

# White paper: Belief markets

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## Abstract

In an era plagued by disinformation and declining trust in traditional authorities, the need for reliable methods to evaluate the truth of statements is more pressing than ever. This paper proposes the concept of "belief markets," a decentralized system inspired by the principles of prediction markets, to address this challenge. Belief markets allow participants to place bets on the veracity of arbitrary statements, continuously adjusting odds based on new evidence provided by the community. By leveraging the collective wisdom and incentivizing rigorous evidence gathering, belief markets aim to create a dynamic and accurate system for determining truth. Implemented via a browser plugin or traditional website and managed through smart contracts on the Solana blockchain, this system ensures transparency, security, and scalability. Belief markets not only combat misinformation but also offer a novel way to fund scientific research, journalism and fact-checking endeavors, ultimately contributing to a more informed and engaged society.

## Introduction

In a world inundated with information, distinguishing between truth and falsehood has become increasingly challenging. Disinformation spreads rapidly, creating a crisis of doubt and eroding trust in traditional authorities. Imagine a system where the truth of statements could be evaluated in the most accurate and honest manner achievable. This system could manifest as a browser plugin, highlighting the reliability of information in real-time with probabilistic accuracy.

Picture reading a news article and instantly seeing which parts are supported by strong evidence and which are dubious. Consider a platform where individuals can earn money by finding and presenting evidence for or against statements. This could revolutionize fields like journalism, where fact-checking becomes a community-driven process, and even extend to scientific research, where findings are continuously validated and funded by the collective effort of truth-seekers.

The potential impact is vast. Not only could such a system mitigate the spread of false information, but it could also foster a more informed and engaged public. Scientific research could receive continuous funding through the discovery and presentation of new evidence. Legal investigations could benefit from crowd-sourced evidence, accelerating the resolution of cases. Ultimately, this belief market could serve as a powerful tool in enhancing the credibility and reliability of information in our society.

## 1 Prediction markets are accurate

You may be surprised, but in the case of evaluating the likelihood of future events, this already exists: prediction markets.

### 1.1 How prediction markets work

Prediction markets are similar to other markets, like stock markets, but instead of trading stocks, people trade "yes" or "no" shares based on specific odds. For example, you can wager an amount  $w$  of dollars on the odds  $Q$  that your favorite horse will win (backing). Alternatively, you can bet against that horse according to odds of your choice (laying). Similar to limit orders in regular markets, you can place limit orders at specific odds or market orders at the best available odds.

## 1.2 Why prediction markets are accurate

Prediction markets, where participants buy and sell shares in the outcome of events, have demonstrated remarkable accuracy in forecasting. For instance, the Iowa Electronic Markets (IEM) have been cited for their precision in predicting U.S. presidential elections. Between 1988 and 2000, the IEM predictions were within 1.5 percentage points of the actual vote, outperforming traditional polls. These markets force participants to "put their money where their mouth is," thus incentivizing them to make well-informed, unbiased predictions. Even if you have a favorite horse, betting on it knowingly that it is slow leads to losses, because your competitors excel at evaluating the actual winning probability without letting emotions and biases interfere.

Research supports the idea that prediction markets aggregate dispersed information effectively. Studies have shown that internal prediction markets used by companies like Google, Yahoo!, and Microsoft have accurately forecasted product success, sales figures, and other business outcomes. This accuracy stems from the ability of markets to integrate diverse information sources and reward participants for uncovering new, relevant information. Whenever a piece of information is not reflected in the odds (prices), it presents an opportunity for profit to those with superior knowledge.

## 2 Generalizing prediction markets

Since prediction markets are so accurate, why not extend them to arbitrary questions like "Was Jesus a real person?", "Is vaccine X safe?" or "Which is the best theory for quantum gravity?". Three main problems arise with this generalization:

A trustworthy arbiter usually settles the payouts based on event outcomes. There is typically a future event with a clear outcome, like a sports event or an election. A trustworthy arbiter or "fact checker" decides who won.

However, these problems are not insurmountable. Let's address them one by one.

