Did fear gauge die, or was it just on holiday?

Jędrzej Białkowski[1]
Department of Economics and Finance,
University of Canterbury, New Zealand

Huong Dieu Dang
Department of Economics and Finance,
University of Canterbury, New Zealand

Xiaopeng Wei
Department of Economics and Finance,
University of Canterbury, New Zealand

Abstract

Motivated by the extremely low level of VIX index and high level of economic policy uncertainty in the U.S. in 2017, we examine the factors which contribute to this puzzling phenomenon. Our analysis shows that low VIX with high policy uncertainty could be attributed to the combined impacts of imprecision of political signals, investors' opinions dispersion, and representativeness as one of investors' behavioral biases. More specifically, the representativeness weakens the relationship between VIX and policy uncertainty consistently, while the imprecision of political signals and high level of investors' opinion dispersion curtails the positive impact of policy uncertainty on VIX most of the time.

Keywords: VIX, Economic Policy Uncertainty, Baker-Bloom-Davis Index, AAII Sentiment Survey, Representativeness Bias, Investors' opinions, Belief dispersion;

JEL codes: G11, G14, G23, G41

[1] Corresponding Author: Department of Economics and Finance, UC Business School, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand. Phone: +64 3 369 4060. Email: jedrzej.bialkowski@canterbury.ac.nz

1. Introduction

The Chicago Board Options Exchange's (CBOE) volatility (VIX) index, which is a measure of the implied volatility of S&P 500 index options, has been widely used as a proxy for the "fear gauge" of market participants. Launched in 1993 by the CBOE, VIX index captures investors' expectations of the stock market volatility over the next 30-day period. The level of VIX index is important not only for market participants who consider it a barometer of the equity market volatility, but also for investors of VIX-related products.[2] Crisis periods are characterized by higher values of VIX index, when it is expensive for investors to close losing positions (Whaley [2000]; Whaley [2008]; Shaikh and Padhi [2014]).

Empirical studies have documented a significant positive correlation between stock market volatility and economic policy uncertainty (Balcilar, Li, and Chang [2013]; Sum and Fanta [2012]; Liu and Zhang [2015]). Periods characterized by high economic policy uncertainty often experience significantly lower real stock market returns (Kang and Ratti [2013]; Brogaard and Detzel [2015]). Uncertainty over government's policy actions raises the volatility of the stochastic discount factor, resulting in higher risk premia and more volatile stock returns (Pastor and Veronesi [2012]). Economic policy uncertainty also swings investors' views on the impact of the current policy and the probability of a policy change (Pastor and Veronesi [2012]), leading to a higher extent of disagreements among market participants. Dispersions in investors' opinions, in turn, intensify stock market volatility. As VIX index is derived from the prices of S&P 500 index options, which tend to be more expensive in volatile economic policy environment (Kelly, Pastor, and Veronesi [2016]), it is expected that a higher degree of

[2] The average daily trading volume of VIX exchange-traded products has exceeded USD 800 million, making it one of the most popular exchange-traded products (Whaley [2013]).

economic policy uncertainty is associated with a higher VIX index level.

The Baker-Bloom-Davis (BBD) news-based index and the BBD overall index are often employed as proxies for the extent of economic policy uncertainty.[3] Since the 2016's U.S. Presidential election, VIX index has hovered at extremely low levels while both BBD indices and the S&P500 index have reached high values. The average level of VIX index in 2017 corresponds to the 2nd percentile of its values over the period 1997-2016 while the average of the BBD news-based index in 2017 is equivalent to its 77th percentile measured over the same time period. On 3 November 2017, VIX index plummeted to its lowest closing value of 9.14 whereas the S&P 500 index reached a historical peak of 2587.84 then. The substantial divergences between VIX index and BBD indices have continued for an extended period of time. This puzzling phenomenon is unlikely the outcome of a short-lived anomaly. The observed divergences suggest that factors other than the performance of the U.S. equity market may have played important roles in affecting the relationship between VIX and economic policy uncertainty, driving VIX index to its extremely low levels.

The year of 2017 was inundated with fake news and imprecise political signals, which led to a high degree of dispersion in investors' opinions. It also observed one of the longest bullish spell in the U.S equity market, which tended to nurture a strong representative bias among investors. Motivated by the intrigue developments in 2017, this study examines if and how the quality of political signals, disperse opinions and representative bias among investors contributed to the historical low levels of VIX index, despite the observed high level of economic policy uncertainty. We are not aware of any studies which *empirically* examine the contributions of the three factors

[3] The constructions of the BBD news-based index and BBD overall index will be discussed in the data section. These two indices have been employed in a number of studies (e.g. Brogaard and Detzel [2015], Loh and Stulz [2018])

to this puzzling phenomenon.

Political news send signals which suggest the course of actions a government may pursue. Rational investors perceive political signals, dissect relevant information and update their views on prospective economic policies. Investors respond to political signals, and their responses, as seen in share prices, are stronger when the extent of political uncertainty is higher (Pastor and Veronesi [2012, 2013]). However, when political news is noisier, investors tend to be skeptical about government's prospective policy actions. Investors continue to observe political signals, but they pay less attention than they would otherwise (Pastor and Veronesi [2017]). In other words, in spite of the high economic policy uncertainty, noisy political signals are likely to result in small updates in investors' beliefs, which contribute to lower market volatility.

In an environment inundated with imprecise political signals, it is more difficult for investors to interpret conflicting information and form accurate views on the prospective policy actions. Investors are more likely to disagree on the probability and the potential impacts of a policy change [Pastor and Veronesi, 2012, 2013]. Higher dispersion in investors' opinions tends to result in higher expected market volatility [Dumas, Kurshev, and Uppal, 2009; Banerjee and Kremer, 2010]. In this aspect, noisy signals create divergences in investors' opinions, which intensify market volatility.

The year of 2017 also presented us an interesting background to reflect on the strong performance of the U.S. equity market and its potential impacts on investors' behaviors. Investors exhibit representativeness bias in their trading activities. They expect a price continuation based on the past 'trends' and they perceive investment risks based on their most recent investment experience (De Bondt [1993]). Most investors tend to believe that the ongoing bullish spell in the U.S. equity market will continue. Thus, investors tend to overlook political signals and underestimate the impact of economic policy

uncertainty on investment risks. The representative bias of investors is likely to contribute to a lower degree of market volatility.

This study finds that the quality of political signals plays an important role in explaining the level of VIX index. More precisely, we show that policy uncertainty together with the quality of political signals helps to explain the level of VIX. We also find evidences that investors' opinions dispersion has significant impact on expected market volatility and this impact interacts with the effect of policy uncertainty on VIX. In addition, our results show that the commonly accepted positive relationship between VIX index and economic policy uncertainty is weakened during a time characterized by bullish investors' sentiment. The reported results provide insights into the dynamics of co-movement of VIX index and proxies of economic policy uncertainty.

The remainder of this paper is structured as follows. Section 2 reviews the literature and outlines the hypotheses. Section 3 describes the data and variables employed. Section 4 presents the methods. Section 5 discusses the results, and Section 6 concludes the main findings.

2. Literature and Hypotheses Development

The observed extremely low level of VIX index albeit a high degree of economic policy uncertainty has drawn increasing attention from practitioners and researchers.[4] The year of 2017 presented this study an interesting background to examine three factors, which have received little attention in *empirical* studies on VIX index. These three factors include the quality of political signals, the dispersion of investors' opinions and representativeness as one of investors' behavioral biases.

[4] See, for example, Banerji [2017], Figlewski [2017], Ciolli1 [2017], Moyo [2017], Pastor and Veronesi [2017], Watts [2017] and Weber [2018].

2.1 Does the quality of political signals matters?

The studies conducted by Pastor and Veronesi [2012, 2013] develop theoretical models and explain the relationships between stock price, market volatility and economic policy uncertainty. In their proposed model, the government decides the economic policies to be adopted while investors are uncertain about government's prospective policy actions. Changes in economic policies will lead to price reactions in the financial markets, and the magnitudes of the reactions depend on the extent the changes were anticipated. Pastor and Veronesi consider two types of uncertainty: the uncertainty regarding whether a current policy will be changed and the uncertainty regarding the impact of a new policy on share prices and market volatility. They find that both types of uncertainties significantly affect stock price and market volatility. Referring to Pastor and Veronesi [2012, 2013], Pastor and Veronesi argue that the proposed model implies that market volatility is an increasing function of the product of political uncertainty and the quality of political signals (). When political signals are precise on government's prospective policy actions, it is expected that market volatility and economic policy uncertainty move together. However, when faced with poor political signals, investors do not update their beliefs often and hesitate to react in the financial markets. In this situation it is not unusual to observe low market volatility albeit a high level of economic policy uncertainty. This scenario is consistent with the puzzling phenomenon observed in the U.S. in 2017.

In over twelve months following the 2016's Presidential election, U.S. investors were bombarded with a large flow of political news. Most frequently heard on media were the appointments and dismissals of high ranking officials in the White House Office and the Cabinet, the announcements of economic reforms and plans to change domestic and foreign policies. The year of 2017 was also inundated with a large number of fake news

and half-truths. According to the *Washington Post Fact Checker*'s database, as of 2 March 2018 President Trump has made 2,436 false or misleading claims in 406 days since he took the oath of office.[5] The prevalence of fake news and imprecise news made it difficult for investors to interpret political signals, to dissect reversals and contradictions, and to evaluate their potential impacts on investment risks (Pastor and Veronesi [2017]). As a result, investors tend to wait and see, which leads to lower market volatility.

In light with the theoretical model proposed by Pastor and Veronesi [2012] and the developments in the U.S. in 2017, we put forward the following hypotheses:

H1a: Policy uncertainty has positive and statistically significant impact on the level of VIX index.

H1b: The imprecision of political signals lowers the level of VIX index.

H1c: The imprecision of political signals weakens the positive impact of policy uncertainty on VIX index.

2.2. Does the dispersion in investors' opinions matter?

Past studies show evidences that investors tend to be overconfident and often overreact to political signals [De Bondt and Thaler, 1985; Darrat, Zhong, and Chen,2007]. As opinions among investors diverge widely, their stronger reactions bring about more pronounced impacts on share prices. This leads to higher absolute price changes and stock prices to be more volatile. As a result, market volatility intensifies [Dumas, Kurshev, and Uppal, 2009; Banerjee and Kremer, 2010].

