

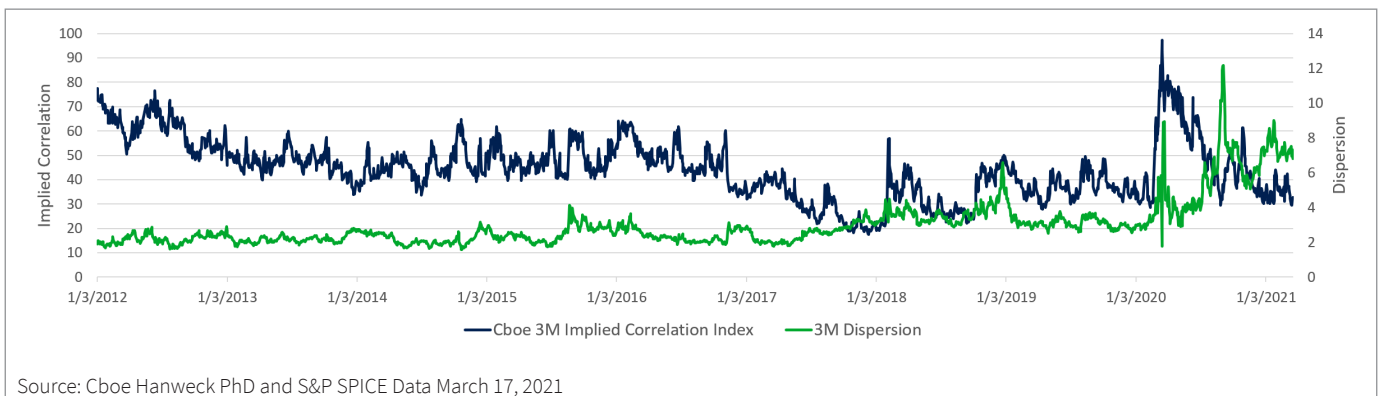
Why Correlation?

Correlation is defined as the linear co-dependence between portfolio components. For over 70 years, financial investors have used correlation as risk management tool to set systematic risk exposure levels and maximize risk diversification benefits. Harry Markowitz's Modern Portfolio Theory¹ decomposed total risk exposure into correlation risk and diversifiable risk and demonstrated that lower correlation levels provide greater diversification benefits and reduce tail risk. The 2008-2009 financial crisis made it increasingly evident that a myopic view considering only volatility risk without correlation is dangerously insufficient as correlation levels can sharply increase during periods of financial stress. Market participants need to closely monitor correlation levels to make sure risk exposures line up with risk appetite levels and to effectively develop risk transfer strategies.

What is Dispersion?

For options, correlation can be used to break down the components of implied volatility and compare the relative value of an index option with a basket portfolio of its component options. A stronger understanding of the drivers affecting correlation in equity markets will benefit Cboe volatility market participants, providing them with a more effective way to hedge underlying risk, and construct speculative strategies by isolating volatility components.

One such strategy is Dispersion. A long dispersion trade involves selling an ATM straddle on the SPX and buying ATM straddles on the component stocks. The trade is effectively betting on decreasing correlation, as a reduction will lead to a larger decrease in the SPX option implied volatility relative to that of the basket option portfolio. The Cboe Implied Correlation Index is built to serve as an indicator to help Dispersion investors time trades and manage risk.



The graph above shows large spikes in 3M Dispersion during the 2008-2009 Financial Crisis and the March 2020 COVID-19 Crash. This increase in Dispersion is a result of a large increase in SPX implied volatility without as large an increase in component option volatilities. Dispersion in the graph is calculated using the following:

$$Dispersion = \sum_{i=1}^N w_i \sigma_i^2 - \sigma_{Index}^2$$

¹ Harry Markowitz, Portfolio Selection, The Journal of Finance, Vol. 7, No. 1. (Mar., 1952), pp. 77-91.

What is the Cboe Implied Correlation Index?

