

Prediction Markets

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1. The Promise of Prediction Markets, K.J. Arrow et. al., Science. 2008
2. Results from a Dozen Years of Election Futures Markets Research.
Berg et al. 2001.

Paper 1: The Promise of Prediction Markets

Goal: Understanding the ability of groups to make predictions is a powerful research tool that should be freed from unnecessary government constraints.

Point: Helps predict event outcomes with lower forecast errors

The Principle of Prediction Market

- Information is often widely dispersed among economic actors, it is highly desirable to find a mechanism to collect and aggregate that information.
- Trade contracts that pay based on the outcomes of unknown future events.



Power of Prediction Market

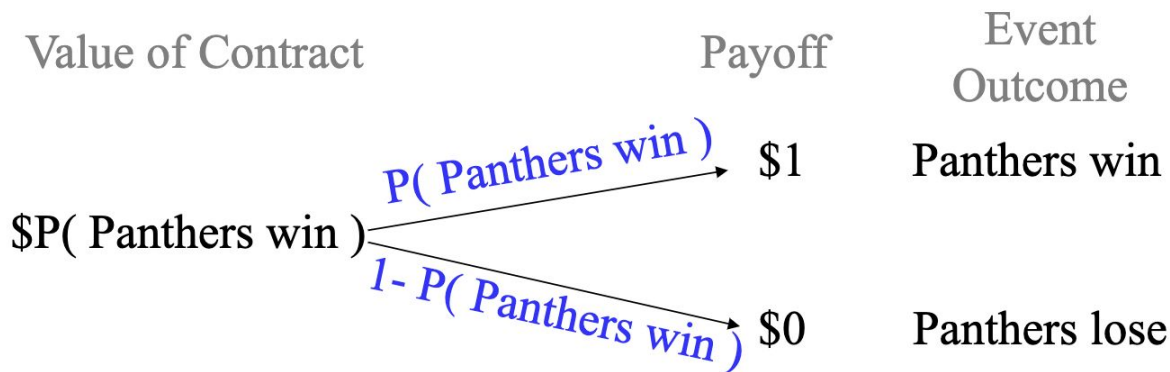
1. Used to increase the accuracy of poll-based forecasts of election outcomes
2. Official corporate experts' forecasts of printer sales
3. Statistical weather forecasts used by the National Weather Service

How and Why Prediction Markets Work

- speculation price discovery
 - expectation of random variable | all information

HOW A MARKET Prediction markets use

\$1 if Panthers win, \$0 otherwise



SELL

probability.

The Advantage of Prediction Market

1. Accuracy
2. Probability equal to the price
3. Analyzability
4. Persistent

The Way Facilitate Prediction Market

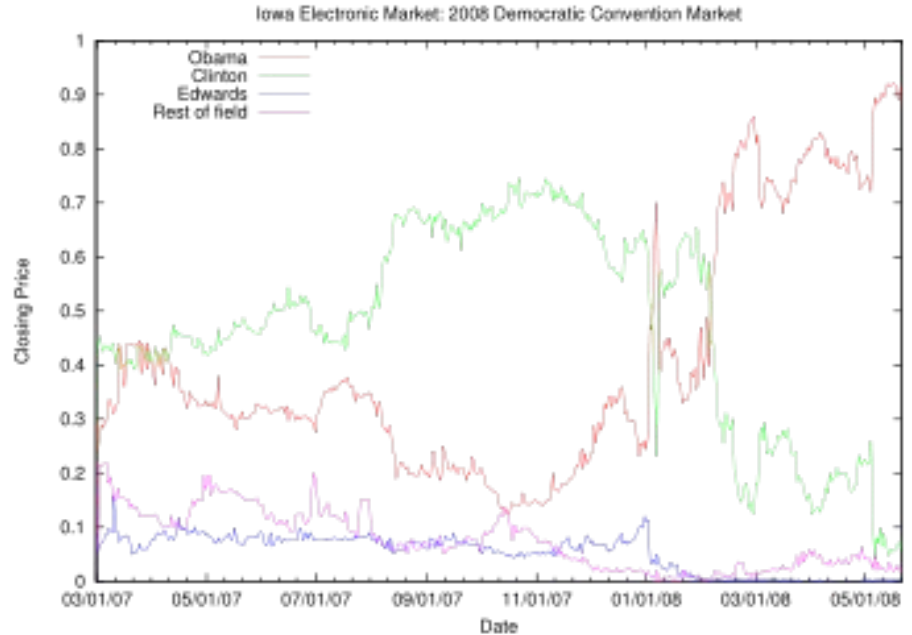
1. The Commodity Futures Trading Commission (CFTC), the federal regulatory agency that oversees futures market activity, should establish safe-harbor rules for selected small-stakes markets.
 - a. non-profit research institute
 - b. government agencies
 - c. Composition of private companies and non-profit organizations not primarily engaged in research
2. Congress should support the CFTC's efforts to develop prediction markets. To the extent that the CFTC incurs costs in promoting innovation, Congress should provide the necessary funding.

