

# Partisan Polarization and Political Risk

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## Abstract

This study uses market expectations of electorally-induced financial turbulence to investigate the effect of partisan polarization on political risk in the United States. I argue that, to the extent that asset prices are responsive to policy shifts, hedging against an unfavorable election outcome should be more valuable when candidates are expected to adopt very different policies. The findings reveal that, as U.S. national elections became more polarized, investors grew more anxious about large post-electoral price changes, rather than mere exposure to electoral uncertainty. The greater sensitivity of asset prices to electoral outcomes led to an increase in how much investors had to pay to insure themselves against election risk. The intensification of polarization in the Trump era created a significant wedge between market sentiment and electoral forecasts. These findings suggest that partisan polarization can not only affect democratic norms, but can also undermine financial markets' ability to price political risk.

Keywords: Political Risk, Elections, Polarization

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# Introduction

On the day of the 2020 U.S. presidential election, the Chicago Board Options Exchange (CBOE) Volatility Index – known as Wall Street’s “fear gauge” – stood at 35.55, indicating that anxiety loomed large in the minds of investors. By the end of the week, however, it sank 30%, to 24.86. This drop in the index suggests that, despite president Trump’s refusal to commit to a peaceful transfer of power, investors became less worried about politically-induced market turbulence after the election day had passed. It also reveals that the market had more than priced in political risk. The index uses as inputs the prices of financial derivatives, called options, that can be used to hedge or speculate on future price changes. The buyer of an option pays the seller a certain sum, called the *premium*, for the right to buy or sell a security at a predetermined value, called the *exercise* price, by a certain date. If the difference between the underling security’s price and the exercise price exceeds the premium, an option holder will turn a profit. Otherwise, the option will expire worthless, but the loss to its owner will be limited to the premium paid. The combination of high pre-election premiums and lower-than-expected post-electoral volatility – reflected in the index reversal– rendered selling, rather than buying, options a profitable trading strategy on the days surrounding the election.

Market valuations, however, do not always respond to electoral outcomes. For instance, option prices barely moved in the previous U. S. presidential election pitting an incumbent against a challenger, held in 2012 between Barack Obama and Mitt Romney.<sup>1</sup> This example of an alternative outcome, associated with a less acrimonious, but otherwise similar, electoral contest illustrates the main issue that motivates the analysis in this study – how partisan polarization affects political risk.

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<sup>1</sup>The CBOE Volatility Index stood at 18.42 on the day before the election, dropped to 17.58 on election day, rose to 19.08 the day after the election, and closed the week at 18.61.

An extensive literature has examined the impact of rising partisan polarization in the United States on the quality governance and policy outcomes, including uncompromising obstructionism, political gridlock, and heightened policy uncertainty (cf. Baker et al. 2014; Abrajano and Hajnal 2015; Lee 2015; Canen, Kendall, and Trebbi 2020). Evidence of the consequences of polarization for economic outcomes (such as investment, output, and employment) in the United States also exists (Canes-Wrone and Park 2012; Baker, Bloom and Davis 2016; Azzimonti 2018). In addition, studies in political science have investigated how electoral outcomes affect equity market valuations (Herron 2000; Leblang and Mukherjee 2004; Füss and Bechtel 2008; Sattler 2013).<sup>2</sup> Most of the existing research, however, examines the effect of electoral outcomes on realized, or *post-electoral*, changes in asset prices.

In this study, I depart from this work by focusing on investors' *ex ante* beliefs that an election outcome will foster increased variability in asset prices. Specifically, I use option prices on dates leading up to and passing through a national election. This strategy is an improvement on previous research for two reasons. First, options are intrinsically forward-looking contracts. As such, they account for the market's forecast of likely movements in asset prices before and after elections. Second, to the extent that asset prices are responsive to policy shifts, investors should be willing to pay higher premiums to hedge against an unfavorable election outcome (Kelly, Pástor, and Veronesi 2016).

I argue that investors' decision to use options as a hedge against post-electoral price changes depends on their prospective losses associated with betting on the wrong outcome. If the leading candidates are expected to adopt very similar policies, then the reversal costs from making an investment before the election would be inconsequential. In contrast, high polarization would increase the extent to which irreversible investments will be affected by the election outcome.

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<sup>2</sup>See Ferrara and Sattler (2018) for a recent survey of the political science research on the effect of politics on financial markets. See also Wisniewski (2016) for a survey of the literature on election risk in the fields of finance/economics.

To empirically investigate how partisan polarization in the United States affects political risk, I examine all national elections (presidential as well as mid-term ones) between 1986 and 2020. Following Dubinsky et al. (2019), I derive an analytical estimator of *electoral risk* using changes in market expectations of asset price movements around elections. Based on various indexes developed by the CBOE, the evidence shows that the sensitivity of asset prices to election outcomes is considerable, statistically significant, and varies substantially over time. More importantly, the results reveal that electoral price risk nearly doubled during the period between 2012 and 2020, relative to the 1986-2010 era. These findings suggest that hedging against election risk became more expensive over time. They also raise the question of whether the electoral outcomes of the past ten years warranted higher option prices.

A comparison between the electoral risk estimates (based on option prices) and the actual post-electoral volatility of stock market returns, indicates that exposure to post-electoral price movements did not fetch a significant premium between 1986 and 2010. After 2010, however, the actual post-electoral price change amounts to 3.3% on average, while the average post-electoral price jump estimated from option prices is 5.34%. This difference implies that traders could profit from selling options around elections during this latter period. To examine this issue in more depth, I consider the returns to different volatility trading strategies. The analysis reveals that selling *electoral insurance*, in the form of variance swaps, has been extremely lucrative in the past 10 years. I further probe into the expensiveness of options around elections, by looking at the profitability of positions designed to benefit from low, rather than large, post-electoral volatility. The analysis reveals that, as partisan polarization increased, sellers of option had an opportunity to profit from investors' fears of large post-electoral price changes, rather than mere exposure to electoral uncertainty.

Finally, I consider whether option prices were consistent with electoral forecasts during the 2016 and 2020 presidential elections. My findings indicate that, in the month leading to the 2016 election, option prices overestimated the probability of a Trump victory by

an average of approximately 11 percentage points (28.7% compared to the 17.8% winning chance predicted by the polls). In the 2020 election, the evidence suggests that, during the last month of the campaign, option prices indicated a 48% chance of Trump refusing to vacate the Oval Office should he lose the election, compared to 44% according to prediction markets. In this case, market sentiment pushed options prices well above their expected level based on election forecasts.

Overall, my results contribute to an emerging literature that cuts across the fields of political science and finance (Ferrara and Sattler 2018). They reveal that electoral risk premiums are larger when the leading candidates are expected to adopt very different policies. They also indicate that while market participants loath electoral uncertainty, it is downward post-electoral jumps in stock prices what they fear the most. In addition, my analysis provides direct evidence connecting partisan polarization to political risk premiums. I find that the greater sensitivity of asset prices to electoral outcomes has lead to a significant increase in how much investors have to pay to insure themselves against electoral risk.

The remainder of the paper is organized as follows. In Section 1, I discuss the relationship between partisan polarization and post-electoral changes in asset prices. Next, I investigate how electoral risk is priced in the options market. In Section 3, I analyze electoral risk premiums in the United States during the period between 1986 and 2020. I further examine electoral risk pricing during the Trump era in Section 4. A final section concludes.

## 1 Partisan Polarization and Asset Prices

Investors concerned about non-commercial risks need to consider their exposure to political events that may affect the value of their assets. These political risks can originate in specific government actions, such as laws or regulations. They can also arise from policy shifts. Recent research has examined how market valuations respond to electoral uncertainty. For

example, Pastor and Veronesi (2013) develop a model in which stock prices respond to political signals. In its original version, the government decides which policy to adopt and investors are uncertain about the future policy choice. Kelly, Pástor, and Veronesi (2016) interpret the model as one of democratic elections: investors are uncertain about who will be elected. Either way, the model implies that hedging against an unfavorable election outcome should be more valuable when the leading candidates are expected to adopt very different policies (Pastor and Veronesi 2013: p. 534-535).<sup>3</sup>

Carnahan and Saiegh (2021) also examine the effect of electoral outcomes on asset prices. They model traders' decisions as a sequential sampling problem, where the optimal stopping strategy is driven by information-gathering costs and an investment's suitability to the future state of the world. Their findings indicate that risk-neutral traders' optimal investment strategies depend on: (1) their ability to make an accurate electoral forecast; and (2) the prospective losses associated with placing a bet on the wrong candidate. Financial markets are forward-looking; meaning that asset prices reflect current expectations of future value. Therefore, if electoral outcomes are fully predictable, the identity of the winning candidate should already be priced ahead of the electoral contest. In contrast, when the leading candidate has a considerable electoral advantage over his/her competitors, the outcome of the election will hardly be a surprise to investors. With regard to the degree to which investors' decisions may be affected by the electoral results, if the leading candidates are expected to adopt similar policies, then the reversal costs would be inconsequential. In contrast, sufficiently high polarization would increase the extent to which irreversible investments will be affected by the electoral outcomes.

