THINK INDIA JOURNAL

ISSN:0971-1260
Vol-22- Issue-14-December-2019

Prediction of Wipro Returns using Box-Jenkins Methodology

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Abstract

Forecasting of stock returns is and will always be a vitally important financial notion confronted by investors. Their exist fluctuations in stock returns and investors are always keen to show their interest as they want to take the advantage of potential returns from the organization by way of investing in stocks. Hence, it becomes a matter of concern for investors to predict future stock returns so that they can attain their objective of wealth maximization. This reason creates an urge to explore forecasting of stock returns empirically. This research paper employed ARIMA methodology, developed by Box and Jenkins in 1970, which rely on the previous values of the variable itself. In the paper, this methodology is applied on the stock returns of one of the top IT companies listed on NSE i.e. Infosys Ltd. Data of daily return was collected from 1 April 2008 till 31st March 2018. Results concluded that ARIMA model had strong capability of forecasting in short run.

Keywords: ARIMA, Stock Returns, Forecasting

Introduction

Forecasting stock returns is always been a topic for discussion in contemporary financial literature. Investors try hard to contemplate possible future returns of a company's given common stock. The question arises how to identify a probable closest return of a given stock. Traditionally, researchers have made an effort to forecast the stock returns by studying the factors which affects given firm's value or profitability. In the present research paper, an effort has been made to envisage our variable by way of the lagged values of the variable itself. Based on the popular notion of letting the data speak for itself (Gould,1981). Therefore, ARIMA (Auto

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Regressive Integrated Moving Average) technique has been applied to forecast the stock returns on the basis of its previous values and error term.

There have been many studies conducted on different sectors that have applied ARIMA model for prediction of various time series variables which might include stock prices as well. However, fewer studies have been conducted on IT sector to envisage stock returns of IT company using ARIMA model. More specifically, no study, as per review of literature, has been done using the daily stock returns of IT company. The present work initiates to fill this gap by taking daily stock returns of one IT sector company in India i.e. Wipro.

It is an Indian multinational company which was established by Mohamed H Premji at Bengluru, Karnataka in 1945. Initially, the company was set up as a manufacturer of edible oils. Later on, after the death of Mohamed Premji it was taken over by Azim Premji who is currently working as a chairman in the company. During the 1970s and 1980s, the company transformed itself into leading player in IT services & product and FMCG business. On 7 June 1977, company named itself as Wipro Products Limited from Western India Vegetables Products Limited. Later in 1982, company changed its name to Wipro Limited (Western India Products). Moreover, Wipro had a total of 1,71,425 employees at the end of March 2019, out of which 30% were women. In addition, its revenue was at $7.1 billion in 2015 which rose to $ 8.47 billion in 2017-18. It is a global provider of all types of IT solutions and services which include consulting, systems integration, IT enabled services, Information Systems in US, UK, China, Australia, Japan, Germany, France, Canada, South Korea, South Africa, Romania, Hungry etc.

Review of Literature

Afeef, M & et.al (2018) employed ARIMA methodology to forecast stock prices of a Pakistan based company namely Oil & Gas Development Company Limited (OGDCL). The researcher considered daily adjusted closing stock prices of OGDCL for almost 15 years starting from 2004 till 2018 with 3632 observations. Results depicted that for the purpose of prediction in short-run, ARIMA modeling has great potential. Consequently, it was suggested for investors to consider the findings of the study to supplement their aptitude of forecasting. **Gay (2016)** made an effort

