“Stock Price Prediction of HCL Technologies Limited Using ARIMA model”

By
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Abstract

The study's main goal is to investigate how ARIMA models may be used to anticipate stock prices. The HCL Technologies stocks are used in this study for our investigation. Within the IT sector, HCL Technologies is one of the most well-known organisations. The historical stock price of the HCL indicates that following the COVID-19 epidemic, stock prices rose sharply. Therefore, stock price forecasting provides investors with information to help them maximise their profits. Because ARIMA models are so good at capturing seasonality & trend, they are most often used for timeseries data forecasting. Yahoo Finance was used to compile the historical stock values of HCL Technologies between January 1, 2015, & August 14, 2023. The ACF & PACF graphs are used to identify the proper ARIMA model components.

Key words: ARIMA, PACF, ACF, & HCL Technologies Limited

Introduction

The term "stock market" describes the marketplace where a variety of assets, including bonds, stocks, & other securities, are exchanged. Because it allows investors to own stock in a firm, it is one of the most significant aspects of the capitalist economy. One of the most important things an investor can do to reduce risk & boost growth & profit is to forecast stock prices.

Government regulations, geopolitical events, macroeconomic data, & a host of other variables all have an impact on stock values. Because stock values are notoriously volatile, predicting them is a difficult undertaking. Therefore, investors search for a way to optimise earnings while minimising risk.

One of the key components for forecasting patterns & trends in stock price movements is time series analysis. Instead of being created at random, stock prices are frequently thought of as a discrete time series model built on a set of precise numerical data items that have developed over time at consistent intervals. So, in order to assess stock price fluctuations with enough information to aid in decision-making, a model must be identified. In the IT sector, one of the well-known stock prices is HCL Technologies Limited. Following the COVID-19 epidemic, the HCL stocks saw an abrupt increase in value. It announced a 6% year-over-year increase in 2022, outperforming Infosys & Wipro in the process. Following the pandemic, there was a notable surge in stock values as a result of the growing dem& for technology & the digital transition. Because of this, stock prices are volatile; thus, projecting the price of stocks for the future helps investors minimise risk & maximise profit.

Box-Jenkins created the improved algorithmic model known as the ARIMA model in the 1970s. As a result, the Box Jenkins technique is another name for it. It is one of the most used models for time series data forecasting. Even with the advancement of machine learning algorithms such as Neural Networks & Decision Trees, analysts continue to employ the classic ARIMA approach extensively when predicting stock values. Seasonal & non-seasonal changes, as well as nonlinear trends, are well handled by ARIMA models. When building the model, it is crucial to identify the ARIMA model's constituent parts, i, e, p, d, & q. The values of p & q are ascertained using the PACF & ACF plots. The RIMA model equation may be found by

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

Literature Review

• Banerjee D's work employed the ARIMA model to forecast the Indian stock market using historical data from the past. The six-year monthly closing stock indices on Sensex from 2007 to 2012 were used by the authors in their research. They made predictions about the future stock indexes of Sensex based on their study.

• M.H. Rahman & M.M. Hossain projected the Bagab&hu Multipurpose Bridge's earnings using the Holt-Winters technique. They conducted a comparative study between the Holt-Winter multiplicative & additive models. According to their research, the Holt-Winter multiplicative model outperforms the additive approach in terms of accuracy.

• S. Mehtab & Jaydip Sen used machine learning algorithms like the Convolution Neural Network & LSTM approach to estimate the NIFTY 50 index over a five-year period of time, from December 2014 to July 2020. They came to the conclusion from their research that deep learning models, such as CNN, are far more accurate at predicting time series data.

• In 2014, Mondal, P. et al. used the Box Jenkins ARIMA model to predict 56 equities from various industries. With 85% accuracy, the analysis determined that the forecast was effective.

• In 2018, Kumar & Khanna conducted research on the stock market volatility of several nations, including China, Japan, & India. They calculated the volatility using the GARCH & ARCH models. They discovered from their research that, in contrast to other stock markets, the Indian stock market is steady.