Paper 2: Results from a Dozen Years of Election Futures Markets Research

Goal: Understand the Iowa political market and analyze market results

Iowa Prediction Market

- University of Iowa College of Business
- Small-scale, real-money futures markets



Political Prediction Market Design

Data:

- 49 markets
- 41 elections
- 13 countries

- operate 24-hours a day, using a continuous, double-auction trading mechanism
- Traders invest their own funds, make their own trades, and conduct their own information search

Iowa Market Mechanism

- A system of contracts that calculate events linked to future outcomes.
- Unit Portfolios:
 - Contracts enter into circulation by the voluntary purchase from the system of bundles of contracts
- Zero-Sum Game

Prediction Market (Election):

Trader: JDoe		Refresh		Iowa Electronic Markets		
US\$: 5.00000		11/01/00 11:59:59 PM		PRES00 VS		
Contract	BestBid	BestAsk	LastPrice	QuantityHeld	YourBids	YourAsks
DemVS	0.475	0.481	0.479	0	0	0
ReformVS	0.011	0.017	0.015	0	0	0
RepVS	0.510	0.518	0.514	0	0	0

-Market Orders-	Qty	Confirm?	<input checked="" type="checkbox"/>	Market Order			
-Limit Orders-	Price	Qty	Expire	11/19/00 11:59PM	Confirm?	<input checked="" type="checkbox"/>	Limit Order

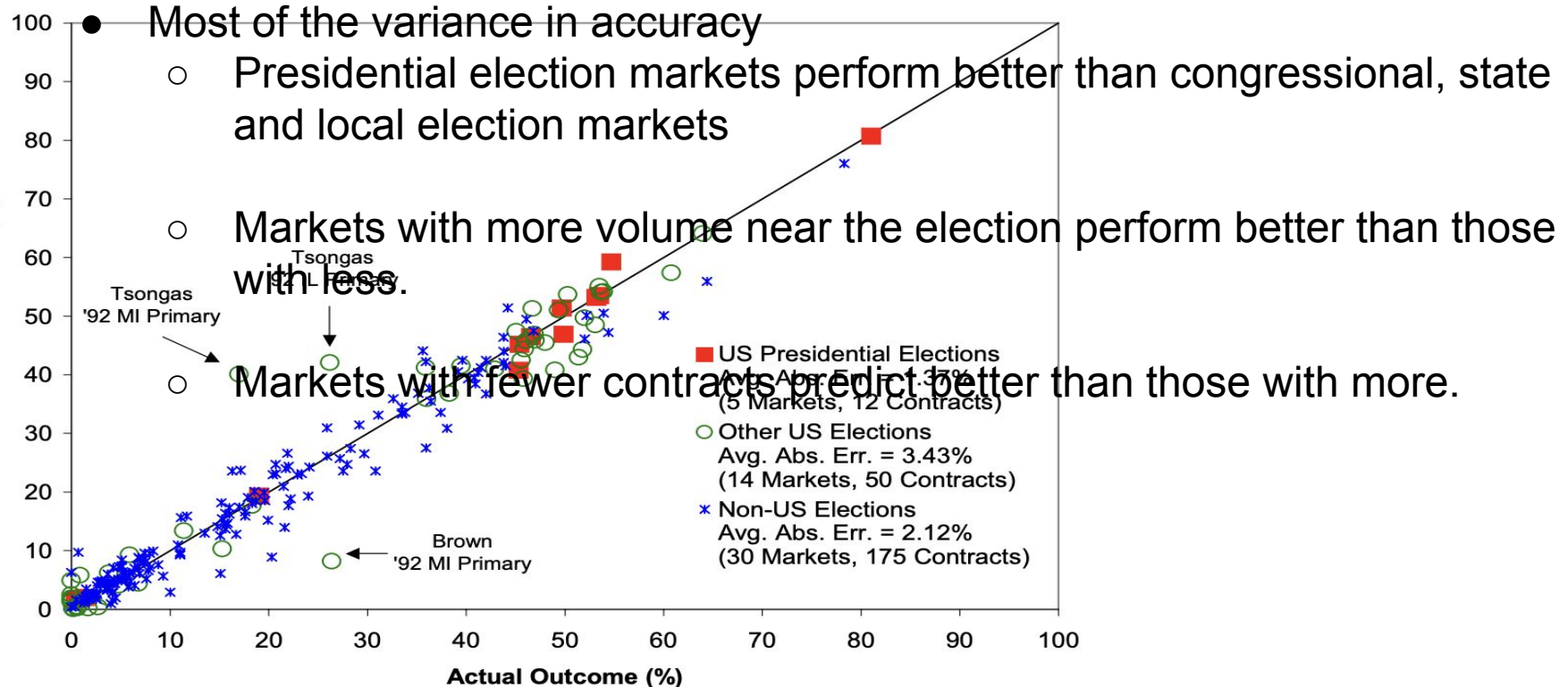
PRES00_VS	Go To Market	My Account	Logout
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- Market Orders
- Limit Orders
- Best Bid
- Ask Prices
- Last Trade Price

