

Research Article

Modeling Markov Switching ARMA-GARCH Neural Networks Models and an Application to Forecasting Stock Returns

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The study has two aims. The first aim is to propose a family of nonlinear GARCH models that incorporate fractional integration and asymmetric power properties to MS-GARCH processes. The second purpose of the study is to augment the MS-GARCH type models with artificial neural networks to benefit from the universal approximation properties to achieve improved forecasting accuracy. Therefore, the proposed Markov-switching MS-ARMA-FIGARCH, APGARCH, and FIAPGARCH processes are further augmented with MLP, Recurrent NN, and Hybrid NN type neural networks. The MS-ARMA-GARCH family and MS-ARMA-GARCH-NN family are utilized for modeling the daily stock returns in an emerging market, the Istanbul Stock Index (ISE100). Forecast accuracy is evaluated in terms of MAE, MSE, and RMSE error criteria and Diebold-Mariano equal forecast accuracy tests. The results suggest that the fractionally integrated and asymmetric power counterparts of Gray's MS-GARCH model provided promising results, while the best results are obtained for their neural network based counterparts. Further, among the models analyzed, the models based on the Hybrid-MLP and Recurrent-NN, the MS-ARMA-FIAPGARCH-HybridMLP, and MS-ARMA-FIAPGARCH-RNN provided the best forecast performances over the baseline single regime GARCH models and further, over the Gray's MS-GARCH model. Therefore, the models are promising for various economic applications.

1. Introduction

In the light of the significant improvements in the econometric techniques and in the computer technologies, modeling the financial time series have been subject to accelerated empirical investigation in the literature. Accordingly, following the developments in the nonlinear techniques, analyses focusing on the volatility in financial returns and economic variables are observed to provide significant contributions. It could be stated that important steps have been taken in terms of nonlinear measurement techniques focusing on the instability or stability occurring vis-a-vis encountered volatility. Further, the determination of stability or instability in terms of volatility in the financial markets gains importance especially for analyzing the risk encountered. In addition to impact of the magnitude and the size of shocks

on volatility, the financial returns are under the influence of sudden or abrupt changes in the economy. Hence, the volatility of economic data has been explored in econometric literature as a result of the need of modelling uncertainty and risk in the financial returns. The relationship between the financial returns and various important factors such as the trade volume, market price of financial assets, and the relationship between volatility, trade volume, and financial returns have been vigorously investigated [1–4].

The ARCH model introduced by Engle [5] and the Generalized ARCH (GARCH) model introduced by Bollerslev [6] are generally accepted for measuring volatility in financial models. GARCH models have been used intensively in academic studies. A tremendous amount of GARCH models exist and various studies provide extended evaluation of the development.

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financial inclusion and generating significant efficiency improvements across the economy To build inclusive societies and address rising inequalities global and national leaders must bridge the digital divide across and within countries to reap the benefits of digital financial services and build appropriate regulatory frameworks for ensuring trusted transactions in a digitalized economy This means finding the right balance between enabling financial innovation and addressing risks including insufficient consumer protection a lack of financial and digital literacy unequal access to digital infrastructure and data biases that need action at the national level This book focuses on financial technology with a particular emphasis on the impact of digital finance on the finance and banking industries Chapters address topics such as FinTech big data Bitcoin corporate governance and economic policy while also considering current global issues like climate change and the COVID 19 pandemic Supported by the most recent research and illuminating case studies this handbook offers an insightful overview of how the finance and banking sectors are changing under the influence of the digital age

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Modelling Volatility with Markov-switching GARCH Models María Ferrer Fernández, 2022
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A New Approach to Markov-Switching GARCH Models Markus Haas, 2010 The use of Markov switching models to capture the volatility dynamics of financial time series has grown considerably during past years in part because they give rise to a plausible interpretation of nonlinearities Nevertheless GARCH type models remain ubiquitous in order to allow for nonlinearities associated with time varying volatility Existing methods of combining the two approaches are unsatisfactory as they either suffer from severe estimation difficulties or else their dynamic properties are not well understood In this article we present a new Markov switching GARCH model that overcomes both of these problems Dynamic properties are derived and their implications for the volatility process discussed We argue that the disaggregation of the variance process offered by the new model is more plausible than in the existing variants The approach is illustrated with several exchange rate return series The results suggest that a promising volatility model is an independent switching GARCH process with a possibly skewed conditional mixture density

A Family of Markov-Switching GARCH Processes Ji-Chun Liu, 2012

Estimating and Testing Markov Switching Models with Economic and Financial Applications René Garcia, 1992

An Implementation of Markov Regime Switching GARCH Models in Matlab Thomas Chuffart, 2017 MSGtool is a MATLAB toolbox which provides a collection of functions for the simulation and estimation of a large variety of Markov Switching GARCH MSG models Currently the software integrates a method to select the best starting values for the estimation and a post estimation analysis to ensure the convergence The toolbox is very flexible a user friendly with a large number possible options In this paper we give some illustrative examples

Markov-Switching GARCH Models in R David Ardia, 2019 We describe the package MSGARCH which implements Markov switching GARCH models in R with efficient C object oriented programming Markov switching GARCH models have become popular methods to account for regime changes in the conditional variance dynamics of time series The package MSGARCH allows the user to perform simulations as well as Maximum Likelihood and MCMC Bayesian estimations of a very large class of Markov switching GARCH type models The package also provides methods to make single step and multi step ahead forecasts of the complete conditional density of the variable of interest Risk management tools to estimate conditional volatility Value at Risk and Expected Shortfall are also available We illustrate the broad functionality of the MSGARCH package using exchange rate and stock market return data

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