[5]Source: President Trump has made 2,436 false or misleading claims so far https://www.washingtonpost.com/news/fact-checker/wp/2018/03/02/president-trump-made-2436-false-or-misleading-claims-so-far/?utm_term=.d9d7e3542240

As Pastor and Veronesi [2012, 2013] argue, in a volatile economic policy environment, investors are more likely to disagree on the potential impacts of policy changes, which results in a higher degree of opinions dispersion. In other words, in case of equally divided opinions among investors, the dispersion is high. Moreover, considering the large flow of imprecise news released by the U.S. government in 2017, it was even more difficult for investors to interpret low quality political signals. Thus, the degree of opinions dispersion among investors could be even higher than ever observed. A number of studies on heterogeneous opinions present strong evidence that dispersion in investors' opinions significantly raises market volatility [Scheinkman and Xiong, 2003; Buraschi and Jiltsov, 2006; Andrei, Carlin, and Hasler, 2015]. In light of this discussion, we propose the following hypotheses:

H2a: High opinions dispersion increases the level of VIX.

H2b: High opinions dispersion weakens the positive impact of policy uncertainty on VIX index.

2.3. Why do investors care about losing money (and fear gauge) if the bullish spell in the U.S. equity market continues?

Humans tend to judge a situation based on their most recent encounters instead of evaluating the situation as it is now (Tversky and Kahneman [1974]). Similarly, investors are prone to perceive an investment as good or bad based on its most recent performance (De Bondt and Thaler [1985]; Benartzi and Thaler [1995]; Barberis, Shleifer, and Vishny [1998]). Investors tend to be too optimistic in bull markets and too pessimistic in bear markets. The so-called representativeness bias leads to the expectation that the recent trends in prices will persist (De Bondt [1993]). The fact that

humans have relatively short memory further aggregates the implication of the representativeness bias. Investors tend to expect that the recent trends in prices are representative of the future trends, and consequently, they are likely to buy equities that have recently gained in value (Shleifer [2000]; Kim and Nofsinger [2008]).

Previous studies on behavioral finance have presented supportive evidences that the representativeness bias influences investors' interpretations of market signals and their expectations of market performance. Dhar and Kumar [2001] examined the impacts of price trends on the trading decisions of more than 40,000 householders in the U.S. They observed that investors' buying and selling decisions are affected by short-term price trends. Greenwood and Nagel [2009] investigated the roles of inexperienced investors in the formation of asset price bubbles prior to the global financial crisis (GFC). They reported that inexperienced mutual fund managers exhibited representativeness bias, as evidenced by their investment decisions to increase technology stock holdings during the run-up to the GFC and decrease these holdings during the downturn. Chernenko, Hanson, and Sunderam [2016] also documented that the representativeness bias significantly influences inexperienced mutual fund managers in their holdings of securitized products. Inexperienced managers tend to view the tranquil years prior to the GFC as representative of future years. As a result, these managers tend to underestimate the risks of a disruption in financial markets and they perceive risky non-traditional securitized products more attractive. Outside the U.S., Chiang, Hirshleifer, Qian, and Sherman [2011] examined how the experience in IPO auctions affects investors' decisions to bid in subsequent auctions in Taiwan. They observed that individual investors become optimistic after achieving good investment returns, which is consistent with the representativeness bias documented in behavioral finance literature.

Our analysis reveals that the end of December 2017 marked the 14th consecutive month

over which the S&P 500 Total Return Index achieved positive returns. Since 1871 such persistent positive performance has only occurred six times, with each bullish streak lasting at least 12 consecutive months. The longest bullish spell of 15 months was recorded in late 1950's. As the bull market unfolded in 2017, investors were more likely to expect this strong performance to persist and let their guards down. They tended to underestimate potential investment risks and lower their assessments of market volatility. If a negative economic political signal arrived at the time investors' sentiment was high, its impact on market volatility was likely to be less pronounced than at other times. Thus, we propose the following hypotheses:

H3a: Market volatility, as proxied by VIX index, is lower in an environment characterized by bullish sentiment among investors.

H3b: Investors' bullish sentiment weakens the positive effect of policy uncertainty on VIX index.

3. Data

This study covers a long period from 2 January 1997 to 31 December 2017. The sample includes 5281 daily observations of VIX index, S&P 500 index, BBD news-based and BBD overall indices. The daily closing values of S&P 500 index, VIX index and BBD news-based index, the weekly values of the American Association of Individual Investors (AAII) sentiment index, and the monthly values of BBD news-based and BBD overall indices were collected from Bloomberg.

3.1. Variables

3.1.1. Economic policy uncertainty

We employ BBD news-based policy uncertainty index and BBD overall policy uncertainty index as alternative measures of economic policy uncertainty; both have been widely employed in the literature.[6]

The BBD news-based policy uncertainty index (*Uncertainty*) quantifies the coverage of policy-related economic uncertainty in the ten popular newspapers namely the USA Today, the Miami Herald, the Chicago Tribune, the Washington Post, the Los Angeles Times, the Boston Globe, the San Francisco Chronicle, the Dallas Morning News, the Houston Chronicle, and the Wall Street Journal. To construct the BBD news-based uncertainty index, the terms related to economic and policy uncertainty was searched in each paper and each month from January 1985. To meet the criteria for being counted, each policy uncertainty article must include the terms in all three categories pertaining to uncertainty, economy and policy.[7] The monthly count of policy uncertainty articles in each paper was divided by the respective monthly total number of articles. The resulting monthly series for each paper is then normalized to have a unit standard deviation before being summed across papers to obtain a monthly multi-paper index. This index is then re-normalized to an average value of 100. In our analysis which employs daily data, the monthly value of the BBD news-based uncertainty index was repeated for every day in that month.

The BBD overall index (*OverallBBD*) consists of three components. The first component is the BBD news-based policy uncertainty index, as discussed above. The second component reflects the number of federal tax code provisions set to expire in future years. The third component captures the degree of disagreements among economic forecasters. To construct the BBD overall index, each component is first

[6] Source: http://www.policyuncertainty.com/us_monthly.html

[7] The terms searched in each article include 'uncertainty' or 'uncertain', 'economic' or 'economy' and one or more of the following terms: 'congress', 'legislation', 'white house', 'regulation', 'federal reserve', 'deficit'.

normalized by its own standard deviation over the periods. The BBD news-based uncertainty index account for a half of the BBD overall index while each of the other three measures (the tax expirations index, the CPI forecast disagreement measure, and the federal/ state/ local purchases disagreement measure) accounts for a sixth.

Exhibit 1 depicts the time-varying relationship between VIX index, the BBD news-based index and the BBD overall index. Panel A of Exhibit 1 features the time-varying ratios of each BBD index to VIX index over the period 1997-2017. Both ratios jumped to the highest values shortly after the U.S. Presidential election in November 2016, and since then they have gone up more than double.

Panel B of Exhibit 1 shows the time series of VIX index, the BBD news-based index and the BBD overall index during the period 2014-2017. A striking feature in Panel B is the substantial divergences between VIX index and the two BBD indices from April 2016 onwards. VIX index has hovered at historical low levels whereas the two BBD indices reached their peaks after the U.S. Presidential election had concluded.

EXHIBIT 1 HERE

Exhibit 2 reports the deciles of VIX index, the news-based BBD index, the overall BBD index, and the S&P 500 index over the period 1997-2016. The co-movements between VIX index and the BBD indices were noticeable for the lowest and the highest deciles. For example, the deciles of high values of VIX index correspond to the deciles of high values of the BBD indices. The last two columns in Exhibit 2 report the 2017's mean value of each index and the 2017's mean as the equivalent percentile of the 1997-2016's values. The average level of VIX index in 2017 corresponds to the 2^{nd} percentile while the average of the BBD news-based index in 2007 is equivalent to the 77^{th} percentile of its values measured over the period

1997-2016. The mean value of the S&P 500 index in 2017 was the highest of its values over the period 1997-2017. This puzzling phenomenon motivates us to conduct a thorough analysis of the dynamics of VIX index.

EXHIBIT 2 HERE

3.1.2. The quality of political signals

To capture the precision of political signals, Pastor and Veronesi [2017] suggest using the *Washington Post Fact Checker* data. However, the relatively short history of this dataset makes it unsuitable for our analysis. We propose and compute the three-month rolling volatility of the daily changes of BBD news-based index (*UncnPrecision*) as a proxy for the quality of political signals. A high volatility reflects the prevalence of imprecise political signals. For robustness tests, we compute the one-month and two-month rolling volatility of the daily changes of BBD news-based index (*UncnPrecision_1m, UncnPrecision_2m)* as alternative precision measures.

Exhibit 3 depicts the time series of VIX index and the three-month rolling volatility of the daily changes of BBD news-based index (*UncnPrecision).* A striking feature in Exhibit 3 is the substantial divergence between the two series following the 2016's U.S. Presidential election. VIX index has plummeted to extremely low levels while *UncnPrecision* has experienced three spells of substantial high values.

EXHIBIT 3 HERE

3.1.3. Dispersion in investors' opinions

To capture investors' opinions dispersion, we employ two measures calculated with the data of the American Association of Individual Investors (AAII) Sentiment Survey. AAII has conducted weekly surveys since 1987. In each survey, its members are asked a simple question: Do you feel the direction of the stock market over the next six months will be up (*bullish*), no change (*neutral*) or down (*bearish*)? The AAII Sentiment Survey is conducted each week from Thursday until Wednesday. The survey is open to all AAII members.[8] The results of the survey are automatically tabulated in the AAII database and published online early every Thursday morning. The survey results are circulated by various organizations and media outlets, including Barron's and Bloomberg.

Our first measure for investors' opinions dispersion, *Dispersion*, is calculated as the standard deviation of AAII sentiment percentages (bullish, bearish and neutral). When investors' opinions disagreements are low, expectation of future market movement should be aligned among market participants. In such a case, most investors agree on the expected direction which market will move towards. As a consequence, there will be a dominant sentiment among market participants. The dominant sentiment could be either bullish, bearish or neutral, whose percentage will be much higher than those of the subdominant sentiments, and lead to a relatively high standard deviation of the three sentiment percentages. Therefore, a higher standard deviation of sentiment percentages (*Dispersion*) indicates a lower level of investors' opinions dispersion. On the other hand, when the dispersion among market participants is high, investors are more likely to stick with their own opinions about the market's future movement and the sentiment percentages tend to be closer to each other. For instance, in the scenario when opinions

[8] AAII has more than 160,000 members. A typical AAII member is a male in his mid-60s, who obtained either a bachelor or a post-graduate degree. AAII members tend to be affluent with a median investment portfolio size of over US$1 million. They possess moderate investment knowledge and engage primarily in fundamental analysis.

divergence among market participants is extremely high, the sentiment percentages of bullish, bearish and neutral would be the same, which will make the standard deviation of sentiment percentages (*Dispersion*) equal to zero. Therefore, a lower value of the standard deviation of sentiment percentages (*Dispersion*) indicates a higher level of investors' opinions dispersion.

