



**Ahmedabad  
University**

**ECO 320: Time Series Econometrics**

**Project**

**Submitted to Prof. Gaurav**

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**Closing Stock Price Prediction using  
the ARIMA model**

### **Abstract**

Stock price prediction is really famous and is used in daily live by many people. It is a very famous topic of finance and economics and it is being studied by many researchers using different models. Closing stock price of TATA Motors is predicted using autoregressive integrated moving average (ARIMA) model. For this paper, average of closing price of every year is taken into consideration. The time series observation from 2003 to 2022 is taken. Our main aim is to find the trend from the stock data and also forecast the stock prices for future years.

Keywords: - ARIMA model, Dickey fuller test, stock price prediction, forecasting

JEL Classification: - C22, C53, E27

### **Introduction**

Society usually believes that the stock market is either unsuited for trading or excessively risky for investing. Despite the fact that there is some danger associated in the stock market, many people are enthusiastic about investing. Maximising returns on investments is the main goal for any investor. Investors continuously make an effort to forecast or predict stock prices in order to achieve this goal. Some investors use technique analysis and some rely on discussion or suggestion given by market and financial experts. "Market has a huge volume of investor with good knowledge and a prediction over their investment. Stock market stills

fails to attract new investor who don't want to come forward to fall into the risk." Devi et al. (2013)

Time series analysis is a technique which is used in analysing the data collected over time. Time series analysis is very useful in forecasting, identifying trends and identify seasonal variation. On the other hand, it becomes difficult when the data quality is poor and also time series analysis is based on the principal of stationarity which does not hold true in real life scenarios.

To forecast the stock price our aim is to get information which can help an investor to decide in a stock market. This can be done by ARIMA model. "Its forecast is usually more accurate and reliable as it is a univariate model and hence cannot exploit the leading indicators or explanatory variables." Meher et al. (2021)

This study is applying ARIMA model to forecast the closing price of TATA motors every year. Motivation was to see if ARIMA model is effective or not. After forecasting the closing share price at the end of the year would like to see if it is what we forecasted or not. Main reason to select TATA motors is that the sale for them has went up recently as they have introduced an electric car. Electric cars are reducing pollution so people tend to go towards it. A big question arises, will this mind set still continue to prevail among people and will the share price for TATA motor increase or decrease in future? Another motivation is that using this ARIMA model want to make an informed investment decision. ARIMA model taken into consideration the autocorrelation and seasonality in the data which is very important in stock price movements.

## **Literature Review**

There are many researching papers in the field of forecasting using the ARIMA model. NSE-Nifty Midcap 50 companies among which has max Midcap value has been taken into consideration for analysis. Their main aim is to use ARIMA model for the stock data for the past five years and find the trend and the market behaviour for future forecast (Devi et al., 2013). The forecasting is significant as it reduces the probability of loss due to incorrect intuitions and blind investment. But predication of stock prices increases the complexity with the collection of more and more historical data (Chi et al., 2019). Forecasting Bangladesh's inflation using ARIMA model and then taking proper strategies to contain this inflation (Fahim, 2012). Predict the share price of some pharmaceutical companies in India using the ARIMA model. They choose the best ARIMA model based on volatility, adjusted R-square and Akaike Information Criterion (AIC) (Meher, 2021). Stock price prediction using the ARIMA model and data from New York Stock Exchange (NYSE) and Nigeria Stock Exchange (NSE). They find that ARIMA model is the best for short term prediction (Adebiyi et al., 2014). Price forecasting is crucial for producer as well as consumer in the electric power market. They predict next day electricity price based using the ARIMA model (Contreras et.al., 2003). Forecasting oil palm price of Thailand using the ARIMA model by considering the minimum of mean absolute percentage error (MAPE) (Nochai, 2006). ARIMA model was used to forecast the daily stock date of State Bank of India for a period of

2 years and it was found that ARIMA (0,1,1) is the most suitable model (Saini et.al., 2016). The volatility data will be predicted based on ARIMA model using the insurance stock market data from Amman Stock Exchange from January 2019 to December 2019 (Wadi et.al., 2019). Volatility data is the measure of the returns for a given market or security index. It can be calculated by using historical prices or volatility from options prices. It provides insights in the behaviour of market and securities helping them to make decisions about their portfolio. This paper forecast return value for S&P Bombay Stock Exchange Sensex index. ARIMA model is used and data from past 10 years is taken and forecasted for April 2017 to March 1 (Latha et.al., 2018).