• Ramakrishna & Kumari forecasted India's rice output in 2018 using an ARIMA model. They discovered a rising tendency in the overall output of rice in their investigation. Additionally, they projected & came to the conclusion that by 2020, rice output will rise to 112.90 mt.

• In 2013, Kazem A. & Sharif E. forecasted stock prices using a machine learning technique, such as support vector regression. They used historical data on the daily stock prices from Microsoft, Intel, & the NASDAQ for their analysis. Based on the MSE & MAPE, they contrasted the suggested method with the other approaches & discovered that the suggested way worked best with the fewest mistakes.

• In 2003, Bircan & Karagoz forecasted the monthly exchange rate for the years 1991–2002 using the ARIMA model. They discovered that the ARIMA (2,1,1) model was the best fit. The model's mistakes were dispersed randomly, & its significance threshold for exchange rate forecasting is set at 5%.

• Nyoni used the ARIMA & GARCH models to calculate Kenya's inflation in 2018. They made use of the yearly historical data from 1960 to 2017. The study concluded that the best model for effectively predicting inflation rates was ARIMA(2,1,2), AR(1)-GARCH(1,1).

Objectives

1. To examine trends & patterns in HCL Technologies Limited's historical stock values.
2. To ascertain the elements influencing HCL Technologies Limited's stock price.

In the IT sector, one of the well-known stock prices is HCL Technologies Limited. Following the COVID-19 epidemic, the HCL stocks saw an abrupt increase in value. Examining the stock Given that it provides insight into future stock prices, price trends & patterns are quite important. Therefore, creating an accurate model will assist investors in reducing risk & maximising return.

Research Methodology

Scope:

The study's main objective is to apply the ARIMA model to analyse the historical pattern of the stock prices of HCL Technologies. One of the well-known companies, HCL Technologies Limited, had volatility in its stock price throughout the epidemic. Therefore, the study provides investors with information to aid in decision-making & risk minimization.

Data Collection

Yahoo Finance is the source of the HCL technologies' historical data. The historical daily stock price data was gathered between August 14, 2023, & January 1, 2015. Using the ARIMA model, the adjusted stock price is utilised to predict the future stock price. Figure 1 displays the sample data from HCL Technologies Limited.

Date	Open	High	Low	Close	Adj Close	Volume
01-01-2015	399.75	402.9125	396.4	401.7	326.1806	1336492
02-01-2015	400.5125	404.7375	400.0125	401.3125	325.8658	933372
05-01-2015	403.75	403.75	392.175	394.5625	320.3849	2012624
06-01-2015	393.5	393.6	380.6625	384.025	311.8284	3470408
07-01-2015	384.875	387	373.175	374.9	304.4189	3540560
08-01-2015	379.25	385	373.75	383.575	311.463	3906036
09-01-2015	384.1625	395.9125	380.725	386.3875	313.7468	6164448
12-01-2015	388.775	394.75	385.175	393.8875	319.8368	2661684
13-01-2015	393.8875	398.7375	390.8375	395.9	321.4709	2916072
14-01-2015	398.975	399.7	387.575	394.7	320.4965	4133276
15-01-2015	398.7375	404.6125	388.1125	398.3125	323.4299	3658976
16-01-2015	398.5	411.025	393.8875	409.75	332.7171	3185348
19-01-2015	412.5	432.5	409.95	411.1625	333.864	3335832
20-01-2015	415.625	419.8125	412.425	418.0375	339.4466	3099268
21-01-2015	415.3	423	410.25	421.8125	342.5119	7541032
22-01-2015	422	423.2625	414.25	416.425	338.1371	3769104
23-01-2015	415.775	417.225	407.825	411.6625	334.2701	4683076
27-01-2015	412.225	412.225	401.8875	404.0875	328.1191	4461772
28-01-2015	402.5	416.4375	402.5	414.85	336.8583	4173388

Fig:1 Sample data of HCL Technologies Limited.

