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December 2, 2021

# Cboe Global Markets

## Trading Nearly Around the Clock with SPX & VIX

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# Trading Nearly Around the Clock with SPX<sup>®</sup> and VIX<sup>®</sup> Options



Prepared for IBKR Webinar

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Head of Index Insights  
Cboe Options Institute

Thursday, December 2, 2021  
12:00 Noon ET

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- Index and benchmark values for the period prior to an index’s launch date are calculated by a theoretical approach involving back-testing historical data in accordance with the methodology in place on the launch date (unless otherwise stated). A limitation of back-testing is that it reflects the theoretical application of the index or benchmark methodology and selection of the index’s constituents in hindsight. Back-testing may not result in performance commensurate with prospective application of a methodology, especially during periods of high economic stress in which adjustments might be made. No back-tested approach can completely account for the impact of decisions that might have been made if calculations were made at the same time as the underlying market conditions occurred. There are numerous factors related to markets that cannot be, and have not been, accounted for in the preparation of back-tested index and benchmark information.

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## Topics Today



- **Academic study** showing that most of the S&P 500 index's net returns occurred outside regular U.S. trading hours
- New **extension of trading hours** for VIX<sup>®</sup> and SPX<sup>®</sup> Options to nearly 24 hours a day
- Adjustment of investor positions and risk more efficiently, particularly in response to global **macroeconomic events** as they are happening
- The impact of convexity, correlation, contango and backwardation in **pricing** and **trading** of VIX futures, VIX options and SPX options



## Two U.S. News Clip Headlines



**The New York Times** (Feb. 2, 2018)

***The Stock Market Works by Day, but It Loves the Night***

**The Wall Street Journal** (April 20, 2020)

**The Markets Are Wild While You're Asleep**

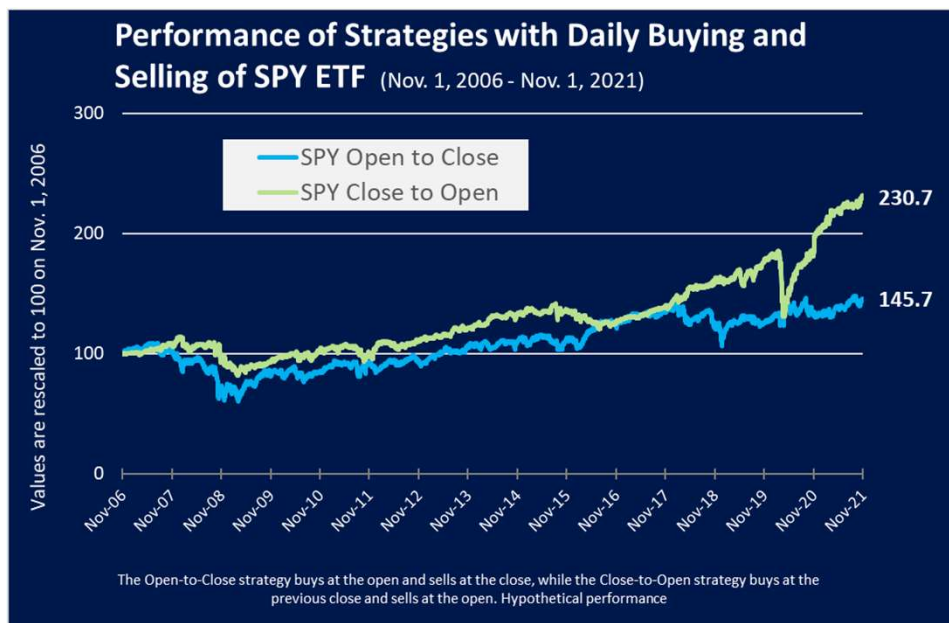
# 15-Year Charts: Open-to-Close and Close-to-Open

Recent studies by Professor Bondarenko and by the New York Fed both found that S&P 500 instruments had bigger upside moves during certain non-US trading hours.

The two charts on this page provide 15-year analyses of moves of the S&P 500 SPY ETF.

- The **Open-to-Close** strategy buys at the daily open and sells at the daily closing price
- The **Close-to-Open** strategy buys at the previous close and sells at the daily opening price

CAUTION: The hypothetical performance in the charts reflects reported prices, but does not reflect transaction costs or ETF distributions. Actual results for investors probably would vary.



## Largest Open-to-Close and Close-to-Open % Moves for the SPY ETF

(Nov. 1, 2006 - Nov. 1, 2021)

Dates	Open to Close	Dates	Previous Close to Open
13-Oct-2008	8.0%	13-Oct-2008	6.1%
28-Oct-2008	7.4%	13-Mar-2020	6.0%
13-Nov-2008	5.9%	19-Sep-2008	5.5%
26-Nov-2008	5.5%	24-Mar-2020	5.1%
23-Jan-2008	5.3%	10-May-2010	4.1%
5-Dec-2008	5.1%	28-Oct-2008	4.0%
3-Dec-2008	4.7%	9-Nov-2020	3.9%
26-Mar-2020	4.7%	6-Apr-2020	3.9%
23-Mar-2009	4.4%	10-Mar-2020	3.8%
26-Dec-2018	4.3%	7-Apr-2020	3.5%
23-Feb-2009	-4.6%	15-Sep-2008	-3.5%
14-Oct-2008	-4.6%	22-Jan-2008	-3.7%
19-Nov-2008	-5.1%	1-Apr-2020	-3.8%
20-Mar-2020	-5.7%	10-Oct-2008	-4.3%
20-Nov-2008	-5.8%	24-Aug-2015	-5.2%
1-Dec-2008	-6.2%	18-Mar-2020	-6.5%
7-Oct-2008	-6.4%	12-Mar-2020	-6.7%
29-Sep-2008	-6.5%	9-Mar-2020	-7.4%
15-Oct-2008	-7.6%	24-Oct-2008	-8.3%
9-Oct-2008	-9.0%	16-Mar-2020	-10.4%

The Open-to-Close strategy buys at the daily open and sells at the daily closing price, while the Close-to-Open strategy buys at the previous close and sells at the daily opening price. The hypothetical performance reflects reported prices, but does not reflect transaction costs or ETF distributions. Actual results for investors probably will vary. Source: Cboe Global Markets.

Seven of the largest close-to-open moves occurred in March 2020 (see right column above).

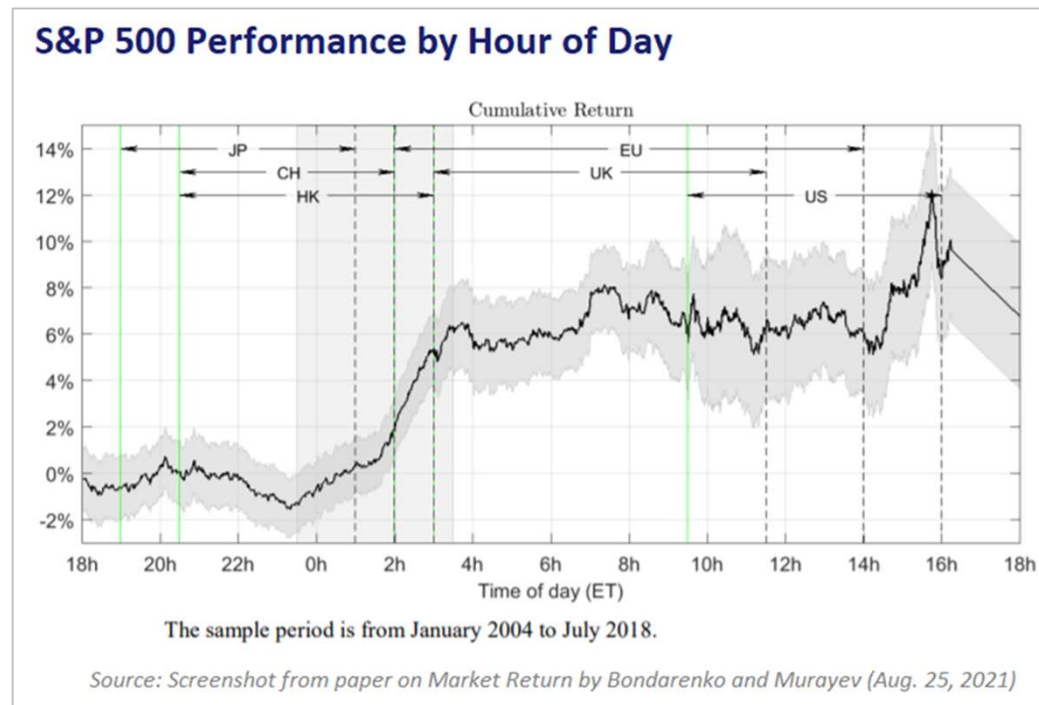
Source for both charts: Cboe Global Markets.