We employ an alternative measure to account for the degree of dispersion in investors' opinions, *Dispersion_Range*, which is defined as the difference between the highest and lowest AAII spot sentiment percentages. Analogously, a high value of *Dispersion_Range* indicates that there is a dominant sentiment among market participants and therefore investors' opinions dispersion is low.

3.1.4. Representativeness bias

To account for investors' representativeness bias, we employ two alternative sentiment indices: the AAII Sentiment Survey and the index constructed by Baker and Wurgler [2006].[9] In our base models, we employ the AAII sentiment index as it has a longer history and has been widely used in the literature. The sentiment index constructed by Baker and Wurgler [2006] is used in the robustness analysis.

We create a dummy variable *Sent*, which is equal to one if the spot value of AAII *bullish* percentage in a week is higher than the spot values of AAII *bearish* percentage and *neutral* percentage, and zero otherwise. We also consider three dummy variables,

[9] Investors' sentiment has been widely discussed in the literature (Barberis, Shleifer, and Vishny Siganos [1998]; Brown and Cliff [2004]; Vagenas-Nanos, Evangelos, and Verwijmeren, Patrick [2017]). It is common in the past literature to apply those two indices as proxy of sentiment. According to Baker and Wurgler [2016], their sentiment index is defined as the first principal component of the correlation matrix of five sentiment proxies, namely value-weighted dividend premium, first-day returns and volumes on IPOs, closed-end fund discount, and equity share in new issues. It is available at http://people.stern.nyu.edu/jwurgler/. The AAII sentiment index is available at http://www.aaii.com/

which capture different lengths of time over which investors' bullish sentiment dominates. The dummy *Sent_8wk* takes the value of one if the eight-week moving average of AAII *bullish* percentage is higher than the eight-week moving averages of AAII *bearish* percentage and *neutral* percentage. The eight-week moving averages are directly reported in AAII database. The other two dummy variables *Sent_4wk* and *Sent_12wk* are constructed similarly as *Sent_8wk*, except that the moving averages are computed over the preceding four weeks and twelve weeks, respectively.

3.2. Statistics

The descriptive statistics of the variables employed in this study are summarised in Exhibit 4. Over the study period 1997-2017, VIX index varied between 9.14 and 80.86, with the mean value of 20.48. Additional analysis (not reported) shows that the 5^{th} percentile of VIX index was 11.18. Of the daily observations in the left tail (low market volatility), there were 31 found in 2005, 50 in 2006, 28 in 2007, 11 in 2014 and 146 in 2017. The 95^{th} percentile of VIX index was 35.81. Of the observations in the right tail (high market volatility), 8 were found in 1997, 30 in 1998, 7 in 2001, 40 in 2002, 67 in 2008, 80 in 2009, 5 in 2010, 28 in 2011, and 2 in 2015.

The daily returns of the S&P 500 index over the study period varied between -9% and 11.6%; both extreme values were observed in October 2008. The mean of daily returns for the main U.S. market benchmark is close to zero.

With regards to economic policy uncertainty, the monthly BBD news-based index (*Uncertainty*) ranged between 44.87 and 283.67, with the mean value of 115.99. The monthly BBD overall index (*OverallBBD*) varied between 57.20 and 245.13, with the average value of 108.94. The average daily change of the news-based BBD index was

0.2% and the average daily change of the overall BBD index was 0.1%.

In terms of investors' opinions dispersion, the average value of the standard deviation of AAII spot sentiment percentages (*Dispersion*) is 0.113 while the mean of the difference between highest and lowest AAII spot sentiment percentages (*Dispersion_Range*) is 0.214. *Dispersion* ranged between 0.005 and 0.361, and *Dispersion_Range* varied between 0.008 and 0.633.

With regards to investors' sentiment (representativeness bias), on average about 40% of AAII members are bullish, 30% are bearish and 30% are neutral about the prospects of the financial market. The highest percentage of bullish AAII members reached 75% in January 2000.

EXHIBIT 4 HERE

The correlation matrix for the key independent variables is presented in Exhibit 5.[10] The selected variables are not highly correlated with one another, and are unlikely to raise any multicollinearity issues.

EXHIBIT 5 HERE

4. Method

To test hypotheses (H1a) and (H1b) regarding policy uncertainty and the quality of political signals, the following model was estimated:

$$VIX_t = \lambda_0 + \lambda_1 \Delta S\&P500_t + \lambda_2 Trend_t + \lambda_3 Uncertainty_t + \lambda_4 UucnPrecision_t + \lambda_5 Uncertainty_t * UucnPrecision_t + \varepsilon_t \quad (1)$$

where:

[10] In Exhibit 5, we only present the correlation matrix for a set of key independent variables for brevity reason. The correlation matrix for all variables shows consistent results and is available upon requests.

VIX_t is the logarithm of VIX index value at time *t*.

$\Delta S\&P500_t$ is the daily log return of S&P 500 index at time *t.*

$UncnPrecision_t$ is the three-month rolling volatility of the daily changes of BBD news-based index. For robustness tests, two other alternative measures were used: the one-month rolling volatility ($UncnPrecision\_1m_t$) and two-month rolling volatility ($UncnPrecision\_2m_t$) of the daily changes of BBD news-based index.

$Uncertainty_t$ is the measure for the degree of economic policy uncertainty at time *t* proxied by the monthly BBD news-based index. Another alternative measure, BBD overall index ($OverallBBD_t$), is also employed for robustness tests.

$Trend_t$ is the time trend variable which controls for potentially omitted trending variables.

To test hypotheses (H2a) and (H2b) about investors' opinions dispersion, the following model was estimated:

$$\begin{aligned} VIX_t = {} & \lambda_0 + \lambda_1 \Delta S\&P500_t + \lambda_2 Trend_t + \lambda_3 Uncertainty_t + \lambda_4 UucnPrecision_t \\ & + \lambda_5 Uncertainty_t \cdot UucnPrecision_t + \lambda_6 Dispersion_t \\ & + \lambda_7 Uncertainty_t \cdot Dispersion_t + \varepsilon_t \end{aligned} \tag{2}$$

where:

$Dispersion_t$ is the measure for disagreements among market participants, and defined as the standard deviation of spot values of AAII bullish, bearish and neutral sentiment percentages. For robustness test, we employ another alternative measure, $Dispersion\_Range_t$, to capture investors' opinions dispersion. $Dispersion\_Range_t$, is defined as the difference between the highest and the lowest percentages among AAII bullish, bearish and neutral spot sentiment percentages. Other independent variables are the same as in model (1).

To test hypotheses (H3a) and (H3b) about investors' sentiment (representative bias), the following model was estimated:

$$\begin{aligned} VIX_t = {} & \lambda_0 + \lambda_1 \Delta S\&P500_t + \lambda_2 Trend_t + \lambda_3 Uncertainty_t + \lambda_4 UucnPrecision_t \\ & + \lambda_5 Uncertainty_t \cdot UucnPrecision_t + \lambda_6 Dispersion_t \\ & + \lambda_7 Uncertainty_t \cdot Dispersion_t + \lambda_8 Sent_t \\ & + \lambda_9 Uncertainty_t \cdot Sent_t + \varepsilon_t \end{aligned} \quad (3)$$

where:

$Sent_t$ is a dummy variable which is equal to one if the spot value of AAII *bullish* percentage in a week is higher than the spot values of AAII *bearish* percentage and AAII *neutral* percentage, and zero otherwise. For robustness tests, we employ three alternative measures of investors' sentiment, $Sent\_4wk_t$, $Sent\_8wk_t$ or $Sent\_12wk_t$. $Sent\_4wk_t$ *is* a dummy equal to one if the four-week moving average of AAII *bullish* percentage is higher than the four-week moving averages of AAII *bearish* percentage and AAII *neutral* percentage, and zero otherwise. Similarly, $Sent\_8wk_t$ and $Sent\_12wk_t$ are for eight-week moving average and twelve-week moving average, respectively. Other independent variables are the same as in model (2).

5. Empirical Results

5.1 Precision of political signals

In this section, we test the hypothesis formulated in section 2 of the paper. First, we examine the effects of policy uncertainty and political signals' quality on VIX level. The Exhibit 6 shows the results of model (1) with different proxies for uncertainty measured by BBD news-based index (*Uncertainty*) in Column 1-3 and BBD overall index (*OverallBBD*) in Column 4-6. In each case we consider three alternative measures on the quality of political signals, which are defined as the three-month

(primary measure), one-month and two-month rolling volatility of daily BBD index returns.[11] In all specifications, the parameter estimation is reported with *Newey-West* standard errors.

EXHIBIT 6 HERE

The results in Exhibit 6 indicate that both the BBD news-based index (*Uncertainty*) and BBD overall index (*OverallBBD*) have statistically significant and positive impacts on VIX index. It can be also found that higher daily return of S&P 500 index reduces the log level of the fear gauge. Those findings are consistent with hypotheses (H1a) that overall VIX tends to be lower in the environment where policy uncertainty is high. The analysis of specification (3) and (6) reveals that the three-month rolling volatility of daily BBD index return ($UncnPrecision_t$), has negative and significant impact on VIX. Specification (1) and (4) present the results with the one-month rolling volatility of daily BBD index return ($UncnPrecision\_1m_t$) and specification (2) and (5) present the results with the two-month rolling volatility of daily BBD index return ($UncnPrecision\_2m_t$). The coefficients on both $UncnPrecision\_1m_t$ and $UncnPrecision\_2m_t$ are found significantly negative, which is consistent with those on $UncnPrecision_t$ and support hypotheses (H1b). On the other hand, the interaction term between policy uncertainty (*Uncertainty*) and the quality of political signals (*Uncnprecision*, *UncnPrecision_1m*, *UncnPrecision_2m*) presents significantly positive sign, which could weaken the negative effects of *Uncnprecision*, *UncnPrecision_1m*, and *UncnPrecision_2m* on VIX level. It suggests that the sign of the combined impacts of the quality of political signals and its interaction term

[11] In Exhibit 7-10, we only present results with the main proxy for the quality of political signals, namely the three-month rolling volatility of daily BBD index returns. We find consistent results with alternative measures on the quality of political signals, which are available upon requests.

depends on the magnitude of policy uncertainty (*Uncertainty*).[12] These findings are in line of the model presented by Pastor and Veronesi [2012, 2013] that implies VIX is affected by the quality of political signals together with policy uncertainty. Independently, for all of our proxies for economic policy uncertainty, the results are the consistent.