While some traders may postpone their investment decisions until the electoral uncertainty is resolved, others may use options to hedge their bets. The issue then boils down to

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<sup>3</sup>The effect is stronger in weaker economic conditions, and it is nonexistent only when the economic conditions are so strong that there is no uncertainty about the election outcome (in that the incumbent is expect to win for sure).

how these instruments should be priced when electoral outcomes are predictable or unpredictable ex-ante, as well as the investment's electoral sensitivity. An important implication of distinguishing between an unforeseen electoral outcome and the potential losses associated with placing a bet on the wrong candidate is that one should examine risk premiums for two types of shocks: to uncertainty, and to realized volatility (jumps).<sup>4</sup>

Regarding the first risk factor, electoral uncertainty, investors typically count on public opinion polls to gauge each candidate's chance of winning. Their reliability came into question following Donald Trump's victory over Hillary Clinton in the 2016 U.S. presidential election. Nonetheless, as Gelman and Azari (2017) note, most national polls predicted the two-party vote with a reasonable level of accuracy. In their view, it was the closeness of the election – prompted by partisan polarization – what hindered analysts' ability to accurately predict the identity of the winning candidate.

Partisan polarization has a much more direct impact on the second risk factor, large price changes. Consider the canonical *Downsian* model of political competition. Because the winner is randomly decided, electoral outcomes are extremely unpredictable. Nonetheless, both candidates should *converge* to the position of the median voter. Even if an investor's forecast about the identity of the winning candidate is incorrect, the electoral results would have no bearing on her investment's reversal costs. So, the election would be unpredictable, but inconsequential for asset prices. Consider now what would happen if the candidates do not converge to same policy position. Because the loss caused by making a wrong decision can be potentially high, market participants may be willing to pay a premium to insure themselves against election risk.

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<sup>4</sup>The former represents an increase in the dispersion of investors' conditional distribution for future outcomes; while the second shock is to the realization of large outcomes, i.e., squared returns (Dew-Becker, Giglio and Kelly 2021). Formally, given some shock  $\varepsilon$ , with  $\text{var}_t(\varepsilon_{t+1}) = \sigma_t^2$ , uncertainty is  $\sigma_t^2$ , while volatility is  $\varepsilon_t^2$  (Dew-Becker, Giglio and Kelly 2021).

## 1.1 Partisan Polarization in the U.S.

In 1968, George Wallace called Republican and Democrats “Tweedle-dum and Tweedle-dee” and declared that there wasn’t “a dime’s worth of difference” between that year’s presidential candidates. This view has become a relic from a distant past. The rise in elite polarization in the United States has been well-documented (McCarty 2019). In the electorate at large, public opinion surveys suggest that Republicans and Democrats are currently more divided along ideological lines than at any point in the last two decades.<sup>5</sup>

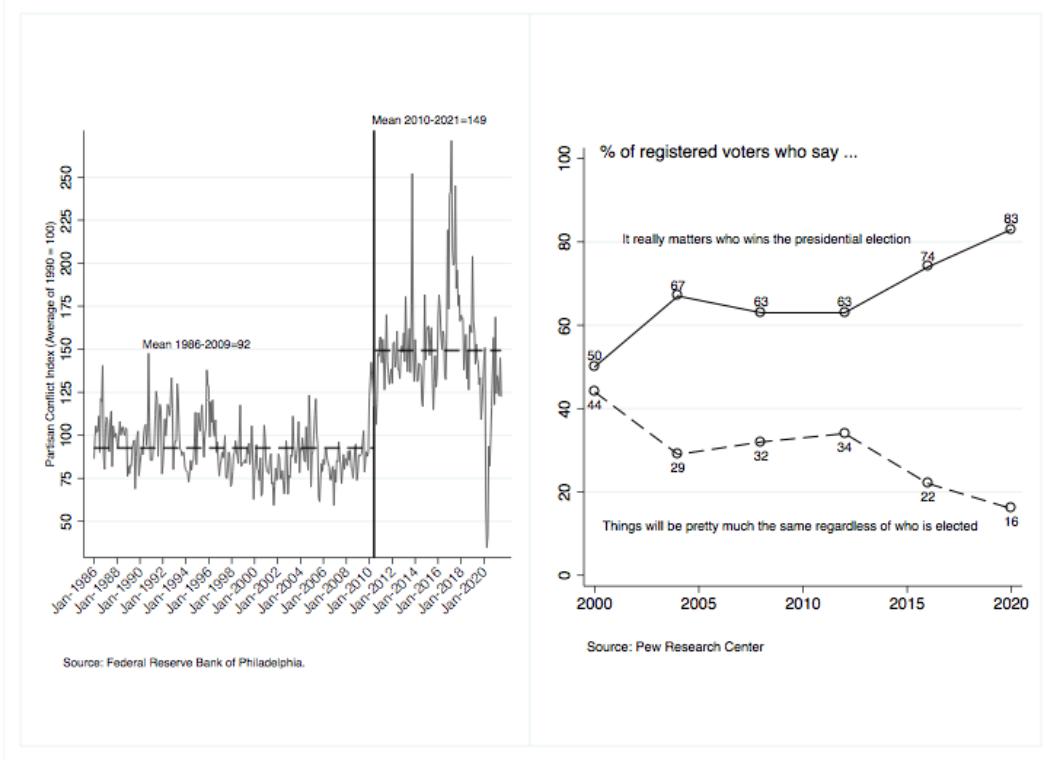
The left panel in Figure 1 shows the *Federal Reserve Bank of Philadelphia*’s Partisan Conflict Index (PCI) between 1986 and 2021. The measure tracks the degree of partisan conflict among U.S. politicians at the federal level by measuring the frequency of newspaper articles reporting disagreement in a given month. Higher index values indicate greater conflict among political parties, Congress, and the President.<sup>6</sup> A Perron-Vogelsang test indicates that the series is stationary with a structural break on June of 2010 ( $t = 3.812$  compared with a 5% critical value of 3.560). The solid vertical line in the graph indicates the break date. The estimated increase in the average value of the index after the break amounts to 56.6 (with a standard error of 2.38), a statistically as well as substantively significant change.

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<sup>5</sup><https://www.pewresearch.org/politics/2017/10/05/the-partisan-divide-on-political-values-grows-even-wider/>

<sup>6</sup><https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/partisan-conflict-index>. To calculate each month’s index value, keyword searches are conducted on major U.S. newspapers, including The Washington Post, The New York Times, Los Angeles Times, Chicago Tribune, and The Wall Street Journal. See Azzimonti (2018) for more details.

Figure 1: Partisan Polarization in the United States



A corollary of partisan conflict is that candidates will hardly *converge* to the position of the median voter, making polarized elections both unpredictable as well as consequential for asset prices. The right panel in Figure 1 shows the percentage of registered voters in the United States who stated that “when it comes to making progress on important issues facing the country, it really matters who wins the presidential election.” The data come from survey responses collected by the Pew Research Center between 2000 and 2020.<sup>7</sup> The evidence shows that voters see more importance in the outcome of the election today than they did in the past. In 2000, about one-half (50%) said the outcome of the election really mattered, while a significantly larger share of respondents said it really mattered who won in 2016 (74%) and 2020 (83%). Unless the identity of the winning candidate can be accurately predicted, the greater the likelihood that the candidates will adopt significantly different

<sup>7</sup><https://www.pewresearch.org/fact-tank/2020/10/07/voters-anxiously-approach-an-unusual-election-and-its-potentially-uncertain-aftermath/>

policies, the higher the price that investors will have to pay to hedge against an undesirable electoral outcome. Therefore, the patterns uncovered in Figure 1 imply that hedging against election risk in the United States should have become more expensive over time.