# Paper by Professors Bondarenko and Muravyev (2021)



From 70-page paper on “Market Return Around the Clock: A Puzzle” by Oleg Bondarenko and Dmitriy Muravyev (2021) <https://bit.ly/Oleg-Night> --

- **four hours** during the trading day (outside U.S. regular trading hours) accounted for the entire average market return,
- rest-of-day net returns were a noisy zero,
- uncertainty reflected by VIX futures prices rose overnight and fell around European open, and
- the results were stronger during the 2020 COVID crisis.

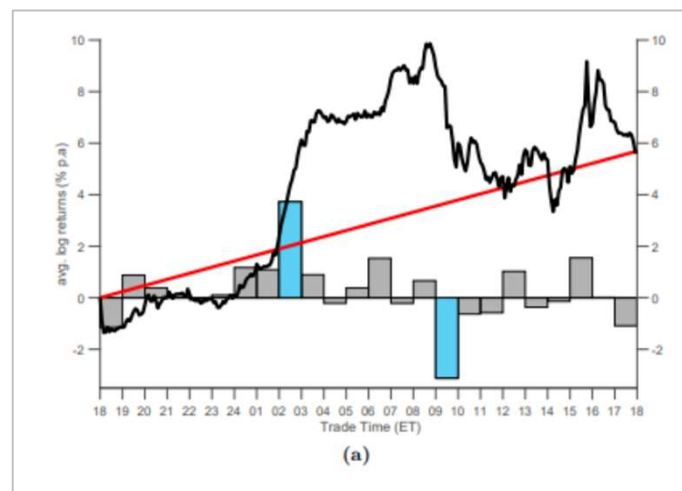




**Abstract**

This paper documents large positive returns to holding U.S. equity futures overnight during the opening hours of European markets. Consistent with models of inventory risk and demand for immediacy, we demonstrate a strong relationship with order imbalances arising at the close of trade from the previous U.S. intraday session. Rationalizing unconditionally positive “overnight drift” returns, we uncover a strong asymmetric reaction to demand shocks: market sell-offs generate robust positive overnight reversals while reversals following market rallies are much more modest. We argue that this demand shock asymmetry is consistent with time-variation in dealer risk bearing capacity.

*Both the black line and the blue bars in the chart show a rise in value of index futures around 2 am ET*

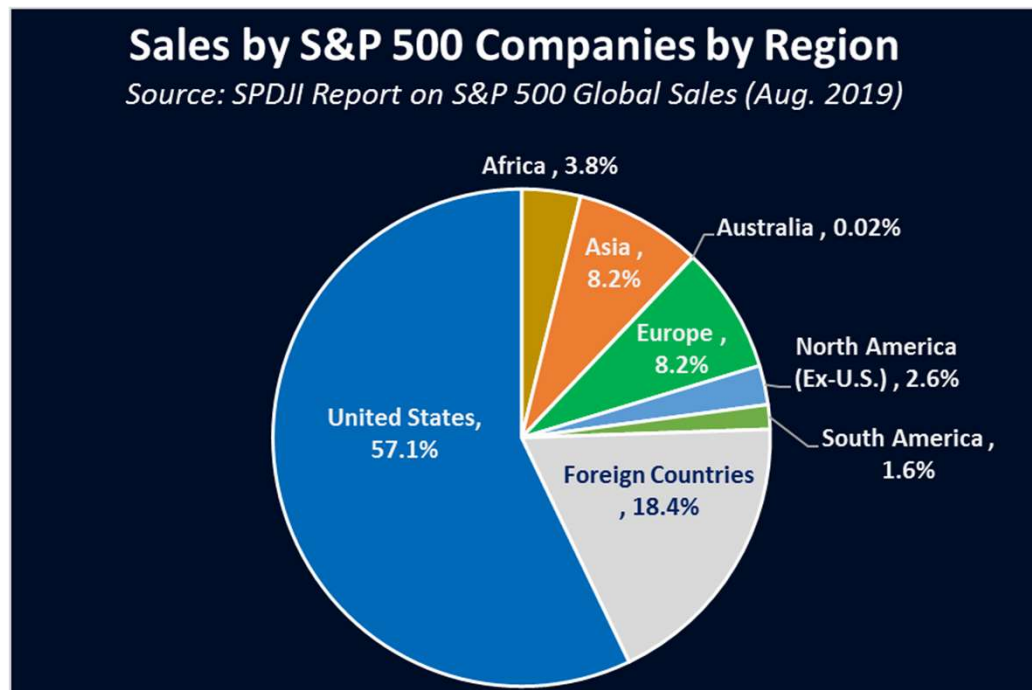


**Figure 2. Intraday Return Averages**

Panel (a) displays the average hourly log returns (bars) and average cumulative 5-minute log returns (solid black line) of the e-mini contract (first close-to-open and then open-to-close).

# Multinational Exposure for the S&P 500 Index

- The topic of index exposure to different geographic areas is an important one for investors who are managing equity risk around the clock.
- As global trade has increased in recent decades, the S&P 500 Index and VIX Index have become multinational indices.
- As shown in the pie chart below, a 2019 report by S&P Dow Jones Indices estimated that the percentage of sales by S&P 500 companies was **57.1%** to U.S. customers, and **42.9%** to non-U.S. customers.



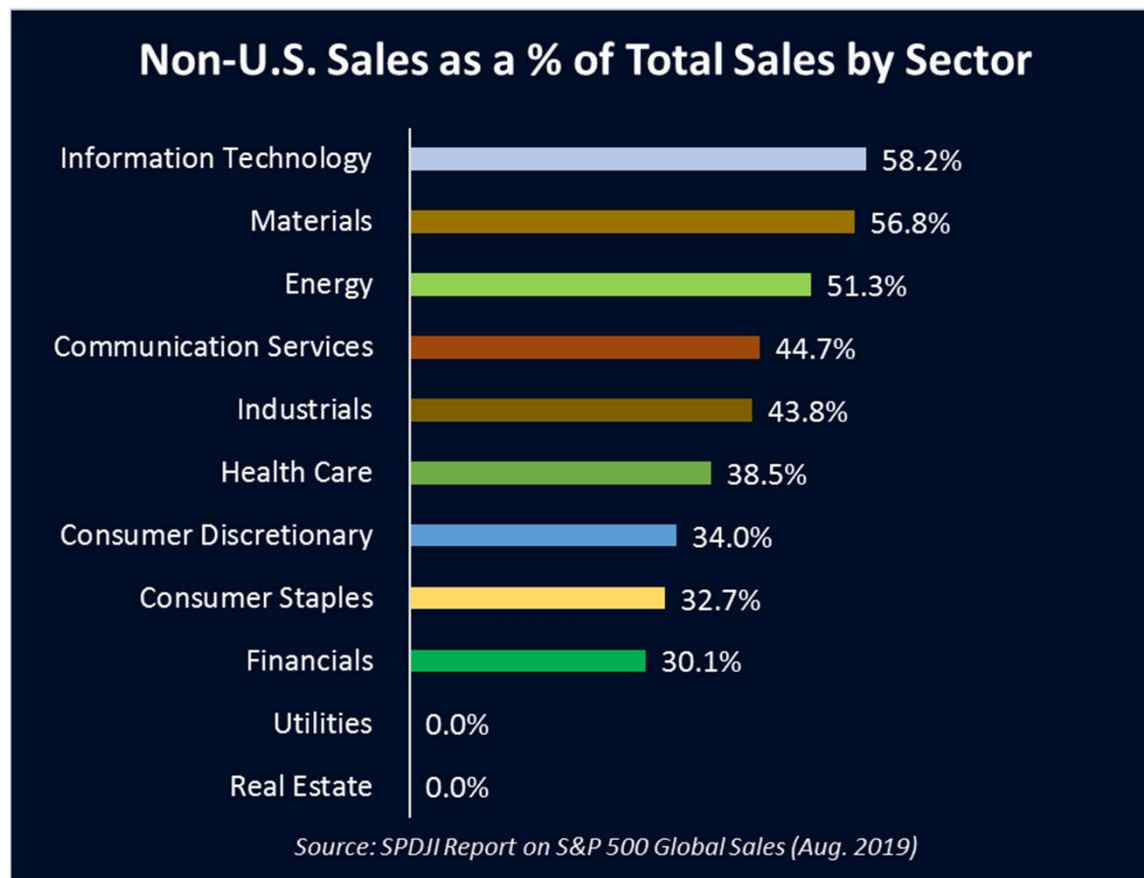
Source: SPDJI Report on S&P 500 Global Sales (Aug. 2019)

## Multinational – Non-U.S. Sales by Sector



The report indicated that a majority of the sales by three S&P 500 sectors –

- **Information Technology** (58.2%),
  - **Materials** (56.8%), and
  - **Energy** (51.3%) –
- were to non-U.S. customers.