5.2 Investors' opinions dispersion

We next examine the impacts of investors' opinions dispersion on the VIX level by adding the dispersion measures to model (1) discussed above (see model (2)). The results are presented in Exhibit 7. In specification (1) and (3), investors' opinions dispersion is proxied by $Dispersion_t$ which is defined as the standard deviation of spot values of AAII bullish, bearish and neutral sentiment percentages. In specification (2) and (4), opinions dispersion is proxied by $Dispersion\_Range_t$, which is defined as the difference between the highest and the lowest percentages among AAII bullish, bearish and neutral spot sentiment percentages. Recall that a high value of $Dispersion_t$ or *Dispersion_Range* indicates a dominate sentiment and therefore low opinions disagreement among investors. As shown in Exhibit 7, all the dispersion measures present significant and negative signs, indicating that a low level of opinions disagreement among investors, proxied by high value in *Dispersion* and *Dispersion_Range*, tend to lower the level of VIX, which is consistent with hypotheses (H2a). On the other hand, the coefficients for the interaction terms between policy uncertainty (*Uncertainty*, *OverallBBD*) and opinions dispersion (*Dispersion*, *Dispersion_Range*) are found significantly positive, which suggests that

[12] Test on the sign of the combined effect of the quality of political signals (*Uncnprecision*, *UncnPrecision_1m*, *UncnPrecision_2m*) by policy uncertainty levels is in section 5.4.

the sign of the combined impacts of opinions disagreement and its interaction with policy uncertainty on VIX could vary with the level of policy uncertainty (*Uncertainty, OverallBBD*).[13] The findings on policy uncertainty and the quality of political signals are consistent with those reported in Exhibit 6 that the policy uncertainty (*Uncertainty*) overall has positive impacts on VIX level while the impacts of the quality of political signals (e.g. *Uncnprecision*) depend on the level of policy uncertainty.

5.3 Representativeness bias

To examine the effects of representativeness, we test if the investors' sentiment impacts the relationship between policy uncertainty and the VIX level. As in cases of previous models, we regress the log value of VIX on daily log return of S&P 500 index, BBD indices, the quality of political signals and opinions dispersion. We then add the dummies designed to reflect market sentiment, namely the current spot and trailing sentiment between four to twelve weeks. Similarly, we run two sets of models within model (3), each with a different proxy for policy uncertainty: monthly BBD news-based index (*Uncertainty*) in Exhibit 8 Panel A and monthly BBD overall index (*OverallBBD*) in Exhibit 8 Panel B.[14]

EXHIBIT 8 HERE

As shown in Exhibit 8, the dummies indicating bullish sentiment among investors *(Sent, Sent_4wk, Sent_8wk, Sent_12wk*) are all found insignificant to influence the

[13] Test on the sign of the combined effect of opinions dispersion (*Dispersion, Dispersion_Range*) by policy uncertainty levels is provided in section 5.4.

[14] In Exhibit 8, we only present results with opinions dispersion proxied by *Dispersion,* the result with opinions dispersion proxied by *Dispersion_Range* are consistent with those in Exhibit 8 and unreported for brevity reason. It's available upon requests.

level of VIX, which does not support hypothesis (H3a) that VIX is lower in an environment characterized by bullish sentiment among investors. The coefficient corresponding to interaction terms between proxy of policy uncertainty (*Uncertainty*) and the dummy for bullish sentiments is significant for all specifications in Exhibit 8. The negative sign of those coefficients suggests that during periods of bullish sentiment among investors, the impact of policy uncertainty on VIX measured by BBD new-based index (*Uncertainty*) is actually lower than at other times. The results on the quality of political signals are in line with those reported in Exhibit 6 and Exhibit 7 and the findings on investors' opinions dispersion are also consistent with those in Exhibit 7 – the impacts of the quality of political signals and opinions dispersion among investors on the level of VIX depend on the level of policy uncertainty. Results with policy uncertainty proxied by BBD overall index are presented in Exhibit 9. The results reported for all specifications in Exhibit 9 are consistent with those presented in Exhibit 8. Thus, it indicates that our findings are robust.

EXHIBIT 9 HERE

Our results show that CBOE's VIX index value is less likely to increase when the high economic policy uncertainty is accompanied with high level of investors' bullish sentiment. Moreover, we found that the coefficients corresponding to an interaction term between investors' sentiment and proxies for policy uncertainty monotonically increase as number of weeks used for calculating a moving average rises from four to twelve weeks. The interaction terms with more recent short-term sentiment exhibit more pronounced negative impacts. The reported results support hypothesis (H3b) that representativeness bias (bullish sentiment) weakens the relationship between economic policy uncertainty and VIX level.

The reported results are robust for different proxies for market sentiment, as we also run these regressions with the investor sentiment index data constructed by Baker and Wurgler [2006]. We find the results consistent with those obtained when AAII sentiment index was used. As a further robustness check of the results reported above, we consider to replace the dummy variable *Sent* capturing bullish sentiment in model (3), with the dummy variable designed to track the current trailing AAII bearish sentiment. The findings are statistically significant and, as expected, the coefficient sign of the interaction terms between bearish sentiment dummy and BBD indices, is positive. This result shows that the impact of policy uncertainty on VIX level strengthens when investors' sentiment is bearish.[15]

5.4 Effect of the interaction terms

As discussed in previous section, the coefficient sign for *UncnPrecision* is found different from that of its interaction term with policy uncertainty, despite both of the coefficients are significant. This result suggests that the direction of the combined effects of the quality of political signals (*UncnPrecision*) could vary with the level of policy uncertainty (*Uncertainty, OverallBBD*). In order to better understand the impact of the quality of political signals (*UncnPrecision*) and policy uncertainty on VIX, we estimate the interacted effects of policy uncertainty conditionally on three different levels of the quality of political signals (*UncnPrecision*), namely the low, average, and high levels. The low level of *UncnPrecision* is calculated as the mean minus the standard deviation (0.372) while the high level is calculated as the mean plus the standard deviation (1.468). Based on the results presented in Colum1, Exhibit

[15] The results with the sentiment index of Baker and Wurgler [2006] and bearish sentiment dummies are not reported for brevity reason. They are available upon requests.

8, Exhibit 10 presents the effects of policy uncertainty (*Uncertainty*) on dependent variable (logarithm of VIX) conditionally on the three levels of the quality of political signals.[16] In Exhibit 10, we also illustrate the median level of policy uncertainty (*Uncertainty*) over 1997-2016 as well as the median level in 2017. *Uncertainty* has a median value of 103.8 over 1997-2016, while its median in 2017 is 134.5. As shown in Exhibit 10, the effect of *Uncertainty* on the dependent variable is found positive for all three levels of *UncnPrecision.* Given the median levels of *Uncertainty* over 1997-2016 and in 2017, it can be found that VIX is lower when *UncnPrecision* is high, which is consistent with Pastor and Veronesi [2012, 2013] suggesting that the imprecision of political signals decreases market volatility. These findings also support our hypotheses (H1c) that the positive impact of policy uncertainty is weakened by imprecise political signals. However, it can be noticed in Exhibit 10 that, when the level of policy uncertainty (*Uncertainty*) moves beyond a certain high level, VIX can be higher even when *UncnPrecision* is high.[17] It suggests the positive impacts of *Uncertainty* can be more pronounced in an environment featured by imprecise political signals during times when the policy uncertainty is quite high. Overall, these findings suggest that that VIX is lower in an environment featured by low-quality political signals most of the time.

EXHIBIT 10 HERE

We next examine the impacts of policy uncertainty and opinions disagreement (*Dispersion*) on VIX. Similarly, we examine the interacted effects of policy uncertainty conditionally on the low, average, and high levels of opinions

[16] As robustness tests, we also examine the effects of interaction terms based on results in other columns and exhibits, which control for all the impacts of the factors. The findings interaction effects are consistent across different result columns and available upon request.

[17] Based on the results presented in Column 1, Exhibit 8, the break-even level of *Uncertainty* *UncnPrecision* is found to be 171.8, which corresponds the 88th percentile of its values measured over the whole study period.

disagreement (*Dispersion*). The low level of *Dispersion* is calculated as the mean minus the standard deviation (0 .054) while the high level is calculated as the mean plus the standard deviation (0. 172). Based on the results presented in Colum1 of Exhibit 8, Exhibit 11 presents the effects of *Uncertainty* on logarithm of VIX conditionally on those three levels of *Dispersion*. Analogically, we illustrate the median level of *Uncertainty* over 1997-2016 (103.8) and its median level in 2017 (134.5). The effect of *Uncertainty* is found positive across all the levels of *Dispersion* in Exhibit 11. Around the median levels of *Uncertainty* over 1997-2016 and in 2017, VIX is found higher when *Dispersion* is high, which suggests that the impact of policy uncertainty on market volatility gets stronger when the level of opinions disagreement is low. In other words, the positive impact of policy uncertainty on market volatility is weakened by high level of opinions disagreement, which is consistent with hypothesis (H2b). On the other hand, when *Uncertainty* is below a certain level, the impact of policy uncertainty on market volatility is more pronounced with higher opinions disagreement.[18] These findings partly support the literature that claiming that higher opinions disagreement leads to higher market volatility (e.g. David [2008], Andrei, Carlin, and Halser [2015]) conditionally on a relatively low level of the policy uncertainty.

EXHIBIT 11 HERE

We finally present the effects of policy uncertainty conditionally on the values of bullish sentiment (*Sent*) in Exhibit 12. As shown in the Exhibit 12, VIX tends to be lower when the market participants show bullish sentiment independently on the level

[18] Based on the results presented in Column 1, Exhibit 8, the break-even level of *Uncertainty* for *Dispersion* is found to be 91.8, which corresponds the 36th percentile of its values measured over the whole study period.

of *Uncertainty*. It suggests that the positive impact of policy uncertainty on VIX is weakened when market sentiment is bullish and supports hypothesis (H3b).

EXHIBIT 12 HERE

6. Conclusion

Motivated by the extremely low level of VIX and relatively high economic policy uncertainty in 2017, we examine the factors affecting the relationship between those two. By investigating the links between CBOE's VIX index and economic policy uncertainty proxied by Baker-Bloom-Davis (BBD) indices, we show that policy uncertainty plays an important role in explaining the level of VIX. We also find evidences that the low quality of political signals significantly affects VIX level and such impact interacts with the effect of policy uncertainty. By testing the interaction term effects conditionally on the three levels of the quality of political signals, we show that, most of the time, the imprecision of political signals weakens the positive impacts of policy uncertainty. This finding supports the model presented by Pastor and Veronesi [2012, 2013]. However, our results also suggest that such effect could be reversed during periods when policy uncertainty is very high. Moreover, we find that investors' opinions dispersion significantly influences expected market volatility and analogously the impact interacts with that of policy uncertainty. The examination of interaction effect shows that, most of the time, the positive impact of policy uncertainty on VIX is weakened by high opinions dispersion. On the other hand, we find evidences that high opinions divergence can strengthen the impact of policy uncertainty during periods when policy uncertainty is relatively low. In addition, our results show that the commonly accepted positive relationship between VIX index and

economic policy uncertainty is weakened during periods characterized by bullish investors' sentiment. This result may be attributed to representativeness bias- investors are prone to make error of extrapolating an investment as good or bad based on its recent performance.

