

Chapter 5

Predicting Exchange Rates Volatility Using Hybrid ARIMA–GARCH Model: A Comparative Analysis

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ABSTRACT

For the last few decades, the Autoregressive Integrated Moving Average (ARIMA) model has been a popular linear model in predicting time series. Recent research has shown that the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model can be a promising alternative to the traditional linear models. A time series can be considered to comprise a linear and non-linear part. This chapter aims to highlight in a relevant way the need to properly define the dynamics of the linear and non-linear parts of the time series as far as the time series prediction is concerned. Using the GARCH model and the combined ARIMA-GARCH model in

DOI: 10.4018/979-8-3693-6215-0.ch005

the analysis and prediction of exchange rates, this study shows that the combined ARIMA-GARCH-T model, which defines the dynamics of the linear and non-linear parts of the exchange rate time series, has a higher predictive power when compared to the GARCH-T model.

INTRODUCTION

Predicting the volatility of financial time series plays an important role for investors as it helps them to understand trading risks and, hence, make better choices. High volatility means that either the market is in danger, or the prices of investments are not stable, which shows that the capital markets are not doing well. To be able to trade effectively, it is important to understand how prices change, be able to predict those changes, and manage investment based on those predictions (Rubio *et al.*, 2023).

A time series is a realization of a stochastic process $\{Y_t, t \in T\}$ where the time index takes on a finite or countably infinite set of values. Determining the future values of a time series given its previous values is referred to as a time series prediction or forecasting. This is done after developing a model that describes the underlying relationship between values of the time series (Zhang, 2003). Money-related choices frequently include a long-term commitment to assets whose returns generally depend on what happens in the future (Brooks, 2008). A good approach to model evaluation by examining the accuracy of the predicted values is that not all the observations are used in estimating the parameters of the model. In other words, the observations are divided into two groups: the first group is used to estimate the model parameters, referred to as the in-sample data set, while the second group, referred to as the out-of-sample data set, is used to construct forecasts or predictions from the estimated parameters. Statistical loss functions can then be used to calculate how close the predicted values are to the actual values.

The time series $\{Y_t, t \in T\}$ is a weak (or covariance) stationary time series if, for every $t \in T$, the mean and variance are constant and

$$Cov(Y_t, Y_{t-j}) = \gamma_j \quad (1)$$

The Autoregressive Moving Average model with orders p and q written as AR-MA(p, q) is a covariance stationary time series defined as;

$$y_t = c + \sum_{i=1}^p a_i y_{t-i} + \varepsilon_t + \sum_{j=1}^q b_j \varepsilon_{t-j} \quad (2)$$

where $a_p, b_q \neq 0$ and $\varepsilon_t \sim WN(0, \sigma_\varepsilon^2)$.

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