The JLS model with ARMA/GARCH errors

Špela Jezernik Širca,
Faculty of Mathematics and Physics, University of Ljubljana

Abstract

D. Sornette et al. [1, 2] proposed that, prior to crashes, the mean function of a stock market index price time series is characterized by Log-Periodic Power Law (LPPL) model, which is also known as Johansen-Ledoit-Sornette (JLS) model. In this paper we present an econometric investigation of the JLS model, that is, we investigate the residuals of the JLS model. We apply an extended autocorrelation functions (EACF) method proposed by Tsay and Tiao [3] and Akaike's Information Criteria, which are known as AIC and BIC, respectively, for model identification of residuals of the JLS model. We incorporate an autoregressive moving average (ARMA) dynamic and a conditional heteroskedasticity (GARCH) structure in the error term of the JLS model. We estimate the highly nonlinear model (the JLS model and the JLS model with ARMA/GARCH errors) using the Differential Evolution algorithm, which performs evolutionary global optimization. For all computations and graphical presentation we use the statistical software R. We present our empirical findings for different financial bubbles of the U. S. stock market index S&P 500. The main contribution of this paper is that we get better statistical properties of residuals using the JLS model with ARMA/GARCH errors and improved estimate of the most crucial nonlinear parameter, the critical time t_c, defined as the end of the bubble and the most probable time for a crash to occur.

Keywords: JLS model, Financial bubbles, Crashes, Log-periodic power law, Econometrics, Model identification, EACF method, ARMA-GARCH models

References

[1] D. Sornette, A. Johansen, J.-P. Bouchaud, *Stock Market Crashes, Precursors and Replicas*, J. Phys. I France 6, (1996) 167–175.

[2] A. Johansen, O. Ledoit, D. Sornette, *Crashes as Critical Points*, Int. J. Theor. Appl. Fin. 3, (2000) 219–255.

[3] R. S. Tsay, G. C. Tiao, *Consistent estimates of autoregressive parameters and extended sample autocorrelation function for stationary and nonstationary ARMA models*, J. Amer. Stat. Assoc. vol. 79, (1984) 84–96.