Taking into account our empirical findings, the record-low VIX level in 2017 could be attributed to the combination of one of the longest bull market and stream of unprecise economic/political signals together with high investors' opinions dispersion, despite high economic policy uncertainty. To sum up, we find that the relationship between the VIX level and economic policy uncertainty is affected by different factors and is subject to changes over time.

Reference

Amengual, D., and D. Xiu. "Resolution of Policy Uncertainty and Sudden Declines in Volatility." *Journal of Econometrics*, (2017).

Andrei, D., B. Carlin, and M. Hasler, 2015, Asset Pricing with Structural Uncertainty and Structural Disagreement, (Working Paper).

Antonakakis, N., I. Chatziantoniou, and G. Filis. "Dynamic Co-Movements of Stock Market Returns, Implied Volatility and Policy Uncertainty." *Economics Letters*, Vol. 120, No. 1 (2013), pp. 87-92.

Asensio, I.O. "The Vix-Vix Futures Puzzle." Working Paper, University of Victoria, 2013.

Avellaneda, M. "Some Remarks on VIX Futures and ETNs." New York University, 2017

Baker, M., and J. Wurgler. "Investor Sentiment and the Cross‐Section of Stock Returns." *The Journal of Finance*, Vol. 61, No. 4 (2006), pp. 1645-1680.

Baker, S.R., N. Bloom, and S.J. Davis. "Measuring Economic Policy Uncertainty." *The Quarterly Journal of Economics*, Vol. 131, No. 4 (2016), pp. 1593-1636.

Banerjee, S., and I. Kremer. "Disagreement and Learning: Dynamic Patterns of Trade." *The Journal of Finance*, Vol. 65, No. 4 (2010), pp. 1269-1302.

Banerji, G., "Market's 'Fear Gauge' Nears 1993 Low." The Wall Street Journal, 2017: https://www.wsj.com/articles/markets-fear-gauge-nears-1993-low-1494263976

Barberis, N., A. Shleifer, and R. Vishny. "A Model of Investor Sentiment1." *Journal of financial economics*, Vol. 49, No. 3 (1998), pp. 307-343.

Benartzi, S., and R.H. Thaler. "Myopic Loss Aversion and the Equity Premium Puzzle." *The quarterly journal of Economics*, Vol. 110, No. 1 (1995), pp. 73-92.

Bessembinder, H., K. Chan, and P.J. Seguin. "An Empirical Examination of Information, Differences of Opinion, and Trading Activity." *Journal of Financial Economics*, Vol. 40, No. 1 (1996), pp. 105-134.

Brogaard, J., and A. Detzel. "The Asset-Pricing Implications of Government Economic Policy Uncertainty." *Management Science*, Vol. 61, No. 1 (2015), pp. 3-18.

Buraschi, A., and A. Jiltsov. "Model Uncertainty and Option Markets with Heterogeneous Beliefs." *The Journal of Finance*, Vol. 61, No. 6 (2006), pp. 2841-2897.

Chernenko, S., S.G. Hanson, and A. Sunderam. "Who Neglects Risk? Investor Experience and the Credit Boom." *Journal of Financial Economics*, Vol. 122, No. 2 (2016), pp. 248-269.

Chiang, Y.-M., D. Hirshleifer, Y. Qian, and A.E. Sherman. "Do Investors Learn from Experience? Evidence from Frequent Ipo Investors." *The Review of Financial Studies*, Vol. 24, No. 5 (2011), pp. 1560-1589.

Ciolli, J., "Why Stock Market Volatility Isn't Really as Low as It Appears." Bloomberg, 2017: https://www.bloomberg.com/news/articles/2017-02-03/correlation-is-causality-when-it-comes-to-silenced-stock-swings

Committee, F.O.M., "Minutes of the Federal Open Market Committee." Federal Reserve, 2009: https://www.federalreserve.gov/monetarypolicy/fomcminutes20091216.htm

De Bondt, W.F., and R. Thaler. "Does the Stock Market Overreact?" *The Journal of finance*, Vol. 40, No. 3 (1985), pp. 793-805.

De Bondt, W.P. "Betting on Trends: Intuitive Forecasts of Financial Risk and Return." *International Journal of forecasting*, Vol. 9, No. 3 (1993), pp. 355-371.

Deng, G., C.J. McCann, and O. Wang. "Are Vix Futures Etps Effective Hedges?" *The Journal of Index Investing*, Vol. 3, No. 3 (2012), pp. 35-48.

Dhar, R., and A. Kumar. "A Non-Random Walk Down the Main Street: Impact of Price Trends on Trading Decisions of Individual Investors." *Yale International Center for Finance. Working Paper*, (2001).

Dumas, B., A. Kurshev, and R. Uppal. "Equilibrium Portfolio Strategies in the Presence of Sentiment Risk and Excess Volatility." *The Journal of Finance*, Vol. 64, No. 2 (2009), pp. 579-629.

Engle, R.F., and G.M. Gallo. "A Multiple Indicators Model for Volatility Using Intra-Daily Data." *Journal of Econometrics*, Vol. 131, No. 1-2 (2006), pp. 3-27.

Eraker, B., and Y. Wu. "Explaining the Negative Returns to Volatility Claims: An Equilibrium Approach." *Journal of Financial Economics*, Vol. 125, No. 1 (2017), pp. 72-98.

Fund, I.M., "World Economic Outlook: Coping with High Debt and Sluggish Growth." IMF Press, 2012:

——, "World Economic Outlook: Hopes, Realities, Risks." IMF Press, 2013:

Gehricke, S., 2015, Modeling Vxx Price, (University of Otago).

Greenwood, R., and S. Nagel. "Inexperienced Investors and Bubbles." *Journal of Financial Economics*, Vol. 93, No. 2 (2009), pp. 239-258.

Hancock, G. "Vix Futures Etns: Three Dimensional Losers." *Accounting and Finance Research*, Vol. 2, No. 3 (2013), pp. 53.

Johnson, T.C., and J. Lee. "On the Systematic Volatility of Unpriced Earnings." *Journal of Financial Economics*, Vol. 114, No. 1 (2014), pp. 84-104.

Kang, W., and R.A. Ratti. "Oil Shocks, Policy Uncertainty and Stock Market Return." *Journal of International Financial Markets, Institutions and Money*, Vol. 26, (2013), pp. 305-318.

Kelly, B., Ľ. Pástor, and P. Veronesi. "The Price of Political Uncertainty: Theory and Evidence from the Option Market." *The Journal of Finance*, Vol. 71, No. 5 (2016), pp. 2417-2480.

Kim, K.A., and J.R. Nofsinger. "Behavioral Finance in Asia." *Pacific-Basin Finance Journal*, Vol. 16, No. 1-2 (2008), pp. 1-7.

Lam, S.S., and W. Zhang. "Does Policy Uncertainty Matter for International Equity Markets?" (2014).

Li, X.-l., M. Balcilar, R. Gupta, and T. Chang. "The Causal Relationship between Economic Policy Uncertainty and Stock Returns in China and India: Evidence from a Bootstrap Rolling Window Approach." *Emerging Markets Finance and Trade*, Vol. 52, No. 3 (2016), pp. 674-689.

Liu, L., and T. Zhang. "Economic Policy Uncertainty and Stock Market Volatility." *Finance Research Letters*, Vol. 15, (2015), pp. 99-105.

Miller, E.M. "Risk, Uncertainty, and Divergence of Opinion." *The Journal of finance*, Vol. 32, No. 4 (1977), pp. 1151-1168.

Moyo, D., "Why Wall Street's Fear Index Remains Calm." Financial Times, 2017: https://www.ft.com/content/03935d3a-b254-11e7-aa26-bb002965bce8

Pastor, L., and P. Veronesi. "Uncertainty about Government Policy and Stock Prices." *The Journal of Finance*, Vol. 67, No. 4 (2012), pp. 1219-1264.

——. "Political Uncertainty and Risk Premia." *Journal of Financial Economics*, Vol. 110, No. 3 (2013), pp. 520-545.

——, "Explaining the Puzzle of High Policy Uncertainty and Low Market Volatility." VOX, 2017: https://voxeu.org/article/puzzle-high-policy-uncertainty-and-low-market-volatility

——, "High Policy Uncertainty and Low Market Volatility." The Wall Street Journal, 2017: https://www.wsj.com/articles/high-policy-uncertainty-and-low-market-volatility-1495703982

Scheinkman, J.A., and W. Xiong. "Overconfidence and Speculative Bubbles." *Journal of political Economy*, Vol. 111, No. 6 (2003), pp. 1183-1220.

Shaikh, I., and P. Padhi. "The Implied Volatility Index: Is 'Investor Fear Gauge'or 'Forward-Looking'?" *Borsa Istanbul Review*, Vol. 15, No. 1 (2015), pp. 44-52.

Shleifer, A. *Inefficient Markets: An Introduction to Behavioural Finance*, OUP Oxford, 2000.

Siganos, A., E. Vagenas-Nanos, and P. Verwijmeren. "Divergence of Sentiment and Stock Market Trading." *Journal of Banking & Finance*, Vol. 78, (2017), pp. 130-141.

Sum, V., and F. Fanta. "Long-Run Relation and Speed of Adjustment of Economic Policy Uncertainty and Excess Return Volatility." (2012).

Tversky, A., and D. Kahneman. "Judgment under Uncertainty: Heuristics and Biases." *science*, Vol. 185, No. 4157 (1974), pp. 1124-1131.

Watts, W., "Why Is Market Volatility So Low When Uncertainty Is So High?" MatchWatch, 2017: https://www.marketwatch.com/story/if-uncertainty-is-so-high-why-is-market-volatility-so-low-2017-03-06

Weber, A., "Markets Must Prepare for More Volatility." Financial Times, 2018: https://www.ft.com/content/d612670a-e0e5-11e7-a0d4-0944c5f49e46

Whaley, R.E. "The Investor Fear Gauge." *The Journal of Portfolio Management*, Vol. 26, No. 3 (2000), pp. 12-17.