### **ARIMA model**

Auto Regressive Integrated Moving Average model is a time series analysis technique used to forecast future values based on past observations.

#### **Methodology**

ARIMA model involves three main components: autoregression (AR), differencing (I) and moving average (MA).

Autoregression means using the past value to predict future values. It is denoted by AR in ARIMA. “p” represents the number of past values in the model. If  $p=2$  then the model is using two most recent observation to predict the next observation.

Differencing refers to the process of transforming a non-stationary time series into a stationary one. A stationary model time series has properties over time i.e, mean and variance.

Moving average means using past errors of a time series to predict the future values. The order of moving average that is  $q$  is the number of past errors used in the model.

ARIMA (autoregression, differencing, moving average)

So, ARIMA model include autoregression, differencing and moving average components to predict the future values for a time series.

### **Identifying Gaps**

There are two gaps in predicting future value pf a closing price of a stock

1. **Market volatility** – The stock market is highly volatile. Market volatility can be for many reasons like political instability, natural disasters and pandemics. So, such fluctuation in market cannot be predicted earlier and so the results can differ.
2. **Unpredictable events** – Unpredictable events include mergers, change in management which have effect on company’s stock. This information we don’t beforehand.

## **Data**

Data taken from NSE – nifty 50 for TATA motors.<sup>1 2</sup> The focus in our study was on the closing stock price in lakhs. Average of every year is calculated to make the calculation easy. The time series is from 2011 to 2022 (11 years). This study will predict for next 3 years. Before 2011 is not considered because the closing stock is valuing at 1518.538 which is very high as compared to other years. This will not give correct forecast if used so it is eliminated.

Year	Average closing stock value
2012	260.8417
2013	319.0042
2014	454.3375
2015	446.3167
2016	444.5625
2017	444.6042
2018	272.1792
2019	163.55
2020	126.8292
2021	348.9333
2022	434.575

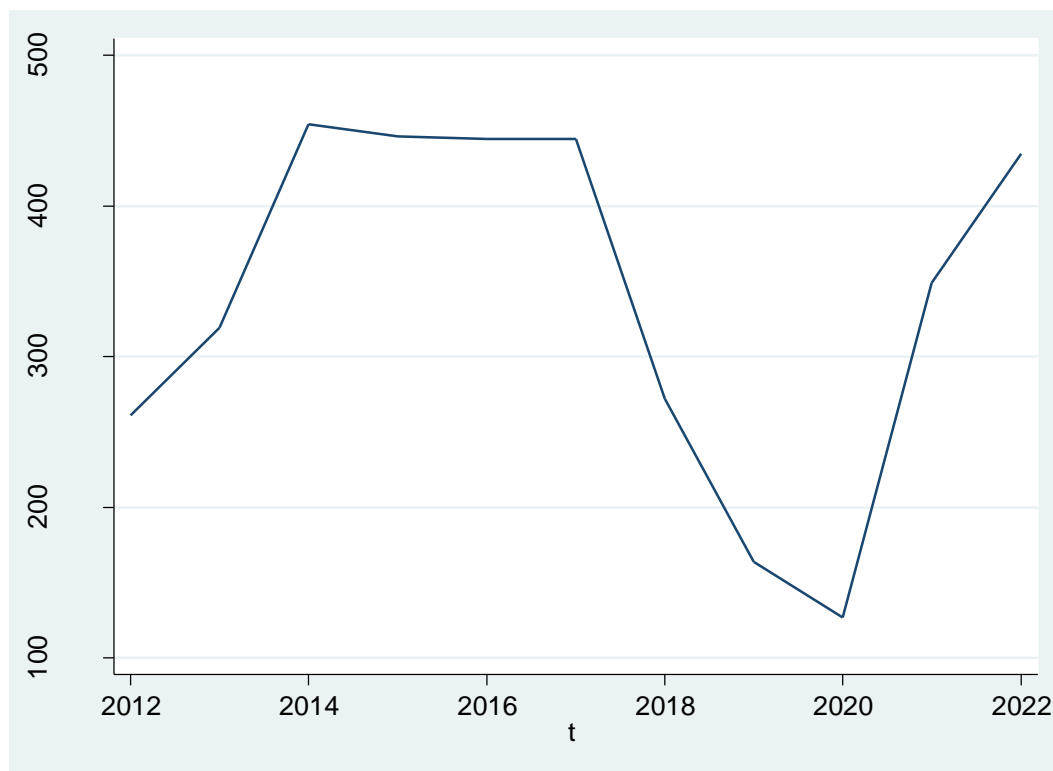
The decline in Tata motors' stock price in 2018 was due to poor financial performance, challenges faced by JLR and currency fluctuations.