Data Analysis

ARIMA MODEL:

Step 1: Verify stationarity

The plot of the HCLTECH.NS Adj closing price is displayed in Figure 2. We can see that following the epidemic, stock values rose significantly. As a result, there is a trend in the time series, & the stock prices fluctuate, indicating that the time series is not stagnant. Both the mean & the variance of the time series are not stationary. Thus, in order to use the ARIMA model, it must be transformed into a stationary series.

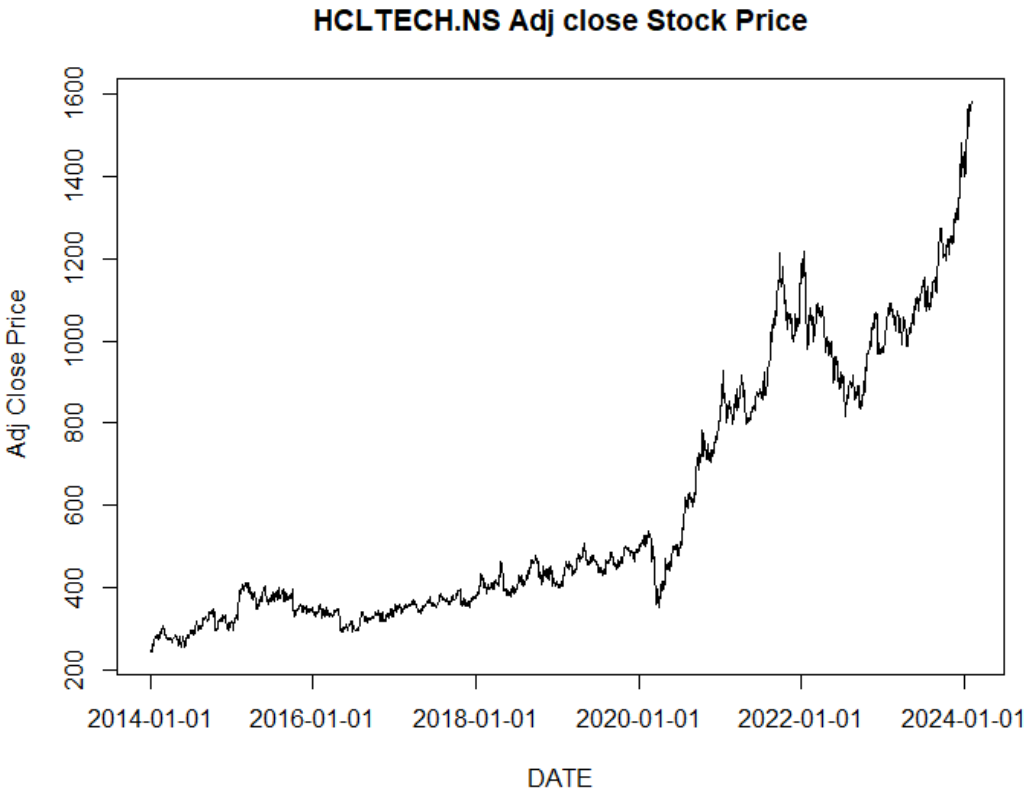


Figure 2 : HCLTECH.NS Adj closing price

Step 2: Examine ADF

The ADF test is used to determine whether or not the time series has a unit root. It is implied that the time series is non-stationary by the existence of the unit root. if the p value indicates the existence of the unit root. The null hypothesis is rejected & the time series' stationarity is confirmed if the p value is less than the critical value. Because p value is greater than critical value, we found in our test that the time series is not stationary.

ADF Test Statistics	-0.1083
P-value	0.9486
No. of lags	7
Number of observations	2121

Step 3: Differencing:

To make the timeseries stable, the differencing procedure involves taking the difference between successive observations in the data. We must make a difference in the time series in order to make the HCL stock price time series stationary, since it is now not. Thus, as seen in Figure 3, we obtain a stable time series data by differencing of the first order.

