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The jump component of S&P 500 volatility and the VIX index

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Abstract

Much research has investigated the differences between option implied volatilities and econometric model-based forecasts. Implied volatility is a market determined forecast, in contrast to model-based forecasts that employ some degree of smoothing of past volatility to generate forecasts. Implied volatility has the potential to reflect information that a model-based forecast could not. This paper considers two issues relating to the informational content of the S&P 500 VIX implied volatility index. First, whether it subsumes information on how historical jump activity contributed to the price volatility, followed by whether the VIX reflects any incremental information pertaining to future jump activity relative to model-based forecasts. It is found that the VIX index both subsumes information relating to past jump contributions to total volatility and reflects incremental information pertaining to future jump activity. This issue has not been examined previously and expands our understanding of how option markets form their volatility forecasts.

Introduction

Forecasts of asset return volatility are crucial inputs into numerous investment decisions. Broadly speaking there are two approaches for obtaining forecasts. There are many econometric model-based forecasts (MBF) designed for such purposes along with market determined option implied volatilities (IV). Given the importance of volatility forecasts, the forecast accuracy and informational efficiency of IV relative to MBF has been considered by numerous authors.

Fleming, 1998, Jiang and Tian, 2003, Becker et al., 2006, amongst others have examined whether various IV measures subsume historical information (predominantly return data) commonly used when forecasting volatility. While Fleming (1998) and Jiang and Tian (2003) find that IV is efficient with respect to such information, Becker et al. (2006) find that S&P 500 IV does not completely subsume a diverse set of information including MBF. Becker et al. (2007) find that IV contains no information beyond volatility persistence as captured by MBF relevant for forecasting the level of total volatility.

These previous studies considered the relationship between IV and forecasts of the level of total volatility. In doing so, these studies ignored the fact that volatility may be generated from both continuous diffusion and discontinuous jump processes in price (see Barndorff-Nielsen and Shephard, 2004, Andersen et al., 2007). Here we extract the component of volatility due to the jump process in price and investigate whether IV contains any information relating to this. Commonly used MBF generate volatility forecasts based on smoothing historical data (often daily squared returns or realized volatility) without any distinction between the diffusion and jump components of volatility.[1] Only very recent developments have sought to redress this issue. In contrast, as IV is market determined, and not constrained to a fixed mapping of such historical data, it may utilize both of the components of total volatility. This may be important as it has been shown to have important implications for volatility forecasting (Andersen et al., 2007).

This article considers two issues relating to the relationship between IV and jump activity. *First*, it will be examined whether IV subsumes historical measures of how jumps contributed to spot market volatility. This will determine how option markets react to, or incorporate jump activity in the S&P 500 price process in their IV forecasts and extends the work of Fleming, 1998, Jiang and Tian, 2003, Becker et al., 2006. *Second*, it will be investigated whether IV reflects information beyond that reflected in MBF in relation to future jump activity and extends the work of Becker et al. (2007). In combination, these research questions reveal further insights into the manner in which option markets form their volatility forecasts.

It is found that IV subsumes information relating to historical jump activity meaning that option markets react to volatility due to both the continuous diffusion and discontinuous jump processes in price. It is also shown that IV contains incremental information relative to MBF in relation to future jump activity. This result differs from that of Becker et al. (2007) in that they found that IV contained no information incremental to that of MBF in relation to the total level of volatility.

This paper proceeds as follows. Section 2 presents a description of the required data. Section 3 outlines the estimates of the various volatility components. Section 4 discusses the empirical methodology employed to address each of the research questions. Sections 5 Results, 6 Concluding remarks present the results and concluding comments, respectively.

Section snippets

Data

To address the research questions at hand, four different sets of data are required. Equity returns, an estimate of IV, realizations of total equity volatility and the volatility component due to jumps in prices. The study is based on data pertaining to the S&P 500 index, from 2 January 1990 to 17 October 2003 (3481 daily return observations). The implied volatility measure utilized here is that provided by the Chicago Board of Options Exchange, the VIX.…

Measuring the components of volatility

This section outlines the methodology used to measure both the diffusion and jump components of total volatility. Following from Barndorff-Nielsen and Shephard, 2004, Andersen et al., 2007 we start from the premise that returns are generated by the stochastic process$dp(\tau) = \mu(\tau)dt + \sigma(\tau)\, dW(\tau) + \kappa(\tau)\, dq(\tau)$

where $p(\tau)$ is the logarithm of the S&P 500 index at time τ, $\mu(\tau)$ the drift, $\sigma(\tau)$ the stochastic volatility process and $W(\tau)$ a standard Brownian motion. The discontinuous jump process is described by…

Methodology

This section describes the empirical methodology used to address the research questions at hand. We begin by outlining the MBF utilized. The methodology employed to determine whether the VIX subsumes the historical price jump component of volatility is described, followed by that used to ascertain whether it contains any incremental information relevant to future volatility.…

Results

Section 5.1 presents the empirical results relating to whether the VIX subsumes historical contribution of jumps to historical volatility, with Section 5.2 presenting those relating to whether the VIX contains any incremental information relevant for explaining the future jump activity in volatility.…

Concluding remarks

The behavior of option implied volatility (IV) has attracted a great deal of research attention. This research has focused on both the forecasting performance and informational content of IV relative to econometric model-based forecasts (MBF). However, as most common MBF simply smooth historical estimates of total volatility when generating forecasts, and IV is a market determined forecast, IV forecasts have the potential to behave differently to MBF when non-smooth price changes (jumps)…

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