Price of stock in 2021 increase because of better-than-expected financial results, electric car business is gaining grip and also in market there is a shortage of semiconductors but TATA motors tackled this problem by securing semiconductor suppliers.

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<sup>1</sup> <https://www.nseindia.com/market-data/live-equity-market?symbol=NIFTY%2050>

<sup>2</sup> <https://www.nseindia.com/get-quotes/equity?symbol=TATAMOTORS>



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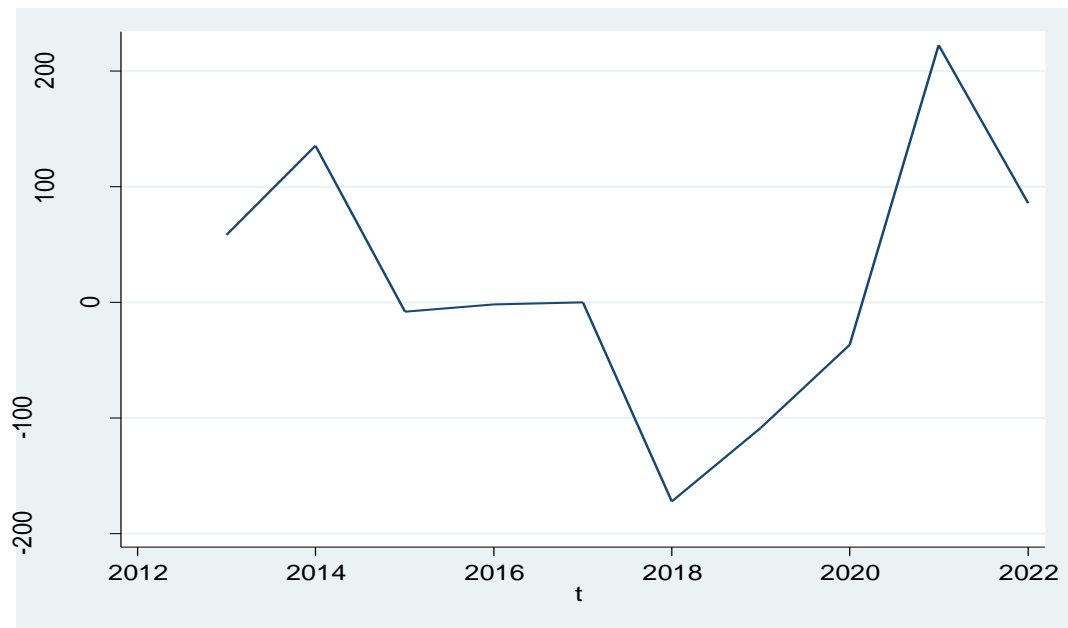
Dickey-Fuller test for unit root Number of obs = 10

	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	<b>-1.452</b>	<b>-3.750</b>	<b>-3.000</b>	<b>-2.630</b>

MacKinnon approximate p-value for Z(t) = 0.5570

### Line graph and dickey fuller test for close price of TATA motor

Test statistics is greater than the critical value so it means we fail to reject the null hypothesis. So, it is not stationary. Also, the p value is greater than 0.05 which means the series is not stationary.