Result of Share Market

- Vote-Share Market
 - the relative vote shares candidates receive determine contract liquidation values.
 - $\$1 \times (\text{the vote share received by the associated candidate})$
- Seat-Share Market
 - contracts liquidate at values determined by the congressional or parliamentary seats allocated to parties in an election
 - $\$1 \times (\text{the seat share allocated to the associated party.})$

Prediction Market (Election):



Discussion

- Now that you've learned about the Iowa political market, what advice do you have to make the Iowa political market work better? Such as adding rules to the market to ensure that the market will not be manipulated.

Optional

Empirical reports:

[Using Prediction Markets to Track Information Flows: Evidence from Google.](#)

Cowgill, Wolfers, and Zitwewitz. 2008.

[Using prediction markets to estimate the reproducibility of scientific research.](#)

Dreber et al. PNAS 2015.

[Prediction Without Markets.](#) Goel et al. EC 2010.

[Prediction Markets.](#) Wolfers and Zitzewitz, The Journal of Economic Perspectives 2004.

Prediction Markets

---Justin Wolfers and Eric Zitzewitz

An anecdote sharing:



An anecdote sharing:

How fast will Egypt's non-oil production grow next year? –Economic Events

Will U.S. troops be withdrawn from Country A in two years or less? – Political Events

...

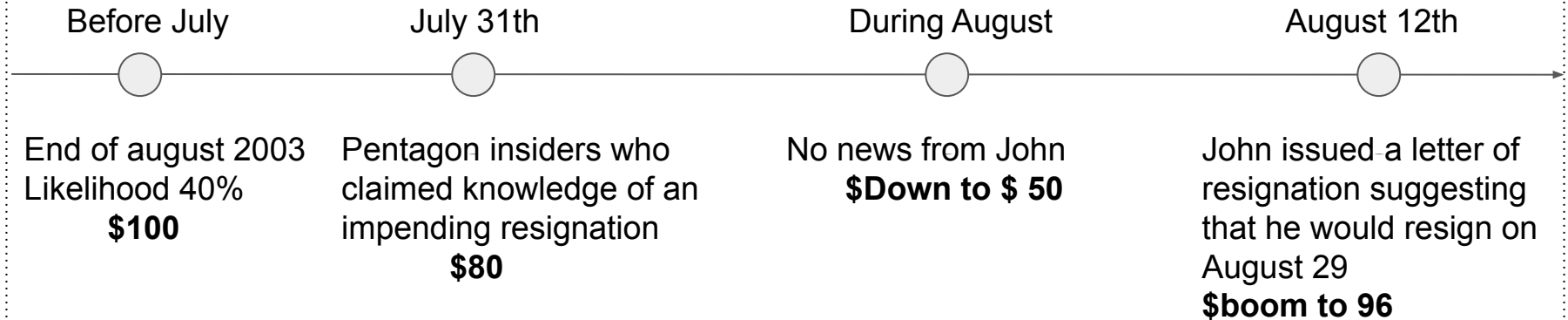
They examine whether combining Economic Events and Political Events helps predict future events and how people perceive the connection between events

An anecdote sharing:



An anecdote sharing:

Timeline:



Prediction Markets

- This anecdote describes an emerging form of financial market, often referred to as prediction markets, but also known as "information markets" or "event futures".
- Analytically, these markets are markets in which participants trade contracts whose returns depend on unknown future events.
- Much of the enthusiasm for prediction markets stems from the efficient market hypothesis. In a truly efficient prediction market, the market price would be the best predictor of events, and no combination of available polls or other information could be used to improve market-generated forecasts.
- This argument does not require that all individuals in the market be rational, as long as the marginal trades in the market are driven by rational traders.

