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Post-'87 crash fears in the S&P 500 futures option market

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Abstract

Post-crash distributions inferred from S&P 500 future option prices have been strongly negatively skewed. This article examines two alternate explanations: stochastic volatility and jumps. The two option pricing models are nested, and are fitted to S&P 500 futures options data over 1988–1993. The stochastic volatility model requires extreme parameters (e.g., high volatility of volatility) that are implausible given the time series properties of option prices. The stochastic volatility/jump-diffusion model fits option prices better, and generates more plausible volatility process parameters. However, its implicit distributions are inconsistent with the absence of large stock index moves over 1988–93.

JEL classification: G13

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Deviations of stock index option prices from the benchmark Black–Scholes model have been extraordinarily pronounced since the stock market crash on October 19, 1987. Out-of-the-money (OTM) put options that provide explicit portfolio insurance against substantial downward movements in the market

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have been trading at high prices (as measured by implicit volatilities) relative to at-the-money options. The OTM puts have been even more "overpriced" relative to OTM calls that will pay off only if the market rises substantially. The pronounced implicit volatility patterns emerged immediately after the stock market crash, and have since been a permanent feature of the S&P 500 futures options market. These patterns differ fundamentally from those observed prior to the crash.

The implication is that the distribution implicit in option prices since the crash of 1987 is substantially negatively skewed, in contrast to the essentially symmetric and slightly positively skewed lognormal distribution underlying the Black–Scholes model. There are three possible explanations for such a shift in implicit distributions: a change in investors' assessment of the S&P 500's stochastic process, a change in investors' aggregate risk aversion, and mispricing of post-crash options due, e.g., to option market frictions or market organization. The second explanation could be justified by a crash-related relative wealth redistribution between less and more risk-averse investors. The third explanation is sometimes used by option market practitioners, who argue that heavy demand for out-of-the-money put options has driven up prices.

This article examines the first explanation: that investors' assessment of the S&P 500 stochastic process has changed. There are two different ways of modeling the post-crash emergence of negatively skewed implicit distributions: crash fears, and time-varying volatility inversely related to market returns. The former approach assumes that the stock market crash sharply increased option market participants' assessed probability of *further* stock market crashes – a view somewhat validated by the subsequent 5–8% drops on January 11, 1988 and October 13, 1989. Option pricing models exploring a crash fears explanation typically employ variants of Merton's (1976) jump-diffusion model; e.g., Bates (1991) and Bakshi et al. (1997).

The second approach draws upon the inverse relationship between the level of underlying equity prices and the instantaneous conditional volatility observed empirically for individual firms (Black, 1976) and for broad market indices (Nelson, 1991). Theoretical explanations for the phenomenon include the "leverage" effects of Black (1976), whereby lower overall firm values increase the volatility of equity returns, and the "volatility feedback" effects of Poterba and Summers (1986) and Campbell and Hentschel (1992), among others, whereby higher volatility assessments lead to heavier discounting of future expected dividends and thereby lower equity prices. However, the explanations of time-varying stock market volatility most relevant to the rapid emergence of substantial post-crash negative implicit skewness in stock index options appear to be those that focus on the demand by investors for option-like payoffs, or portfolio insurance. In Platen and Schweitzer (1998), the impact of option writers dynamic hedges upon an imperfectly liquid underlying asset market alters the underlying asset price process, and therefore alters option prices. Their