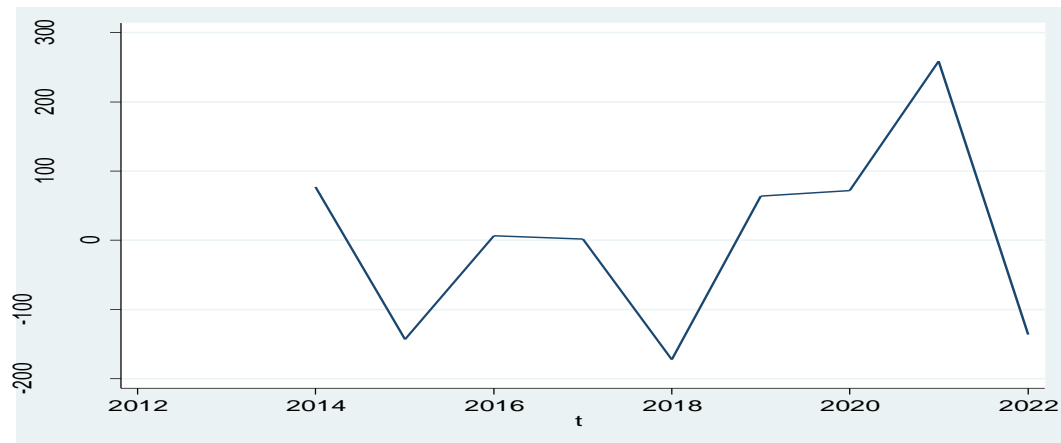
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Dickey-Fuller test for unit root			Number of obs	=	9
Test Statistic	Interpolated Dickey-Fuller				
	1% Critical Value	5% Critical Value	10% Critical Value		
Z(t)	-1.812	-3.750	-3.000	-2.630	

MacKinnon approximate p-value for Z(t) = 0.3745

### Line graph and dickey fuller test for first difference of close price of TATA motor

Test statistics is greater than the critical value so it means we fail to reject the null hypothesis. So, it is not stationary. Also, the p value is greater than 0.05 which means the series is not stationary.



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. dfuller d2closem
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Dickey-Fuller test for unit root Number of obs = 8

Test Statistic	Interpolated Dickey-Fuller			
	1% Critical Value	5% Critical Value	10% Critical Value	
Z(t)	-3.025	-3.750	-3.000	-2.630

MacKinnon approximate p-value for  $Z(t)$  = 0.0326

### Line graph and dickey fuller test for second difference of close price of TATA motor

Test statistics is less than the 5% and 10% critical value so it means we reject the null hypothesis for 5% and 10%. So, it is stationary. Also, the p value is smaller than 0.05 which means the series is stationary.

From the AC and PAC graphs we get no inference as only 2 lags and it is inside the grey box. So, will try all combination for ARIMA.

### ARIMA

#### Natural log of close price of TATA motor

ARIMA	BIC
<b>(0,1,0)</b>	<b>15.70819</b>
(1,1,1)	19.54651
(0,1,1)	17.28894
(1,1,0)	17.51754
(3,1,1)	Not feasible
(2,1,0)	18.27006
(2,1,1)	15.44103
(2,1,2)	Not feasible

(1,1,2)	Not feasible
(0,1,1)	17.52049

From this table we can interfere that ARIMA (0,1,0) is best as it has the least BIC.