## 2 Election Risk Pricing

Options are forward-looking contracts. As such, their prices should provide an “early warning” of how the value of their underlying assets will react to impending elections whose actual outcome is not yet known. Market efficiency often precludes investors from predicting the direction of assets’ price changes associated with a given election outcome. Investors, however, usually anticipate that increased price variability will ensue from the revelation of the winning candidate’s identity (Białkowski, Gottschalk, Piotr 2008; Boutchkova et al. 2012).

The market’s forecast of a likely movement in a security’s price, usually known as *implied volatility*, can be derived from option prices. Consider an extension of the Black-Scholes model with a single price jump occurring immediately after a scheduled news announcement (Leung and Santoli 2014). As Dubinsky et. al (2019) note, this extension has two important implications: (1) implied volatilities should increase continuously prior to release of new information; (2) implied volatility should discontinuously fall after the information is released (see Supplementary Online Appendix A, equations A1 and A2 for more details). The behavior of implied volatility around prescheduled news releases seem to conform to these expectations, including investors’ reactions to (i) earning announcements (Patell and Wolfson 1979 & 1981; Ederington and Lee 1996; Dubinsky et al. 2019); (ii) Federal Open Market Committee (FOMC) meetings (Chen and Clements 2007; Vähämaa and Äijö 2011; Gospodinov and Jamali 2012); as well as (iii) monthly employment report, CPI report, and PPI report dispatches (Nikkinen and Sahlström 2004).<sup>8</sup>

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<sup>8</sup>For example, Patell and Wolfson (1979) show that implied volatilities rise to a maximum level immedi-

National elections have a predictable schedule, and may have a potentially sizable impact on asset prices. In this case, an important source of uncertainty is the identity of the winning candidate, which is only revealed with certainty after the election concludes. As such, the impact of elections on option-implied volatility has also received scholarly attention. For instance, Gemmill (1992) documents that the implied volatility of the FTSE 100 index increased substantially before the 1987 British parliamentary election.<sup>9</sup> Goodell and Vähämaa (2012) and Mnasri and Essaddam (2021) examine US presidential elections between 1992 and 2008, and find that the implied volatility of the S&P 500 increases before elections when the voters become more, rather than less, certain about the identity of the eventual winner. Using cross-national for the period 1990-2012, Kelly, Pastor and Veronesi (2016) show that one-month at-the-money (ATM) options whose lives span national elections tend to be more expensive than neighboring ones. They also find that the value of option protection is higher in a weaker economy and when the election outcome is more uncertain. Carvalho and Guimaraes (2018) study the effect of the 2014 Brazilian presidential election on options prices of state-controlled companies (Petrobras, Banco do Brasil and Eletrobras). Their results highlight the vulnerability of state-controlled companies to political risk.

My contribution, relative to existing work, is to investigate how the electoral risk associated with partisan polarization is priced in the option market. I examine all national elections in the United States (presidential as well as mid-term ones) between 1986 and 2020. I am thus able to test if hedging against election risk in the U.S. has become more expensive in the last decade vis-a-vis the previous period. Furthermore, I use data on option contracts with different strike prices (including both at-the-money (ATM) and out-of-the-money

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ately preceding the release of the news, and drop to their “normal” levels after the news is assimilated into the securities price. The magnitude of this earnings-induced increase in implied volatility depends on (1) the uncertainty of earnings information and (2) the magnitude of the market’s response to the earnings information. In their view, the release of prescheduled news resolves uncertainty in the market, and since implied volatility is the expected future volatility, such an announcement reduces the degree of future uncertainty (Patell and Wolfson 1979 & 1981).

<sup>9</sup>Gwilym and Buckle (1994) update Gemmill’s analysis for the 1992 British parliamentary election.

(OTM) options), with varying expiration dates (ranging from three months to three days). Therefore, in my empirical analyses, I am able to: (1) assess the sensitivity of security prices to electoral uncertainty as well as to post-electoral downside risk; and (2) test for changes in the variances of stock returns around elections using an event window that is sufficiently narrow to minimize the presence of other contaminating information.

## 2.1 Electoral Risk in the U.S. (1986-2020)

The discussion presented above suggests that there should be a detectable pattern in the changes of implied volatility before and after elections. To illustrate this point, Figure 2 shows the expected volatility of the S&P 500 index in a window of seven trading days centered on the 2020 United States presidential election (October 29th-November 6th).<sup>10</sup> The ordinate shows the implied volatility of S&P options calculated using at- and out-of-the-money puts and calls with more than 2 days and less than 9 days to expiration.<sup>11</sup> The implied volatility increased rapidly from 45.2% to over 56% as time approached the election. However, once the identity of the winning candidate was revealed – and its effects were assimilated into stock prices–, the volatility dropped significantly to 37.8% (and subsequently to 23.7%).

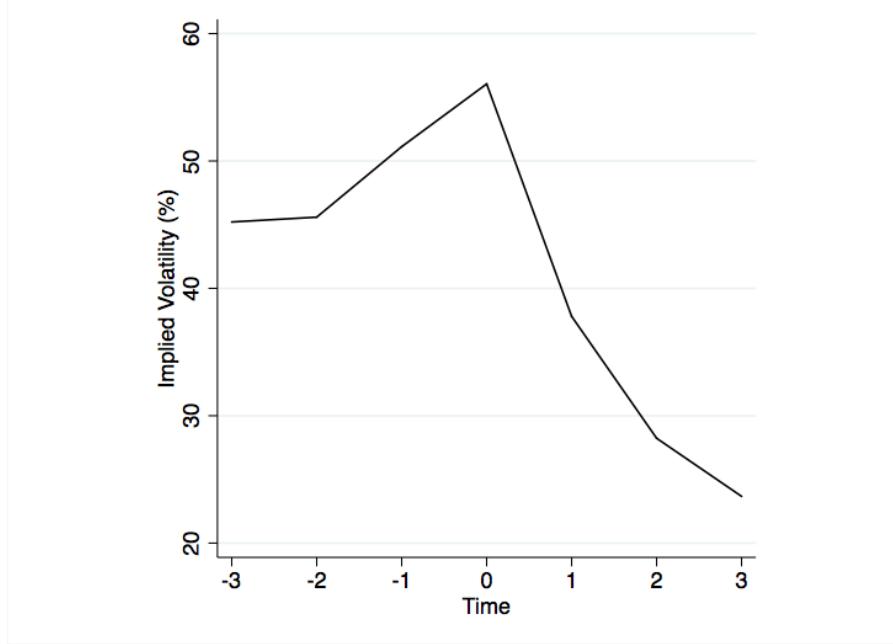
The pattern uncovered in Figure 2 suggests that the anticipated stock price reaction (in terms of variability) to election outcomes can be detected in pre-electoral option prices. It also implies that, as discussed in Dubinsky et al. (2019), it is possible to derive an analytical estimator of the *electoral* price risk based on implied volatility dynamics around elections.

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<sup>10</sup>The days are identified in the horizontal axis as 3,-2,-1, 0, 1, 2,3, with day zero denoting the trading day immediately before the identity of the winning candidate is revealed (i.e. November 3rd, election day).

<sup>11</sup>The data corresponds to the near term SPX option series used by the Chicago Board Options Exchange (CBOE) to calculate their 9-Day Volatility Index (VIX9D). These include PM-settled weekly SPX options expiring on Friday November 6th, 2020 and on Friday November 13th, 2020. See <https://www.cboe.com/us/indices/dashboard/VSTN/>

Figure 2: Option-Implied S&P Volatility



Let  $\sigma_{IV,t_1}$  and  $\sigma_{IV,t_2}$  represent the implied volatilities of two options at times  $t_1$  and  $t_2$ , with identical maturity at time  $T$ . Assuming that the identity of the winning candidate is revealed after the close on date  $t_1$  (or before the open on the next trading date,  $t_2$ ), then the annualized implied variance should be  $\sigma^2 + \frac{(\sigma_e^Q)^2}{T-t}$  just before the election, and  $\sigma^2$  after the election. Applying equation (A2) in Supplementary Online Appendix A, and solving for  $\sigma_e^Q$ , one can obtain the following estimator of electoral risk based on the post-electoral decrease in implied volatility:

$$\sigma_e^Q = \sqrt{(T-t)(\sigma_{IV,t_1}^2 - \sigma_{IV,t_2}^2)} . \quad (1)$$

Consider the changes in the expected volatility of the S&P 500 index around the 2020 U.S. presidential election illustrated in Figure 2. The implied volatility fell from 56% on Tuesday November 3rd to 37.8% in the following day. This drop in implied volatility implies a post-electoral price change of  $\sigma_e^Q = 5.62\%$ .

