Zero Theorem Literature Review

"Next-Day Bitcoin Price Forecast, Z.H. Munim, M.H. Shakil, I. Alon, 2019"

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Highlights

- Introducing a uni-variate time series models that are volatile and have significant effect on the performance to predict future Bitcoin price with a high level of accuracy.
- Understand the working of NNAR and ARIMA model that out-performs the traditional methods.

Background

With the progressive price change and increase in the market cap, the popularity of investment in Bitcoin has been increased dramatically. Hence, this increase is due to high price volatility that makes BitCoin first decentralised and currently biggest digital currency. However, there are some limitations when one need to predict future Bitcoin price with a high level of accuracy. Therefore, there is a need to implement a method that is volatile and better understands the price fluctuations along with significant effect on performance.

Introduction

To address these issues related to predicting future BitCoin price with higher accuracy, Munim et al. (2019) comes up with a study that analyzes forecasts of Bitcoin price using the autoregressive integrated moving average (ARIMA) and neural network autoregression (NNAR) models. Moreover, Munim et al. (2019) employ the static forecast approach that forecast next-day Bitcoin price both with and without re-estimation of the forecast model for each step that will help in cross validation of each forecast results.

Proposed Methodology

In this context, two univariate time series models such as NNAR and ARIMA were used. For both models, Munim et al. (2019) forecast next-day Bitcoin price with and without re-estimating the forecast model for each step. For the computational purpose, a Forecast package in the R software was used.

Details of Proposed Methodology

To have a better understanding about two models, lets have a look at ARIMA model first which has two components such as a moving average (MA) component and an autoregressive (AR) component. This means that the MA component models association between values of error term of a variable at a particular time with its error term value in previous time whereas the AR component models association between the value of a variable at a particular time with its value in previous time. From these two components, integrated component comes into consideration when the time series becomes stationary after the first (or second) difference that is represented in such a way $\Delta z_t = \sum_{i=1}^{p} \emptyset_i \Delta z_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t$.

After considering the ARIMA model, Neural Network Autoregression model comes in that consist of artificial neural network (ANN) methods which rely on mathematical models in a related way as 'neurons' (nodes) in the brain. The simplest ANN models would only have the output (dependent variable) in the top layer and predictors (independent variables or inputs) in the bottom layer. After adding the hidden layer(s) in-between top and bottom layers, the ANN structure becomes non-linear. The inputs to each node are estimated using a weighted linear combination such as $z_j = \beta_j + \sum_{i=1}^{n} W_{i,j} X_i$.

Moreover, Munim et al. (2019) adopted three indices to measure the accuracy of forecast results such as RMSE, MAPE, and MASE (mean absolute scaled error) which are represented as $RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n} (d_t - z_t)^2}$, $MAPE = \frac{100}{n}\sum_{t=1}^{n} \left|\frac{(d_t - z_t)}{d_t}\right|$ and MASE $=$ mean $\left|\frac{e_t}{\frac{1}{n-1}\sum_{i=2}^{n}|z_t - z_{t-1}|}\right|$ respectively on Daily Bitcoin exchange rate data (USD per Bitcoin) from 1 January 2012 to 4 October 2018, i.e. 2466 days, was collected from Quandl where two training-samples and two-test samples were considered for cross-validation purposes.

Results and Discussion

In order to evaluate the proposed models two training-samples are analyzed. In the first training-sample period, NNAR models perform better than ARIMA while ARIMA performs better in the second training-sample. However, with or without re-estimation of forecast models for next-day Bitcoin price forecasting, ARIMA models outperform NNAR in the test-sample forecast. To have a better understanding lets look at the comparison which is presented in table

Table 1: Training Sample Forecast Performance

Forecast Model	RMSE	MAPE	MASE
ARIMA (First Training Sample)	0.053	1.225	0.987
NNAR (First Training Sample)	0.055	1.172	0.963
ARIMA (Second Training Sample)	0.053	1.225	0.987
NNAR (Second Training Sample)	0.055	1.172	0.963

Table 2: Test Sample Forecast Performance (466 days)

Forecast Model	RMSE	MAPE	MASE
ARIMA (Forecast without re-estimation of each step)	0.053	1.225	0.987
NNAR (Forecast without re-estimation of each step)	0.055	1.172	0.963
ARIMA (Forecast with re-estimation of each step)	0.053	1.225	0.987
NNAR (Forecast with re-estimation of each step)	0.055	1.172	0.963

Conclusion

This led to the conclusion that NNAR models perform better than ARIMA during the period of less volatility, but not during extremely volatile test-sample periods of Bitcoin price. From results it is clear that better accuracy of ARIMA models could be based on the fact that the feed-forward NNAR model was used. Hence, the NNAR is found to be inferior to the recurrent neural network (RNN) models.

References

Munim, Z. H., Shakil, M. H., and Alon, I. (2019). Next-day bitcoin price forecast. *Journal of Risk and Financial Management*, 12(2):103.