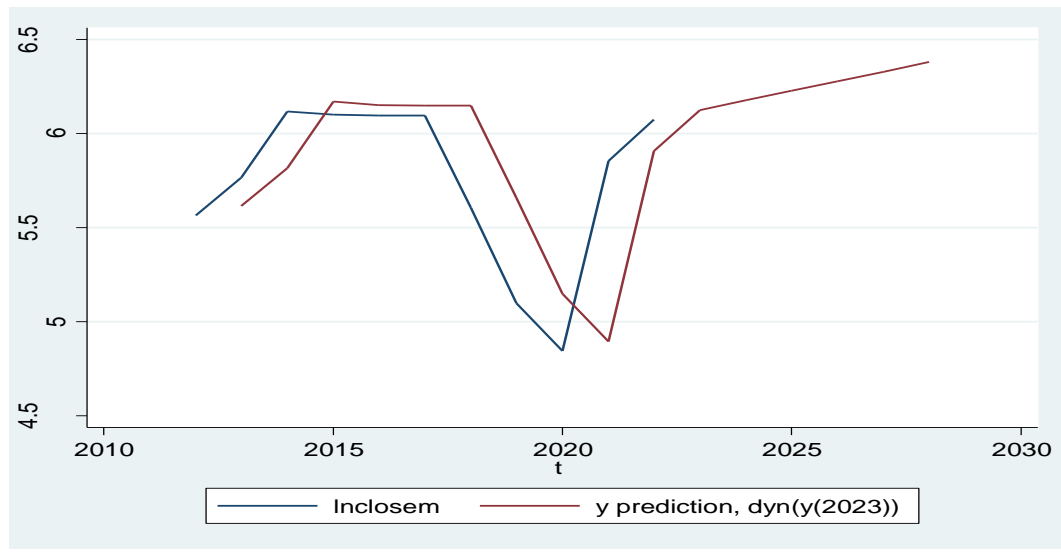
### **Double difference of close price of TATA motor**

ARIMA	BIC
(0,1,1)	109.6398
(0,1,0)	112.185
<b>(0,1,2)</b>	<b>107.537</b>
(0,1,3)	109.6144
(0,1,4)	111.5545
(0,1,5)	108.3522
(0,1,6)	113.9582
(0,1,7)	116.0138
(1,1,0)	111.2233
(1,1,1)	108.4113
(1,1,2)	111.694
(1,1,3)	Not feasible
(2,1,0)	112.672
(2,1,1)	110.4334
(3,1,0)	113.6486
(3,1,1)	111.8576
(3,1,2)	Not feasible

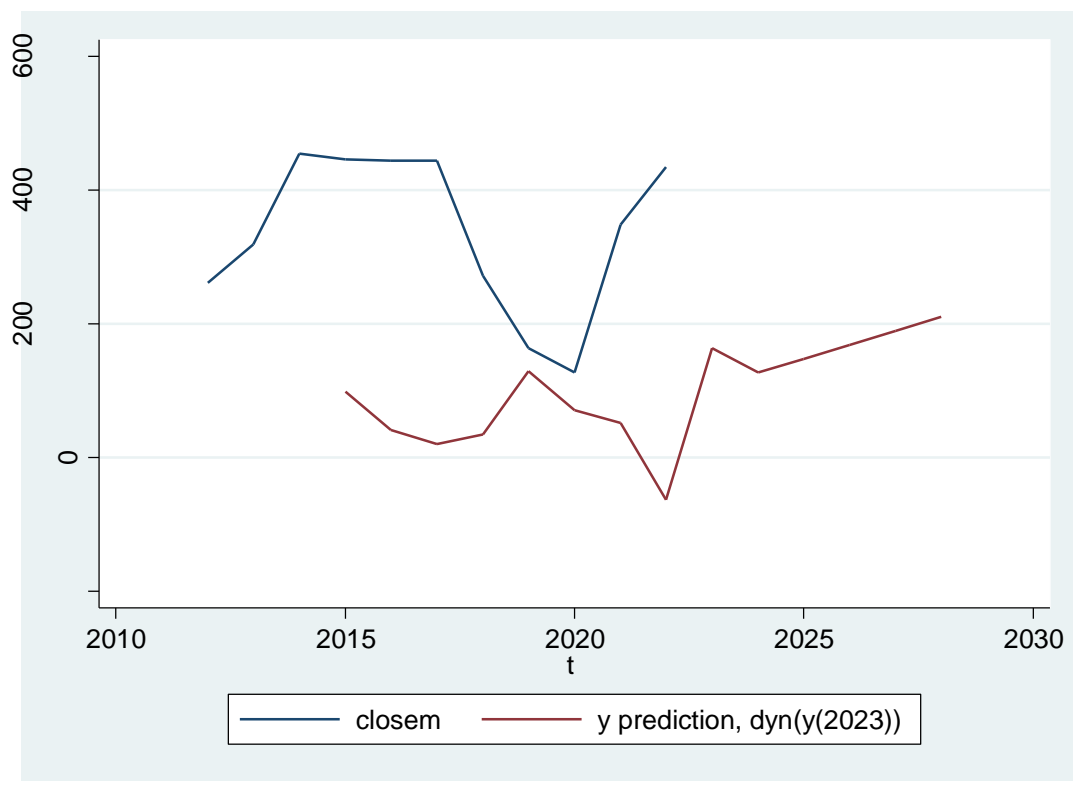
From this table we can interfere that ARIMA (0,1,2) is best as it has the least BIC.