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to investigate the relationship of macroeconomic variables on stock returns of BRIC countries that include Brazil, Russia, India and China. He made use of the Box-Jenkins method to serve the purpose. The factors taken into account were the exchange rates and the oil prices. No statistically significant association was found to be there between the given macroeconomic factors and stock returns for any of the BRIC economies. Moreover, no significant link was identified of stock return with its lagged values for any of the four countries. **Gupta, S & Kashyap, S. (2015)** did endeavour to generate prediction of exchange of Indian currency vis-à-vis USD, GBP, YEN and EURO. They applied Box-Jenkins methodology (ARIMA) on the collected data of twelve months starting from April 2014 to March 2015. In addition, they applied ADF test to verify the stationarity of data and the results were attained at first difference in the data. The best terms of AR and MA were selected after exercising various models and finally best-fit model was selected on the basis of minimum SBC, AIC, sum of squared errors and Q statistics to predict the respective currencies. The forecasted results can provide insights to policymakers, forex dealers, government, corporate etc. to design policies along with generation of prediction in the desired time period. **Hamjah (2014)** also used ARIMA for prediction of rice production in Bangladesh. He compared the actual data of rice production with the predicted values and concluded that model had a very short run prediction capability. **Mondal, P & et.al. (2014)** studied 56 stocks from seven different sectors listed on NSE. Researchers collected data of 23 months for the empirical study. Further, AIC was used to select the best ARIMA model. Results indicated that ARIMA provides best accurate results as above 85% of predictions using ARIMA model for all sectors were accurate. Moving to specific sectors, forecasting of FMCG sector was more accurate as compared to the predictions for Banking and Automobile sectors. **Devi, B & et.al. (2013)** selected top four companies out of which Nifty Midcap 50 was selected on the basis of having maximum midcap value for analysis. The historical data of selected companies for past five years was collected and trained by applying ARIMA model with different parameters. Further, the accuracy of predicted results was checked using criteria like AIC and BIC. Lastly, analysis of trained model was conducted to find the market behaviour and trend for future forecast.

Objectives

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- To forecast the stock returns of Infosys company.
- To analyze the variation in actual and forecasted stock returns of Infosys.
- To check the applicability of ARIMA model in predicting stock returns of Infosys.

ARIMA Model

ARIMA model is explained in Box-Jenkins methodology. This methodology is used to identify a potential model out of general class of models. In addition, it uses both the techniques of autoregressive (AR) and moving average (MR) for forecasting as well as tries to search best combination of two techniques. This model was initially introduced by two statisticians namely George P Box and Gwilym Jenkins in their book "Time Series Analysis: Forecasting and Control" (Box & Jenkins, 1970).That's why it is also known as Box-Jenkins methodology. In order to get better results from the model, it is suggested by researchers to work on at least 100 observations or more.

ARIMA models are generally expressed like "ARIMA(p,d,q)" , here the three terms are defined as follows:

- "AR" in ARIMA is called **Autoregressive term** in the model.
- "I" in ARIMA is called the **Integrated** feature of a time series."I" also takes care of differencing to make a time series stationary.
- "MA" in ARIMA represents **Moving Average** term in the model. It assumes that a time series is a function of its errors.

The creators of the model, Box and Jenkins, have focused on the principle of parsimony which emphasize on keeping the model as simple and concise as possible. For the prediction of time series, both the model developers proposed a four tier model. The four steps of ARIMA model are:

1) **Model Identification**

2) **Parameter estimation**

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3) **Diagnostic Checking**

4) **Forecasting**

Research Methodology

While using time series econometric framework, it is advisable to extricate information related to a variable which can be gathered from the variable itself (Asteriou & Hall, 2007). The general equation of an ARMA model (Asteriou & Hall, 2007) is as follows:

$$Y_t = \varphi_1 Y_{t-1} + \varphi_2 Y_{t-2} + - + \varphi p Y_{t-p} + \varepsilon t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + - + \theta q \varepsilon_t - q$$

Here, Y_t is the predicted value of the variable, $Y_{t-1,}$ Y_{t-2},…..Y_{t-p} are the lagged values of the autoregressive term(AR), ε_t is the error term, ε_{t-1}, ε_{t-2}, - - -, ε_{t-q} are the lagged values of the moving average(MA) or error terms, φ and θ are the coefficients of the regressors.

