

Inferring Economic Risk from Options Contracts and Public Prediction Markets

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This paper responds to two questions posed by the organizers of Perry World House's 2021 Global Order Colloquium: 1) what are the odds of a major global downturn in the next 5 years? and 2) what data points should a world leader see every day to better understand the future of the global economy?

I respond to the first question by noting that one can use S&P 500 options to create an approximation to a security that pays \$100 if the market falls by 50% from today's levels in the next 27 months. Such a security would cost about \$8.40. I argue that while these market-implied probabilities reflect risk premia and therefore overstate the objective probability of adverse economic events, market-implied probabilities may be better inputs into decisions about resource allocation and mitigation.

I respond to the second question by assessing the extent to which existing public prediction markets provide probabilities that are useful indicators of economic, political, and natural risks. I argue that while the regulatory environment for prediction markets has improved in the last decade and markets such as Betfair, Kalshi, Nadex, and Predictit have successfully run markets that speak to these risks, their full potential remains largely unrealized.

What are the odds of a major global downturn in the next 5 years?

When asked for probabilities, I turn whenever possible to asset prices, ideally from deep, liquid markets with minimal participation constraints. Equity markets tend to decline sharply during economic downturns, so the probability of low future equity prices can be taken as an informative of the probability of a future recession.

One can calculate market-implied probabilities for different levels of equity prices from the prices of options with adjacent strike prices. For example, on September 17, 2021, the S&P 500 closed at 4432.99. At the same time, one could purchase a December 2023 S&P 500 Put with a strike price of 2250 for \$68.90, and sell a same-dated put option with a strike price of 2200 for \$64.70.

This options position, known as a bearish vertical spread, would have a net cost of \$4.20. The position will ultimately be worth \$0 on expiry if the S&P 500 is worth more than 2250 in December 2023, \$50 if it is worth less than 2200, and an intermediate amount if the S&P 500 falls between 2200 and 2250. The options position therefore approximates a binary option that pays \$50 if the S&P 500 is worth less than about 2225 in December 2023, and the \$4.20 cost implies an 8.4 percent probability of that event occurring.

This same exercise can be repeated for the full set of adjacent strike prices, yielding a market-implied cumulative distribution function for the value of the S&P 500 in December 2023 (Figure 1, see Appendix).¹ The probabilities of severe future market

declines will strike many as quite high. While market volatility is still above pre-pandemic levels, even during the more quiet market periods before the pandemic, option prices still implied a greater than 6% probability of a drop of 50% or more greater over the next 3 years (Table 1, see Appendix).

The S&P 500 has not fallen 50% in any 36-month period since the early 1930s, although it did come close in 1999-2002 and 2006-9. Nevertheless, even a 6% or greater probability of such a decline seems at odds with the historical experience.

It would make sense that an options position paying off in a low-wealth state of the world would be expensive relative to its expected value, and indeed this is a feature of standard models such as the Capital Asset Pricing Model (Jackwerth, 2004). The options position provides insurance against declines in portfolio values that would otherwise require reductions in consumption from already reduced levels. For this reason, endowments purchase “portfolio insurance” that is essentially a position in equity index options that pays off in the low-wealth state of the world. This insurance is expensive to provide, particularly for regulated financial institutions, since it involves paying out when one is likely to be capital-constrained.

Nevertheless, I would argue that for policy makers, the fact that market-implied probabilities of economic events reflect the scarcity of resources in those states of the world is a feature, not a bug. If private investors are willing to pay a premium to shift resources into a certain state of the world, that is arguably a sign that the government should be more interested in actions that reduce the probability of that event, or mitigate its effects.

Hurricanes can be dealt with by transferring resources from unaffected areas. Global economic hurricanes cannot be. Our past strategy, of dealing with these events by transferring resources from the future, may not always be as feasible, as smaller countries have discovered in their financial crises.