To examine the impact of national elections on asset prices in the United States, I rely on the estimator in Equation (1), and changes in implied volatility around elections using various indexes developed by the CBOE. For example, its VIX index provides a 30-day expectation of volatility given by a weighted portfolio of out-of-the-money European options on the S&P 500. While the VIX index is reported for a 30-day maturity, the formulas used to calculate its value are valid at any horizon. In addition, the CBOE uses the same methodology to compute volatility indexes on broad-based stock indexes, exchange traded funds, as well as individual stocks and commodities.<sup>12</sup> For each of these indexes, the sample is restricted by CBOE data availability. For instance, the S&P 500 9-Day Volatility Index (VIX9D) starts on January 4th, 2011. Nonetheless, the S&P 30-day index, the price history is available from January 2nd, 1986 to the present. Therefore, it is possible to examine electoral price risk for national elections in the United States between 1986 and 2020. It should also be noted that, from Equation (1),  $\sigma_{IV,t_1}^2 > \sigma_{IV,t_2}^2$  must hold. Otherwise, the estimator is not defined. Elections on which the hypothesis of a decreasing implied volatility after the identity of the winning candidate is violated are thus excluded from the analysis.

Table 1 provides electoral price risk estimates for different asset classes. Jensen's inequality implies that the average of the standard deviations is less than the square root of the average. Therefore to be conservative, and following Dubinsky et al. (2019), I average the estimators in volatility units. I report summary statistics over the sample period from 1986 to 2020, including the average (Mean), and the standard error (SE) of all observations without errors. The column Error counts the number of elections on which the hypothesis of a decreasing implied volatility after the identity of the winning candidate is announced is violated. The last column provides the number of elections under consideration (Obs.).

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<sup>12</sup>For the technical details on the calculation of the VIX index, please see the CBOE VIX white paper: <https://cdn.cboe.com/resources/vix/vixwhite.pdf>.

Table 1: Electoral Price Risk, 1986-2020

All Elections						
Asset	Maturity	Mean	S.E.	Error	Obs.	Period
S&P 500	30-day	2.99	0.41	6	12	1986-2020
S&P 500	30-day	2.37	0.31	5	8	1986-2010
S&P 500	30-day	4.25	0.81	1	4	2012-2020
S&P 500	9-day	4.37	0.82	1	4	2012-2020
Russell 2000	30-day	3.81	0.65	1	5	2010-2020
DJIA	30-day	3.72	0.59	1	5	2010-2020
NASDAQ-100	30-day	3.72	0.69	1	5	2010-2020
MSCI EAFE	30-day	3.13	0.63	3	4	2008-2020
MSCI EEM	30-day	4.59	0.53	2	3	2012-2020
Crude Oil ETF	30-day	3.79	0.84	1	5	2010-2020
Gold ETF	30-day	2.88	0.26	1	5	2010-2020
Presidential Elections Only						
S&P 500	30-day	3.64	0.56	3	6	1988-2020
S&P 500	30-day	2.81	0.27	2	4	1986-2010
S&P 500	30-day	5.31	0.42	1	2	2012-2020
S&P 500	9-day	5.57	0.11	1	2	2012-2020

The empirical evidence indicates that national elections in the United States have an effect on diversified portfolios, including those offering exposure to stocks in Emerging Markets (MSCI EEM), as well as specific asset classes (such as oil or gold). Using the Wilcoxon signed-rank test, the null that large post-electoral price moves are not priced in options can be rejected for most cases. The two exceptions (marked in grey) are given by the 30-day S&P 500 between 1986-2010, and the MSCI EAFE that provides exposure to companies in Europe, Australia, Asia, and the Far East.

The results also reveal that the sensitivity of asset prices to election risk is quite large. To place these estimates in context, consider the S&P 500 intra-day returns between 1986 and 2020 (excluding the day immediately after a national election). Their mean value was 0.04%, with a standard deviation of 1.16%. The estimated post-electoral price change is substantially higher, with a variance ratio larger than six, on average. A simple value at risk (VAR) calculation indicates that the probability that a hypothetical USD 100 investment in the S&P 500 would lose more than USD 3 in a single day during this period was roughly 1.2%. The evidence in Table 1 also reveals that electoral risk varied substantially over time, ranging from 2.37% between 1986 and 2010 to approximately 4.25% during the 2012-2020 period, respectively. In addition, the average electoral risk is higher for presidential, rather than congressional races. Finally, an examination of the cases where  $\sigma_{IV,t_1}^2 < \sigma_{IV,t_2}^2$  (the column *Error*), indicates that their frequency was much higher during the 1986-2010 period than in the 2012-2020 era. These last two findings suggest that most elections with negligible risks were concentrated in contests with relatively inconsequential outcomes.

### 3 Electoral Volatility and Risk Premiums

The evidence presented in the previous section indicates that election risk in the United States is routinely priced by the option market. The findings also reveal that, in the last decade, insuring against election risk has become more expensive. An important question is whether the electoral outcomes of the past ten years warrant the higher option prices. If options market participants correctly forecast the magnitude of the post-electoral price changes, then no significant difference between the expectation of future realized variance under the risk-neutral measure and the expectation under the physical measure should exist. Otherwise, a discrepancy between them would indicate that investors demand a premium for bearing the electoral risk of an option position (Bollerslev, Tauchen and Zhou 2009).

How much compensation did investors require in the form of electoral risk premium? A comparison between the option-implied electoral risk estimate ( $\sigma_e^Q$ ) and the realized post-electoral volatility of returns can shed some light on this question. Following Dubinsky et al. (2019), I compute the expected 1-day volatility derived from option prices by adding to the post-electoral jump volatility 1 day's diffusive volatility, and compare it to the realized volatility (measured as squared returns). In the case of the S&P 500, the average actual jump (3%) is indistinguishable from the average estimated post-electoral jump for the 1986-2010 period. After 2010, however, the average actual jump amounts to 3.3%, while the average estimated post-electoral jump is 5.34%, implying an average risk premium of roughly 204bps.

### 3.1 Variance Swap Returns

The post-2010 electoral risk premiums suggest that option traders had an opportunity to profit from investors' fears of large post-electoral price movements. To further examine this issue, I analyze S&P 500 variance swap returns between 2011 and 2020. A variance swap is an instrument which allows investors to trade future realized (or historical) volatility against current implied volatility (see Supplementary Online Appendix B for more details).

Selling a variance swap will be profitable if the market delivers less realized volatility than that implied by the option's exercise price. It can thus be likened to selling insurance, with a steady income punctuated with occasional large drawdowns. Conversely, the buyer of a variance swap will profit if the subsequent realized volatility is above the level set by the option's exercise price.<sup>13</sup> Therefore, buying a variance swap is like buying insurance: paying a relatively small premium for a potentially large payout if things go wrong, but expecting to forfeit some, or all, of the premium on most occasions. Given these insurance-like characteristics, long volatility positions on an underlying index (such as the S&P 500)

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<sup>13</sup>Variance swaps, however, are convex in volatility: a long position profits more from an increase in volatility than it loses from a corresponding decrease.

are usually biased to make a loss, while short volatility positions are, on average, profitable. This bias is referred to as the volatility risk premium.<sup>14</sup>

I am interested in the reward required by a risk averse investor for being exposed to the post-election jump risk. Most market participants think in terms of volatility. Therefore, the profit/loss of holding a variance swap is usually expressed in *vega notional*, which represents the average profit or loss for a 1% (1 vega) change in volatility.<sup>15</sup> Following Kelly, Pastor and Veronesi (2016), I compare the payoffs of variance swap contracts in a “treatment” group to those in two neighboring “control” groups. The first group contains contracts whose expiration includes the day when the outcome of a national election is revealed. The latter two consist of contracts initiated around elections, but whose expiration excludes that date. Denoting the trading day immediately following the identity of the winning candidate is revealed as  $t = 1$ , the treatment group includes the payoffs of contracts,  $p_{\tau,m}^{Treat}$  initiated at time  $\tau \in \{-m - t < \tau < t\}$ . The pre-treatment group includes the payoffs of contracts,  $p_{\tau,m}^{Pre}$  initiated at time  $\tau \in \{-2m - t < \tau < -m\}$ , and the post-treatment group is consists of the payoffs of contracts,  $p_{\tau,m}^{Post}$  initiated at time  $\tau \in \{t - 1 < \tau < m + 1\}$ . While the contracts in each of these groups have different expiration dates, all of them have the same time to maturity. Therefore, the average payoffs for each of these groups are fully comparable.