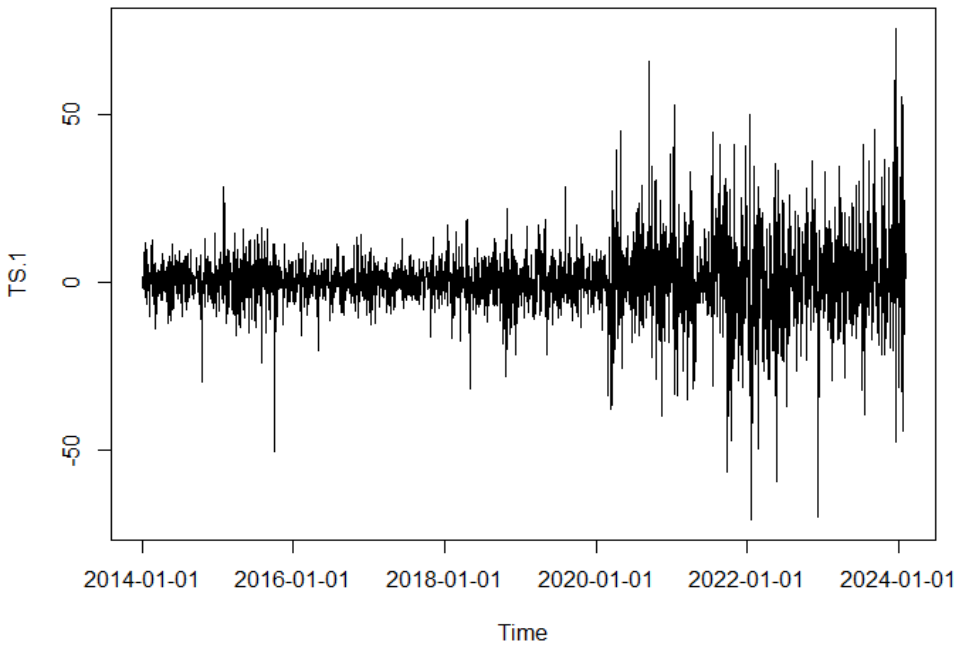


Figure 3: Differenced time series of HCL stock price.

Step 4: ACF & PACF plot:

These two plots are crucial for identifying the ARIMA model's components. The requisite p values are provided by the PACF plot, & the ACF plot yields the value of q. The correlation between the timeseries & its lag values is provided by the ACF. It aids in ascertaining the data's seasonality. The effect of the intermediate delays is reduced with the use of the PACF graphic. The values of q & p, respectively, are provided by the significant spike in the ACF & PACF plots. Figure 4 displays the plot of the ACF & PACF.