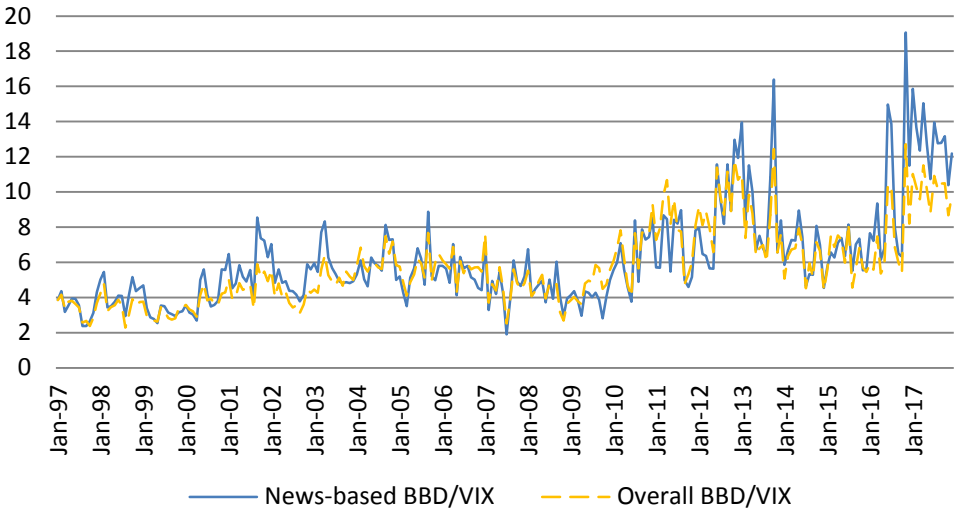
——. "Understanding Vix." (2008).

——. "Trading Volatility: At What Cost?" *Journal of Portfolio Management*, Vol. 40, No. 1 (2013), pp. 95.

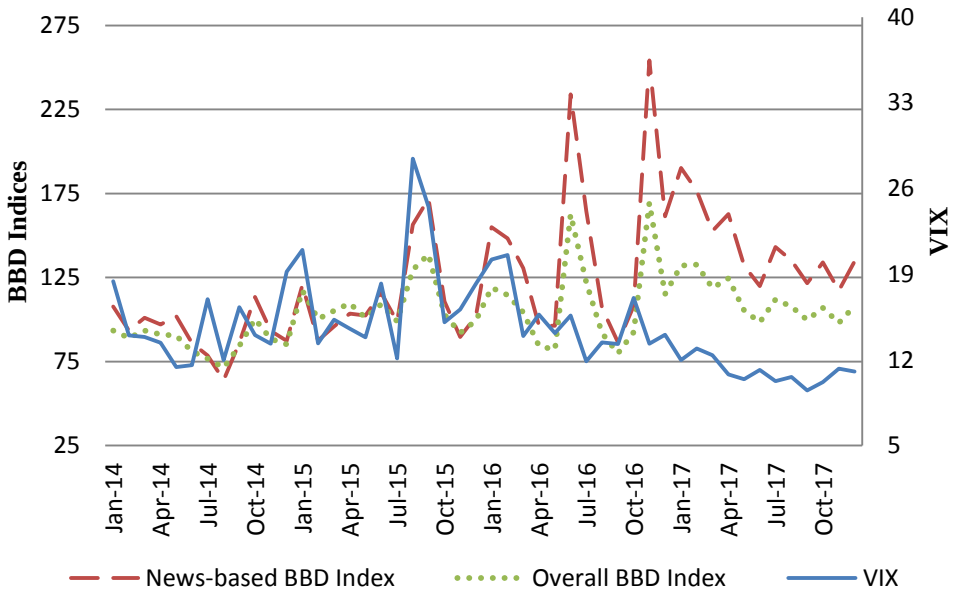
Zhang, J.E., and Y. Zhu. "Vix Futures." *Journal of Futures Markets*, Vol. 26, No. 6 (2006), pp. 521-531.

Exhibit 1 VIX Index and Economic Policy Uncertainty

Panel A
Ratio of Uncertainty Indices to VIX



Panel B
Co-movement of VIX and Uncertainty Indices



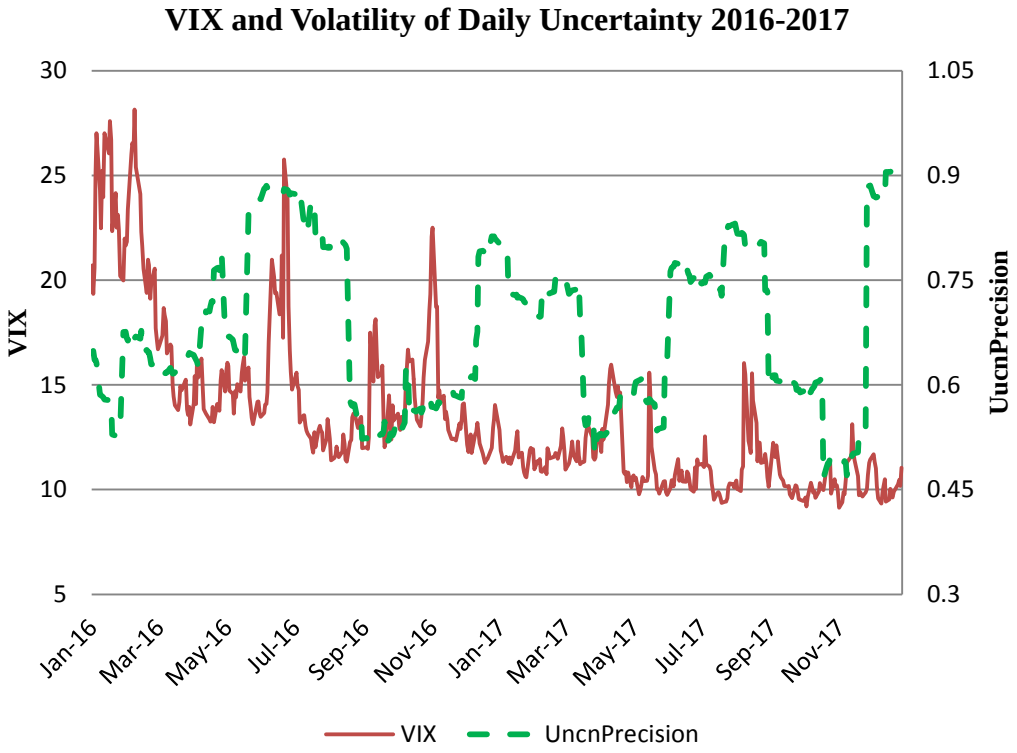
Panel A presents the ratio of economic policy uncertainty indices (news-based Baker-Bloom-Davis index and overall Baker-Bloom-Davis index) to VIX from January 1997 to December 2017. Panel B presents the value of VIX index and economic policy uncertainty indices from January 2014 to December 2017.

Exhibit 2 CBOE VIX, Economic Policy Uncertainty and S&P 500 Index

VIX deciles (1997-2016)	1-10th	11-20th	21-30th	31-40th	41-50th	51-60th	61-70th	71-80th	81-90th	91-100th	2017	Means of 2017 as percentile of 1997-2016
CBOE VIX	11.64984	13.26109	14.81006	16.68558	18.65952	20.43294	22.27789	24.48948	27.88584	39.36984	11.09024	2th
News based BBD	79.12014	105.7046	106.9593	112.22	112.0564	105.3188	110.3203	116.5465	128.3308	170.3311	142.6863	77th
Overall BBD	78.27846	96.63493	103.5737	115.8798	112.1819	101.98	105.168	110.5349	114.7799	148.9907	111.6307	64th
S&P500	1519.599	1668.396	1575.911	1430.027	1273.445	1214.081	1258.014	1233.576	1188.812	977.4561	2449.076	Historical high
Observations	504	504	503	501	504	503	503	503	503	503	251	

This Exhibit presents the means of CBOE VIX, news-based Baker-Bloom-Davis (BBD) uncertainty index, overall BBD uncertainty index and S&P500 index based on the deciles of VIX for period 1997-2016. The last two columns present the mean of these indices in 2017 as the percentiles in 1997-2016 period.

Exhibit 3 Precision of Policy Signals and CBOE VIX



This exhibit presents the value of VIX index and the quality of policy uncertainty (*UncnPrecision*), measured by the volatility of the daily news-based BBD index within a three-month rolling period from January 2016 to December 2017.

Exhibit 4 Summary Statistics

Variables	Obs	Mean	Standard Deviation	Min	Max
VIX	5281	20.479	8.449	9.140	80.86
ΔS&P500	5281	0.000	0.012	-0.090	0.116
S&P500	5281	1387.2	421.6	676.5	2690.2
Uncertainty	5281	116.02	44.84	44.78	283.67
OverallBBD	5281	108.94	35.62	57.20	245.13
UncnPrecision_1m	5281	0 .875	0.630	0.264	5.241
UncnPrecision_2m	5281	0.904	0.576	0.330	4.246
UncnPrecision	5281	0.920	0.548	0.338	3.567
Bullish	5281	0.398	0.100	0.165	0.750
Bearish	5281	0.307	0.098	0.067	0.703
Neutral	5281	0.295	0.081	0.077	0.529
Dispersion	5281	0.113	0.059	0.005	0.361
Dispersion_Range	5281	0.214	0.112	0.008	0.633
Sent	5281	0.545	0.498	0.000	1.000
Sent_4wk	5281	0.580	0.494	0.000	1.000
Sent_8wk	5281	0.613	0.487	0.000	1.000
Sent_12wk	5281	0.625	0.484	0.000	1.000

This exhibit presents the summary statistics for all variables examined in our study as well as relevant market indices used for calculation. *VIX* is the value of CBOE Volatility index. *S&P500* is the value of equity market index. *ΔS&P500* is the daily log return of S&P 500 index. *Uncertainty* is the value of Baker, Bloom and Davis news-based policy uncertainty index. *OverallBBD* is the value of Baker, Bloom and Davis overall policy uncertainty index. $UncnPrecision\_1m_t$ is the measure for the precision of policy uncertainty, which is calculated as the one-month rolling volatility of daily BBD-index returns. $UncnPrecision\_2m_t$ is the measure for the precision of policy uncertainty, which is calculated as the two-month rolling volatility of daily BBD-index returns. *UncnPrecision* is the measure on the quality of political signals, measured by three-month rolling volatility of daily returns of BBD index. *Bullish* is the reported bullish percentage in AAII index. *Bearish* is the reported bearish percentage in AAII index. *Neutral* is the neutral percentage in AAII index. $Dispersion_t$ is the measure for investors' opinions dispersion, calculated as the standard deviation of AAII bullish percentage, AAII bearish percentage, and AAII neutral percentage. $Dispersion\_Range_t$ is another measure for investors' opinions dispersion, defined as the difference between the highest AAII sentiment percentage and the lowest AAII sentiment percentage. $Sent_t$ is a dummy set to one if the spot value of AAII bullish percentage in that week is higher than the spot values of AAII bearish and neutral percentage, and zero otherwise. $Sent\_4wk_t$ is a dummy set to one if the four-week moving average of AAII bullish percentage is higher than the four-week moving averages of bearish and neutral percentage, and zero otherwise. Similarly, $Sent\_8wk_t$ and $Sent\_12wk_t$ are for eight-week and twelve-week moving average of AAII bullish percentage respectively.