Extensive data on quoted prices for S&P 500 variance swaps across multiple national elections are difficult to obtain. But, the VIX index is equal to the square root of a variance swap on its underlying, the S&P 500. Therefore, variance swap strikes can be easily inferred from VIX levels. To minimize the presence of contaminating information, I restrict my attention to a small window around each electoral contest. Specifically, I use the CBOE

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<sup>14</sup>If an investor has a long position, it means that the investor has bought and owns the variance swap. If the investor has a short position, it means that the investor sold the variance swap to someone else.

<sup>15</sup>So, for instance, suppose a 9-day variance swap is stuck at 20 with a vega notional of USD 100. An investor holding a long position will be delivered the difference between the realised variance over the next seven trading days and the current strike price, multiplied by the variance notional. If the index only realises 15%, the payoff will be equal to  $100 \times \frac{15^2 - 20^2}{40} = -437.5$ , a loss of 4.375 vegas.

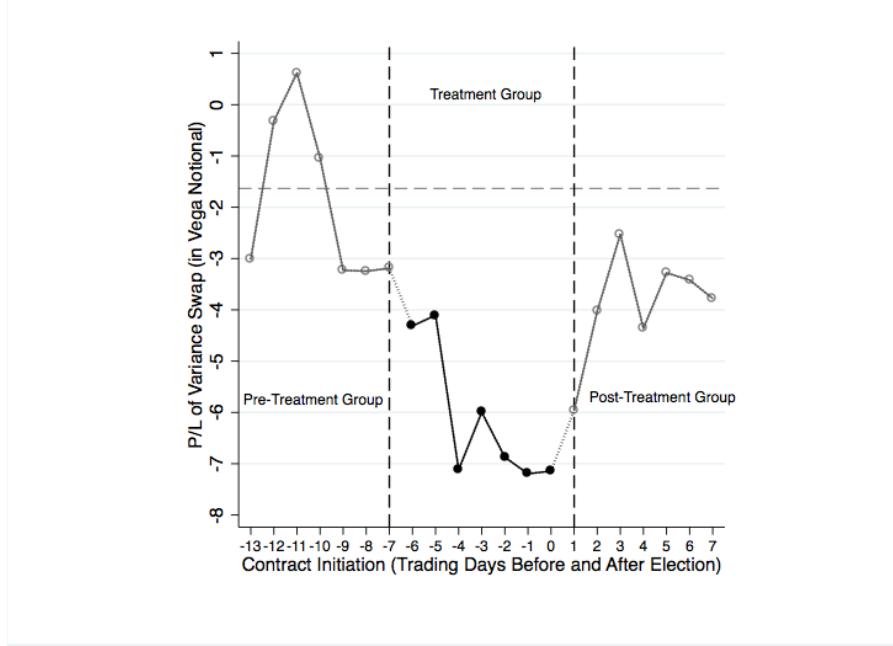
9-Day Volatility Index (VIX9D), which is based on the entire strip of options contracts, as a proxy for the prices of variance swaps on the S&P 500 that mature in seven trading days.<sup>16</sup> Because the VIX tends to trade slightly above variance swap prices, and to account for capped variance swaps (which usually trade below uncapped variance swaps), I estimate the variance swap strike prices at 175bps below the VIX9D. Using these estimated values of  $SP_{\tau,m}$ , the sum of squared daily log returns of the S&P 500, and equation (4), I calculate the payoffs  $p_{\tau,m}$  for the variance swaps contracts included in the “treatment” group as well as the two neighboring “control” groups.

Figure 3 shows the average profit/loss (p/l) of long variance swap contracts initiated around the five national elections that took place in the United States between 2011 and 2020. The vertical axis displays the the average p/l of the variance swap contracts, expressed in terms of vega notional. The contract initiation dates,  $\tau$ , are shown in the horizontal axis, with day one denoting the trading day immediately after a national election. Therefore, while the calculation of payoffs of contracts initiated at  $-8 < \tau < 1$  (treatment group) includes price changes in the S&P 500 on the day when the identity of the winning candidate is revealed, contracts initiated outside of that window (control groups) do not. The solid circles, connected by a black line, indicate the average p/l of contracts in the treatment group, whereas the p/l of the contracts in the control groups are represented by the hollow circles, connected by a grey line. For reference, the average p/l of long variance swaps of in the full sample (excluding the three-weeks window around national elections used to calculate the average payoffs in treatment/control groups), -1..63, is represented by the horizontal dashed grey line.

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<sup>16</sup>The CBOE uses calendar days rather than trading days in the VIX calculations, thus the discrepancy between 9 and 7 days.

Figure 3: P/L of Long Variance Swap Contracts around Elections, 2012-2020



The evidence reveals that the average loss of long variance swap contracts with an expiration date immediately preceding the resolution of electoral uncertainty (i.e. initiated at  $\tau = -6$ ) was -3.19, compared to -4.31 for a similar variance swap initiated the day after. Likewise, the average loss of long variance swaps initiated the day when the identity of the winning candidate was revealed (i.e.  $\tau = 1$ ) was -5.96, compared to -7.14 for a similar one initiated the day before. This loss of roughly one additional vega (illustrated by a dotted grey line) represents the average exposure to the election outcome. The evidence also indicates that the bias of long volatility positions on the S&P 500 in the treatment group were larger (i.e. the expected returns from receiving the fixed rate in variance swaps were more negative), compared to variance swaps in the control groups. This electoral volatility risk premium (EVRP) can be calculated as:

$$EVRP = \overline{p_{\tau,m}^{Treat}} - \frac{1}{2}(\overline{p_{\tau,m}^{Pre}} + \overline{p_{\tau,m}^{Post}}), \quad (2)$$

where  $\overline{p_{\tau,m}^{Treat}}$ ,  $\overline{p_{\tau,m}^{Pre}}$ , and  $\overline{p_{\tau,m}^{Post}}$  are averages of the payoffs associated with the variance swap contracts included in the treatment, pre-treatment, and post-treatment groups, respectively. The average EVRP across all five elections amounts to -3.17 (t-statistic=-3.49), indicating that variance swap holders were willing to pay a larger premium to hedge against electoral price risk during the 2011-2020 period. This finding is not only statistically but also economically significant. Selling volatility has historically been profitable; but selling *electoral* insurance in the past 10 years has been even more lucrative, raking in more than six times the variance swap contract's vega notional.

### 3.2 Electoral Volatility Trading

The returns from long variance positions – which are typically negative–, should increase in absolute terms (i.e. they should be even more negative) whenever variance swap strike levels are excessively high. To further probe into the expensiveness of options around elections, following Gao, Xing, Zhang (2018) I look at the profitability of a *strangle*. This is a trading strategy that involves combining a put and a call on the same asset, with different exercise prices – not necessarily at-the-money – and time to maturity.<sup>17</sup> This strategy is a particularly appealing when one expects a security or an entire index to make a large move following an event, but one is unsure about the direction of this move. National elections fit this description very well. They are recurring, have a predictable schedule, and have the potential to trigger large price movements. It is often difficult, however, to predict the direction of the movement.

Suppose someone considers that option prices are overestimating the magnitude of a post-electoral price movement. She could then write a strangle (i.e. sell both calls and puts) ahead of the election to capture the volatility premium impounded in option prices. Her profit will

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<sup>17</sup>In the case of a strangle, the exercise price of the put should be less than the exercise price of the call. When the put and the call have the same exercise price, the position is called a *straddle*.

be limited to the total premiums received, whereas her potential loss will be unlimited if the price of the underlying asset rises, and substantial if it falls. Therefore, the strategy's success depends on the magnitude of price movement (regardless of its direction) and the change in implied volatility. If the options market had correctly priced the post-electoral price change, then she will likely lose money. In contrast, her position will be profitable if the price reaction of the underlying asset to the revelation of the winning candidate's identity is smaller than what is implied by the (combination of both) option prices.

