Box-Cox transformation and Option Pricing

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Abstract

The Box-Cox transformation, which is a basic method in time series analysis, is not so popular among researchers and practitioners in financial engineering. The well-known Black-Scholes model assumes that stock price exhibits geometric Brownian motion. In other words, log transformed return follows a generalized Wiener process. The log transformation is a special case of the Box-Cox transformation. The goal of this article is to present a valuation method for the option under the assumption that the Box-Cox transformed return process follows a generalized Wiener process. We also empirically examine the effect of the generalization from the log transformation to the Box-Cox transformation in both the stock process itself and the option price based on AIC.

Our result indicates first that, in general, the Box-Cox transformation with optimal parameter is close to the log transformation in a continuing Bull market, while it is not in a Bear market. Second, the result for an equity process based on AIC is mostly reflected in the option price and AIC nearly captures precisely the difference in option prices with respect to the difference in equity process models.

As a practical implication, our option pricing model assuming that the Box-Cox transformed return process follows a generalized Wiener process is able to capture the volatility skew phenomenon often observed in the option market.

Key words: Box-Cox transformation, option pricing, AIC, Ito-formula, volatility skew

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Received April 4, 2005; Received in final form September 27, 2005; Accepted September 27, 2005.