Unfortunately, the strategy of assessing the probability of future economic events using long-dated option prices is limited to those events that are well-proxied by assets with such options. Options for U.S. equities and equity indices are available only for expiry dates 2-3 years into the future. Options on futures are currently offered for December 2025 expiry for commodities such as crude oil, gold, European carbon emission permits, and equity indices. But trading in these options is extremely infrequent, and the only pricing data available are typically the daily settlement prices set by the exchange, which are used to set maintenance margin requirements when (or if) anyone trades the instruments.²

Over the counter markets also exist for swaps on interest rates, currencies, and inflation. Options on these swaps are called swaptions, caps, and floors. The derivatives on inflation (Kitsul and Wright, 2012) have received particular attention over the last two years. Figure 2 plots the probability of moderately low and high inflation over the next 5 years implied by this market (see Appendix). The chart was generated by a dashboard created by economists at the Minneapolis Fed; similar charts can be created for probabilities implied by options for some of the underlying assets discussed above.

What data points should a world leader see every day to better understand the future of the global economy?

The indicators of probability that can be constructed from options traded on exchanges or off exchanges address a small subset of the economic uncertainties interesting to policy makers, and essentially none of the geopolitical or natural ones. Prediction markets can potentially play a role in augmenting these. Prediction markets can either be the public markets discussed in Wolfers and Zitzewitz (2004), or markets that are run among a closed community of experts, such as the Policy Analysis Market (Hanson, 2007) or the market component of the Good Judgment Project (Atanasov, et. al., 2017). I will focus my attention on public prediction markets.

Public prediction markets have evolved significantly since the Commodity and Futures Trading Commission's (CFTC) action led to the closure of Intrade in late 2012. The CFTC has allowed the North American Derivatives Exchange (Nadex), Predictit, and Kalshi to operate exchanges allowing trading in binary options in the United States under no-action relief. Betfair offers a betting exchange to non-U.S. customers, and several prediction markets operate in a decentralized manner using cryptocurrency.

Table 2 (see Appendix) summarizes currently extant public prediction markets. The Iowa Electronic Market pioneered modern prediction markets (e.g., Berg, et. al., 2008), but recently it has run markets only on the highest-profile U.S. elections, and it attracts very little volume. Betfair primarily runs markets on sports, and its non-sports markets tend

to be those that are popular with European sports bettors. Its markets on elections in the U.K., U.S., and other major countries attract significant volume. It also attracted meaningful volume to its markets on the Brexit vote and subsequent policy making process.

Nadex runs options markets on underlying assets that are also tracked by very liquid futures markets. Most of its volume is in binary options with intraday expiry (e.g., will the S&P 500 be above 4300 at 9:35 AM). While these markets are not redundant with those run by larger exchanges, they provide limited additional information to policymakers interested in long-term economic risks. Nadex launched markets on U.S. economic indicators (non-farm payrolls, weekly jobless claims, GDP, and unemployment) in 2020, but these markets have attracted little volume so far.

Predictit primarily runs markets on elections. It has also run markets on politically linked news events. Until early 2020, it interpreted this later category to include economic numbers, monthly and annual global temperature averages, and even very active markets on the number of messages President Trump and other prominent politicians posted on Twitter. In December 2019, Presidential candidate Andrew Yang's campaign received a death threat from a group of bettors instructing him not to tweet for the rest of the week.³ Perhaps as a result of this episode, Predictit eliminated its markets on tweets and also reduced its offerings of markets on events less tightly connected to politics.

Predictit is formally an academic experimental market, operating under an updating of the CFTC no-action letter provided to the Iowa Electronic Markets

in 1988. It is allowed to offer markets on elections, but must limit the number of investors in each contract to 5000 and the amount of downside risk of each investor in each contract to \$850. In other work, I have found evidence of large short-aversion and favorite-longshot biases on Predictit consistent with the predicted effects of these restrictions (e.g., by Manski (2006)).