I calculate average strangle returns around U.S. national elections for the period between 2006 and 2020 using the CBOE's VIX Strangle Index (VSTG). The index tracks the value of a hypothetical portfolio which overlays a short strangle of VIX options and a long VIX call on one-month Treasury bills.<sup>18</sup> I consider positions that are opened and closed over different windows around the election day. Based on the implied volatility dynamics around elections uncovered above, I focus on buy-and-hold strategies that cover the running up of electoral uncertainty until electoral uncertainty is partially or fully resolved. Specifically, the starting date is chosen on day -2, and the ending dates are either days 0, or 1, with day zero denoting the trading day immediately before the identity of the winning candidate is revealed. So, for the strategy over [2,0], the VSTG index is bought on day -2 (the Friday before the election) and sold on election day (a 3-day holding period). In the strategy over [2,1], the VSTG index is also bought on day -2 (the Friday before the election), but it is sold the day after the election day (a holding period of 4 days).

The distinction between the ending dates should capture two different effects around elections: the pre-electoral effect and the post-electoral one. The first effect is relevant for

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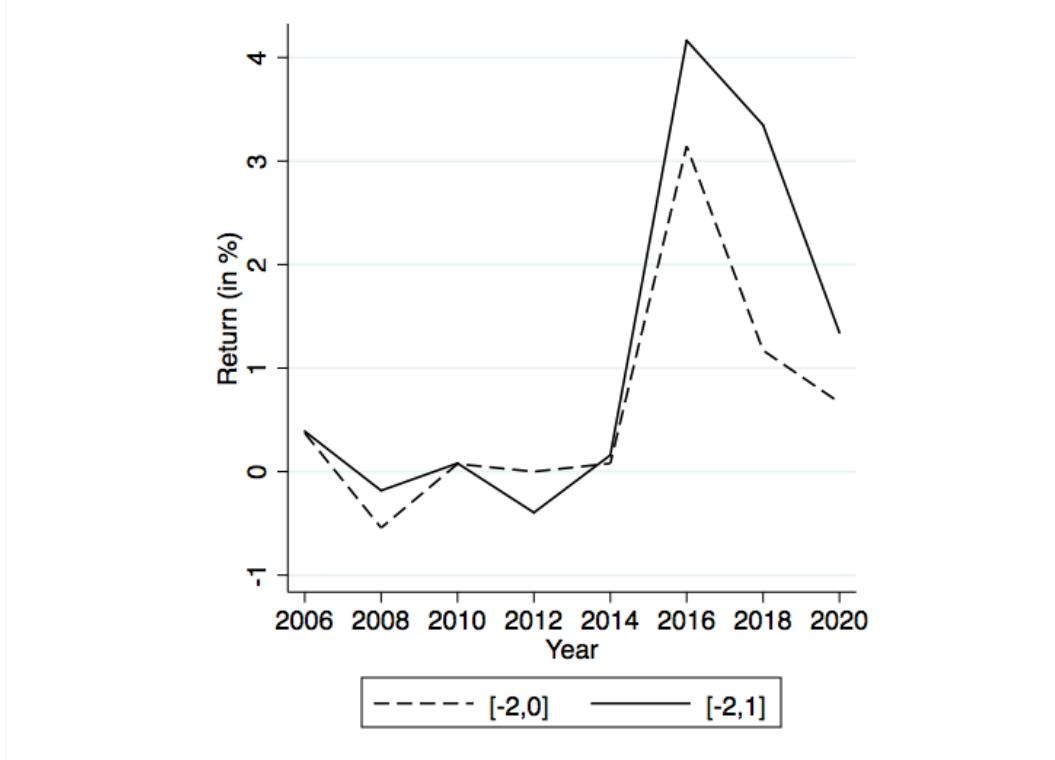
<sup>18</sup>VIX options did not exist until 2006, so the VSTG is only available after March 21st, 2006. The short VIX put and call have strikes set at the 5th and 95th percentile values of the forward distribution of VIX. The long VIX call has a strike set at the 99th percentile. The number of capped short VIX strangles is set to ensure that 80% of the value of the portfolio at the previous rebalancing date is preserved. For more details on the calculation of the index, please go to: [https://cdn.cboe.com/api/global/us\\_indices/governance/VSTG\\_Methodology.pdf](https://cdn.cboe.com/api/global/us_indices/governance/VSTG_Methodology.pdf).

the strategy ending on day zero, which is strictly before election outcomes are revealed. The value of the VSTG index might increase before the election day due to electoral uncertainty (an unforeseen outcome). The second effect should capture the actual exposure to the election outcome. If the magnitude of the post-electoral price change is small enough, the strangle returns will be positive, leading to a further increase in the VSTG index.

Figure 4 shows the returns associated each of the two hypothetical VSTG trading strategies for all the national election held in the United States between 2006 and 2020. The dashed line corresponds to the strategy over  $[-2,0]$  (i.e. the pre-electoral effect), and the solid line to the strategy  $[-2,1]$  (i.e. the post-electoral effect). The average return of the  $[-2,0]$  strategy for the five elections that took place between 2006 and 2014 was  $-0.003\%$ , compared to  $1.66\%$  (with a significant t-statistic of 2.84) for the three following ones (2016, 2018, and 2020). In the case of the  $[-2,1]$  strategy, the average four-day return for the five elections that took place in the 2006-2014 period was  $0.01\%$ , but rose to  $2.95\%$  (with a significant t-statistic of 4.60) thereafter. As a benchmark, the average return for a 3-day (4-day) holding period over all trading days (excluding the positions opened/closed around the election day) was  $0.059$  ( $0.088$ ) between 2006 and 2014, and  $0.001$  ( $0.001$ ) in the post-2014 period.

The post-2014 returns associated with the two hypothetical VSTG *electoral* trading strategies are both statistically as well as economically significant, indicating that option prices overestimated both electoral uncertainty as well as post-electoral price jumps in the last three U.S. national elections. In the former case, there is usually not much that the investment community does not already know in the final two days before the contest regarding the election's outcome. Nonetheless, as Figure 4 shows, while the option market slightly underpriced the likelihood of Barak Obama's victory in 2008, it significantly overpriced electoral uncertainty in the Trump era.

Figure 4: VSTG Index Returns, 2006-2020



The difference between the returns to the VSTG [-2,1] strategy before and after the 2016 U.S. presidential election are even more pronounced. It is thus possible to compute difference-in-differences (DD) estimates of the post-electoral effect on VSTG returns. Before 2016, both strategies deliver similar returns (the average difference between the [-2,1] and [-2,0] strategies is 0.01% with a t-statistic of 0.11). In contrast, after the 2014 election, the average difference is 1.29% (with a t-statistic of 2.84) in favor of the [-2,1] strategy. These findings indicate that since 2016, investors have not only been concerned about electoral uncertainty (an unforeseen outcome), but also about the realization of extreme negative events (an undesirable outcome).

## 4 Election Forecasts and Option Prices

The analysis of long variance swaps' returns as well as short strangles' earnings yield three important results. First, selling protection against election risk has become increasingly profitable in recent years. Second, the source of those profits can be traced not only to electoral uncertainty, but also to investors' fears of large post-electoral price changes. Third, the peak in the returns associated with *electoral* short strangles occurred in 2016, suggesting that the option market's overestimation of election risk coincided with the arrival of Donald Trump on the political scene. In this section, I examine the relationship between S&P option prices and electoral forecasts to account for the rise in risk premiums in the last two U.S. presidential elections. Implied volatility can be interpreted as the market's expectation of the average return volatility over the life of an option contract. Consequently, semi-strong form efficiency requires that market participants correctly estimate how an anticipated news release will affect the valuation of asset prices. In the context of a presidential election, option prices should thus reflect all publicly available information regarding each candidate's chance of winning. Otherwise, a discrepancy between the option market and public opinion polls would indicate that electoral risk pricing is not informationally efficient.