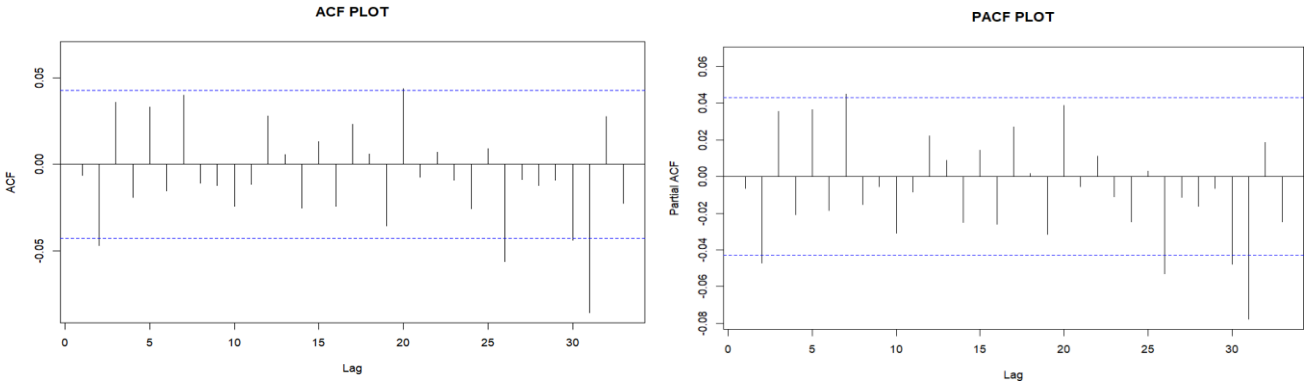


Figure 4: plot of the ACF & PACF

Step 5: Identification of Models

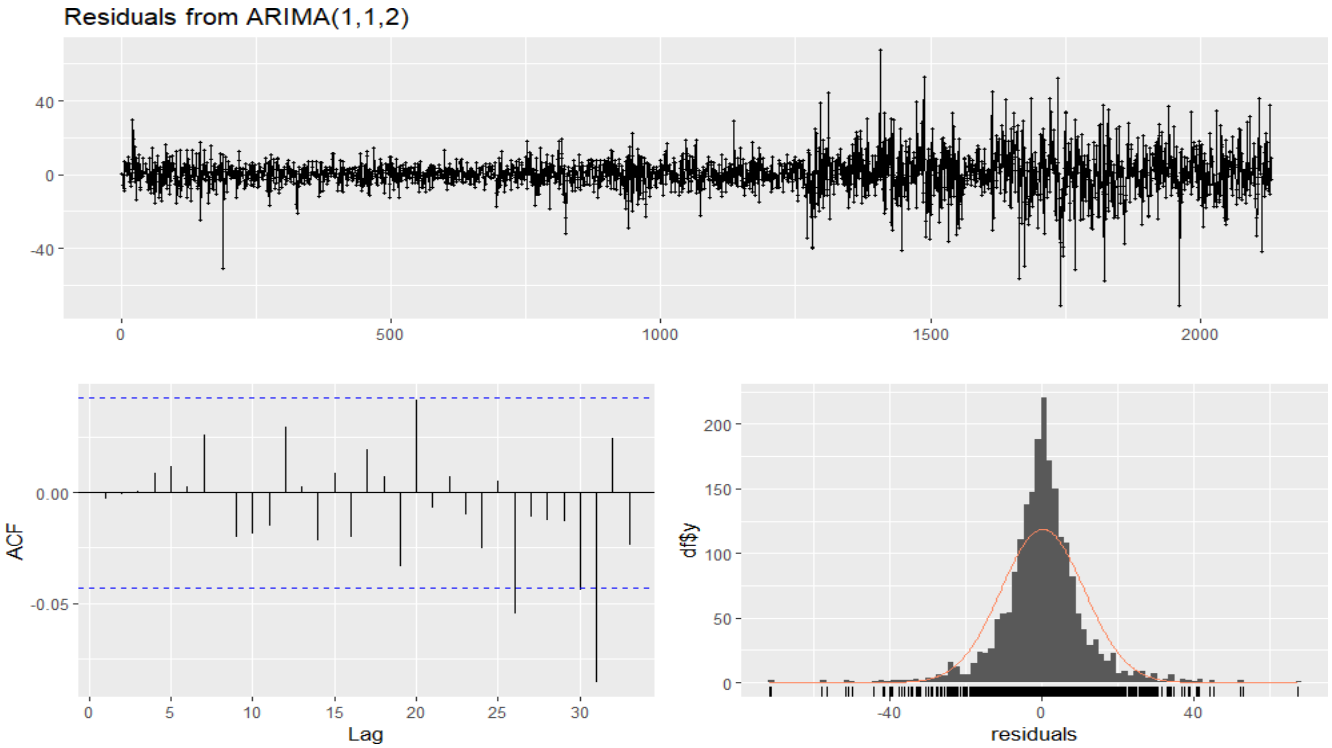
Finding the ideal values for p, d, & q is the next stage in choosing the right model. To get the ideal value of p, d, & q, we used the auto arima function in R studio. Our best result was model ARIMA(0,1,1).