Applying ARMA process on non stationary data will definitely provide no results. Therefore, the most appropriate and efficient ARIMA model was applied on daily stock returns of Wipro collected from 1 April 2008 till 31st March 2018 in order to forecast more accurate results of stock returns.

Descriptive Statistics

	WIPRO
Mean	0.0334
Maximum	10.7291
Minimum	-14.6404
Std. Dev.	1.9673

The outcome exhibits the minimum and maximum value of **Wipro** stock returns as -14.6404 and 10.7291 respectively along with the standard deviation of 1.9673 and mean of 0.0334. After

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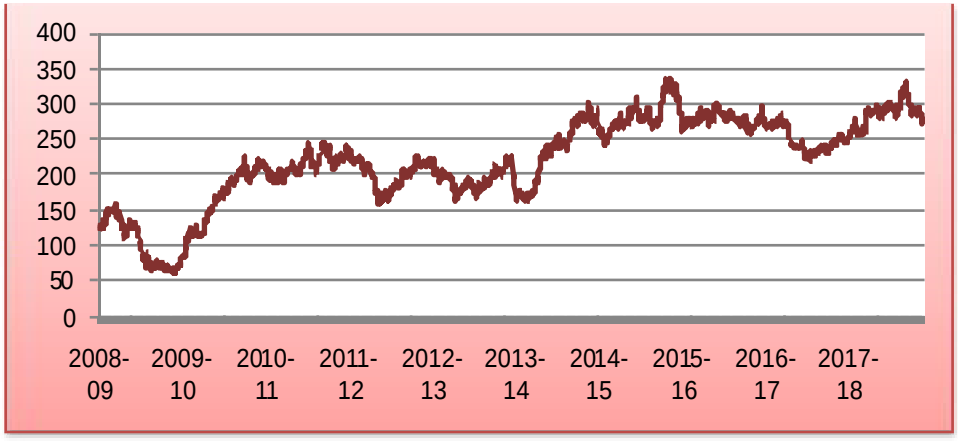
looking at the value of standard deviation it can be concluded that there is not much dispersion in the stock returns of Wipro Company as well as the mean value depicts the average market return of the company.

Trend Analysis of TCS Stock Prices



Above figure illustrates the stock price of Wipro which took start from 122 levels and then slip to Rs 68 levels due to the global slowdown. But after, Jan'09, stock picked up the pace and does a bull run for 1 year, making a high of Rs211. After this, there is a consolidation phase till September'13 which further followed a steady but increasing trend. From 2015 till 2018, stock moves in a particular range only, however, there was a slight decrease in 2016 but it again rises and recovered the same. In this, the stock is more range bound and after a bull run, it takes time to consolidate.

Unit Root Test

So, it can be identified that time series of Wipro is non stationary. If the series is not stationary then it becomes necessary to conduct some transformation steps. Regarding the same, initially the stock prices of Wipro were converted into log normal stock returns and after that the test of Augmented- Dickey Fuller was applied on the series.

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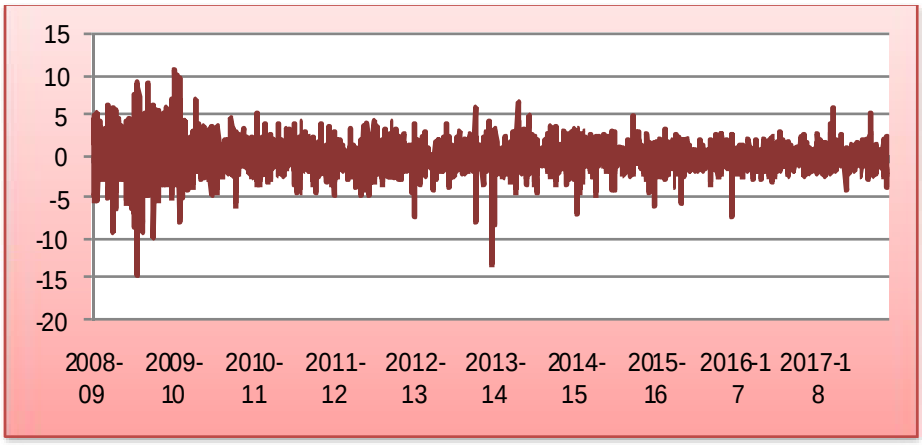
The results of ADF test which has been employed on the log normal stock return series of Wipro depicts the ADF value as -50.9609 and probability value as 0.00 which is less than .05. This ensures the stationarity of series at first differencing. Along with this, the value of Durbin-Watson stat i.e. 2 ensures that there exist no autocorrelation in the series.



