A Closed-Form Option Valuation Formula in Hidden Markov Jump Diffusion Models

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Abstract

To improve the empirical performance of the Black-Scholes model, alternative models have been proposed to address the leptokurtic feature of the asset return distribution, volatility smile and e_ects of volatility clustering phenomenon. However, analytical tractability of the option valuation remains a problem for most of the alternative models. In this paper, we propose a Markov jump di_usion model, that not only can incorporate both the leptokurtic feature and volatility smile, but can also present the economic features of volatility clustering and long memory. To evaluate derivatives prices, we apply Lucas's general equilibrium framework to provide closed form formulas for option and futures prices. When the jump size follows a speci_c distribution, such as a lognormal distribution or a default probability, we devise explicit analytic formulas for the equilibrium prices. Through these formulas, we illustrate the e_ect of jumps, via stochastic intensity, on implied volatility and volatility surface as well as sensitivity analysis in stock option prices.

KEY WORDS: contingent claims, equilibrium analysis, European call option, long memory, Markov jump di_usion model, Markov modulated Poisson process, rational expectations, volatility clustering.