

A Multivariate Stochastic Unit Root Model with an Application to Derivative Pricing

Offer Lieberman and Peter C. B. Phillips

November 11, 2015

Abstract

This paper extends recent findings of Lieberman and Phillips (2014) on stochastic unit root (STUR) models to a multivariate case including asymptotic theory for estimation of the model's parameters. The extensions are useful for applications of STUR modeling and because they lead to a generalization of the Black-Scholes formula for derivative pricing. In place of the standard assumption that the price process follows a geometric Brownian motion, we derive a new form of the Black-Scholes equation that allows for a multivariate time varying coefficient element in the price equation. The corresponding formula for the value of a European-type call option is obtained and shown to extend the existing option price formula in a manner that embodies the effect of a stochastic departure from a unit root. An empirical application reveals that the new model substantially reduces the average percentage pricing error of the Black-Scholes and Heston's (1993) stochastic volatility pricing schemes in most moneyness-maturity categories considered.