# Interest in Use of Options



Excerpts from a March 2, 2021, [story in Bloomberg news](#):

## **“Derivatives Are Replacing Bonds as Some Fund Managers’ New Hedge**

(March 2, 2021)

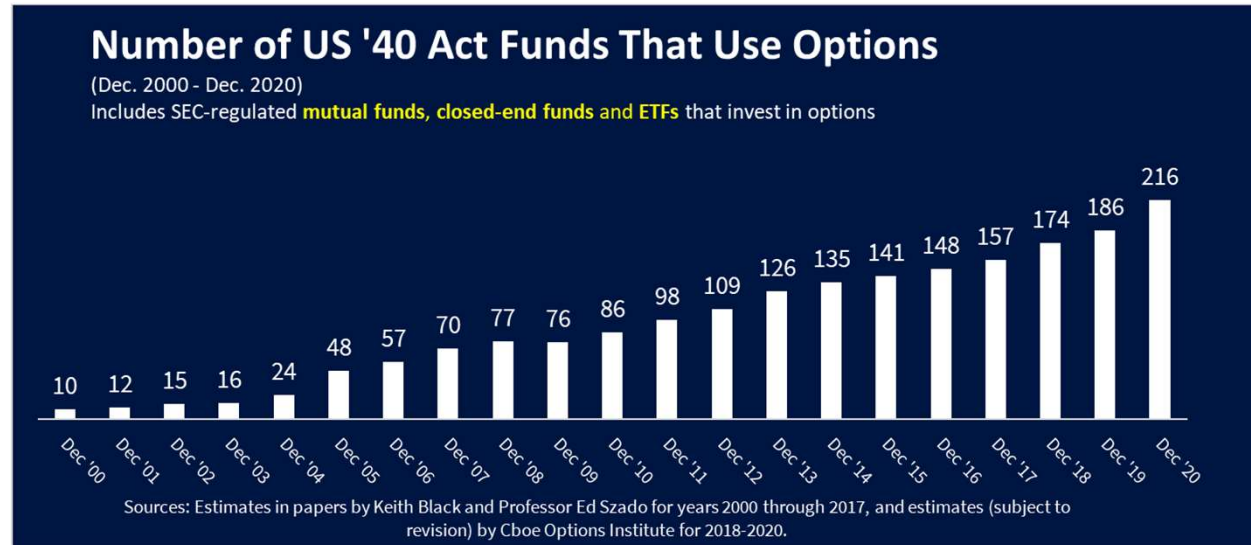
- **Specialists like Ardea, Capstone gain institutional clients**
- **Bonds seen as more risk than risk mitigation: Universa**

... Now risk-averse institutional investors are increasingly turning to them for protection amid a perilous time for global debt markets. All manner of complex solutions, from put options to receiver swaptions, are gaining traction as a way to overcome the drawbacks of bonds as a hedge after debt failed to insulate portfolios at key moments last year. Throw in the glaring threat of fixed-income losses as the economy rebounds, and the likes of pensions, university endowments and sovereign wealth funds are tapping asset managers specializing in derivatives to help solve these woes. ... “

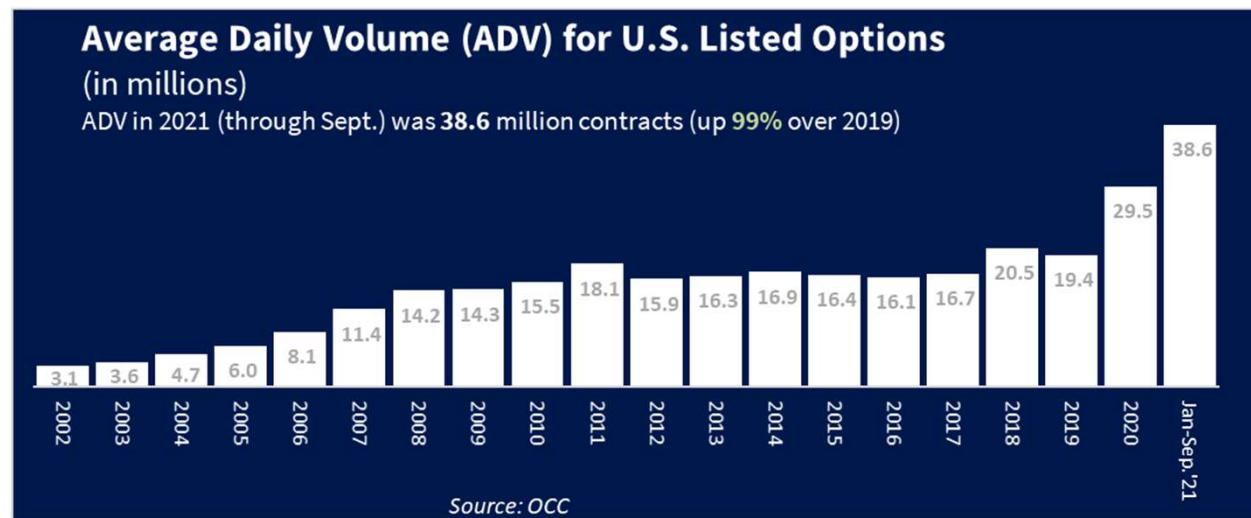
# Growth in Use of Options



An estimated 216 U.S. '40 Act funds invested in options in 2020



ADV grew to 38.6 million in 2021 (through Sept.)





## Extension of Global Trading Hours (GTH) for Options



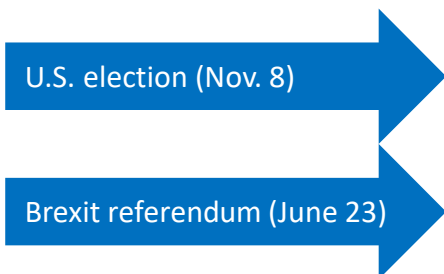
- On **Nov. 21, 2021** - Trading hours for **SPX<sup>®</sup>** and **VIX<sup>®</sup> options** were extended:

Time Zone	Global Trading Hours	Regular Trading Hours
Chicago	7:15 PM - 8:15 AM	8:30 AM - 3:15 PM
London*	1:15 AM - 2:15 PM	2:30 PM - 9:15 PM
Hong Kong*	8:15 AM - 9:15 PM	9:30 PM - 4:15 AM
Sydney*	11:15 AM - 12:15 PM	12:30 AM - 7:15 AM

\*Trading hours are determined by the time in Chicago. Note that Daylight Saving Time (DST) procedures vary by time zone and will affect the times shown here. For non-U.S. cities shown in this table, the trading hours may shift by one hour as the U.S. changes between Standard Time and Daylight Saving Time.