Prediction Markets

The paper begin by describing the types of contracts that might be traded in prediction markets, before proceeding to survey several applications. then it draw together a rough and fairly optimistic description of what we have learned from early experiments, raise some market design issues, and conclude with some evidence on the limitations of prediction markets.

Prediction Markets - Types of Prediction Markets

Table 1

Contract Types: Estimating Uncertain Quantities or Probabilities

<i>Contract</i>	<i>Example</i>	<i>Details</i>	<i>Reveals market expectation of . . .</i>
Winner-take-all	Event y : Al Gore wins the popular vote.	Contract costs $\$p$. Pays $\$1$ if and only if event y occurs. Bid according to value of $\$p$.	Probability that event y occurs, $p(y)$.
Index	Contract pays $\$1$ for every percentage point of the popular vote won by Al Gore.	Contract pays $\$y$.	Mean value of outcome y : $E[y]$.
Spread	Contract pays even money if Gore wins more than $y^*\%$ of the popular vote.	Contract costs $\$1$. Pays $\$2$ if $y > y^*$. Pays $\$0$ otherwise. Bid according to the value of y^* .	Median value of y .

Prediction Markets

Applications and Evidence

Prediction Markets - Applications and Evidence

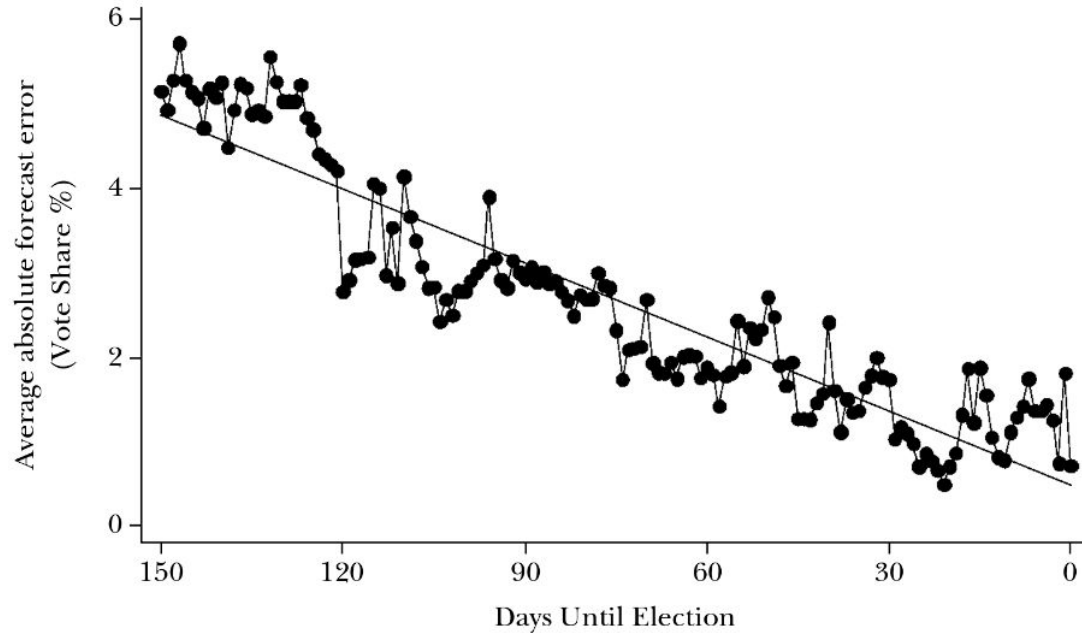
- ❖ Perhaps the best-known prediction market among economists is the Iowa Electronic Market, run by the University of Iowa. The original Iowa experiment, run in 1988, allowed trade in a contract that would pay 2.5 cents for each percentage point of the popular vote in the presidential election won by Bush, Dukakis or others.

