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January 2016 | No 1

# Taming Volatility: A New Perspective on Variance Swaps

While the variance swaps market has grown significantly and is currently worth trillions of dollars, pricing these derivatives remains problematic. SFI's Damir Filipovic and Loriano Mancini, and former SFI PhD student Elise Gourier, provide a powerful new pricing model, revealing how to use variance swaps to construct and maintain an optimal investment portfolio.

Volatility is a fact of life in financial markets. The trading prices of assets, including—for example—stocks, vary over time. They move up and down on a daily basis; some more than others. At times, during economic crises or market panics for example, prices can fluctuate wildly. For some of those actively involved in financial markets volatility is welcomed as an opportunity to make money, trading the daily ebb and flow of price movements. For others though, volatility provides unwanted turbulence, making risk harder to assess, return curves harder to predict, and portfolio and wealth management more difficult. Fortunately for those who prefer a less volatile world or at least markets where volatility is more predictable, finance's seemingly never ending capacity for innovation has produced a number of solutions. To begin with, you can trade volatility using the Chicago Board Options Exchange Volatility Index, more commonly known as the VIX. By using a variety of strategies it is possible to speculate on, or minimize exposure to, volatility in the future. Or you can get even closer to volatility by trading variance swaps.

### Volatility exposure

A variance swap is an over-the-counter financial derivative that allows two parties to take a position on volatility. Such derivatives underpin the VIX index. In effect a variance swap reflects the variation or degree of movement of an underlying asset, whether that is a stock price, a currency or commodity, or an interest rate. One party purchases the variance swap contract from a counterparty at a fixed price reflecting the predicted volatility over time. The swap runs for a specific period of time—the term. At the end of this period the actual realized variance over the period is averaged out and converted into a monetary amount; this will either be more than or less than the strike price and the difference is settled between the parties accordingly. In this way it is possible for parties to protect themselves—to hedge—against a level of volatility over a particular time horizon. This is similar to buying insurance against a specific risk, such as a bad weather event for example.

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While the use of variance swaps may sound fairly straightforward, it is not. One considerable challenge for sellers, for example, is pricing the swaps correctly. And, while there are pricing models available, they do not necessarily properly factor in variance over time. However, recent research by finance academics including SFI's Damir Filipovic and Loriano Mancini has provided finance professionals with a new tool for assessing the value of these derivatives. The authors have created a new class of model for modelling variance swap rates, and therefore risk. A non-linear model that is practical to use, it also goes beyond existing industry standard models. In demonstrating the model's applicability, the authors show how it accurately reflects the variance swap rates, and thus the volatility, for the S&P 500 for the period from January 1996 to January 2010. At any one point in time the model shows the variance swap rate for a maturity of 2, 3, 6, 12, and 24 months. The sample time period includes the most recent financial crisis and, as would be expected, the model shows variance swap rates rising steeply post crisis reflecting increased anticipated volatility and investors' willingness to pay for volatility protection.

*"Given that the model can be used to produce future scenarios, it can be used as a tool for helping to develop risk management strategies."*

The authors' model makes possible more realistic pricing of variance swaps, and does this for any maturity, including those that might not be popularly quoted. One might, for example, have two parties where one wants to buy a ten-month variance swap from the other: the model can be used to work out a reasonable variance swap rate for a ten-month time horizon. Also, given that the model can be used to produce future scenarios, it can be used as a tool for helping to develop risk management strategies—by financial institutions planning their capital requirements, for example.

### Optimal portfolio strategy

Furthermore, and importantly, the variance swap model can be used by those involved in selecting and managing investment portfolios. The authors investigate the challenge of optimal portfolio choice, and the role of variance swaps as a component in an optimal mix of investments. In particular, they look at a portfolio investing in a stock index, a mixture of variance swaps (three month and two-year horizons), index put options, and risk free bonds.

*"Investors can optimize the relative weightings of their portfolios dynamically, depending on their risk profile. This is a method that would have outperformed the S&P 500 index over time."*

In doing so, their analysis reveals that an optimal portfolio involves adopting a short–long strategy with respect to variance swaps, with weighting depending on the risk profile of the investor. On average the long-term strike price is greater than the realized variance, so shorting the long-term variance swap allows the investor to pocket any difference. At the same time by buying short-term variance swaps the investor partially hedges portfolio losses against imminent volatility in the underlying asset.
Indeed, using the authors' methods investors can optimize the relative weightings of their portfolios dynamically, at any given time, depending on their risk profile and the maturity of the various components of their portfolio. As the authors demonstrate over a fourteen-year period from 1996 to 2010, this is a method that—with the portfolio rebalanced daily—would have outperformed the S&P 500 index over time for a risk-tolerant investor. While for a risk-averse investor it would have produced steady wealth growth, avoiding volatility and reducing the risk of significant losses during a market crisis. All this during a period in which there were two substantial market crashes.

The full paper can be found at http://bit.ly/1H8fA5L.

**Key Words**
Stochastic volatility
Variance swap
Quadratic term structure
Dynamic optimal portfolio

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