- Trading hours for **VIX<sup>®</sup> futures** already are nearly 24 x 5

# 2016 Dates with Largest Volumes in GTH



In 2016 some markets were surprised by the results of the Brexit referendum on June 23 and the U.S. election on Nov. 8. The VIX futures GTH volumes in the 2 following sessions were the highest in 2016

## 2016 Dates with Largest Volumes During GTH



	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
Nov 9, 2016	14.38	-23.3%	15.36	-39.3%
Jun 24, 2016	25.76	49.3%	30.71	45.3%

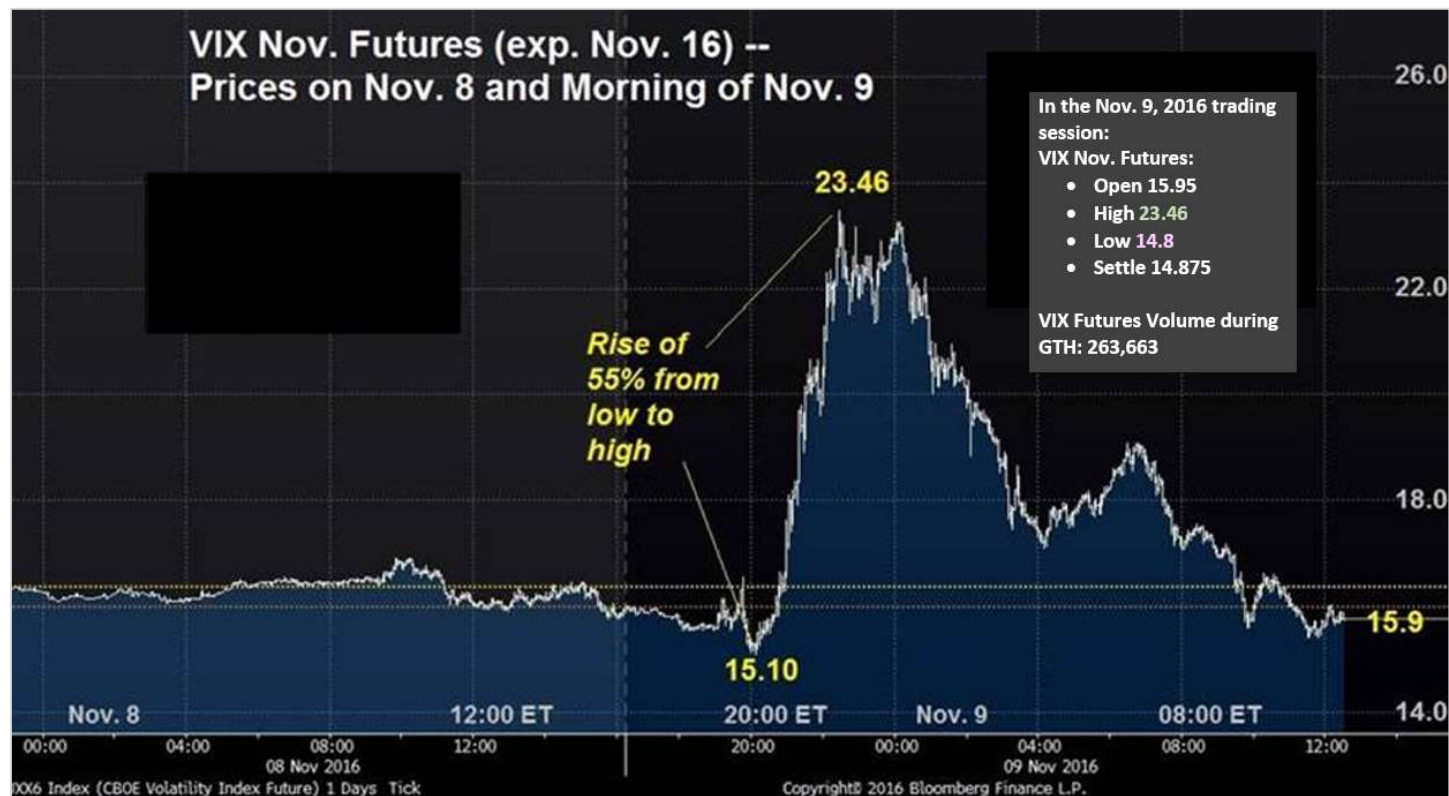
	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
May 31, 2016	14.19	8.2%	11.85	21.3%
Nov 9, 2016	14.38	-23.3%	15.36	-39.3%

	VIX Index Close	% Change in VIX Index	VVIX Index Close	% Change in VVIX Index
Nov 4, 2016	22.51	1.9%	120.23	0.0%
Nov 9, 2016	14.38	-23.3%	96.14	-11.5%

## VIX Futures on Nov. 8 & 9, 2016 – U.S. Election

- On the Tuesday U.S. election night of November 8, 2016, the reported prices for the November VIX futures rose from a low of **15.10** at 8:07 p.m. E.T., to a high of **23.46** at 10:27 p.m. E.T., a rise of **55%** over a 140-minute period.
- On the next morning, the price of the VIX Nov. futures retreated, as a story at [cbsnews.com](http://cbsnews.com) noted that *“Conciliatory comments from U.S. President-elect Donald Trump in the aftermath of his stunning victory over Hillary Clinton helped global stock markets erase a large chunk of their earlier losses Wednesday.”*
- The November VIX futures settlement price on November 9, 2016, was **14.875**.
- VIX futures volume during the GTH session on November 9, 2016, was **263,663**.



# 2020 Dates with Largest Volumes in GTH



WHO raised Coronavirus alert to highest level (Feb. 28)

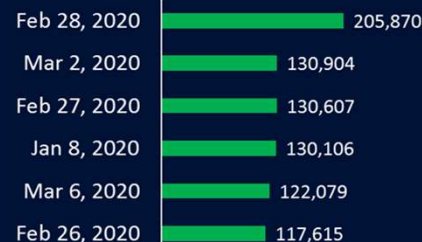
Italy's Lombardy region imposed complete lockdown on towns (Feb. 25)

VIX Index closing values:

- **13.68** on Feb. 14, 2020
- **82.69** on Mar. 16, 2020
- **504%** gain over 20 trading days

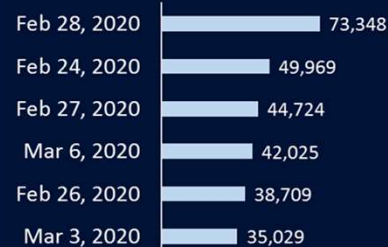
## 2020 Dates with Largest Volumes in GTH

### VIX Futures Volume in GTH



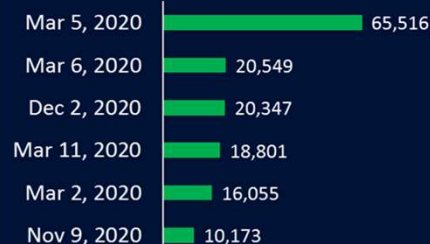
Source: Cboe Global Markets

### S&P 500 Opt. Volume in GTH



Source: Cboe Global Markets

### VIX Options Volume in GTH



Source: Cboe Global Markets

	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
Feb 28, 2020	<b>40.11</b>	<b>2.4%</b>	<b>52.9</b>	<b>-3.4%</b>
Mar 2, 2020	<b>33.42</b>	<b>-16.7%</b>	<b>42.17</b>	<b>-20.3%</b>
Feb 27, 2020	<b>39.16</b>	<b>42.1%</b>	<b>54.74</b>	<b>57.1%</b>
Jan 8, 2020	<b>13.45</b>	<b>-2.5%</b>	<b>12.22</b>	<b>-1.0%</b>
Mar 6, 2020	<b>41.94</b>	<b>5.9%</b>	<b>48.55</b>	<b>-0.2%</b>
Feb 26, 2020	<b>27.56</b>	<b>-1.0%</b>	<b>34.84</b>	<b>-4.2%</b>

	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
Feb 28, 2020	<b>40.11</b>	<b>2.4%</b>	<b>52.9</b>	<b>-3.4%</b>
Feb 24, 2020	<b>25.03</b>	<b>46.5%</b>	<b>31.9</b>	<b>102.3%</b>
Feb 27, 2020	<b>39.16</b>	<b>42.1%</b>	<b>54.74</b>	<b>57.1%</b>
Mar 6, 2020	<b>41.94</b>	<b>5.9%</b>	<b>48.55</b>	<b>-0.2%</b>
Feb 26, 2020	<b>27.56</b>	<b>-1.0%</b>	<b>34.84</b>	<b>-4.2%</b>
Mar 3, 2020	<b>36.82</b>	<b>10.2%</b>	<b>47.34</b>	<b>12.3%</b>

	VIX Index Close	% Change in VIX Index	VVIX Index Close	% Change in VVIX Index
Mar 5, 2020	<b>39.62</b>	<b>23.9%</b>	<b>119.66</b>	<b>5.0%</b>
Mar 6, 2020	<b>41.94</b>	<b>5.9%</b>	<b>127.16</b>	<b>6.3%</b>
Dec 2, 2020	<b>21.17</b>	<b>1.9%</b>	<b>107.52</b>	<b>-0.8%</b>
Mar 11, 2020	<b>53.9</b>	<b>14.0%</b>	<b>146.93</b>	<b>5.8%</b>
Mar 2, 2020	<b>33.42</b>	<b>-16.7%</b>	<b>114.69</b>	<b>-8.8%</b>
Nov 9, 2020	<b>25.75</b>	<b>3.6%</b>	<b>116.78</b>	<b>3.4%</b>

# 2021 Dates (through Nov. 4) with Largest Volumes in GTH



Dates in 2021 on which there was significant volume during GTH and the VIX Index rose more than 20% include:

- Jan. 27 (VIX Index up **61.6%**),
- July 19 (VIX Index up **22%**) and
- September 20 (VIX Index up **23.5%**).