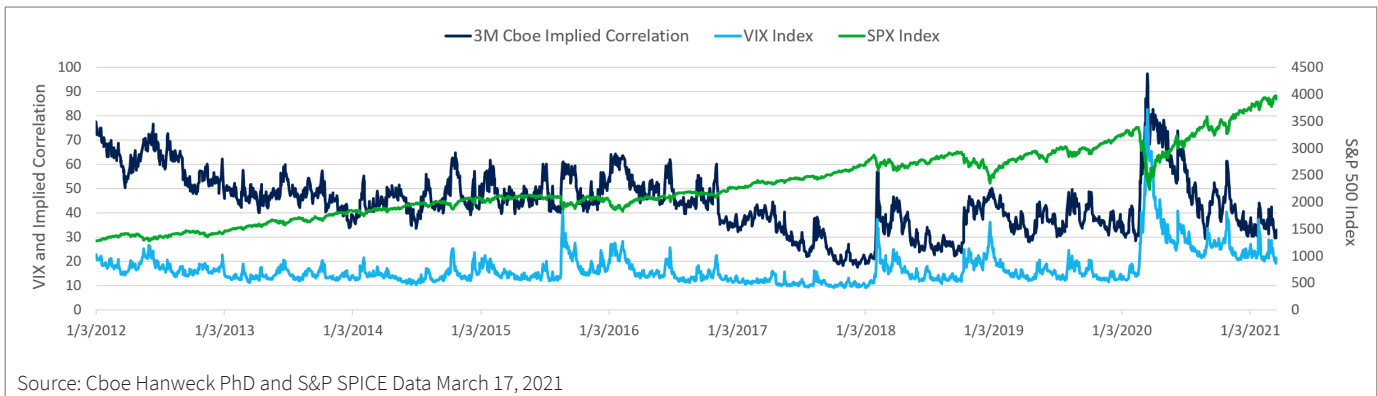
Cboe has created the 1M, 3M, 6M, 9M, 12M, 18M and 24M Implied Correlation Indices, differing on the implied volatility maturities used in the calculation. This document focuses on the Cboe 3M Implied Correlation Index, but there are also sections discussing interesting properties and behaviors exclusive to the other tenors.

The 3M Cboe Implied Correlation Index measures the 3-month expected average correlation across the top 50 value-weighted stocks in the S&P 500 Index and uses 3-month ATM trading day implied volatilities from Cboe Hanweck PhD. The 50-stock basket portfolio is identified on the trading date prior to the index calculation date and is adjusted for market events like acquisitions, mergers, and spinoffs.

The index calculation uses Harry Markowitz's risk decomposition² and isolates the average correlation to obtain the following:

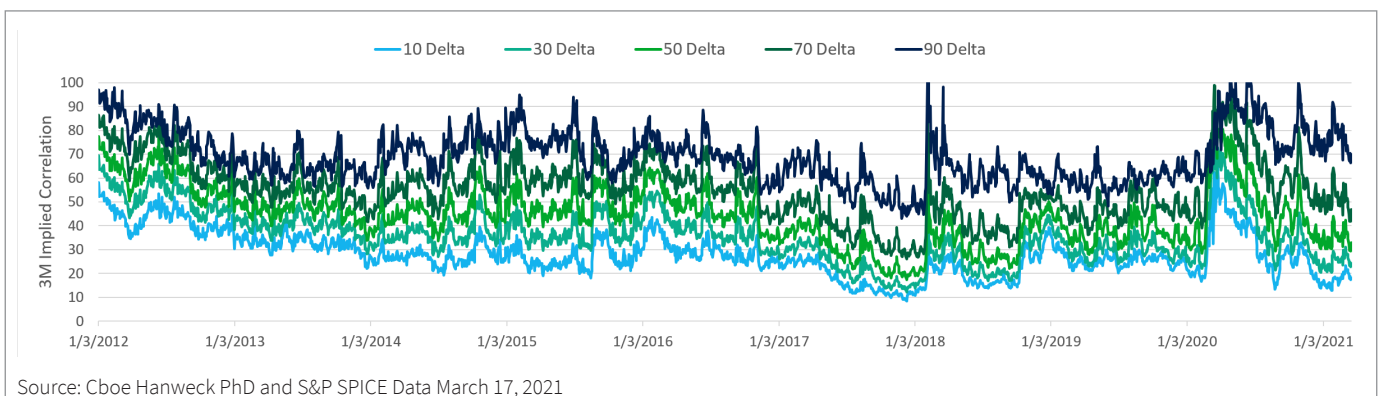
$$\rho_{Average} = \frac{\sigma_{Index}^2 - \sum_{i=1}^N w_i^2 \sigma_i^2}{2 \sum_{i=1}^{N-1} \sum_{j>i}^N w_i w_j \sigma_i \sigma_j}$$