Graph of Wipro Stationarity Series

Above figure shows differenced daily stock prices of Wipro. This indicates that values of series fluctuate randomly around zero which confirms the stationarity of series.

Model Identification

After achieving the results of stationarity in the series through log normal stock returns values, researcher stepped further and introduced Box-Jenkins methodology. After applying the function "auto.arima", best model has been estimated which identified the number of AR and MA terms on which returns of Wipro depends. Finally, the ARIMA model (2,0,1) came out to be as the best fit model for prediction of Wipro stock returns. In the estimated model, the value of AR comes out to be 2 which explains that stock returns of Wipro can be forecasted by considering stock returns of previous two days whereas I stands as 0 which shows stationarity of natural log returns series at differencing. Moreover, the value of MA comes out to be 1 which represents that stock returns of Wipro are affected by error term of previous one day.

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Model Estimation

Using R studio, following are the estimated parameters on the basis of model identified:

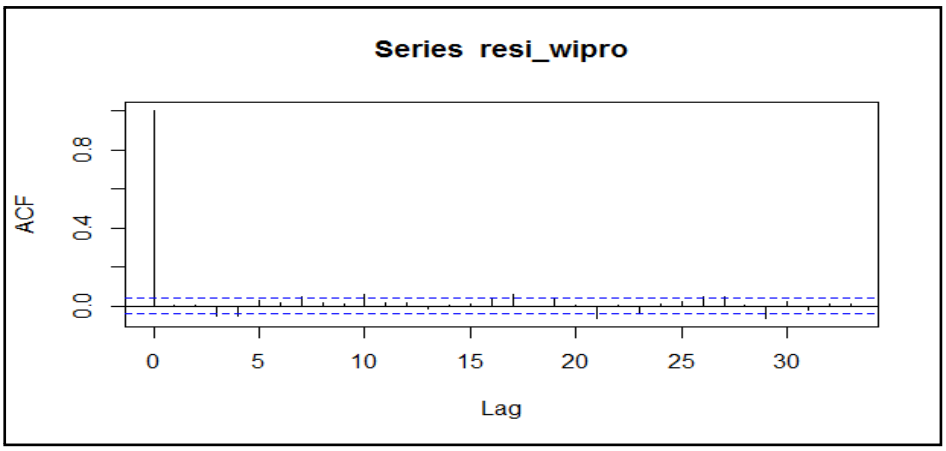
The coefficients depict the AR and MR terms of the ARIMA model whereas S.E shows the standard error. The mathematical equation of ARIMA model is

$$Y_t = 0.0332 - 0.8808\, Y_{t-1} - 0.0462\, Y_{t-2} + 0.0381 + 0.8564\, \varepsilon_{t-1}$$

Here the p-value of each coefficient has been examined in order to determine whether or not the parameters are significantly significant. As a result, it has been discovered that p-values of coefficients ar1, ar2 and ma1 are found to be significant as its value comes out to be less than 5% significance level.

Residuals Diagnostic

For a best forecasting model it is mandatory to diagnose the leftover residuals generated from the model. If these are left unchecked then, it may lead to the problem of autocorrelation. Therefore, the assumption of presence of autocorrelation among the residuals has been diagnosed by preparing correlograms of both autocorrelation as well as partial autocorrelation.