Prediction Markets

Accuracy of Prediction Markets

Prediction Markets - Accuracy of Prediction Markets

Figure 1
Information Revelation Through Time

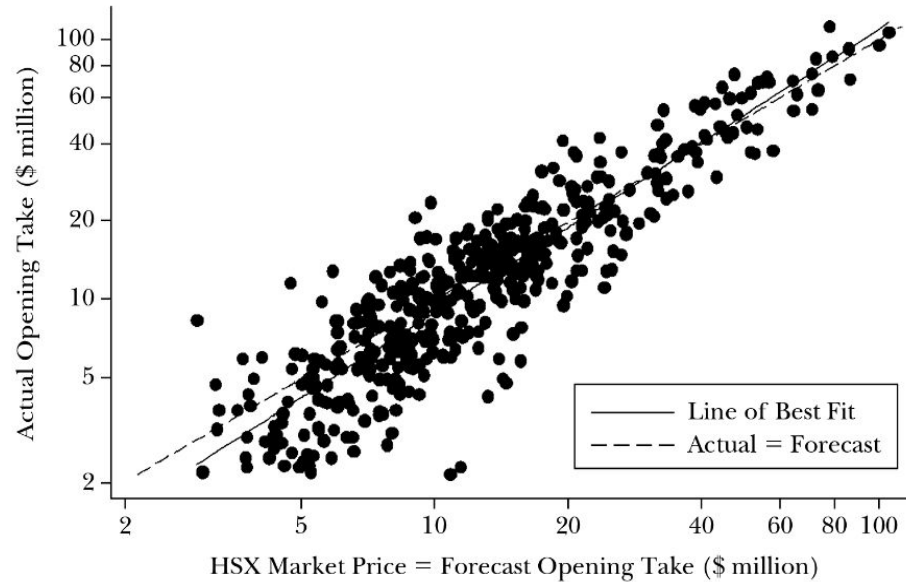


Source: Author's calculations based on data available at <http://www.biz.uiowa.edu/iem>.

Prediction Markets - Accuracy of Prediction Markets

Figure 3

Predicting Movie Success



Source: Data from 489 movies, 2000–2003 (<http://www.hsx.com>).

Prediction Markets

Possibilities for Arbitrage

Prediction Markets - Possibilities for Arbitrage

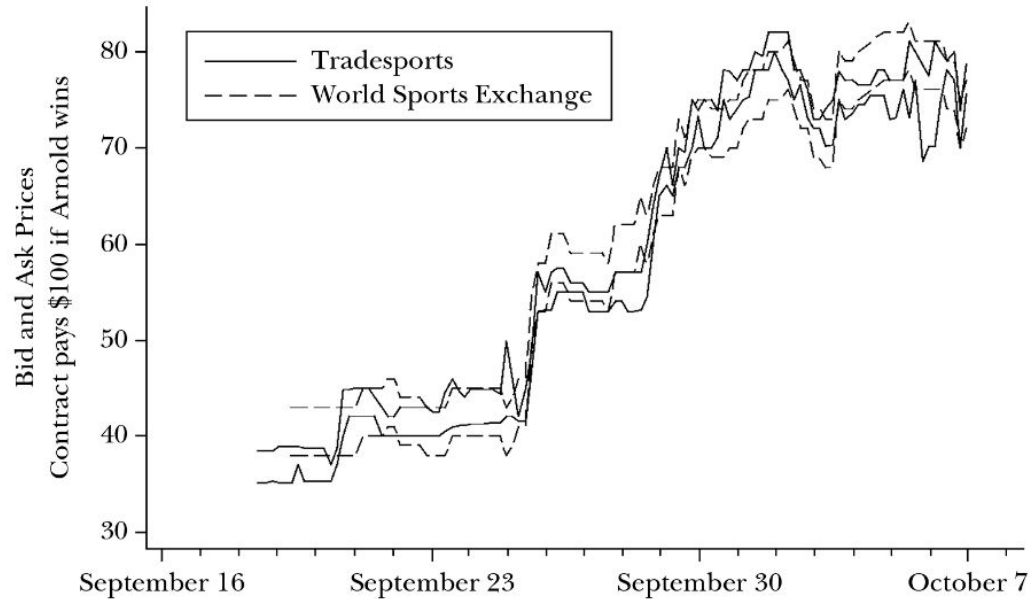
There are several ways of looking for arbitrage opportunities:

- Whether prices for similar contracts can be arbitrated across different exchanges or different securities
- Whether predictable patterns in the movement of the prices allow for arbitrage
- Whether arbitrageurs might be able to exploit predictable deviations from rationality

Prediction Markets - Accuracy of Prediction Markets

Figure 4

2003 California Gubernatorial Election



Source: Prices collected electronically every four hours by David Pennock.

Prediction Markets - How can event Markets Be Easily Manipulated?

Discuss: What examples can you think of where event markets could easily be manipulated?



Prediction Markets - Innovative Future Applications?

Prediction markets provide three important functions:

- 1) an incentive to seek information
- 2) an incentive to disclose truthful information
- 3) an algorithm to aggregate dissenting opinions.

Using prediction markets to estimate the reproducibility of scientific research

Anna Dreber

Thomas Pfeiffer

Johan Almenberg

Siri Isaksson

Brad Wilson

Yiling Chen

Brian A. Nosek

Magnus Johannesson

Tested the potential of using prediction markets to estimate reproducibility

Source: Reproducibility Project: Psychology (RPP)

First set of prediction markets:

23 replication studies

Second set of prediction markets:

21 replication studies

Market

Participants could bet on whether or not the key original result would be replicated.