The graph below demonstrates the strong relationship between the VIX® Index and the Cboe 3M Implied Correlation Index. Considering that VIX® Index is affected either by changes in correlation levels or implied volatilities of S&P 500 component options, we can identify periods of large volatility increases caused primarily by broad market systematic factors. One recent example of such a case is the March 2020 COVID-19 Crisis, when a large decline in S&P 500 index is matched with a spike in Implied Correlation and VIX® Indices.



The Implied Correlation Skew:

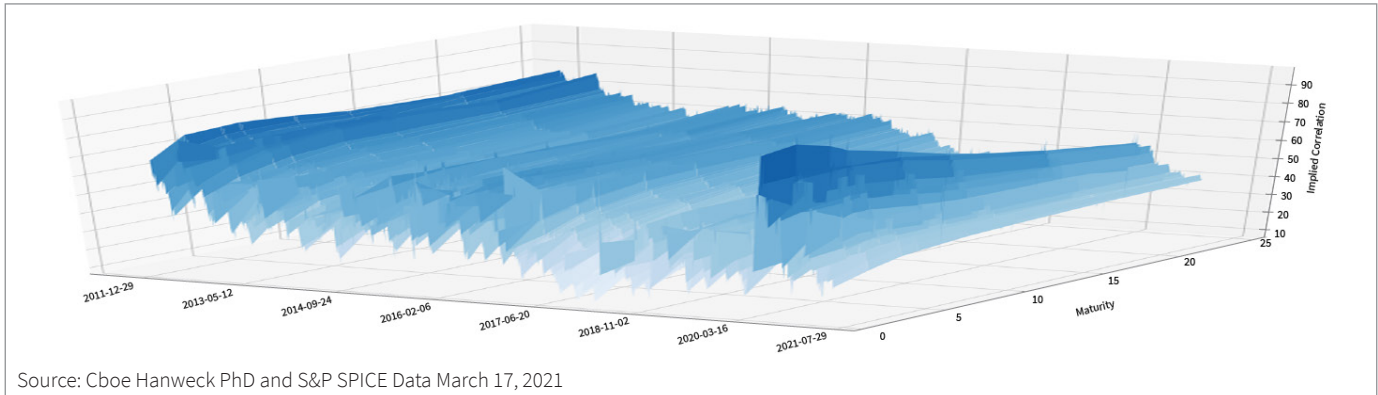
The graph below plots Implied Correlation Skews, calculated using various delta implied volatilities. The Implied Correlation skews signify market expectations of tail event codependences. The 90 delta Implied Correlation, for example, quantifies investor expectations about the likelihood of negative systemic shocks (crash risk). The spread between the Implied Correlation skews and the 50 delta Implied Correlation measures the curvature of the Implied Correlation Skew Curve and measures the expected movement in implied correlation from a major market shock.



²Ibid

The Implied Correlation Term Structure:

