports (<http://tradesports.com/>), Hollywood Stock Exchange (<http://www.hsx.com/>), Foresight Exchange (<http://www.ideosphere.com/>), Knew the News (<http://www.knewthenews.com/>), iPredict (<https://www.ipredict.co.nz/>). All websites accessed on 28 February 2013.

<sup>viii</sup> See Cowgill, Wolfers, and Zitzewitz (2009, note 2) for a list of some major companies who have used PMs.

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<sup>ix</sup> See Lumenogic's website here: <http://www.lumenogic.com/www/index.html> (accessed 28 February 2013).

<sup>x</sup> E.g. Consensus Point (their website available here: <http://www.consensuspoint.com/>, accessed on 28 February 2013).

<sup>xi</sup> Bet2Give was a PM that ran from 2007-2010 and in which traders' profits were donated to each of their chosen not-for-profit organisations, but Bet2Give took 5% of every initial trader deposit. (See here for details: <http://video.cnbc.com/gallery/?video=613230523&play=1>, accessed on 28 February 2013). iPredict is a company owned by the commercial arm of Victoria University of Wellington and was initially set up to make a profit while creating a repository of information that would be useful for political and economic research.

<sup>xii</sup> DARPA is a research and technology division of the United States military and has the purpose of maintaining "the technological superiority of the U.S. military and prevent[ing] technological surprise from harming our national security by sponsoring revolutionary, high-payoff research bridging the gap between fundamental discoveries and their military use" (See the DARPA website here: [www.darpa.mil/about.aspx](http://www.darpa.mil/about.aspx), accessed on 1 March 2013). Although DARPA itself tends to keep a low profile, some of the innovations it has helped to develop, such as the Internet and stealth technology, are widely known (Looney 2004, p. 405).

<sup>xiii</sup> Senators Dorgan and Wyden decried Pam as being "horribly offensive" and a "federal betting parlour on atrocities and terrorism" (See a transcript of Senators Dorgan and Wyden's press conference here: <http://hanson.gmu.edu/PAM/govt/senator-wyden-dorgan-pressconf-7-28-03.txt>, accessed on 1 March 2013).

<sup>xiv</sup> See, for example, [http://money.cnn.com/2003/07/29/news/terror\\_futures/?cnn=yes](http://money.cnn.com/2003/07/29/news/terror_futures/?cnn=yes), and for a list of all of the media comments on this issue, see <http://hanson.gmu.edu/myPAMpress.html> and <http://hanson.gmu.edu/otherPAMpress.html>. All websites accessed on 28 February 2013.

<sup>xv</sup> See the press release here: <http://www.cftc.gov/opa/enf05/opa5124-05.htm> (accessed on 1 March 2013).

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<sup>xvi</sup> E.g. Intrade's prediction that "A successful WMD terrorist attack [will] occur anywhere in the world before... 31 Dec 2013" (currently an 11.4% chance, available from:

<http://www.intrade.com/v4/markets/contract/?contractId=745538>, accessed on 28 February 2013, will probably not be available from 1 January 2014 onwards), Foresight Exchange's prediction "A nuclear weapon will be used (in other than a test capacity) somewhere in the world by 1/1/2020" (currently an 18% chance, available from: <http://www.ideosphere.com/fx-bin/Claim?claim=Nuke20>, accessed on 28 February 2013), and iPredict's prediction "United States and/or Israel to execute an air strike against Iran before 1 Jan 2014" (currently a 25.6% chance, available from: [https://www.ipredict.co.nz/app.php?do=contract\\_detail&contract=IRAN.AIR.JAN2014](https://www.ipredict.co.nz/app.php?do=contract_detail&contract=IRAN.AIR.JAN2014), accessed on 28 February 2013).

<sup>xvii</sup> Intrade's prediction that "A successful WMD terrorist attack [will] occur anywhere in the world before... 31 Dec 2013" (currently an 11.4% chance, available from:

<http://www.intrade.com/v4/markets/contract/?contractId=745538>, accessed on 28 February 2013, will probably not be available from 1 January 2014 onwards).