At the same time, Predictit has been very successful in attracting liquidity in its markets, including on relatively esoteric topics (e.g., the margin of victory in primary elections for individual House seats). Somewhat amazingly, Predictit's volume on events ranging from Presidential elections to mayoral races compares favorably with the volumes achieved by Intrade, despite Intrade's lack of position limits. Predictit allows easy deposits using credit cards, makes it easy to announce a trade via social media, combines a market discussion board with its trading screen, and has advertised on political websites such as the *Huffington Post* and *Breitbart*. Markets require traders who are overconfident or willing to trade for liquidity or entertainment reasons to escape the No Trade Theorem (Milgrom and Stokey, 1982), and of these innovations may explain its success in attracting liquidity (at the cost, perhaps, of larger biases in its pricing).

Kalshi, which began operations in July 2021, is not allowed to run markets on elections, but does not have to limit investor stakes and appears to have more freedom in the topics it can choose for its markets. It is running markets on COVID case counts, local COVID policy (e.g., restaurant and school closures), economic numbers, and climate and severe weather events. Its volumes are still very low

compared with Predictit.

Cryptocurrency-based markets like Polymarket are not at all constrained in their topics. The mechanics of transferring currency to and from the marketplace may be a deterrent though for many casual market participants, who as argued above are crucial to the success of a prediction market.

In short, policy towards prediction markets has advanced since 2012, and some markets that speak to economic, political, and natural risks have attracted at least modest liquidity. At the same time, U.S. policy still prevents the public prediction market most likely to yield useful information about these risks to policy makers. Such a prediction market would be allowed to run markets in popular topics (sports, elections) that attract liquidity to more policy-relevant topics. It would be allowed to embrace the liquidity attracting innovations of Predictit, without the limits on positions or participation (and ideally with the lower fees that larger scale would allow). It would be open to investors from any country. Such a prediction market could eventually provide market-based probabilities to populate a dashboard of risks, helping policy makers make appropriate decisions about resource allocation and risk mitigation.

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Appendix

Figure 1. Cumulative distribution function for Dec 2023 value of S&P 500 implied by CBOE options. Based on closing bid-ask midpoints on September 17, 2021

