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Estimating *m*-regimes STAR-GARCH model using QMLE with parameter transformation

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Abstract

It is well known in the literature that obtaining the parameter estimates for the Smooth Transition Autoregressive-Generalized Autoregressive Conditional Heteroskedasticity (STAR-GARCH) can be problematic due to computational difficulties. Conventional optimization algorithms do not seem to perform well in locating the global optimum of the associated likelihood function. This makes Quasi-Maximum Likelihood Estimator (QMLE) difficult to obtain for STAR-GARCH models in practice. Curiously, there has been very little research investigating the cause of the numerical difficulties in obtaining the parameter estimates for STAR-GARCH using QMLE. The aim of the paper is to investigate the nature of the numerical difficulties using Monte Carlo Simulation. By examining the surface of the log-likelihood function based on simulated data, the results provide several insights into the difficulties in obtaining QMLE for STAR-GARCH models. Based on the findings, the paper also proposes a simple transformation on the parameters to alleviate these difficulties. Monte Carlo simulation results show promising signs for the proposed transform. The asymptotic and robust variance–covariance matrices of the original parameter estimates are derived as a function of the transformed parameter estimates, which greatly facilitates inferences on the original parameters.

Keywords: STAR; GARCH; Monte Carlo simulation; Re-parameterization

1. Introduction

The literature of nonlinear time series analysis has been growing rapidly in the last two decades. Interestingly, the literature focuses mainly on regime-switching models, such as the Smooth Transition Autoregressive (STAR) model of Teräsvirta [10] and Markov-Switching (MS) model of Hamilton [6]. This is perhaps not surprising as many economic and financial variables exhibited regimes switching behaviours. For examples, Teräsvirta and Anderson [11] applied STAR model to characterize dynamics of Gross National Product (GNP) during recession and expansion; Franses and van Dijk [4] and Chan and McAleer [3] followed the work of Lundbergh and Teräsvirta [8] and applied the STAR models with Generalized Autoregressive Conditional Heteroskedastic errors (STAR-GARCH) to analyze the dynamics of stock returns.

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