## 2021 Dates (through Nov. 4) with Largest Volumes in GTH



Date	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
Oct 20, 2021	15.49	-1.3%	12.69	-4.9%
Jan 28, 2021	30.21	-18.8%	30	-28.0%
May 13, 2021	23.13	-16.2%	23.21	-21.5%
Jan 27, 2021	37.21	61.6%	41.64	103.5%
Jul 19, 2021	22.5	22.0%	22.15	35.9%
Sep 20, 2021	25.71	23.5%	27.7	40.9%

Date	VIX Index Close	% Change in VIX Index	VIX9D Index Close	% Change in VIX9D Index
Sep 28, 2021	23.25	23.9%	24.56	44.8%
Aug 19, 2021	21.67	0.5%	21.24	-8.1%
Sep 20, 2021	25.71	23.5%	27.7	40.9%
Oct 7, 2021	19.54	-7.0%	18.13	-7.2%
May 19, 2021	22.18	3.9%	21.21	1.0%
May 11, 2021	21.84	11.1%	22.03	11.9%

Date	VIX Index Close	% Change in VIX Index	VVIX Index Close	% Change in VVIX Index
Jan 28, 2021	30.21	-18.8%	133.22	-15.5%
Feb 1, 2021	30.24	-8.6%	129.44	-5.7%
Apr 27, 2021	17.56	-0.5%	103.39	-0.6%
Jul 19, 2021	22.5	22.0%	139.54	8.3%
May 14, 2021	18.81	-18.7%	117.56	-9.6%
May 13, 2021	23.13	-16.2%	130.01	-11.1%

# 2021 – Key Dates and Average Daily Volume (ADV)



In 2021 VIX futures volume during around-the-clock GTH was about 11% of all VIX futures volume

In Nov. 2021 the GTH trading hours for the S&P 500 options and VIX options will be extended

## Dates with Largest Volumes in GTH in 2021 (through Nov. 4)



## Average Daily Volume in 2021 (through Nov. 4)

VIX Futures	
ADV During RTH	188,556
ADV During GTH	23,485
ADV (RTH + GTH)	212,040

S&P 500 Options	
ADV During RTH	1,317,794
ADV During GTH	11,332
ADV (RTH + GTH)	1,329,127

VIX Options	
ADV During RTH	508,926
ADV During GTH	2,439
ADV (RTH + GTH)	511,365

Source: Cboe Global Markets

# Notional Value for Powerful Products

## POWERFUL TOOLS

VIX futures and options and S&P 500 options all are tools that have the potential to be very powerful for investors who wish to manage or adjust their exposure.

For example, the table shows that over a period of 20 trading day in early 2020, the S&P 500 Index fell **25.3%**, while there were significant reported gains for two VIX products that expired on March 18<sup>th</sup> – the VIX March futures rose **358%**, and the VIX March 20 call options rose **6393%**. Note that these were unusually strong gains for the futures and options, and that often **there can be losses** involved with the purchases of the futures and options.

## Changes in Reported Closing Values Over 20 Days in 2020

(Feb. 19 to Mar. 17, 2020)

Date	S&P 500 Index	VIX Index (not investable)	VIX March 20 Futures (that expired on March 18th)	VIX March 20 call options (that expired on March 18th)
19-Feb-2020	3386.15	14.38	15.39	\$0.75
17-Mar-2020	2529.19	75.91	70.55	\$48.70
% change	<b>-25.3%</b>	<b>428%</b>	<b>358%</b>	<b>6393%</b>

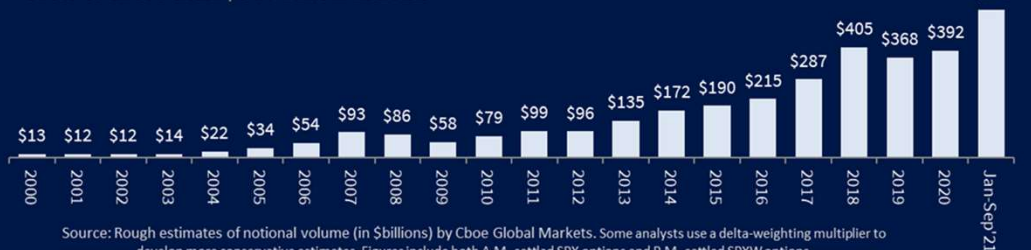
Past performance is not predictive of future returns. Source: Cboe Global Markets

## NOTIONAL VALUE

Institutional investors often prefer larger notional sizes for trading instruments to be used. In recent months the notional value covered by one SPX options contract usually has been above **\$400,000**, and so far in 2021, the average daily notional value of S&P 500 options trading volume has been around **\$540 billion**.

## Notional Value of Avg. Daily Volume for S&P 500 Options at Cboe (in \$billions)

Grew to more than \$540 billion in 2021



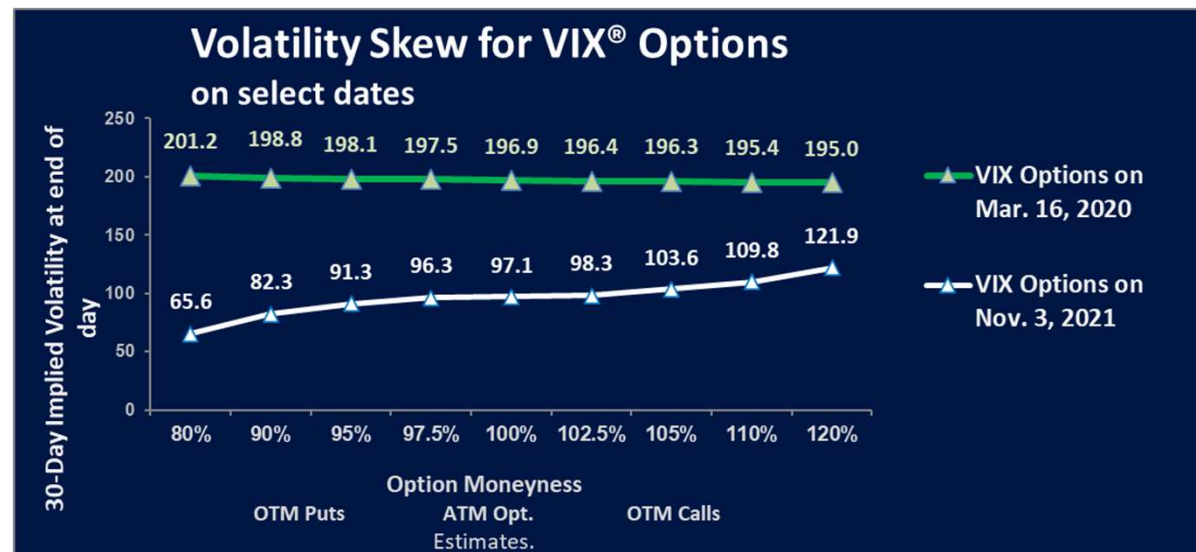
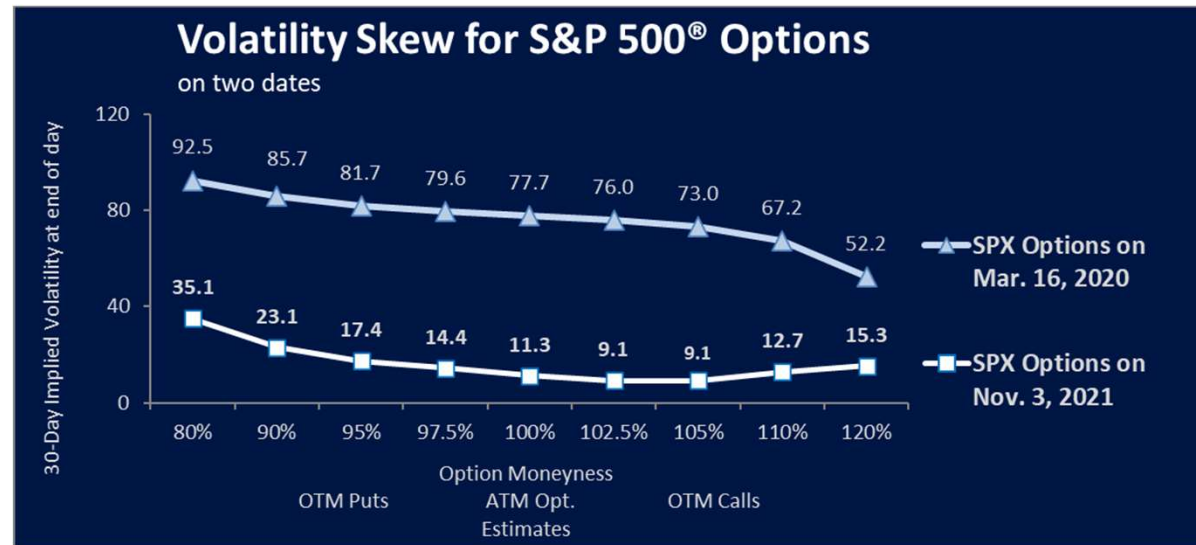
# Volatility Skew and the Vertical Spread Strategy