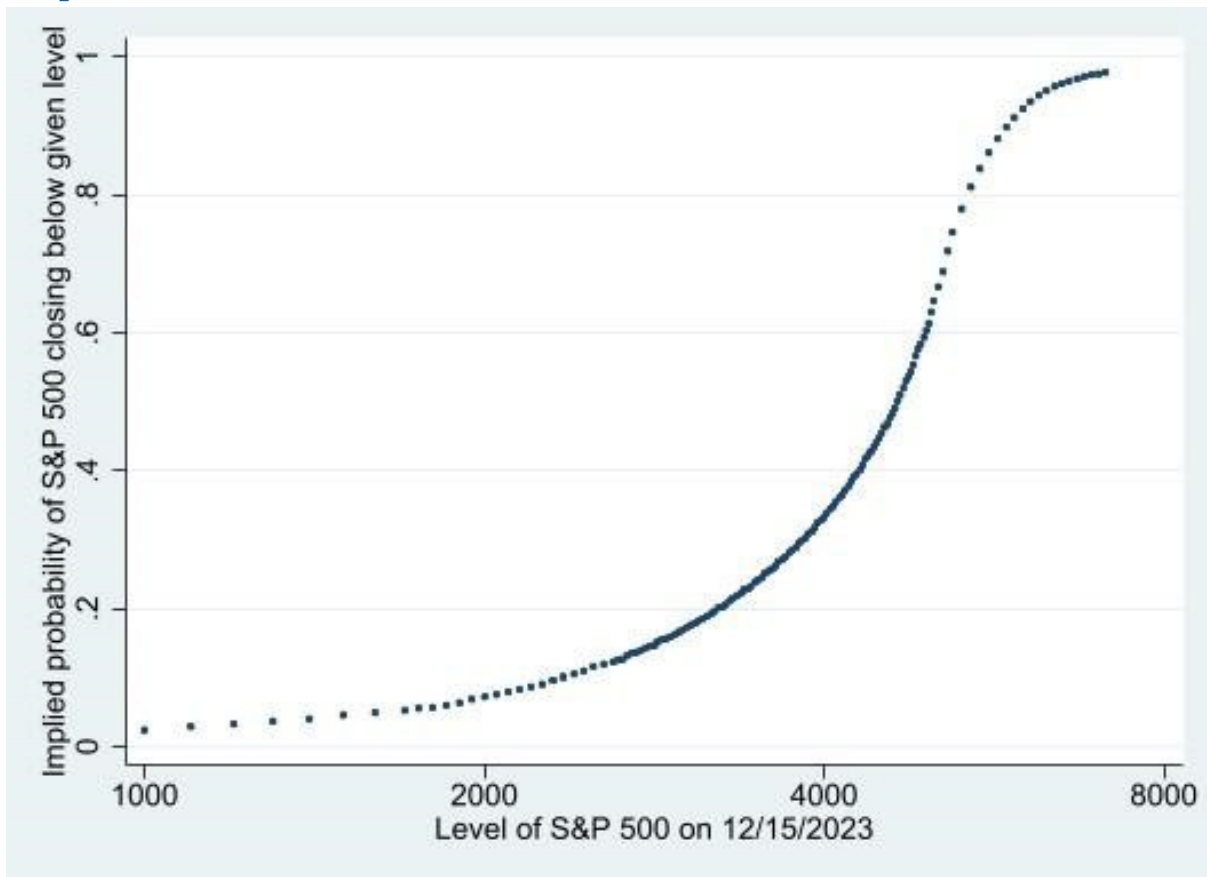


Table 1. Market-implied probability of large future declines in the S&P 500 on selected dates

Date	S&P 500 close	S&P 500 30-day option-implied volatility index (VIX) close	Longest-dated option expiry	Implied probability of >50% future drop by that date
12/30/2005	1248.29	12.07	12/20/2008	4.3%
12/29/2006	1418.30	11.56	12/19/2009	3.6%
12/31/2007	1468.36	22.50	12/18/2010	10.3%
12/31/2008	903.25	40.00	11/17/2011	22.6%
12/31/2009	1115.10	21.68	12/22/2012	13.7%
12/31/2010	1257.64	17.75	12/21/2013	12.6%
12/30/2011	1257.60	23.40	12/20/2014	17.1%
12/31/2012	1426.19	18.02	12/19/2015	13.5%
12/31/2013	1848.36	13.72	12/16/2016	8.2%

Date	S&P 500 close	S&P 500 30-day option-implied volatility index (VIX) close	Longest-dated option expiry	Implied probability of >50% future drop by that date
12/31/2014	2058.90	19.20	12/15/2017	9.6%
12/31/2015	2043.94	18.21	12/21/2018	9.2%
12/30/2016	2238.83	14.04	12/20/2019	8.7%
12/29/2017	2673.61	11.04	12/18/2020	6.0%
12/31/2018	2506.85	25.42	12/17/2021	6.8%
12/31/2019	3230.78	13.76	12/16/2022	6.4%
3/23/2020	2337.4	61.59	12/16/2022	16.8%
12/31/2020	3756.07	22.75	12/15/2023	12.2%
9/17/2021	4432.99	20.81	12/15/2023	8.4%

Note: Implied probabilities are approximated as the difference in the closing bid-ask midpoints for the put options with strike prices that surround 50% of the closing level of the S&P 500 on the date in question, divided by the difference in the strike prices. Especially early in the sample, bid-ask spreads are wide and the intervals between the strike prices can be quite wide. Data is from Option Metrics and is for CBOE S&P 500 options (ticker: SPX).

Figure 2. Probability of high or low inflation over the next 5 years implied by inflation derivatives. Source: Created by the author using <https://www.minneapolisfed.org/banking/current-and-historical-market--based-probabilities>