### 4.1 The Trump Factor

As in Gemmill (1992), I rely on the simple one-step binomial pricing framework introduced by Cox, Ross and Rubinstein (1979) to analyze if S&P option prices were consistent with electoral forecasts in the last two U. S. presidential elections (see Supplementary Online Appendix C for more details). In the case of 2016, according to Wolfers and Zitzewitz (2018), markets expected the S&P 500 to be worth around 11% less under President Trump than Clinton when U.S. markets closed on November 8th, 2016 (election day). At the same time, public opinion polls suggested only a 28.6% chance that Trump would win. Were

option prices consistent with the electoral forecasts? To answer this question, I calculate the probability of a Trump victory derived from option prices and compare them with Trump's winning probabilities according to public opinion polls. I place my focus in the closing month of the campaign; namely, the period between October 10th, 2016 and November 8th, 2016. I rely on the *Fivethirtyeight* election forecasts to obtain daily predictions of Trump's winning probabilities based on opinion-poll data.<sup>19</sup> Next, I estimate the daily values of the probability of a Trump victory derived from option prices using equation (C2) in Supplementary Online Appendix C. I rely on the VIX index to capture the market's expectation of S&P 500 returns' volatility. The index is reported for a 30-day maturity, so time to expiration (in years) is set to  $\frac{30}{365} = 0.082$ . Finally, as a proxy for the risk-free interest rate, I use the 1-Month U.S. Treasury par yields.<sup>20</sup>

The left panel of Figure 5 shows the probabilities of a Trump victory estimated from public opinion polls (dashed line) and from S&P 500 options (solid line) for the period between October 10th, 2016 and November 8th, 2016. The findings indicate that, in the closing days of the campaign option prices were consistent with the electoral forecasts. Indeed, for the last three observations (Nov. 4-Nov. 8), the options and polls probabilities are almost identical. Moreover, as noted above, market professionals were expecting a 11% decline in the S&P 500 if Trump won the election. The estimated values of the up and down move multipliers on election day (not shown), are 1.055, and 0.948, respectively. These figures imply that markets expected the S&P 500 to be worth roughly 10.7% less under President Trump than Clinton, which is very similar the expected fall estimated by Wolfers and Zitzewitz (2018). The behavior of options prices, however, was inconsistent with the information in opinion polls throughout most of the final month of the campaign. Before November 4th, 2016, option prices overestimated the probability of a Trump victory by an average of approximately 11

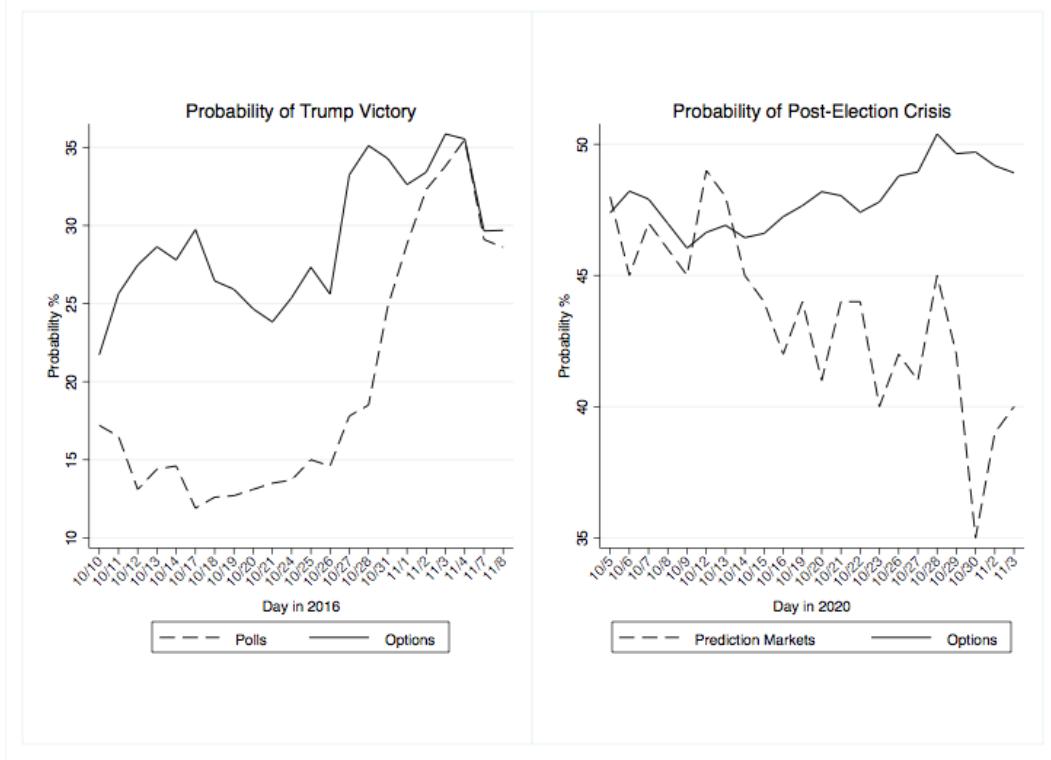
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<sup>19</sup><https://projects.fivethirtyeight.com/2016-election-forecast/>

<sup>20</sup><https://www.treasury.gov/resource-center/data-chart-center/interest-rates/>

percentage points (28.7% compared to the 17.8% winning chance predicted by the polls). These results indicate that, overly fearful of a Trump victory, market participants were willing to consistently pay higher premiums to hedge against such an outcome.

Figure 5: Election Forecasts and Option Prices



Turning to the 2020 U.S. presidential election, markets did not seem to care too strongly whether the victorious candidate would be Democratic or Republican. Instead, as the *Economist* noted, investors appeared to be especially keen on downside protection to hedge against the prospect of a period without a clear winner, as well as the potential for outright post-election chaos. In particular, markets were especially spooked by President Trump's reluctance to say that he would accept the election result.<sup>21</sup> Once again, I examine the closing month of the campaign. In this case, I focus on the period between October 5th, 2020

<sup>21</sup><https://www.economist.com/finance-and-economics/2020/10/10/how-investors-are-hedging-against-possible-election-chaos-in-america>. See also: <https://www.reuters.com/article/usa-election-markets/with-biden-bets-and-trump-hedges-investors-prepare-for-u-s-election-day-idUSKBN27I0NZ>

and November 3rd, 2020. Whereas no forecasts based on public opinion polls on the issue exist, it is possible to use data from prediction markets to assess the probability that Trump would refuse to vacate the Oval Office should he lose the election. For example, *PredictIt*, an online prediction market, offered traders to sell shares on the event “Will Trump or Biden personally concede defeat within two weeks of Election Day?” I use these data to estimate the probability that Trump would refuse to accept the election result.<sup>22</sup> Next, I estimate the probability of a post-election crisis derived from option prices using the same inputs as before (i.e. the VIX index, and U.S. Treasury par yields).

The right panel of Figure 5 shows the probabilities that Trump would refuse to accept the election outcome estimated from prediction markets (dashed line) and from S&P 500 options (solid line) for the period between October 5th, 2016 and November 3rd, 2020. Their contrast is remarkable. In period’s initial four days (Oct. 5-Oct. 8), there was some similarity between them. But, thereafter prediction markets signalled a falling probability that Trump would refuse to concede defeat, whereas option prices signalled a rising probability of a post-electoral crisis, reaching 50% on October 28th, 2020.<sup>23</sup> The estimated values of the up and down move multipliers on that date (not shown), are 1.122, and 0.891, respectively. These figures imply that markets expected the S&P 500 to fall by 23.1% if Trump refused to accept the election result.

To further quantify the abnormal expensiveness of the S&P options around the 2020 U.S. presidential elections, consider the following position. Suppose that on October 7th, 2020, a market maker bought 100 plain vanilla, at-the-money calls on the S&P 500 index expiring

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<sup>22</sup>Daily closing prices for the period between October 5th, 2020 and November 3rd, 2020 were obtained from PredictIt, <https://www.predictit.org/markets/detail/6906/Will-Trump-or-Biden-personally-concede-defeat-within-two-weeks-of-Election-Day>. Data on election day (November 3rd, 2020) come from Smarts, <https://smarts.com/event/41808439/politics/us/us-presidential-election-2020/will-trump-concede?lang=en-US>

<sup>23</sup>In addition to president Trump, the incumbent vice-president, Mike Pence also seemed reluctant to concede defeat. In the October 8th, 2020 vice presidential debate, he provided evasive answer to a question posed by the moderator about a peaceful transition of power.

three days after the election (Friday November 6th, 2020). According to the CBOE data, the premium for one call was 102.7 dollars. Assuming that there were no additional fees or commissions, the market maker should have borrowed 10,270 dollars to buy the call options. Suppose also that the marker maker immediately hedged the long position by short selling an appropriate number of units of the underlying index. At expiration, the position would have produced a net loss of 1,533 dollars, or approximately 15%. Note that, over the 30-day period, realized daily volatility (1.23%) was lower than the level of implied sold (1.38%). Hence, the higher prices of option prices, fueled by investors' fears of a constitutional crisis, made the hypothetical riskless hedge position unprofitable.