Exhibit 5 Correlation Matrix for Independent Variables

	VIX	ΔS&P500	Uncertainty	OverallBBD	UncnPrecision	Dispercion
ΔS&P500	-0.112***					
Uncertainty	0.364***	-0.030**				
OverallBBD	0.381***	-0.022	0.888***			
UncnPrecision	0.017	-0.007	-0.256***	-0.407***		
Dispersion	0.142***	-0.010	-0.117***	-0.114***	0.003	
Sent	-0.170***	0.020	-0.127***	-0.084***	-0.050***	0.280***

VIX is the log value of VIX index at time *t*. $\Delta S\&P500_t$ is the daily log return of equity market index. $Trend_t$ is the time trend control variable. $Uncertainty_t$ is the value of BBD news-based uncertainty index at time *t* and $OverallBBD_t$ is the value of BBD overall uncertainty index at time *t*. $UucnPrecison_t$ is the measure for the quality of political signals (precision of policy uncertainty), which is calculated as the three-month rolling volatility of daily returns of BBD index. $Dispersion_t$ is the measure for investors' opinions dispersion, calculated as the standard deviation of AAII bullish percentage, AAII bearish percentage, and AAII neutral percentage. $Sent_t$ is a dummy set to one if the spot value of AAII bullish percentage in that week is higher than the spot values of AAII bearish and neutral percentage, and zero otherwise. *,**,*** corresponds to statistically significance at the 10%, 5% and 1% level, respectively.

Exhibit 6
The Impact of the Quality of Political Signals on CBOE VIX

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta S\&P500_t$	-2.9058***	-2.8990***	-2.8786***	-2.9296***	-2.8879***	-2.8877***
	(-6.48)	(-6.44)	(-6.40)	(-6.88)	(-6.81)	(-6.81)
$Trend_t$	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-36.80)	(-36.14)	(-32.24)	(-42.01)	(-41.54)	(-39.67)
$Uncertainty_t$	0.0034***	0.0025***	0.0025***			
	(8.63)	(6.69)	(6.41)			
$OverallBBD_t$				0.0051***	0.0040***	0.0039***
				(11.60)	(9.83)	(8.96)
$UncnPrecision\_1m_t$	-0.2173***			-0.2348***		
	(-4.81)			(-4.59)		
$Uncertainty_t * UncnPrecision\_1m_t$	0.0011***					
	(2.63)					
$OverallBBD_t * UncnPrecision\_1m_t$				0.0019***		
				(3.35)		
$UncnPrecision\_2m_t$		-0.3558***			-0.4012***	
		(-8.23)			(-8.44)	
$Uncertainty_t * UncnPrecision\_2m_t$		0.0021***				
		(5.84)				
$OverallBBD_t * UncnPrecision\_2m_t$					0.0035***	
					(7.42)	
$UucnPrecision_t$			-0.3557***			-0.4213***
			(-7.87)			(-8.57)
$Uncertainty_t * UucnPrecision_t$			0.0021***			
			(6.14)			
$OverallBBD_t * UucnPrecision_t$						0.0038***
						(8.11)
Intercept	3.0514***	3.1966***	3.1943***	2.8798***	3.0181***	3.0221***
	(63.53)	(62.51)	(57.03)	(61.33)	(61.98)	(57.92)
Adj.R-squared	0.477	0.483	0.48	0.544	0.553	0.552
N	5281	5281	5281	5281	5281	5281

This exhibit presents the results on how policy uncertainty and the quality of political signals can affect VIX level. The dependent variable is the log value of VIX index at time *t*. $\Delta S\&P500_t$ is the daily log return of equity market index. $Trend_t$ is the time trend control variable. $Uncertainty_t$ in is the value of BBD news-based uncertainty index at time *t* and $OverallBBD_t$ is the value of BBD overall uncertainty index at time *t*. $UncnPrecision\_1m_t$ is the measure for the precision of policy uncertainty, which is calculated as the one-month rolling volatility of daily BBD-index returns. $UncnPrecision\_2m_t$ is the measure for the precision of policy uncertainty, which is calculated as the two-month rolling volatility of daily BBD-index returns. $UucnPrecison_t$ is the measure for the quality of political signals (precision of policy uncertainty), which is calculated as the three-month rolling volatility of daily returns of BBD index. Results are reported with *Newey-West* standard errors. *, **, *** corresponds to statistically significance at the 10%, 5% and 1% level, respectively.

Exhibit 7
The Impact of Investors' Opinions Dispersion and Uncertainty on VIX

	(1)	(2)	(3)	(4)
$\Delta S\&P500_t$	-2.8514***	-2.8465***	-2.8791***	-2.8725***
	(-6.59)	(-6.58)	(-7.23)	(-7.22)
$Trend_t$	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-31.00)	(-30.92)	(-37.84)	(-37.67)
$Uncertainty_t$	0.0009*	0.0010*		
	(1.85)	(1.89)		
$OverallBBD_t$			0.0015***	0.0015***
			(2.82)	(2.87)
$UucnPrecision_t$	-0.3591***	-0.3568***	-0.4119***	-0.4073***
	(-7.88)	(-7.84)	(-8.28)	(-8.19)
$Uncertainty_t$ * $UucnPrecision_t$	0.0022***	0.0022***		
	(6.20)	(6.15)		
$OverallBBD_t$ * $UucnPrecision_t$			0.0037***	0.0037***
			(7.79)	(7.70)
$Dispersion_t$	-1.5203***		-2.4512***	
	(-4.61)		(-6.55)	
$Uncertainty_t$ *$Dispersion_t$	0.0135***			
	(4.37)			
$OverallBBD_t$ * $Dispersion_t$			0.0226***	
			(6.09)	
$Dispersion\_Range_t$		-0.7800***		-1.2731***
		(-4.54)		(-6.53)
$Uncertainty_t$ * $Dispersion\_Range_t$		0.0071***		
		(4.40)		
$OverallBBD_t$ * $Dispersion\_Range_t$				0.0119***
				(6.16)
Intercept	3.3658***	3.3580***	3.2823***	3.2735***
	(49.96)	(49.87)	(52.08)	(52.02)
Adj.R-squared	0.489	0.489	0.566	0.566
N	5281	5281	5281	5281

This exhibit presents the results of the regressions which incorporate the impacts of representativeness bias. The dependent variable is the log value of VIX index at time *t*. $\Delta S\&P500_t$ is the daily log return of equity market index. $Trend_t$ is the time trend control variable. $Uncertainty_t$ is the value of BBD news-based uncertainty index at time *t*. $OverallBBD_t$ is the value of BBD overall uncertainty index at time *t*. $UucnPrecison_t$ is the measure for the quality of political signals (the precision of policy uncertainty), which is calculated as the three-month rolling volatility of daily returns of BBD index. $Dispersion_t$ is the measure for investors' opinions dispersion, calculated as the standard deviation of AAII bullish sentiment percentage, AAII bearish sentiment percentage, and AAII neutral sentiment percentage. $Dispersion\_Range_t$ is another measure for investors' opinions dispersion, defined as the difference between the highest AAII sentiment percentage and the lowest AAII sentiment percentage. Results are reported with *Newey-West* standard errors. *, **, *** corresponds to statistically significance at the 10%, 5% and 1% level, respectively.

Exhibit 8

The Impact of Representativeness Bias on VIX and Uncertainty Relationship

	(1)	(2)	(3)	(4)
$\Delta S\&P500_t$	-2.6514***	-2.7293***	-2.8032***	-2.8234***
	(-6.63)	(-6.85)	(-7.12)	(-7.15)
$Trend_t$	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-31.86)	(-33.31)	(-34.07)	(-33.57)
$Uncertainty_t$	0.0017***	0.0014***	0.0014***	0.0010*
	(3.43)	(3.01)	(2.67)	(1.91)
$UucnPrecision_t$	-0.3614***	-0.3865***	-0.3691***	-0.3843***
	(-8.41)	(-9.24)	(-8.54)	(-8.62)
$Uncertainty_t$ * $UucnPrecision_t$	0.0021***	0.0022***	0.0021***	0.0023***
	(6.41)	(7.09)	(6.41)	(6.64)
$Dispersion_t$	-1.0927***	-1.3201***	-1.2466***	-1.3344***
	(-3.54)	(-4.44)	(-4.26)	(-4.29)
$Uncertainty_t$ *$Dispersion_t$	0.0119***	0.0131***	0.0119***	0.0124***
	(4.32)	(4.96)	(4.54)	(4.36)
$Sent_t$	0.0049			
	(0.13)			
$Sent_t$ * $Uncertainty_t$	-0.0013***			
	(-3.83)			
$Sent\_4wk_t$		0.0230		
		(0.59)		
$Sent\_4wk_t$ * $Uncertainty_t$		-0.0016***		
		(-4.60)		
$Sent\_8wk_t$			-0.0410	
			(-0.92)	
$Sent\_8wk_t$ * $Uncertainty_t$			-0.0011***	
			(-2.85)	
$Sent\_12wk_t$				-0.0721
				(-1.57)
$Sent\_12wk_t$ * $Uncertainty_t$				-0.0008**
				(-2.23)
Intercept	3.3466***	3.4219***	3.4493***	3.5134***
	(51.51)	(55.13)	(50.95)	(52.20)
Adj.R-squared	0.531	0.541	0.538	0.536
N	5281	5281	5281	5281

This exhibit presents the results of the regressions which incorporate the impacts of representativeness bias. The dependent variable is the log value of VIX index at time *t*. $\Delta S\&P500_t$ is the daily log return of equity market index. $Trend_t$ is the time trend control variable. $Uncertainty_t$ is the value of BBD news-based uncertainty index at time *t*. $UucnPrecison_t$ is the measure for the quality of political signals (the precision of policy uncertainty), which is calculated as the three-month rolling volatility of daily returns of BBD index. $Dispersion_t$ is the measure for investors' opinions dispersion, calculated as the standard deviation of AAII bullish sentiment percentage, AAII bearish sentiment percentage, and AAII neutral sentiment percentage. $Sent_t$ is a dummy set to one if the spot value of AAII bullish percentage in that week is higher than the spot values of AAII bearish and neutral percentage, and zero otherwise. $Sent\_4wk_t$ is a dummy set to one if the four-week moving average of AAII bullish percentage is higher than the four-week moving averages of bearish and neutral percentage, and zero otherwise. Similarly, $Sent\_8wk_t$ and $Sent\_12wk_t$ are for eight-week and twelve-week moving average of AAII bullish percentage respectively. Results are reported with *Newey-West* standard errors. *, **, *** corresponds to statistically significance at the 10%, 5% and 1% level, respectively.