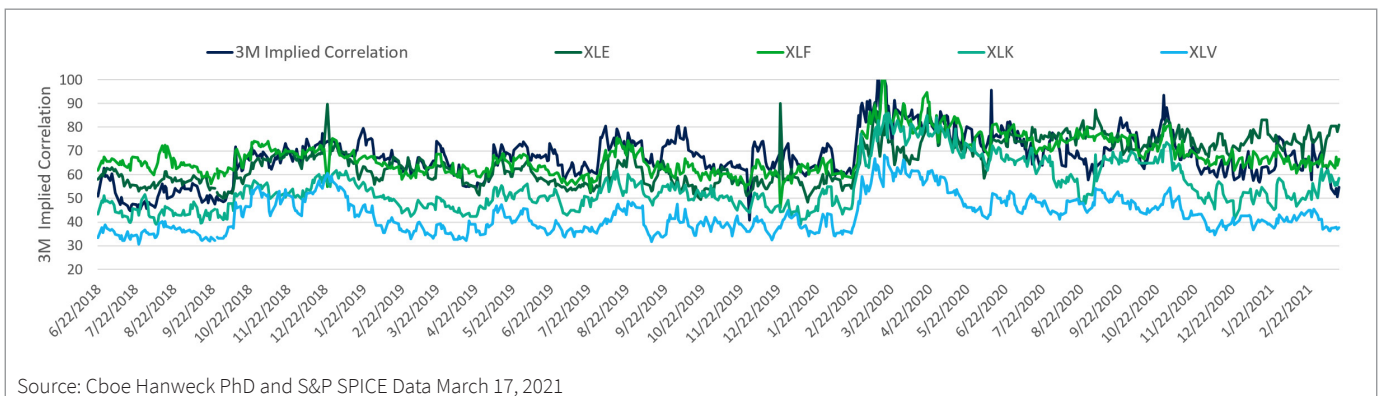
The methodology to calculate the Cboe 3M Implied Correlation Index can be extended to calculate Implied Correlation for other maturities: the 1M, 3M, 6M, 9M, 12M, 18M and 24M Implied Correlation tenors are plotted below. Like implied volatility surfaces, the correlation surface below shows market expectations of correlation risk over time. We observe correlation backwardation during the Financial Crisis and COVID-19 Crash, indicating that market participants predicted a medium to long-term reduction in correlation, indicating a similar expected decrease in SPX volatility.



Implied Correlation Index by Sectors:

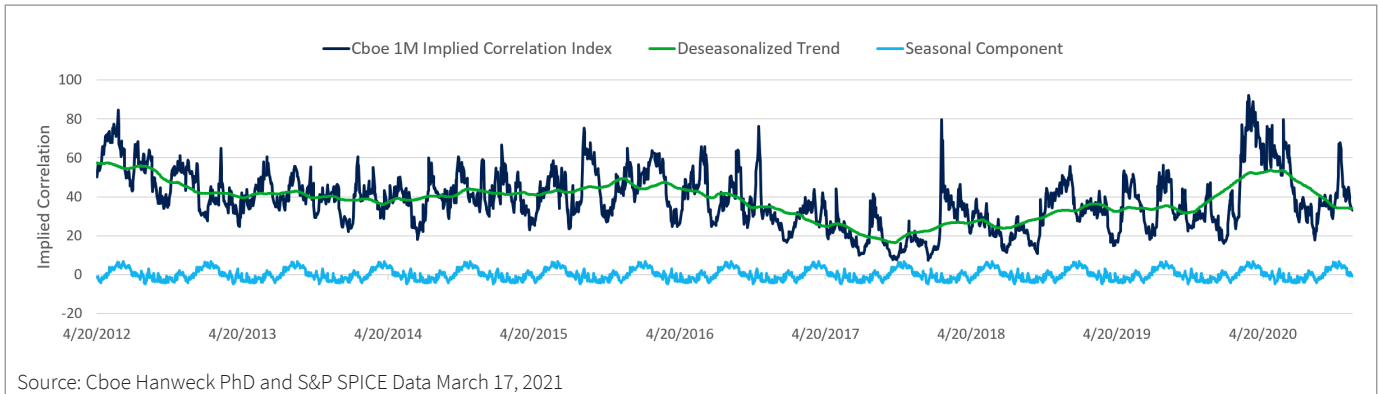
Sector ETF Name	Sector ETF Ticket	List Date
Communication Services Sel Sect SPDR® ETF	XLC	6/19/2018
Consumer Discret Sel Sect SPDR® ETF	XLY	12/22/1998
Consumer Staples Select Sector SPDR® ETF	XLP	12/22/1998
Energy Select Sector SPDR Fund	XLE	12/22/1998
Financial Select Sector SPDR Fund	XLF	12/22/1998
Health Care Select Sector SPDR Fund	XLV	12/22/1998
Industrials Care Select Sector SPDR Fund	XLI	12/22/1998
Information Technology Select Sector SPDR Fund	XLK	12/22/1998
Materials Select Sector SPDR Fund	XLB	12/22/1998
Real Estate Select Sector SPDR Fund	XLRE	10/8/2015
Utilities Select Sector SPDR Fund	XLU	12/22/1998

