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Weighted possibilistic moments of fuzzy numbers with applications to GARCH modeling and option pricing

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ABSTRACT

Carlsson and Fuller [C. Carlsson, R. Fuller, On possibilistic mean value and variance of fuzzy numbers, Fuzzy Sets and Systems 122 (2001) 315–326] have introduced possibilistic mean, variance and covariance of fuzzy numbers and Fuller and Majlender [R. Fuller, P. Majlender, On weighted possibilistic mean and variance of fuzzy numbers, Fuzzy Sets and Systems 136 (2003) 363–374] have introduced the notion of crisp weighted possibilistic moments of fuzzy numbers. Recently, Thavaneswaran et al. [A. Thavaneswaran, K. Thiagarajah, S.S. Appadoo, Fuzzy coefficient volatility (FCV) models with applications, Mathematical and Computer Modelling 45 (2007) 777–786] have defined non-centered nth order possibilistic moments of fuzzy numbers. In this paper, we extend these results to centered moments and find the kurtosis for a class of FCA (Fuzzy Coefficient Autoregressive) and FCV (Fuzzy Coefficient Volatility) models. We also demonstrate the superiority of the fuzzy forecasts over the minimum square error forecast through a numerical example. Finally, we provide a description of option price specification errors using the fuzzy weighted possibilistic option valuation model.

1. Introduction

The use of fuzzy set theory as a methodology for modeling and analyzing certain financial problems is of particular interest to a number of researchers due to fuzzy set theory's ability to quantitatively and qualitatively model those problems which involve vagueness and imprecision. Recent studies have shown that a fuzzy random variable can be considered as a measurable mapping from a probability space to a set of fuzzy variables (see Cherubini [4] for details). Fuzzy time series models provide a new avenue to deal with subjectivity observed in most financial time series models. Most of the fuzzy financial models developed so far have generally, been confined to modeling parameters through some form of defuzzification or linear type of fuzzy numbers such as Trapezoidal Fuzzy Number (Tr.F.N.) or Triangular Fuzzy Number (T.F.N.). The main reason for using a linear membership function is to avoid complex nonlinear computations (for more details see [5,6]). Linear membership functions are not always appropriate in decision making applications since they do not represent the linguistic terms being modeled. As pointed out by Appadoo et al. [7], Medaglia et al. [5] and Medasani et al. [6], there are difficulties associated with the selection of the solution of a problem that uses a linear membership function. Furthermore, these studies have highlighted the importance of having membership functions that can be easily tuned and adjusted. These favorable properties serve as a motivation for us to study higher order weighted possibilistic moments of a nonlinear type of fuzzy number. We provide three main results in the paper.

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