Exhibit 9

The Impact of Representativeness Bias on VIX and Uncertainty Relationship

	(1)	(2)	(3)	(4)
$\Delta S\&P500_t$	-2.7125***	-2.8009***	-2.8318***	-2.8598***
	(-7.34)	(-7.61)	(-7.88)	(-7.84)
$Trend_t$	-0.0002***	-0.0002***	-0.0002***	-0.0002***
	(-39.28)	(-40.49)	(-41.11)	(-40.07)
$OverallBBD_t$	0.0027***	0.0024***	0.0025***	0.0019***
	(4.81)	(4.56)	(4.25)	(3.30)
$UucnPrecision_t$	-0.3977***	-0.4193***	-0.3993***	-0.4194***
	(-8.43)	(-9.16)	(-8.68)	(-8.66)
$OverallBBD_t$ * $UucnPrecision_t$	0.0034***	0.0036***	0.0034***	0.0036***
	(7.66)	(8.20)	(7.74)	(7.81)
$Dispersion_t$	-1.7159***	-1.9280***	-1.9032***	-1.9995***
	(-4.80)	(-5.65)	(-5.59)	(-5.58)
$OverallBBD_t$ * $Dispersion_t$	0.0181***	0.0191***	0.0183***	0.0189***
	(5.33)	(5.91)	(5.63)	(5.45)
$Sent_t$	-0.0053			
	(-0.13)			
$Sent_t$ * $OverallBBD_t$	-0.0013***			
	(-3.38)			
$Sent\_4wk_t$		0.0250		
		(0.61)		
$Sent\_4wk_t$ * $OverallBBD_t$		-0.0017***		
		(-4.28)		
$Sent\_8wk_t$			-0.0140	
			(-0.31)	
$Sent\_8wk_t$ * $OverallBBD_t$			-0.0014***	
			(-3.28)	
$Sent\_12wk_t$				-0.0585
				(-1.25)
$Sent\_12wk_t$ * $OverallBBD_t$				-0.0009**
				(-2.24)
Intercept	3.2218***	3.2851***	3.3014***	3.3777***
	(50.08)	(53.54)	(49.85)	(50.94)
Adj.R-squared	0.607	0.614	0.614	0.608
N	5281	5281	5281	5281

This exhibit presents the results of the regressions which incorporates the impacts of investors' opinions dispersion. The dependent variable is the log value of VIX index at time *t*. $\Delta S\&P500_t$ is the daily log return of equity market index. $Trend_t$ is the time trend control variable. $OverallBBD_t$ is the value of BBD overall uncertainty index at time *t*. $UucnPrecison_t$ is the measure for the quality of political signals (the precision of policy uncertainty), which is calculated as the three-month rolling volatility of daily returns of BBD index. $Dispersion_t$ is the measure for investors' opinions dispersion, calculated as the standard deviation of AAII bullish sentiment percentage, AAII bearish sentiment percentage, and AAII neutral sentiment percentage. $Sent_t$ is a dummy set to one if the spot value of AAII bullish percentage in that week is higher than the spot values of AAII bearish and neutral percentage, and zero otherwise. $Sent\_4wk_t$ is a dummy set to one if the four-week moving average of AAII bullish percentage is higher than the four-week moving averages of bearish and neutral percentage, and zero otherwise. Similarly, $Sent\_8wk_t$ and $Sent\_12wk_t$ are for eight-week and twelve-week moving average of AAII bullish percentage respectively. Results are reported with *Newey-West* standard errors. *, **, *** corresponds to statistically significance at the 10%, 5% and 1% level, respectively.

Exhibit 10

Effects of the quality of political signals and policy uncertainty on VIX

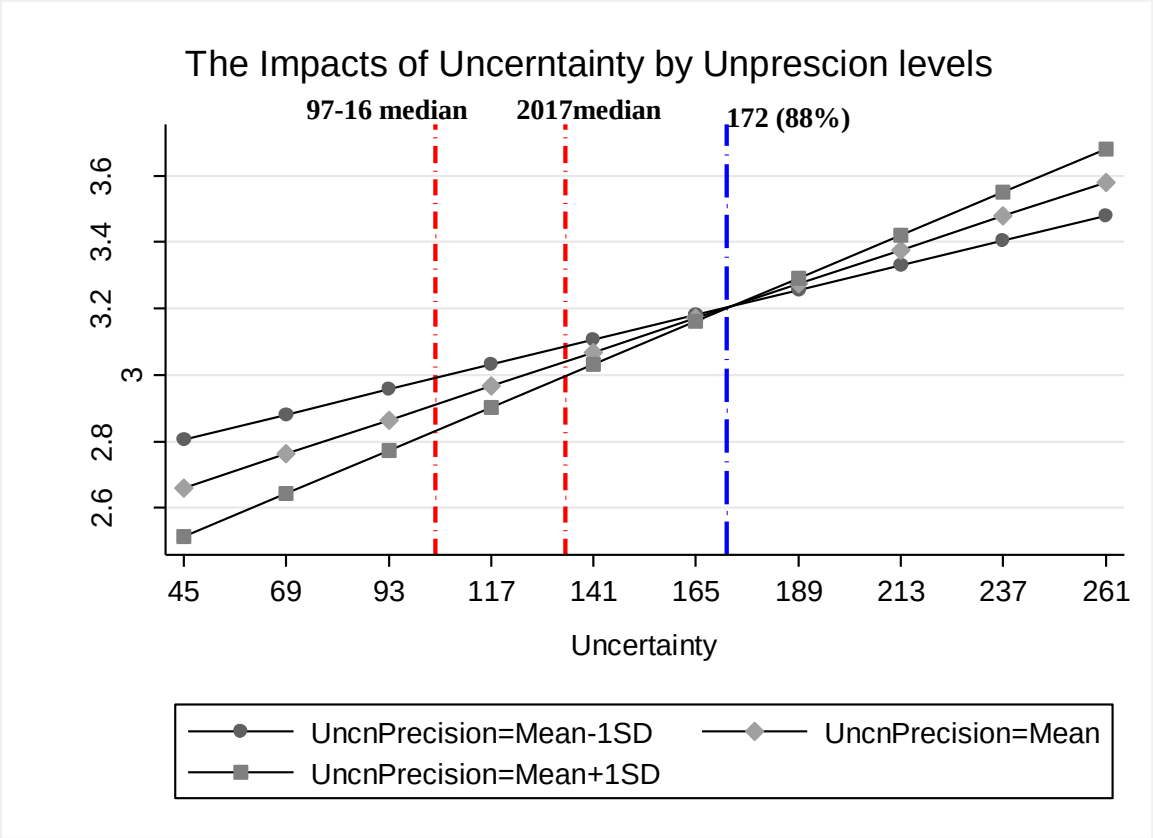


Exhibit 11

Effects of investors' opinions dispersion and policy uncertainty on VIX

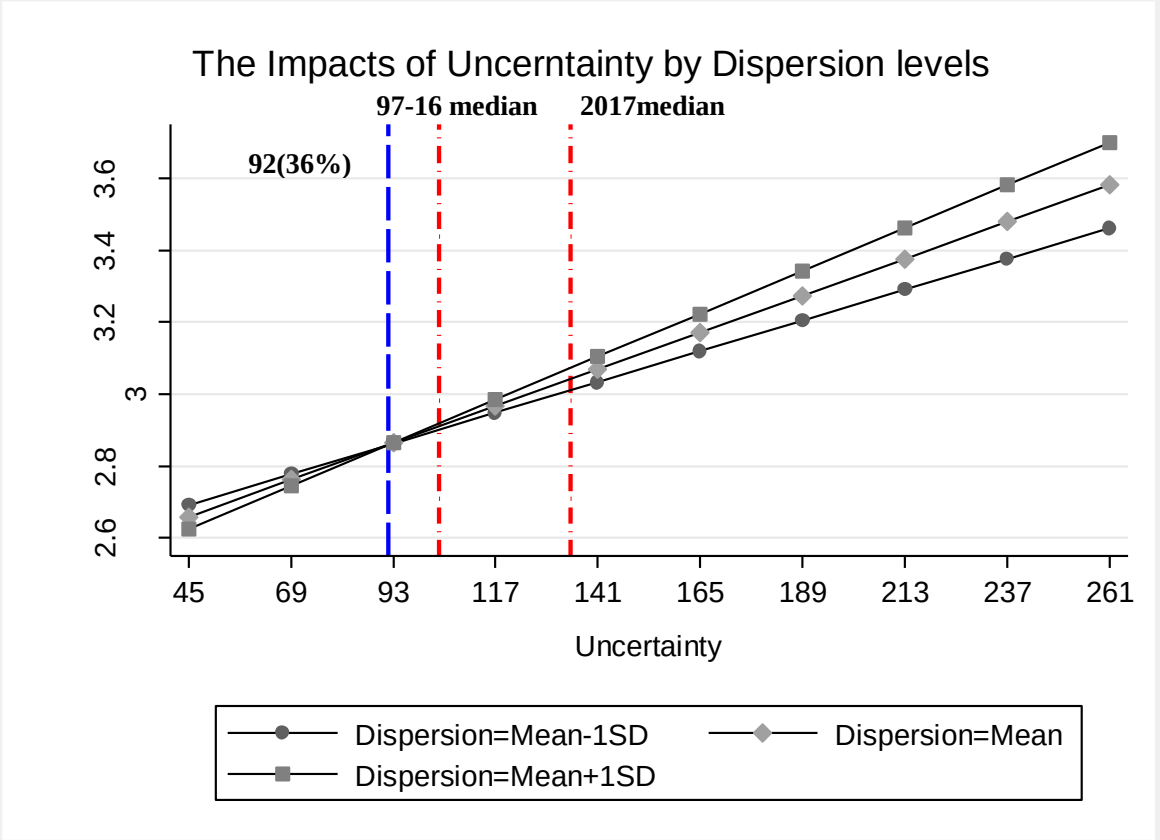


Exhibit 12

Effects of representativeness and policy uncertainty on VIX