Charts show the estimated 30-day volatility skew for SPX options and for VIX options on two dates –

- **March 16, 2020** (when the VIX Index hit its all-time daily closing high of 82.69) and
- **Nov. 3, 2021** (when the VIX Index closed at 15.10).

On Nov. 3, 2021, the highest implied volatilities for each contract were for the out-of-the-money **puts** for the S&P 500 options, and for the out-of-the-money **calls** for the VIX options.

**STRATEGY IDEA** For investors who are intrigued by the negative skewness often shown by stock index options, a strategy that could be explored for its pros and cons is the Vertical Put Spread strategy, which involves selling a put and simultaneously buying another put at a different strike price, but with the same expiration.

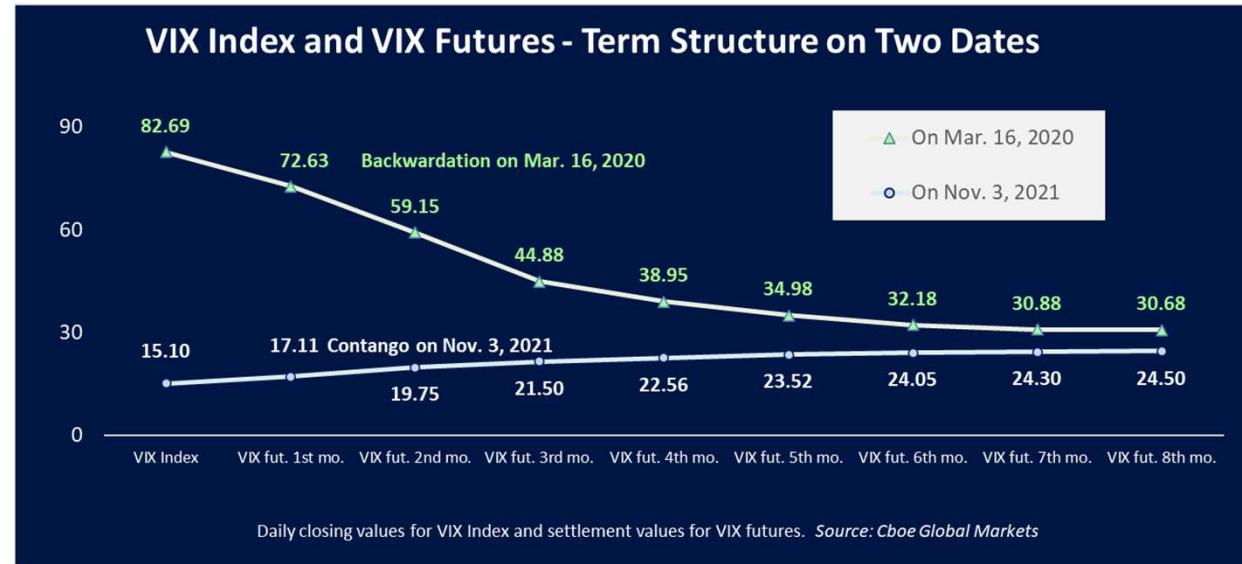


Source: Cboe Global Markets

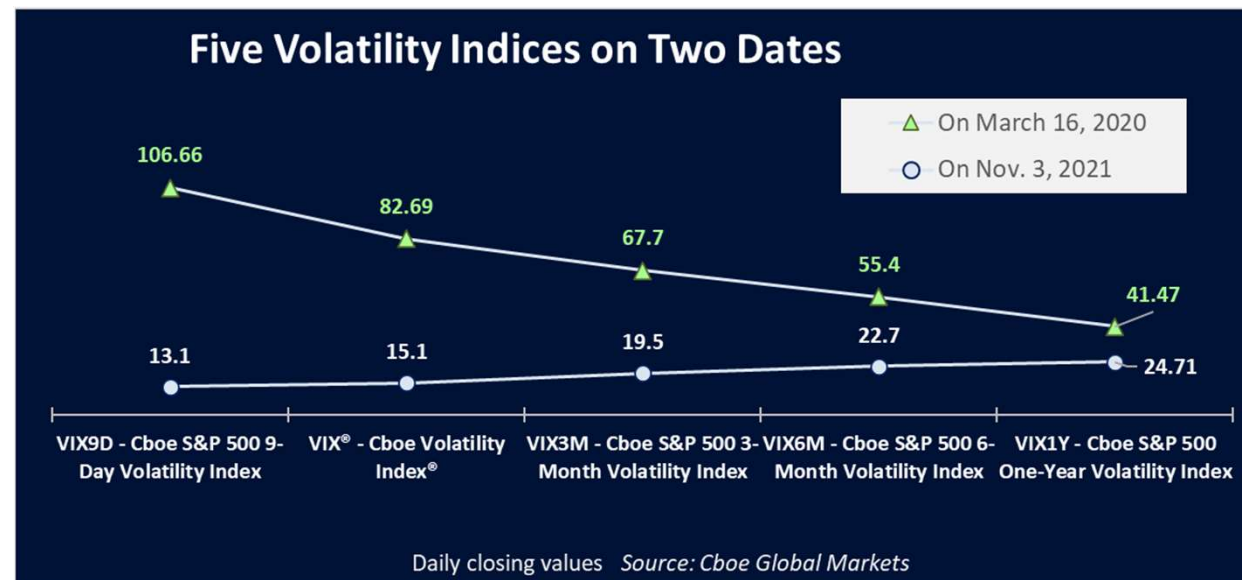


# Term Structure on 2 Dates

- The VIX term structure was in **backwardation** on March 16, 2020 (the date on which the VIX Index hit its all-time daily closing high of 82.69) and was in **contango** on November 3, 2021
- The VIX term structure has been in contango on most trading days since the launch of VIX futures in 2004, and the VIX Index has tended to be **mean-reverting**