## Conclusions

A significant number of scholars have examined the deleterious effects of political sectarianism (cf. Finkel et al. 2020). Most of this work, however, focuses on the behavior of voters and politicians. This study shows that partisan polarization, can not only affect democratic norms and political accountability, but can also undermine the ability of financial markets to efficiently price election risk. As elections in the United States became more polarized, their outcomes turned out to be more consequential for asset prices, leading to a significant increase in the price that investors had to pay to hedge against electoral risk. The evidence also indicates that the rise in option prices allowed option traders to profit from investors' fears of large post-electoral price movements. Finally, the analysis suggests that further rise in partisan polarization during the Trump era led to inefficiencies in electoral risk pricing.

The electoral risk premiums uncovered here are not only statistically significant, but they are also fairly large in economic magnitude. For example, selling 9-day S&P 500 variance swap on election day in 2020 with a vega notional of USD 100,000 would have turned a profit of approximately USD 1,637,444. In the case of the delta-hedged position opened

on October 7th, 2020 discussed above, the premium for one call given by the “incorrect” volatility of 26.34% was USD 102.7, compared to a price of USD 91.7 derived from the “correct” volatility of 23.5%. The cost of a standard contract is usually 100 times the quoted price; so in this case, the loss would have been USD 1,100 per contract.

These findings are particularly noteworthy because they uncover the adverse effects of polarization in the most unlikely of places: the option market. In contrast to many securities, option prices are closely tied down by arbitrage considerations. In addition, whereas trading in stocks and/or bonds has become increasingly common among retail investors, most of the option trading strategies examined in this study require a significant degree of financial experience, as well as considerable funding in terms of margins and collateral. Given these high stakes, one would expect that rational, rather than emotional, decision-making would govern these transactions. Nonetheless, as with voters and politicians, the behavior of the participants in the option market has been affected by the rising tide of partisan polarization that has afflicted the United States in recent years.

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# Supplementary Online Appendix to “Partisan Polarization and Political Risk”

Appendix is for online publication only.

Date: March 2, 2022

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## A Black-Scholes Model with an Announcement Jump

Following Leung and Santoli (2014), consider an extension of the Black-Scholes model with a single price jump occurring immediately after a scheduled news announcement, whose size is normally distributed with a volatility of  $\sigma_e^{\mathbb{Q}}$  (where  $\mathbb{Q}$  is the risk-neutral probability). Suppose that equity prices are log-normally distributed, and that the price of a European call with strike  $K$  and maturity  $T$  is given by

$$C(t, S_t) = C_{BS} \left( T - t, S_t; \sqrt{\sigma^2 + \frac{(\sigma_e^{\mathbb{Q}})^2}{T-t}}, K, r \right), \quad 0 \leq t < T_e \quad (\text{A1})$$

where  $C_{BS}(\tau, S; \sigma, K, r)$  represents the usual *BS* formula with time to maturity  $\tau$  and spot price  $S$ , and  $T_e$  is the scheduled news announcement date.

Given this price formula, the implied volatility (IV) can be expressed as the deterministic function:

$$I(t; K, t) = \begin{cases} \sqrt{\sigma^2 + \frac{(\sigma_e^{\mathbb{Q}})^2}{T-t}} & \text{if } 0 \leq t < T_e \\ \sigma & \text{if } T_e \leq t < T, \end{cases} \quad (\text{A2})$$

where  $\sigma$  is the diffusive volatility (Leung and Santoli 2014).

## B Hypothetical Variance Swap Contract

Consider the following hypothetical variance swap contract. One party agrees to pay a fixed amount at maturity (i.e. the price of the variance swap), in exchange for a payment equal to the sum of squared daily log returns of the S&P 500.

The payoff,  $p_{\tau,m}$  at expiration of a contract initiated at time  $\tau$  and with maturity  $m$ , and Strike Price,  $SP_{\tau,m}$ , is given by:

$$p_{\tau,m} = VN_{\tau,m} \times [(RVS_{\tau,m})^2 - (SP_{\tau,m})^2] \quad (\text{B1})$$

where  $VN$ , the Variance Notional, is determined as:

$$VN_{\tau,m} = \frac{\text{Vega Notional}}{2 \times SP_{\tau,m}},$$

and the Realized Volatility Strike of the S&P 500 is calculated using the formula:

$$RVS_{\tau,m} = \sqrt{\frac{252 \times \sum_{i=\tau+1}^{\tau+m} \left( \ln \frac{\text{Index}_i}{\text{Index}_{i-1}} \right)^2}{m}} \times 100.$$

## C One-Step Binomial Pricing Framework

Let  $O_t$  be a European option on an underlying asset with a current price  $S_t$ . Denote the option's strike by  $K$ , its expiry by  $T$ , and the election day as  $T_e$ , where  $t < T_e < T$ . An option bought ahead of the date when the identity of the winning candidate is revealed (at time  $t \leq T_e$ ) will give someone the right to trade the underlying at a strike price of  $K$  after the election takes place. To keep things simple, I assume that the underlying asset will pay no cash dividends during the life of the option. I also ignore transaction costs, margin requirements, and taxes.

Suppose that at expiration, the spot price of the underlying asset can only have two possible values. With probability  $q$ , it can increase, and become  $S_T^u = uS_t$ , where  $u > 1$ ; and with probability  $(1 - q)$ , it can decrease, and become  $S_T^d = dS_t$ , where  $d < 1$ . Therefore, for  $S_T = \{S_T^u, S_T^d\}$ , the option's value at expiration will be  $C_T = \max(0, S_T - K)$  in the case of a call, and  $P_T = \max(0, K - S_T)$  in the case of a put. To avoid riskless arbitrage opportunities,  $O_T$  should be equal to the value of  $O_t$  invested for the time interval  $\Delta = T - t$  at the risk-free interest rate,  $O_T = O_t e^{r\Delta}$ , or equally,  $O_t = O_T e^{-r\Delta}$ .

As Cox, Ross and Rubinstein (1979) show, the value of the option  $O_t$  can be calculated as:

$$O_t = e^{-r\Delta} [pO^u + (1 - p)O^d], \quad (\text{C1})$$

where  $O^u$  is the value of the option at expiration if the price of the underlying goes to  $uS_t$ ,  $O^d$  is the value of the option at expiration if the price of the underlying goes to  $dS_t$ , and:

$$p = \frac{e^{r\Delta} - d}{u - d}. \quad (\text{C2})$$

There are many plausible available choices with regard to the parameters  $u$  and  $d$ . For instance, the price of the underlying asset could either increase by 1.8% or decrease by 1.5%. Following Cox, Ross, and Rubinstein (1979), I adopt the parametrization,  $u = e^{\sigma\sqrt{\Delta}}$ , where  $\sigma$  is the volatility of the underlying asset. Assuming that the product of the up move multiplier and the down move multiplier is 1, then  $d = e^{-\sigma\sqrt{\Delta}}$ .

Equation (C2) can help us elucidate the relationship between option prices and electoral forecasts. First, notice that, as long as the interest rate is positive, then  $d < e^{r\Delta} < u$ . Therefore,  $p$  has the properties of a probability: it will always be greater than zero and less than one. Second, as Cox, Ross, and Rubinstein (1979) note,  $p$  is the value that would justify the current price of the underlying asset,  $S_t$ , in a risk-neutral world. In the context of a national election examined here, we can interpret  $p$  as the probability that the spot price will increase to  $S_T^u$  at time  $T_e < T$ .

So, consider a presidential election between two candidates,  $L$  and  $R$ . Assume that on day  $t < T_e$  during the campaign, the option  $O_t$  expires in one month, the riskless interest rate is 2.5%, and the volatility of  $S_t$  is 20%. According to those inputs, and using equation (7),  $p = 0.68$ . Suppose the market expects the underlying asset to increase (decrease) in value if  $R$  wins (loses). To the extent that asset prices are sensitive to electoral outcomes, then  $R$ 's probability of winning, as predicted by public opinion polls should be roughly 68%. Otherwise, the behavior of options prices would be inconsistent with the information in public opinion polls.