Plot of ACF

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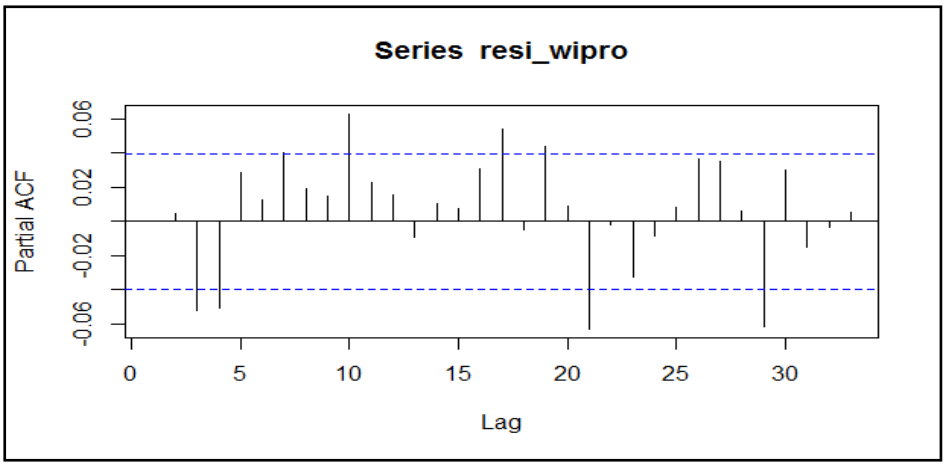

Plot of PACF

Above figure depicts the ACF for different return values of Wipro. From the above ACF plot, researcher identified that the spikes are within the significant lines. Therefore, there is no existence of autocorrelation which makes the model a good fit for the returns data.

Secondly, an analysis of PACF plot of Wipro shown in figure 5.25 depicts a lag at 3, 4, 10, 17 and 29 just crosses the significance limit. This means that these spikes have a value which is significantly different from zero and that is an evidence of autocorrelation at these lags whereas remaining all other lags of PACF lies within significance limit and moves around zero. Hence it can be concluded that our selected model is a perfect fit for forecasting.

Forecasting

Finally, when researcher have identified a successful ARIMA model (2, 0, 1), then forecasting next 7 days log normal returns of Wipro has been done. The daily stock returns are compared with the returns generated by the best fit ARIMA (2,0,1) model which are shown in below table alongwith the calculated value of S.E.

Forecasted Returns of Wipro

Date	Actual Returns %	Forecast Returns %	SE%

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2 April 2018	2.980832702	2.802022917	0.17881
3 April 2018	-2.003925997	0.982174062	-2.9861
4 April 2018	-0.815792137	0.753562791	-1.56935
5 April 2018	1.638957535	0.633070692	1.005887
6 April 2018	-0.809077253	0.555508825	-1.36459
9 April 2018	0.388987017	0.500173504	-0.11119
10 April 2018	0.331551356	0.458135418	-0.12658

Source: Output from R Studio

The results depicts that only on 2nd and 5 April 2018, the value was under forecasted by 0.17% and 1% respectively, except both these days remaining all the returns from 3rd April 2018 till 10th April 2018 have been over forecasted . The range of over forecasted values lies between 0.11% to 2.98% which confirms that model is precise or best fit for prediction.

Findings & Conclusion

The findings of the study from the above analysis states that **ARIMA model (2,0,1) is the best fitted model** to forecast the **log normal stock returns of Wipro**. The results represented that only on 2nd and 5 April 2018, the value was under forecasted by 0.17% and 1% respectively, except both these days remaining all the returns from 3rd April 2018 till 10th April 2018 have been over forecasted . The range of over forecasted values lies between 0.11% to 2.98% which confirms that model is precise or best fit for prediction.

From the above findings it can be concluded that ARIMA model has sufficient potential to predict future values in short run.

The implication of the study is that it is expected to be worthful for prospective investors by guiding them to invest or disinvest in a particular stock at correct time.

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