3-month Implied Correlation for 11 Sectors and the S&P 500 Index were calculated using the option implied volatilities on the Sector ETFs listed above. The S&P 500 Implied Correlation measures the expected average correlation across all component stocks in the index, as opposed to just the top 50 stocks as in the Cboe Implied Correlation Index. The Sector ETF 3-month Implied Correlations were calculated using S&P Spice Component Data Files and Cboe Hanweck PhD option implied volatilities on sector component stocks. The graphs below compare the S&P 500 Implied Correlation to the Sector Implied Correlation of a few select sectors.



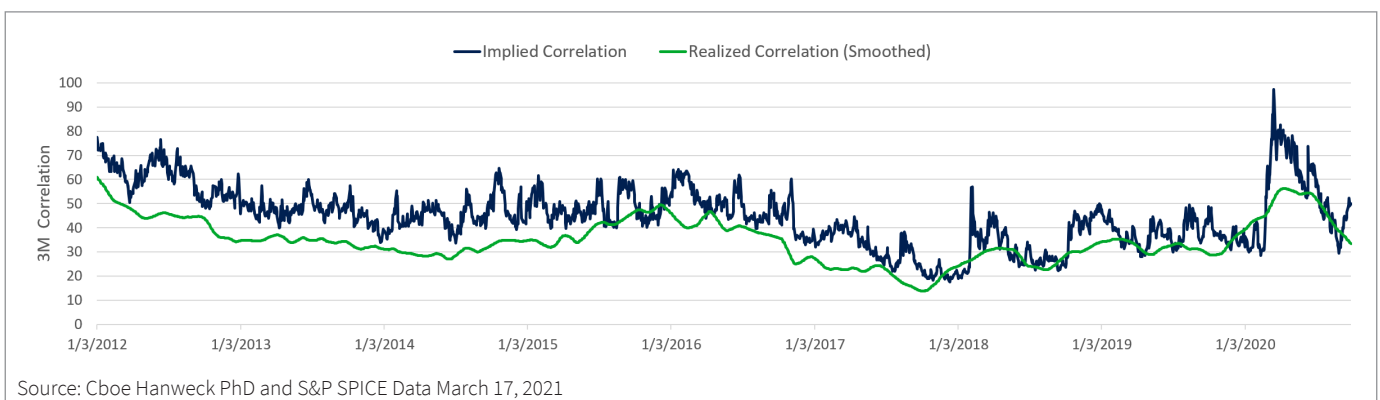
Earnings Impact on Implied Correlation:

The graph below shows the deseasonalized trend and seasonalized component of the Cboe 1M Implied Correlation Index calculated using a multiplicative deseasonalisation model. A consistent quarterly seasonal pattern is most clearly observable in the Cboe 1M Implied Correlation Index. Considering that most firms release earnings within close intervals, we would expect higher investor uncertainty during earning periods to translate into amplified short maturity option implied volatilities across most component stocks and implied correlations as shown below.



