NUS INVESTMENT SOCIETY

Academic Research Review

ARIMA/GARCH Model for Trading

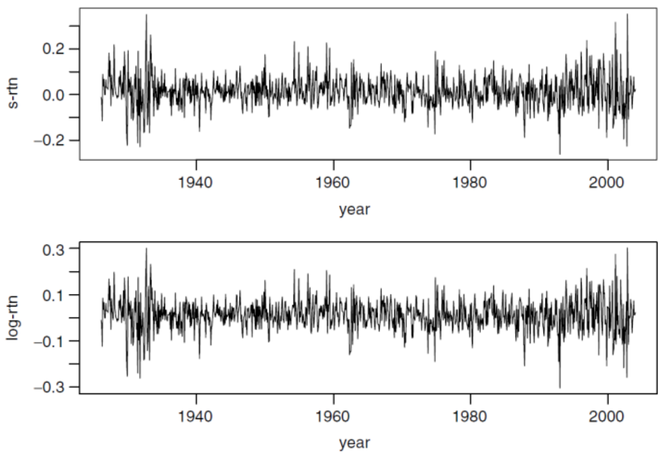
EXECUTIVE SUMMARY

Financial time series analysis is concerned with the theory and practice of asset valuation over time. A time series is a sequence of observations which are usually ordered in time. The movement of stock prices with time is an example of a time series. By fitting an appropriate time series model to the movement of a stock's price, we can attempt to forecast how the stock price will change in the near future. In this paper, time series models form the basis of our trading strategy. We first introduce the ARIMA/GARCH model for the time series of stock prices. We then discuss how the model can be used to forecast stock prices. Finally, we will present the back-testing results and share possible improvements and modifications.

INTRODUCTION AND MODEL

The movement of stock prices is a non-stationary time series as its mean and variance changes with time. We quantify the mean with the expected returns of the stock and variance with risk. A higher variance would indicate a higher volatility in the time series.

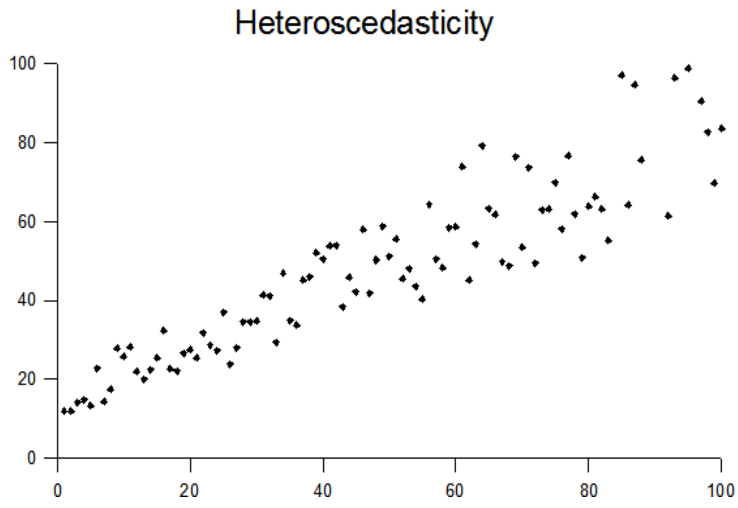
Returns in this report are computed using logarithmic returns instead of simple returns because it preserves numerical stability and reduces algorithmic complexity in some cases. We can see from the picture below that the log function does not affect the returns greatly. In fact, the patterns of the simple and logarithmic returns are very similar.



Autoregressive Integrated Moving Average (ARIMA) models are used because they can reduce a non-stationary series to a stationary series using a sequence of differencing steps. It is to be noted that ARIMA models has a strong memory since the coefficient in its MA representation do not decay over time to zero, indicating that past shock events will have permanent effects to the series.

Variance of a non-stationary time series may change with the seasonality or the trend. This form of regular variability is known as heteroscedasticity. Heteroscedasticity is usually serially correlated and hence conditional on periods of increased variance. Thus we say that such series are conditional heteroskedastic. Modelling conditional heteroscedasticity amounts to augmenting a dynamic equation with governs the time evolution of conditional variance to the asset return, to a time series model. Generalised Autoregressive Conditional Heteroskedastic (GARCH) model would be used to account for conditional heteroskedastic.

The following diagram shows an example of heteroscedasticity in data.



It is to be noted that there is some weakness in the GARCH model. For example, the tail behavior of the model remains too short even with standardized Student-t innovations. Furthermore, the model reacts equally to both positive and negative shocks. Such problems can be rectified with GARCH models with alpha-stable innovations. However, this will not be explored in the report.

METHODOLOGY

To predict if the stock prices are going to increase or decrease the next day, we require the use of training data to make a prediction using the ARMIA/GARCH model. Hence, the previous 500 days of differenced logarithmic returns of stock prices is chosen so as to fit the ARIMA/GARCH model to predict day's optimal stock price.

The explanation of using logarithmic returns in our model is explained in the previous chapter. While the number of days chosen is arbitrary, it is recommended that there should be at least 50-60 data points to be used as training data for the model. A good model can be optimized by selecting an appropriate amount of data points as training data.

To predict the stock price for each day, we will have to loop through each day where each iteration will use the previous 500-day data points to form the appropriate ARIMA/GARCH model.

The looping procedure will provide us with the best fitting ARIMA model, in terms of the Akaike Information Criterion (AIC) where a smaller AIC value will indicate a better fit. This best fitting ARIMA model is required to form the GARCH model. Given that we try several separate ARIMA fits and fit a GARCH model, for each day, the forecast can take a long time to generate.

When using the model to predict the future stock price, 2 possible outcomes can occur. One, the GARCH part of the ARIMA/GARCH model does not converge. If this were to occur, we would just long the stock since we are unable to predict the day's price. Two, the GARCH model does converge. The convergence means that we will be able to predict if the stock price will rise (+1) or fall (-1) the next day.

TRADING STRATEGY

The combined ARIMA/GARCH model is used to make a prediction for the next day returns. Based on the model, if the prediction is positive (+1), a long position would be taken. On the other hand, if the prediction is negative (-1), a short position would be taken.

REFERENCES

Indirect estimation of GARCH models with alpha-stable innovations. (2012). Retrieved November 04, 2016, from https://mpra.ub.uni-muenchen.de/38544/

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