**106.66**  
closing value of  
**VIX9D** Index on  
March 16, 2020



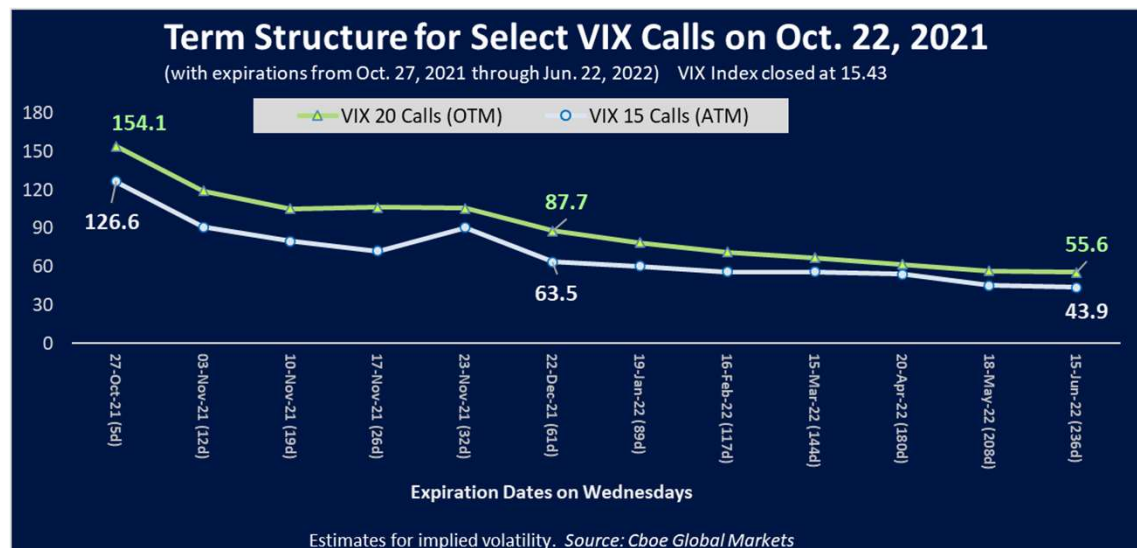
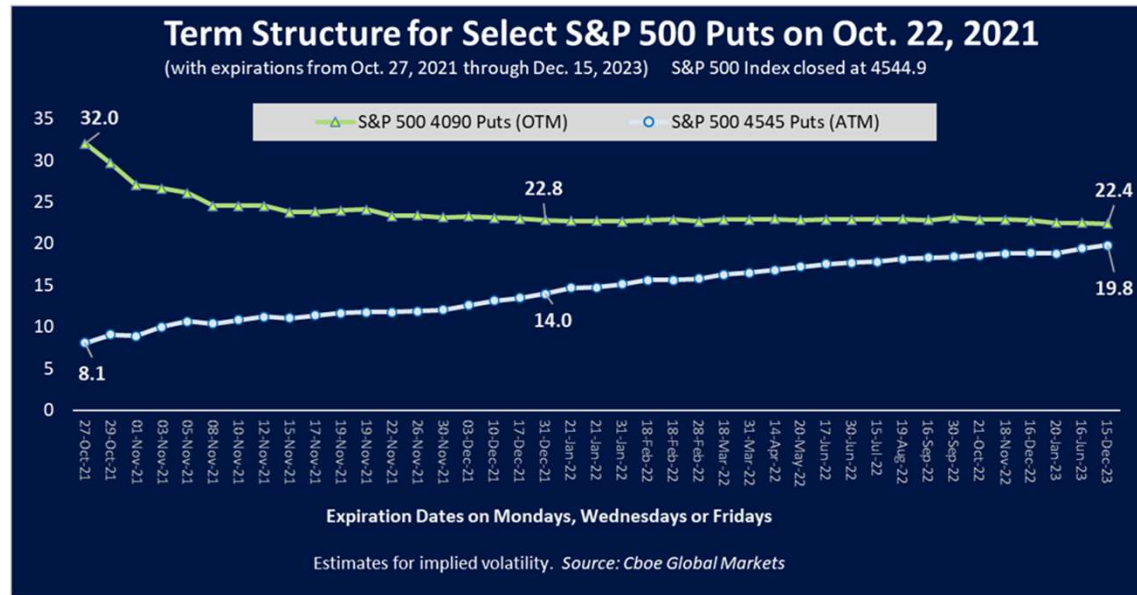
# Index Options Term Structure on Oct. 22, 2021



In the 2 charts the options with the highest implied volatilities are the **short-dated OTM SPX puts** and **OTM VIX calls** – both these contacts are bought by investors who want instruments with the potential to offset stock market declines.

Other investors do cash-secured selling of index puts with high implied volatilities

**STRATEGY IDEA** For options investors who expect a change in a steep term structure in the near future, an options strategy that could be explored is the calendar spread strategy, which involves the buying and selling of a call option (or the buying and selling of a put option) with the same strike price but with different expiration dates.



# Portfolio Protection with SPX Puts and VIX Calls

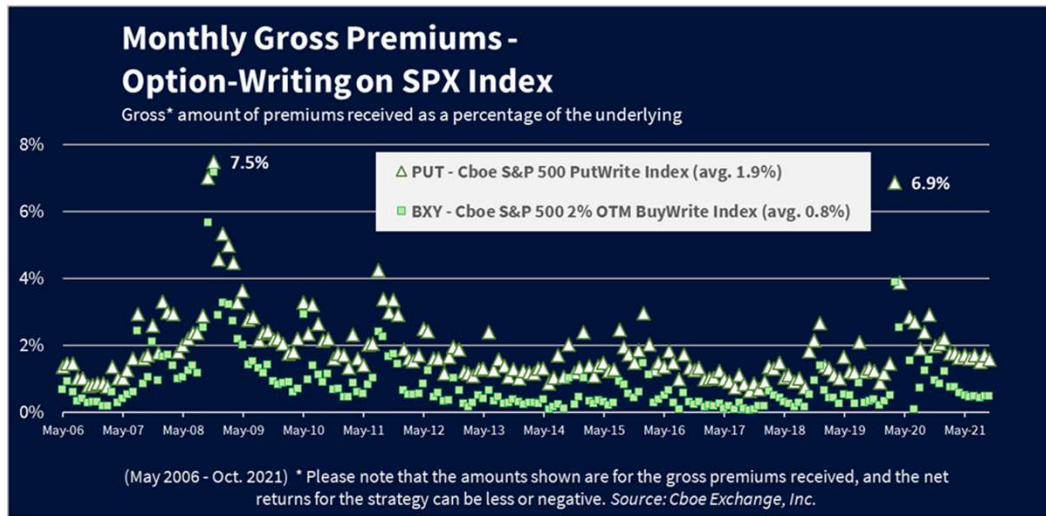
- Cboe offers dozens of benchmark indices designed to track the performance of hypothetical strategies that use options.
- Since the advent of the Covid-19 Pandemic, interest has increased in strategies that can help manage left tail risk and mitigate portfolio drawdowns.
- The chart below shows that two Cboe benchmark indices that buy index options outgained some major “traditional” benchmark indices from year-end 2019 through Nov. 8, 2021 –
  - Cboe VIX Tail Hedge Index (**VXTH<sup>SM</sup>**) bought VIX call options and rose **145%**, and
  - Cboe S&P 500 5% Put Protection Index (**PPUT<sup>SM</sup>**) rose **52%**.
- However, since mid-1986, some Cboe option-writing indices shown later (e.g., PUT and BXMD) had higher returns than the PPUT Index.

The Cboe VXTH Index benefitted from the fact that in 2020 it bought VIX call options which rose in value. The reported daily closing values for the VIX March 20 call options (that expired on March 18th) rose from **\$0.75** on February 19 to **\$48.70** on March 17.