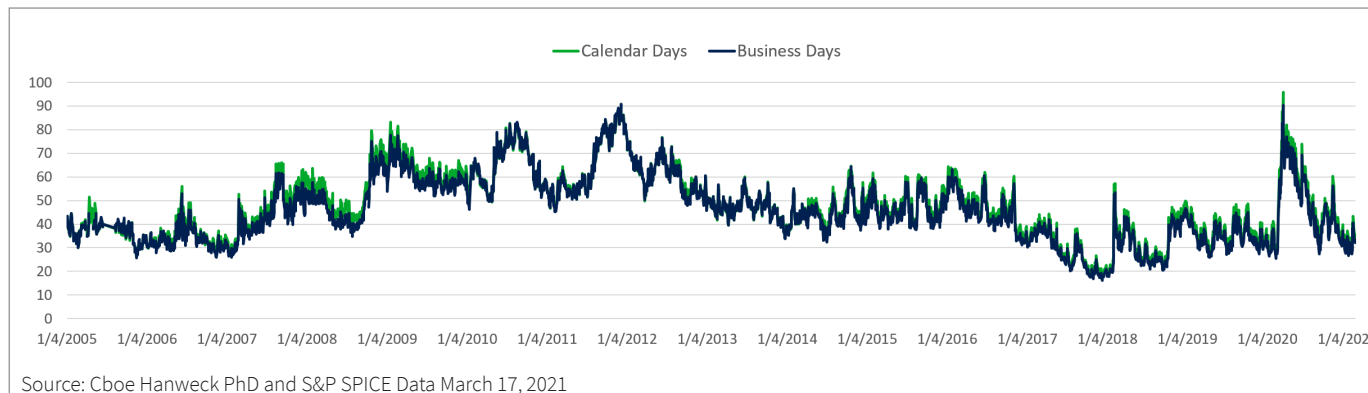
Realized vs Expected Implied Correlation:

The graph below compares the Cboe 3M Implied Correlation Index with a smoothed realized correlation measure. The realized correlation measure is calculated by using a 63-day rolling window and calculating the equity return volatility for each of the top 50 component stocks. Daily return volatilities were annualized using a 252-day period. In addition to having a larger seasonal component, the realized correlation is in most cases slightly below the Cboe 3M Implied Correlation Index. This difference can be explained by higher expectations of future volatilities (implied volatilities) relative to realized historic volatilities. Seasonality can also be explained from the rolling calculation's sensitivity to changes in the Top 50 stock components. Due to the high seasonality due to portfolio rebalancing, we calculated a smoothed 3M realized correlation to improve comparison between the two indices.



Trading vs. Calendar Days:

The Cboe Implied Correlation indices are calculated using business day implied volatilities. Moving from business days to calendar days introduces a ‘Friday Effect’ as market makers remove quotes at the end of a trading week to take the weekend out of the implied volatilities. Therefore, a drop in Friday volatilities followed by an increase during the start of the next trading week results in a spike pattern. Based on the average correlation formula on the first page, we would expect the same pattern to persist for Implied Correlations. However, based on the graph below, there is no discernable difference caused by the ‘Friday Effect’.



General

913.815.7000

Cboe.com

Sales

212.378.8560

sales@Cboe.com

Trade Desk

913.815.7001

tradedesk@Cboe.com

The information in this Factsheet is provided for general education and information purposes only. No statements within this Factsheet should be construed as a recommendation to buy or sell a security or to provide investment advice. Supporting documentation for any claims, comparisons, statistics or other technical data in this Factsheet is available by contacting Cboe Global Markets at www.cboe.com/Contact. Options involve risk and are not suitable for all investors. Prior to buying or selling an option, a person must receive a copy of “Characteristics and Risks of Standardized Options.” Copies are available from your broker or from The Options Clearing Corporation at 125 South Franklin Street, Suite 1200, Chicago, IL 60606 or at www.theocc.com. The Cboe Implied Correlation Indices (the “Indexes”) are designed to represent proposed hypothetical options strategies. The actual performance of investment vehicles such as mutual funds or managed accounts can have significant differences from the performance of the Indexes. Investors attempting to replicate the Indexes should discuss with their advisors possible timing and liquidity issues. Like many passive benchmarks, the Indexes do not take into account significant factors such as transaction costs and taxes. Transaction costs and taxes for strategies such as the Indexes could be significantly higher than transaction costs for a passive strategy of buying-and-holding stocks. Investors should consult their tax advisor as to how taxes affect the outcome of contemplated options transactions. Past performance does not guarantee future results. It is not possible to invest directly in an index. Cboe Global Indices, LLC calculates and disseminates the Indexes. “Cboe” and “VIX” are registered trademarks of Cboe Exchange, Inc. All other trademarks and service marks are property of their respective owners. © 2021 Cboe Exchange, Inc. All Rights Reserved.