TWO SIGMA

Street View

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EXECUTIVE SUMMARY A form of portfolio insurance has become increasingly expensive in the past eighteen months. The skew of put versus call options on the S&P 500 has reached levels significantly higher than the long-term mean. Multiple potential explanations exist. Regulatory changes, including Dodd-Frank, may have structurally altered the market by both forcing banks to better hedge their equity exposures and withdraw from their historical role as a liquidity provider. More worryingly, equity market investors may feel apprehensive about the global economic outlook. Either way, the relative demand for portfolio insurance has increased.

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Inside:
Increased Demand for Portfolio Insurance

INCREASED DEMAND FOR PORTFOLIO INSURANCE

PORTFOLIO INSURANCE PROVED ALL THE RAGE during much of the 1980s. Equity market participants bought put options on the S&P 500 with the hopes of limiting their downside risk while still capturing most of the potential bull-market upside. The strategy's fame quickly turned into infamy, however, when many market historians blamed some of the 1987 crash on portfolio insurance and automated trading.

Portfolio insurance has become more expensive as investors and financial intermediaries like banks have more widely adopted the strategy. The relative skew of put versus call options on the S&P 500 index has sustained levels during the past 18 months far higher than the ten-year average. At times, the skew has reached two standard deviations above the mean. On average, the skew exceeded 1.2 standard deviations. A qualitatively similar pattern exists for options on the Russell 2000 index.

Multiple potential explanations exist. New regulations and assessments in the United States, including Dodd-Frank and the Comprehensive Capital Analysis and Review (CCAR), may have structurally changed the market by both forcing banks to better hedge their equity exposures and withdraw from their historical role as liquidity providers. For example, banks prepare for the Federal Reserve's annual but increasingly important CCAR test by stockpiling put options to try to demonstrate that their equity positions could weather market stress. More worryingly, equity market investors may feel apprehensive about the global economic outlook, inciting them to purchase greater amounts of portfolio insurance than in the recent past. Either way, the relative skew of put versus call options implies that the demand for portfolio insurance has increased relative to the supply.

DATA SUGGESTS THE DEMAND FOR DOWNSIDE MARKET PROTECTION HAS INCREASED

Option-implied volatility helps gauge the market cost to protect against downside risks relative to the cost to capture potential upside gains. In a perfectly efficient market with risk-neutral agents, these costs would equal each other, and a plot of implied volatility versus strike price would "smile" symmetrically.

Not surprisingly, the typical market deviates from this textbook description. In a typical market, the implied volatility of a put option exceeds that of a call option after controlling for the distance from the at-the-money level. Risk aversion likely creates this skew and creates a lopsided "smirk" instead of a symmetric smile.

Figure 1 captures changes in this skew to illustrate how market demand for downside protection – a form of portfolio insurance – has shifted over time. To normalize the typical smirk and reduce idiosyncratic noise, the figure plots a rolling one month z-score. When the z-score exceeds zero, investor demand for buying protection relative to the market supply of protection tops the historical average.

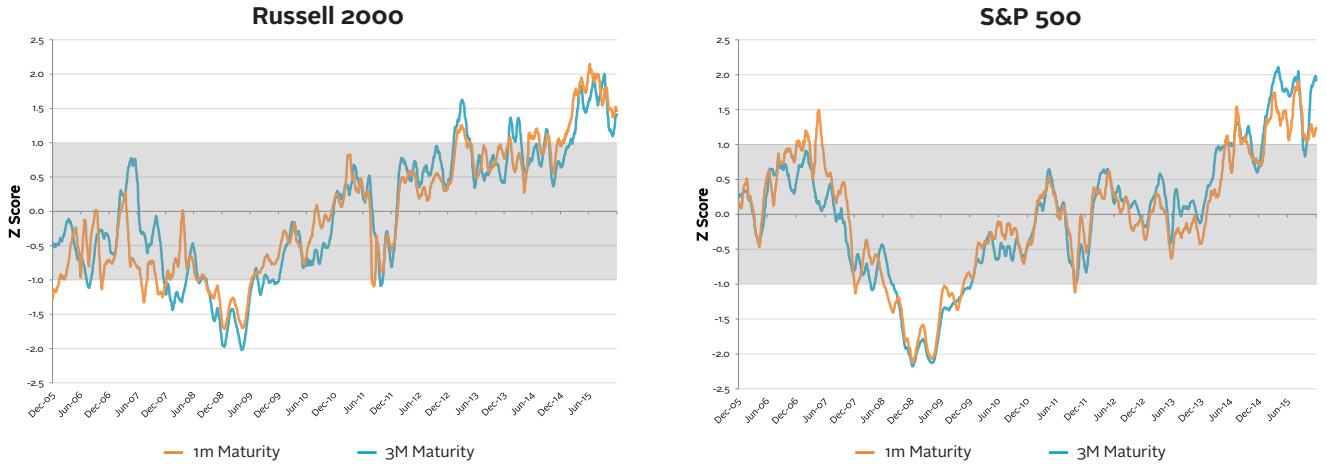
The figure plots both three month (blue) and one year (orange) option maturities. For each maturity, the line shows an average for options both 10 percent away from the at-the-money level (i.e., 110 percent call strikes and 90 percent put strikes) and 20 percent away from at-the-money levels (i.e., 120% call strikes and 80% put strikes). The chart on the left plots options on the S&P 500. The chart on the right depicts the Russell 2000 index.