← Buy VIX Calls  
← Buy SPX Puts

# Premiums and Returns for SPX Option-Writing Strategies

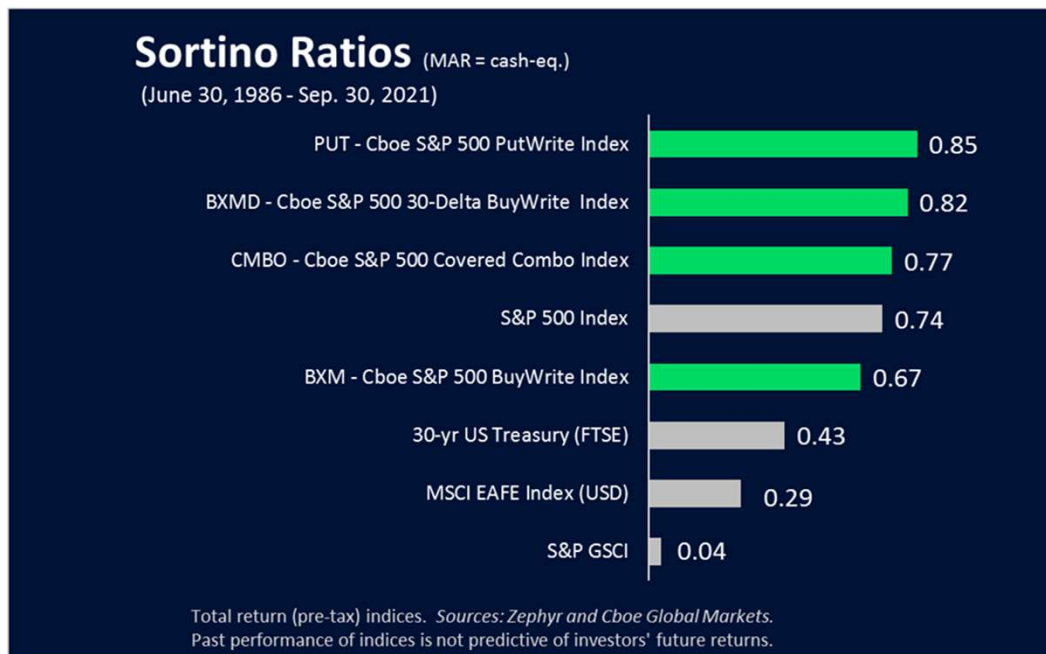


## PREMIUMS

The average of the monthly gross premiums as a percentage of the underlying is:

- 1.9% for the Cboe S&P 500 PutWrite Index (**PUT**<sup>SM</sup>) (that sells cash-secured at-the-money SPX puts) and
- 0.8% for the Cboe S&P 500 2% OTM BuyWrite Index (**BXY**<sup>SM</sup>) (that sells out-of-the-money SPX calls).

At-the-money option writing strategies often collect more premium and have less equity upside participation when compared to out-of-the-money option-writing strategies.



## RISK-ADJUSTED RETURNS

Since mid-1986 three Cboe benchmark indices that sell SPX options - PUT, BXMD<sup>SM</sup>, and CMBO<sup>SM</sup> – all had **higher risk-adjusted** returns (as measured by the Sortino Ratio) than some key “traditional” benchmark indices.

The **implied volatility risk premium** has facilitated strong risk-adjusted returns by key indices that sell SPX options (see Wilshire white paper at [www.cboe.com/Wilshire](http://www.cboe.com/Wilshire))

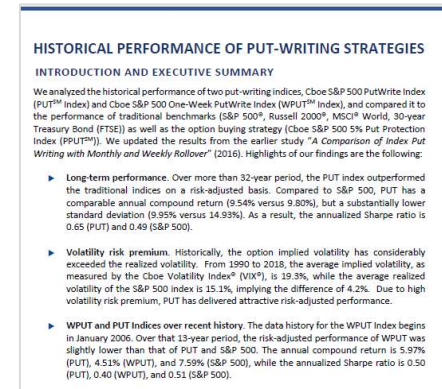
# White Papers on Use of VIX and S&P 500 Options



**CFA Inst. Research Foundation**  
[www.cboe.com/CFA-VIX](http://www.cboe.com/CFA-VIX)



**Wilshire**  
[www.cboe.com/Wilshire](http://www.cboe.com/Wilshire)



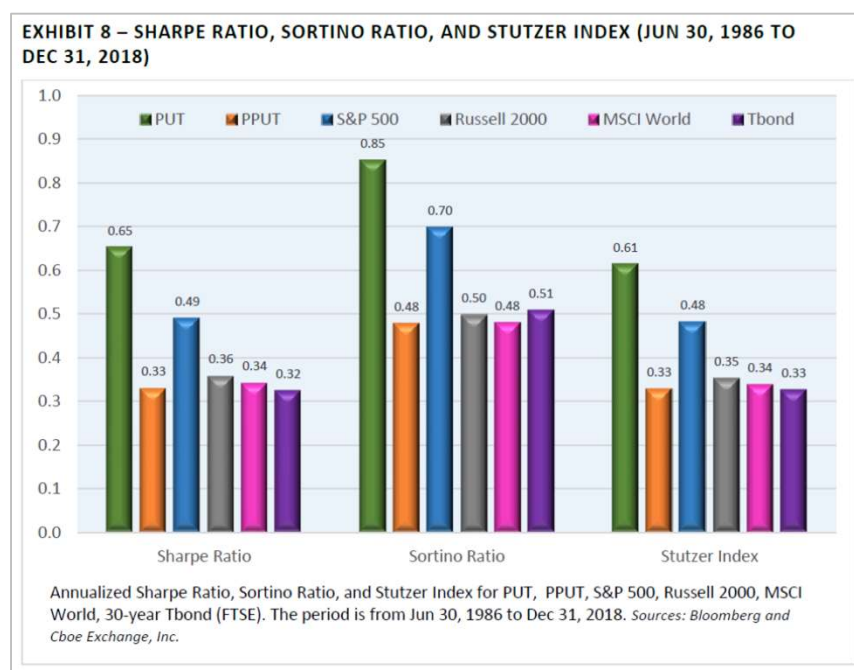
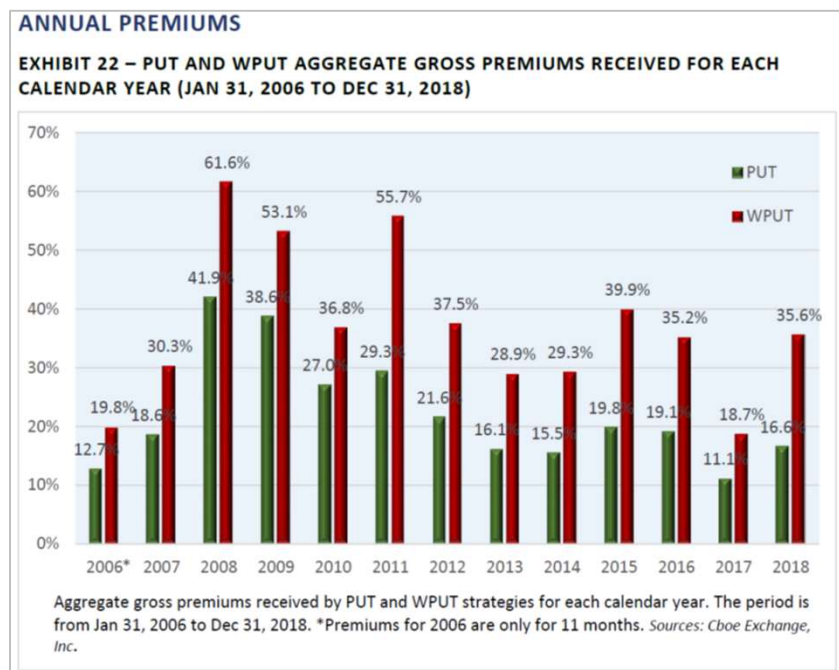
**Prof. Bondarenko**  
[www.cboe.com/Oleg](http://www.cboe.com/Oleg)

Resource: [www.cboe.com/education/research](http://www.cboe.com/education/research)

# 2019 Paper by Professor Oleg Bondarenko



Two Exhibits from paper by Professor Oleg Bondarenko on *Historical Performance of Put-Writing Strategies* (2019) [www.cboe.com/Oleg](http://www.cboe.com/Oleg)



**37.1%\***

average of annual gross premiums  
for WPUT Index

Over 32½ years, **Cboe PUT Index** had the highest risk-adjusted returns as measured by:

- Sharpe Ratio
- Sortino Ratio
- Stutzer Index

# Discussion and Q&A



## YOUR QUESTIONS AND COMMENTS

### TOPICS

- New extension of trading hours for VIX and SPX Options to nearly 24 hours a day
- Academic study showing that most of the S&P 500 index's net returns occurred outside regular U.S. trading hours
- Adjustment of investor positions and risk more efficiently, particularly in response to global macroeconomic events
- The impact of convexity, correlation, & contango on pricing and trading of VIX futures, VIX options and SPX options

### MORE INFORMATION

- Options Education - [www.cboe.com/education](http://www.cboe.com/education)
- White Papers - [www.cboe.com/education/research](http://www.cboe.com/education/research)
- Cboe Indices - [www.cboe.com/index](http://www.cboe.com/index)

**THANK YOU** to the attendees!