Result

We can predict using the ARIMA(0,1,1) model as the residuals display white noise & the ARIMA process is stationary, as can be seen from the figure. A good model is indicated by a lower AIC score & a greater loglikelihood.

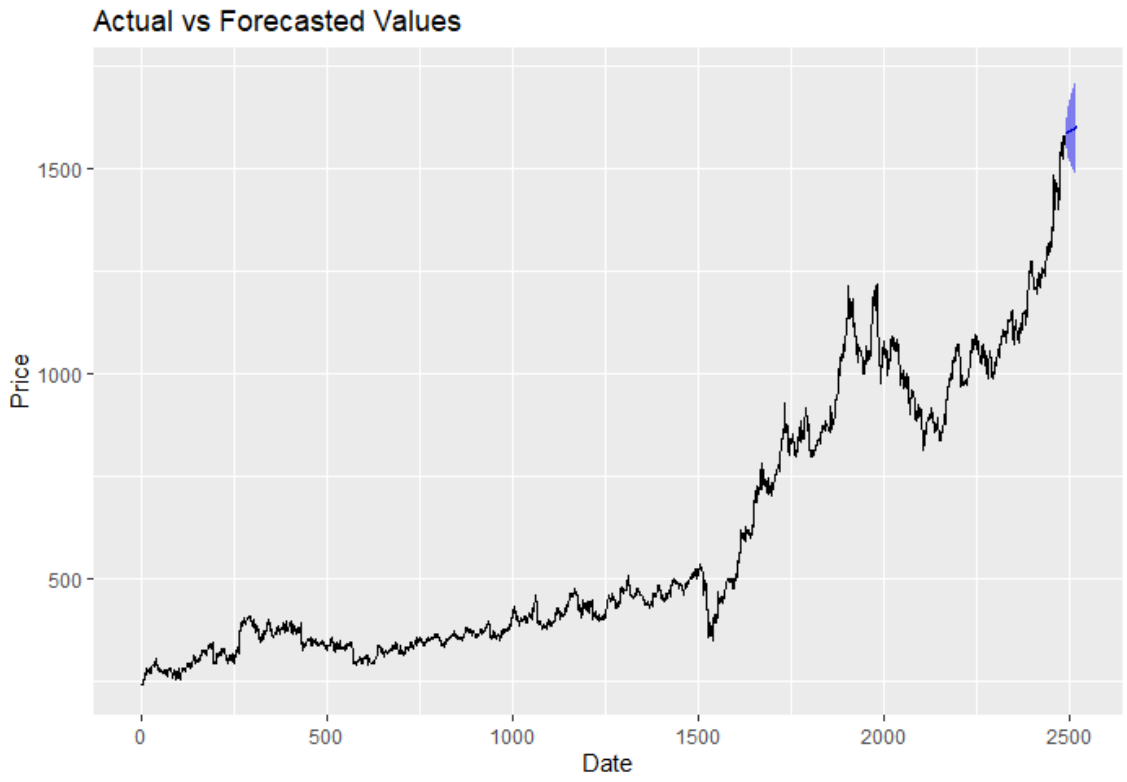
This approach offers investors a useful perspective for formulating a plan & reducing risk. As a result, this model makes shorter-term forecasts with greater accuracy.

Even though the ARIMA model produced positive results, it is important to remember that a variety of factors, including market sentiment & macroeconomic indices, can affect stock prices.



