Anatomy of a Meltdown:
The Risk Neutral Density for the S&P 500 in the Fall of 2008

by

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ABSTRACT

We examine how the risk neutral probability density (RND) for the S&P 500 behaved from minute to minute during the fall of 2008, compared to earlier periods. The RND extracted from a new dataset containing the full real-time record of bid and ask quotes for index options provides an exceptionally detailed view of how investors' expectations about returns and risk responded under extreme market stress, as intraday volatility increased to a level five times higher than it had been two years earlier. Arbitrage keeps the mean of the RND closely tied to the market index, but its fluctuations are much different. While the S&P index exhibits moderate positive autocorrelation, there is consistently large negative autocorrelation in both the RND mean and standard deviation over short intervals. Moreover, we find a strong pattern in how the shape of the RND responds to changes in the level of the stock index: The middle portion of the RND is more volatile, amplifying moves in the index by as much as a factor of 1.5, or more in some cases. This overshooting phenomenon increased in size during the crisis and, surprisingly, was stronger for up moves than for down moves in the market.

Keywords: risk neutral density; implied probabilities; stock index options; 2008 financial crisis

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