P value less than 0.05

Same direction as the original result

participants traded contracts that pay \$1 if the study is replicated and \$0 otherwise.

Each participant was endowed with US\$100 for trading.

Participants

From Open Science Framework and RPP collaboration.

Participants were not allowed to bet in those markets where they were involved in carrying out the replication.

First set:

49 individuals signed up and 47 of these actively participated

Second set:

52 individuals signed up and 45 of these actively participated

Results

Total 2,496 transactions were carried out

The number of transactions per market ranged from 28 to 108 (mean, 56.7)

The number of active traders per market ranged from 18 to 40 (mean, 26.7).

The mean prediction market final price is 55% (range, 13–88%)

Out of the 44 scientific studies ,41 of the studies'replications were completed

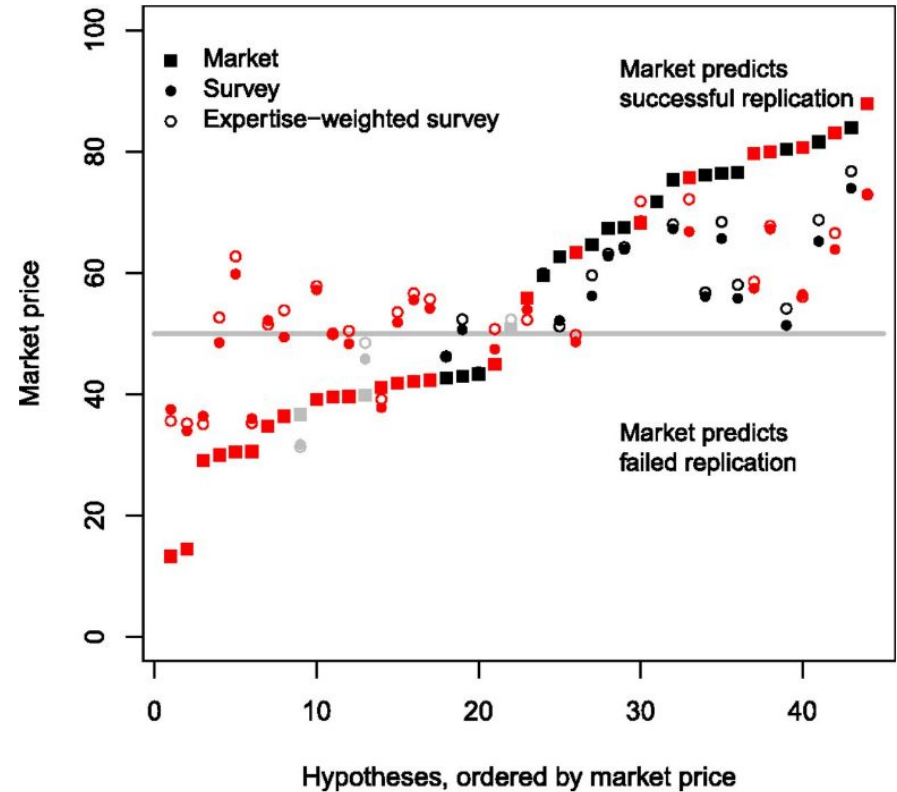
16 studies (39%) replicated

25 studies (61%) did not replicate

50% Threshold

69% of the outcomes are expected to be predicted correctly

observed value of 71%



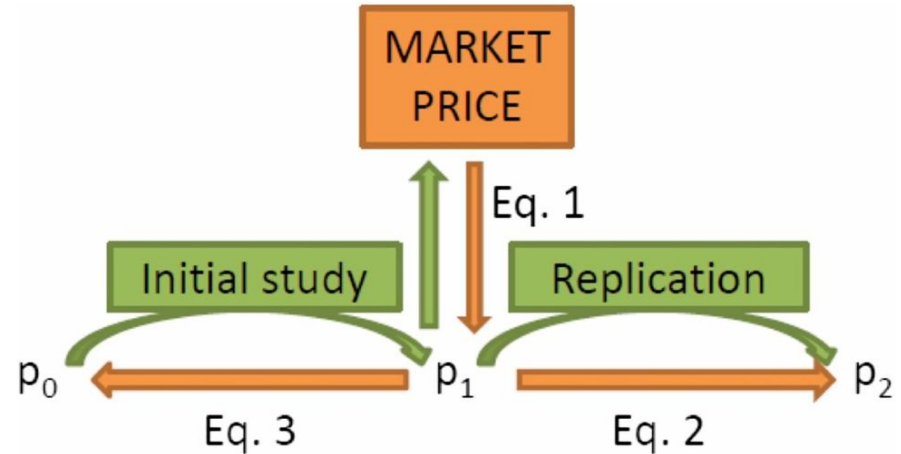
How market prices can be interpreted as probabilities of replication

Three stages

the prior probability (p_0) before observing the outcome of the initial study;

the probability after observing the result of the initially published study (p_1);

and the probability after observing the outcome of the replication (p_2).