For both large market capitalization (S&P 500) and small market capitalization (Russell 2000) US stocks, the relative skew of put versus call options for the past 18 months has significantly exceeded the ten-year average. At times, such as after the equity market crash in China in July, the skew exceeded the mean by two standard deviations. On average for the past 18 months, the various measures of skew (i.e., short- and long-term, large- and small-cap) has exceeded the mean by 1.2 standard deviations.

FIGURE 1

Rolling 1 Month Z-score of implied volatility of puts over calls in the S&P 500 and Russell 2000 Indices

December 2005-December 2015



Notes: Data from Bloomberg through December 11, 2015. Chart begins in December 2005 due to data availability.

INVESTORS HAVE FEW OPTIONS

Perhaps this ought not to surprise anyone familiar with insurance markets. The demand for flood insurance tends to surge in regions that recently suffered a flood. The demand for earthquake insurance exhibits a similar pattern. Behavioral economists ascribe such patterns to the recency bias. According to this theory, individuals tend to overweight the probability of events that have occurred in recent memory relative to events that empirically appear no less likely but that occurred longer ago.

Compared to the relatively tranquil equity markets during the QE3 era, US equity market volatility has risen. As long ago as May 2014, some US Federal Reserve governors threatened to hike interest rates faster than many expected. Some equity market investors may have equated this with a flash flood or violent earthquake in an environment unaccustomed to such turbulence. Perhaps motivated in part by the recency effect, equity investors may have felt the need to purchase more insurance against a market drawdown.

Structural changes in the market may also have contributed to this relative increase in the demand for downside market protection. Even though banks still serve as the largest liquidity providers in the options markets, they seem to have reduced their net and gross exposures. Lower liquidity in most insurance contracts, equity insurance included, tends to lead to higher premiums. Other regulatory requirements, such as Dodd-Frank and the Fed's annual CCAR stress test, have also forced banks to hedge their equity exposure more, which further increases the insurance premium. The CCAR in particular requires banks to hedge their short-term exposure to large market capitalization stocks, which may explain why the skew for three month maturity, S&P 500 options exceeds the skew for other maturities and indices.

No matter the cause, the data seems to suggest that the demand for portfolio insurance relative to its supply has increased to ten-year highs, and concerned investors have few options (no pun intended). They can bite the proverbial bullet and buy relatively expensive insurance. They can cut their overall equity market exposure. They might try to hedge their portfolios using different instruments. For example, the skew for puts on the Russell 2000 is less magnified than the S&P 500. Finally, investors might decide to forgo purchasing insurance during a period when prices appear to exceed their long-term value. No matter the choice, higher priced insurance translates into a less attractive option set for the risk averse.

INTERESTING TECHNOLOGY-RELATED ARTICLES

Two Sigma is a technology company that applies a rigorous, scientific method-based approach to investment management. We draw upon a diverse set of fields to inspire our technology, including artificial intelligence and distributed computing. Occasionally, we read articles in the popular press that describe applications of technology that we find interesting, thought-provoking, and relevant for people thinking about improving the investment management process. Below is a subset of the articles we read this month. Please do not view the inclusion of these articles as an endorsement by Two Sigma of their viewpoints or the companies discussed therein. Two Sigma welcomes discussions (and contributions) about these and other such technology-related articles.

"Data Mining Reveals How Smiling Evolved During a Century of Yearbook Photos" *MIT Technology Review,* November 24, 2015 (http://www.technologyreview.com/view/543871/data-mining-reveals-how-smiling-evolved-during-a-century-of-yearbook-photos/).

> Volatility is not the only thing smiling more these days. Using machine learning technology, PhD students at UC Berkeley produced an "average" yearbook photo face for each decade of the past 110 years. Besides cataloguing general changes in hairstyle and clothing, the images showed how average facial expressions have changed over time. The students developed a lip curvature metric that quantified how a neutral expression in the early 20th century, a relic from sitting for oil portraits, has evolved into one that has increasingly incorporated smiling.

"Google's New Autoreply Sounds Great!!!!" by Nicola Twilley, *The New Yorker,* November 7, 2015 (http://www.newyorker.com/tech/elements/google-new-smart-reply-sounds-great).

> What first appeared as a Google April Fool's joke has now become reality: a self-responding inbox. Google's Smart Reply plug-in provides users with three suggested replies to emails based on the email content. Google Research developed an artificial neural network that found patterns and probabilities underlying email communications to discover common responses. One curious result of the data training, however, was the algorithm's tendency to suggest "I love you" in response to more ambiguous emails. Fine tuning of the algorithm will continue.

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