Stock Price Forecasting

	Forecast	Lower_CI	Upper_CI
2024-02-01	1580.943822	1559.654445	1602.233200
2024-02-02	1577.167816	1546.907495	1607.428136
2024-02-03	1581.230659	1544.627624	1617.833695
2024-02-04	1578.881930	1536.513020	1621.250840
2024-02-05	1581.777371	1534.609305	1628.945437
2024-02-06	1580.383486	1528.658783	1632.108190
2024-02-07	1582.497939	1526.740264	1638.255613
2024-02-08	1581.742843	1522.107365	1641.378321
2024-02-09	1583.334815	1520.149407	1646.520224
2024-02-10	1583.007067	1516.390485	1649.623649
2024-02-11	1584.249502	1514.424916	1654.074088
2024-02-12	1584.207649	1511.273127	1657.142171
2024-02-13	1585.216244	1509.332871	1661.099617
2024-02-14	1585.365654	1506.617182	1664.114125
2024-02-15	1586.217811	1504.725936	1667.709685



Using the ARIMA(0,1,1) model, the stock prices of HCL Technologies Limited are predicted for the upcoming 15 days.

Limitations

In order to anticipate stock prices, the research solely looks at the previous prices of HCL Technologies limited shares. However, a number of other factors, including investor preferences, market mood, macroeconomic data, & more, all have an impact on stock prices. Therefore, we may create an accurate forecasting model by using the aforementioned criteria in the model's development.

Conclusion

The study's goal is to find out if ARIMA can be used to forecast HCL Technologies Limited stock prices. The study ran an ARIMA model & examined the historical stock prices of HCL Technologies from January 1, 2014, to February 1, 2024. The analysis showed that the appropriate model with the lower AIC values is ARIMA(1,1,2). For the following fifteen days, stock prices are predicted using the ARIMA(1,1,2) model. The outcome demonstrates that the predicted & original values are comparable.

Following the COVID-19 epidemic, stock prices on the HCL Technologies Limited generally displayed a sharp spike in price. It announced a 6% year-over-year increase in 2022, outperforming Infosys & Wipro in the process. Following the pandemic, there was a notable surge in stock values as a result of the growing dem& for technology & the digital transition. Therefore, via strategic efforts like service diversification, international development, & efficient marketing, the business may raise profit margins dramatically.

As a result, the study enhances ARIMA's predictive power for stock prices. Nonetheless, the model results are heavily impacted by other factors such as investor preferences & market mood. Thus, research in the future may look at creating a model that takes these variables into account.

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11. ANALYZATION OF THE TIME SERIES MODELLING (ARIMA) EFFICACY IN FORECASTING STOCKPRICES Labani Shit1, Saptarsi Goswami2, & Prapanna Mondal1.

Appendix

```
library(timeSeries)
library(timeDate)
library(quantmod)
library(fUnitRoots)
library(forecast)
library(ggplot2)
# Descriptive Analytics
df<- getSymbols("HCLTECH.NS",auto.assign = FALSE, from= '2014-01-01', to='2024-02-01')
head(df)
View(df)
data_w<-getSymbols("HCLTECH.NS",auto.assign = FALSE,from="2014-01-01",to=Sys.Date())
data1<-data.frame(data_w,date=as.Date(rownames(data.frame(data_w))))
head(data1)
tail(data1)
HCL = timeSeries(data1$HCLTECH.NS.Adjusted,data1$date)
View(HCL)
class(HCL)
plot(HCL, main = "HCLTECH.NS Adj close Stock Price", xlab = "DATE", ylab = " Adj Close Price")
# Calculating differences
HCL_D <- diff(HCL)
plot(HCL_D)
summary(HCL_D)
#Stationarity Check
adfTest(HCL_D,lags = 0,type = "c")
par(mfrow=c(1,1))
#Identifying AR-MA Processes
Acf(HCL_D,main="ACF PLOT")
Pacf(HCL_D,main="PACF PLOT")
#ARIMA Model Identifying best fit model (Model Diagnosis)
ModelN=auto.arima(HCL,max.p = 20,max.q = 20)
summary(ModelN)
checkresiduals(ModelN)
#Forecast
# Getting forecasted values
forecast_result <- forecast(ModelN, level=c(95),h = 30)
forecast_result
plot(forecast_result)
# Plotting actual and forecasted values
autoplot(forecast_result) +
  xlab("Date") +
  ylab("Price") +
  ggtitle("Actual vs Forecasted Values")
```