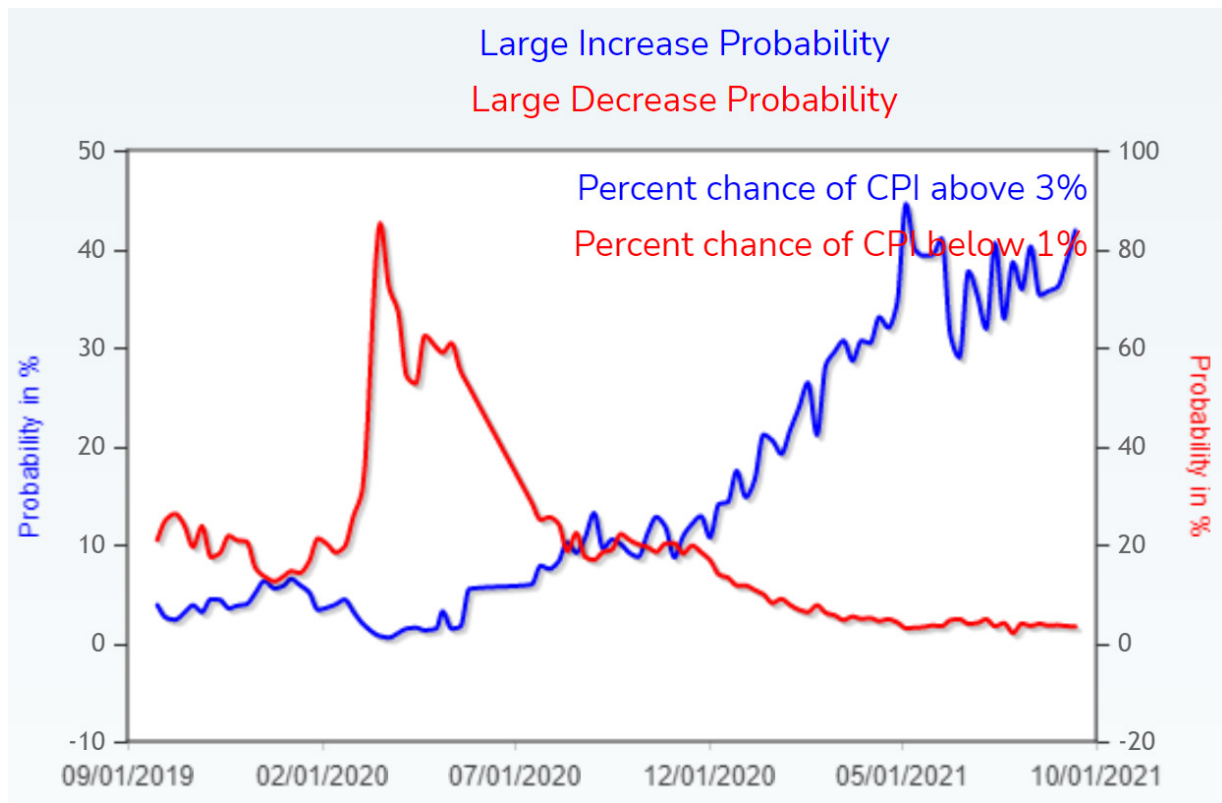


Table 2. Selected public prediction markets extant in September 2021

Market	Founding year	Type of exchange	Primary subject covered	Markets on economic, political, or natural risks?
Iowa Electronic Markets	1988	CFTC-regulated, limited stakes	US elections	US elections
Betfair	2000	Offshore	Sports; some elections and popular culture	Elections, EU membership
Nadex	2004	CFTC-regulated	Short-term options on equity indexes, currency, commodities	Asset prices, economic numbers
Predictit	2014	CFTC-regulated, limited stakes	Elections; politically relevant news	Elections, global temperature, economic numbers
Polymarket	2020	Cryptocurrency-based	Sports, elections, cryptocurrency news, popular culture	COVID case counts, global temperature, economic numbers
Kalshi	2021	CFTC-regulated	News events	COVID case counts/policy, global temperature, economic numbers

Endnotes

1. This cumulative distribution function can also be differentiated to yield a probability density function, typically referred to as a State Price Density (Breedon and Litzenberger, 1978).
2. For example, the Chicago Mercantile Exchange (CME) sets settlement prices for long-date options using dealer quotes when trades are not available. When quotes are not available for some strike prices, settlement prices are estimated by extrapolating the observed relationship between implied volatility and strike price. See https://www.cmegroup.com/market-data/files/CME_Group_Settlement_Procedures.pdf.
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