### **Results and discussion**

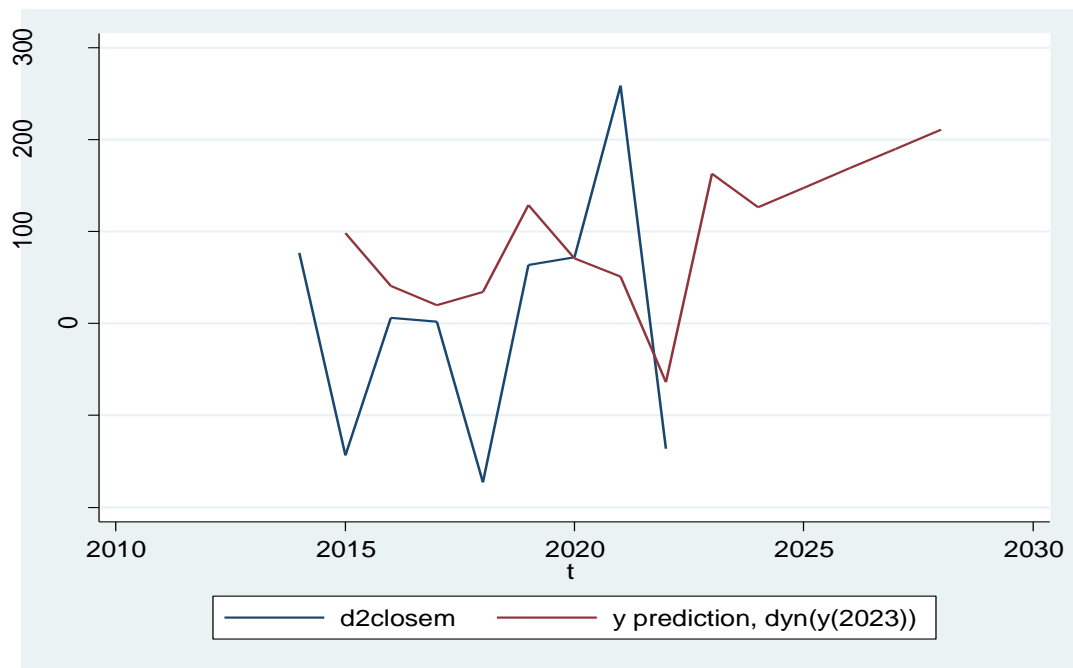




This graph represents the actual and predict of the natural log of the closing stock price of TATA motor. As seen in the graph, after 2022 we forecasted that the stock price would increase. The increase is linear which is because of the natural log as it makes the graph smooth.