Equations

α_0 : false-positive probabilities of the original study

β_0 : power of the original study

α_1 : false-positive probabilities of the replication

β_1 : power of the replication

p_E : probability of observing positive evidence in the replication

p_M : final market price

From Market Price to p_1 (Eq. 1)

When the original study reports a positive outcome, successful replication means a positive outcome in the replication. Such a positive outcome can be either due to a true or false positive.

$$p_1 = (p_M - \alpha_1) / (\beta_1 - \alpha_1) . \quad (1)$$

When the original finding is negative, successful replication means a negative outcome in the replication. Thus, the market price p_M reflects $1 - p_E$, rather than p_E , and p_1 is given by the following:

$$p_1 = (1 - p_M - \alpha_1) / (\beta_1 - \alpha_1) \quad (2)$$

From p_1 to p_2 (Eq. 2)

Once the outcome of the replication is known, it can be used to calculate p_2 from p_1 . In case of a positive outcome, p_2 is given by $p_2 = p_1\beta_1/p_E$. When the original finding is positive, p_1 with positive original outcome can be used to substitute p_1 and p_M can be assumed to reflect p_E

$$p_2 = (p_M - \alpha_1) \beta_1 / p_M (\beta_1 - \alpha_1) \quad (3)$$

When the original finding is negative, p_1 with negative original outcome can be used to substitute p_1 and p_M can be assumed to reflect $1 - p_E$, and thus p_2 can be calculated as follows

$$p_2 = (1 - p_M - \alpha_1) \beta_1 / (1 - p_M) (\beta_1 - \alpha_1) \quad (4)$$

In case of a negative outcome in the replication, p_2 is given by $p_2 = p_1(1 - \beta_1)/(1 - p_E)$. Thus, in case of a positive original result, p_2 can be calculated as follows:

$$p_2 = (p_M - \alpha_1) (1 - \beta_1) / (1 - p_M) (\beta_1 - \alpha_1) \quad (5)$$

In case of a negative original result and a negative outcome in the replication, p_2 is as follows:

$$p_2 = (1 - p_M - \alpha_1) (1 - \beta_1) / p_M (\beta_1 - \alpha_1) . \quad (6)$$

From p_1 to p_0 (Eq. 3)

Probability p_1 can also be used to reconstruct the original prior, p_0 . When the original result is positive, the original prior is given by the following:

$$p_0 = p_1 \alpha_0 / (p_1 \alpha_0 + (1 - p_1) \beta_0) \quad (7)$$

When the original result is negative, the original prior is given by the following:

$$p_0 = p_1 (1 - \alpha_0) / (p_1 (1 - \alpha_0) + (1 - p_1) (1 - \beta_0)) \quad (8)$$

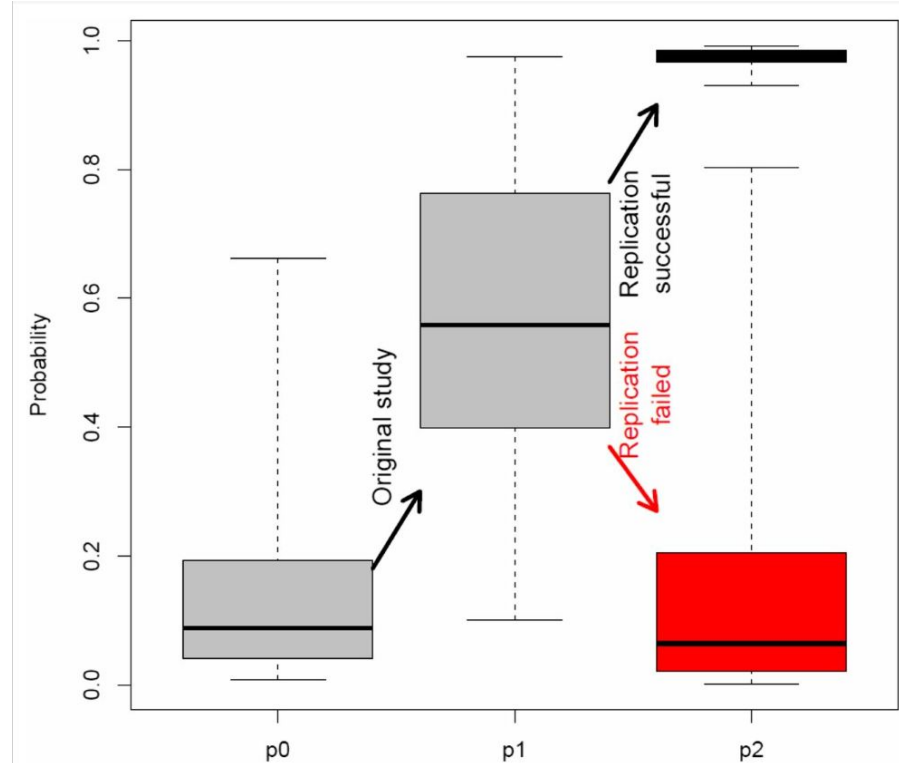
Probability of a hypothesis being true at three different stages