### 2.1 No settlement of the bets necessary

Consider a bet of  $w_1$  dollars with odds  $Q_1$ . If the outcome occurs, the profit is  $G = w_1(Q_1 - 1)$ , otherwise  $G = -w_1$ . If there is no authority to decide the outcome, market dynamics will lead to falling odds until final odds  $Q_2 \approx 1$ . Instead of a formal settlement, the player can sell the bet back to the market by placing a new bet with  $w_2 = -w_1 \frac{Q_1}{Q_2}$ . This neutralizes the bet, and the total profit remains the same regardless of the outcome.<sup>1</sup>Hence, no formal settlement is necessary, and the market can continue indefinitely.

### 2.2 No clear outcomes necessary

A clear outcome like winning or losing seems necessary but isn't. People trade bets in a prediction market just like in normal markets: they back at high odds and lay at low odds, adjusting based on emerging evidence. If an outcome is unclear or both outcomes are equally likely, the odds adjust accordingly, and the payouts reflect this. Clear outcomes are simply strong pieces of evidence among many others that influence the odds.

### 2.3 No arbiter necessary

Since "winning a race" is just a piece of evidence, a special authority isn't required to validate it. Market participants themselves can provide evidence. For example, if a horse is sick, a player can post this information, causing odds to change. The player profits by laying the bet before releasing the information and backing it after the odds increase.

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<sup>1</sup>If the outcome occurs,

$$G = w_1(Q_1 - 1) + w_2(Q_2 - 1) = w_1Q_1 - w_1 - w_1 \frac{Q_1}{Q_2}Q_2 + w_1 \frac{Q_1}{Q_2} = w_1 \left( \frac{Q_1}{Q_2} - 1 \right)$$

Otherwise,

$$G = -w_1 - w_2 = -w_1 + w_1 \frac{Q_1}{Q_2} = w_1 \left( \frac{Q_1}{Q_2} - 1 \right)$$

Hence, the total profits are the same irrespective of the outcome. At the end of the event, if the outcome occurs,  $Q_2 = 1$ , then the profit is  $G = w_1(Q_1 - 1)$ , the same profit obtained with a formal settlement.

### 3 Belief markets

The challenges of generalizing prediction markets to arbitrary statements are surmountable. We can take any statement like "Jesus was a real person" and create a belief market to place bets on it. Anyone can publish evidence for or against the statement, and if the evidence is compelling, the odds will change, allowing the evidence provider to profit from the odds difference. These markets can run indefinitely as long as there is interest. Scientific research or journalism can be financed this way: a scientist/journalist finds evidence, places a bet, publishes the evidence, and sells the bet once the prices have adapted to the evidence. This incentivizes discovering new information, benefiting society by rewarding those who contribute valuable evidence.

Imagine incentivizing people to dig up compelling evidence on various topics, from political controversies and conspiracy theories to criminal cases. As prediction markets have shown, while people may be biased, the risk of losing money deters bias and misinformation. Markets are unforgiving: bias or misinformation leads to losses.

### 4 Implementation

To demonstrate this concept, a browser plugin could be developed. Users can enter new statements they encounter on news websites or social networks, generating a new market for each statement. Users can place bets on these markets. If unsure about the truth value, users can act as market makers, providing bets both for and against the statement at different odds. If a statement (i.e., market) already exists, the plugin highlights it on the website, showing the probability of the statement being true.

As a backend, a Solana smart contract manages the creation of new markets, processing of bets, and storage of order books. It ensures transparency, security, and immutability of the records. Users connect to their Solana wallets to send transactions to the smart contract, placing bets without needing a separate platform, payment system, or KYC requirements. A new token can be launched, and bets can be placed using this token to monetize the idea.

### Conclusion

Belief markets represent a revolutionary approach to evaluating the veracity of statements, leveraging the principles of prediction markets to create a decentralized, incentivized system for fact-checking, journalism and scientific research. By aligning financial incentives with the discovery and presentation of accurate information, belief markets can enhance the reliability of information, contribute to a more informed and engaged public and benefit society as a whole.

### References

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