The Variance Gamma Process and Option Pricing

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Abstract

A three parameter stochastic process, termed the variance gamma process, that generalizes Brownian motion is developed as a model for the dynamics of log stock prices. Theprocess is obtained by evaluating Brownian motion with drift at a random time given by a gamma process. The two additional parameters are the drift of the Brownian motion and the volatility of the time change. These additional parameters provide control over the skewness and kurtosis of the return distribution. Closed forms are obtained for the return density and the prices of European options.The statistical and risk neutral densities are estimated for data on the S&P500 Index and the prices of options on this Index. It is observed that the statistical density is symmetric with some kurtosis, while the risk neutral density is negatively skewed with a larger kurtosis. The additional parameters also correct for pricing biases of the Black Scholes model that is a parametric special case of the option pricing model developed here.

Subject: Derivatives, Theoretical Asset Pricing

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