p_0 : with a median of 8.8% (0.7–66%)

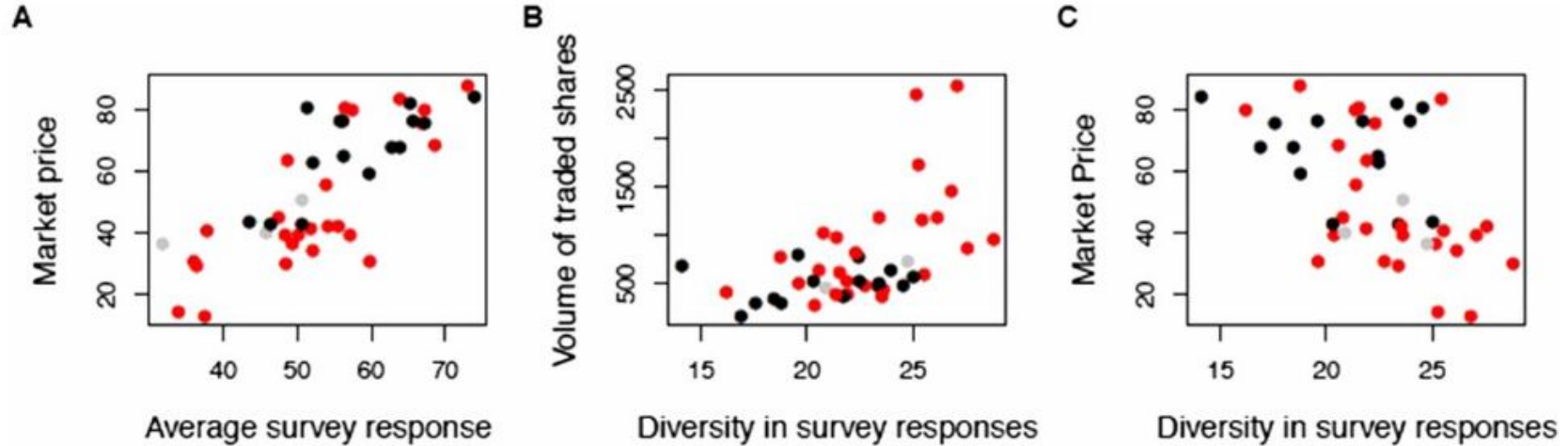
p_1 : with a median of 56% (10–97%)

$p_{2(\text{success})}$: with a median of 98%
(93.0–99.2%)

$p_{2(\text{fail})}$: with a median of 6.3% (0.01–80%)



Markets predict vs. Survey measure of beliefs



A simple average of the survey correctly predicts 58% of outcomes (23 of 40; survey data are missing for one market), which is not significantly different from 50% (one-sample binomial test; $P = 0.429$). A weighted average, using self-reported expertise as weights, correctly predicts 50% (20 of 40) of outcomes, which is not significantly different from 50% (one-sample binomial test; $P = 1.00$). The absolute prediction error is significantly lower for the prediction market than for both the pretrading survey (paired t test, $n = 40$, $t = -2.558$, $P = 0.015$) and the weighted survey (paired t test, $n = 40$, $t = -2.727$, $P = 0.010$; for a more detailed comparison of the prediction market and survey responses).

Conclusion

These results show that prediction markets can give valuable insights into the dynamics of information accumulation in a research field. Eliciting priors in this manner allows us to evaluate whether hypotheses are tested appropriately in a given research field. A common, but incorrect, interpretation of a published result with a $P < 0.05$ is that it implies a 95% probability of the research hypothesis being true. Interestingly, the research implies that to achieve such a high probability of the research hypothesis being true, a “statistically significant” positive finding needs to be confirmed in a well-powered replication. This illustrates the importance of replicating positive research findings before they are given high credibility. It remains to be studied how psychology compares in this aspect to other fields.