This graph represents the actual and predict of the actual close stock price and the predicted stock price (double difference) of TATA motor. Both the graph doesn't make together as the difference between them is two years which is causing this problem.



This graph represents the actual and predict of the closing stock price of TATA motor after the second difference. After second difference they get stationary so it makes sense. As seen in the graph, the forecasted stock prices are mostly increasing. As predicted, in 2024 there is slight drop and afterwards it is increasing at a constant rate till 2030.

Date	closem	dclosem	d2closem	inclosem	error	fclosem	error1	fclosem1	error2	fclosem2	error3	fclosem3
2012	260.842	.	.	5.563914	.	.	.	.	.	.	.	.
2013	319.004	58.16251	.	5.765204	.	.	.1502451	5.614959	.1502451	5.614959	.	.
2014	454.337	135.3333	77.17078	6.11884	.	.	.3025903	5.81625	.3025903	5.81625	.	.
2015	446.317	-8.020782	-143.3541	6.101029	-241.5732	98.21914	-.0688568	6.169886	-.0688568	6.169886	-241.5732	98.21914
2016	444.563	-1.754211	6.266571	6.097091	-34.76133	41.0279	-.0549837	6.152074	-.0549837	6.152074	-34.76133	41.0279
2017	444.604	.041687	1.795898	6.097184	-18.44688	20.24278	-.050952	6.148136	-.050952	6.148136	-18.44688	20.24278
2018	272.179	-172.425	-172.4667	5.606461	-206.9196	34.45296	-.5417691	6.14823	-.5417691	6.14823	-206.9196	34.45296
2019	163.55	-108.6292	63.79579	5.097119	-65.09998	128.8958	-.5603872	5.657506	-.5603872	5.657506	-65.09998	128.8958
2020	126.829	-36.7208	71.90839	4.842841	.7840375	71.12436	-.3053232	5.148164	-.3053232	5.148164	.7840375	71.12436
2021	348.933	222.1041	258.8249	5.854881	207.4756	51.34933	.9609942	4.893887	.9609942	4.893887	207.4756	51.34933
2022	434.575	85.64172	-136.4624	6.074368	-72.72369	-63.73868	.1684422	5.905926	.1684422	5.905926	-72.72369	-63.73868
2023	.	.	.	.	.	163.0884	.	6.125414	.	6.125414	.	163.0884
2024	.	.	.	.	.	126.7322	.	6.176459	.	6.176459	.	126.7322
2025	.	.	.	.	.	147.7806	.	6.227505	.	6.227505	.	147.7806
2026	.	.	.	.	.	.	.	6.27855	.	6.27855	.	168.8289
2027	.	.	.	.	.	.	.	6.329596	.	6.329596	.	189.8773
2028	.	.	.	.	.	.	.	6.380641	.	6.380641	.	210.9257

This is a table representation of the estimates and from this take only the graph and calculation is done.

### **While forecasting stock prices of TATA motors, should we prefer log ARIMA or second difference ARIMA?**

It is preferred to use the second difference ARIMA model over the log ARIMA model. Stock prices are often non stationary. But in case of log ARIMA model it assumes that the data is

stationary. In case of the second difference ARIMA model taken into account the trend and stationery which captures non stationary behaviour.

Second difference ARIMA model involves taking two differences of the original time series and then fitting the ARIMA model. This can remove trend or seasonality in the data and make it more stationary. It is more accurate to forecast the stock price.

### **Policy implication**

As seen in our story, stock price will decrease in 2024 and then increase in consecutive years. So, government should make policies which would motivate people to invest in TATA motors in 2024. This will help people earn more profits.

TATA motors are producing electric car which is very economical so government can even promote that to make our country take a step towards less pollution country.

### **Conclusion**

This paper represents a ARIMA model for stock closing price prediction. Through ARIMA model, we forecast the closing prices of stock price of TATA motors for 6 years. Bayesian Information Criterion was used to find the best ARIMA model. Our study was forecasting the stock price and it always seems that double difference was more preferred in that case.

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