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Modelling and Forecasting of Banking Stock Prices during the Covid-19 Pandemic

-Using an ARIMA Model Approach

*Dr. Magesh Kumar, Dr. Senthil Kumar

***Dr. R. Magesh Kumar**

Assistant Professor

School of Management

Presidency University

Bangalore

Email id: mageshcyp@gmail.com

8148205377

Dr. Senthil Kumar

Associate Professor

School of Management
Presidency University

Bangalore

Email id: mkrsenthil06@yahoo.com

9986795289

*Corresponding author: mageshcyp@gmail.com

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Abstract

One of the significant and growing area of research in finance is the modeling and forecasting of stock prices over the years. The financial impact of the corona virus pandemic in India is very disruptive. The World Bank have amended the India's economic growth for the year 2021 with the lowest figures when compared with the last three decades. This pandemic situation has overall affected the global financial markets. The present research is an attempt to predict the stock prices of top 4 banking firms in India in order to understand the impact of Covid-19 pandemic on stock market. Thus the research has concentrated on this pandemic periods from January 2020 to May 2020. A predictive model of autoregressive integrated moving average (ARIMA) has been used on these stipulated periods to forecast the succeeding four months of the stock prices. To determine the best ARIMA model, the study have used the Box-Jenkins time series approach. Further to validate the fit measures such as Ljung-Box statistics, Root mean square error (RMSE), Mean absolute percentage error (MAPE), Normalized Bayesian information criteria (BIC) have been deployed for each stock index. The research has identified that the ARIMA models (0,1,0), (0,1,5), (0,1,0) (0,1,5) is the most suitable model for Axis banks, ICICI banks, IndusInd banks, and State bank of India. The outcome of the study provides a significant contribution for short term prediction of stock prices. The findings will be highly beneficial to investors by providing an insight in making short investment decisions among the banking stocks in India.

Keywords: ARIMA, Stock rate, Short-term prediction, Forecast, Bank Stock Price, Covid-19 Pandemic, Investment decision

Introduction

In a Corporate sector stock market plays an important role in raising long term funds. Therefore every stock of the company's profit depend upon its shareholder. Corporate sectors can generate huge profit by issuing shares to the individual and to the public. The major financial benefits is acquired from stock market rather compared to other investments like fixed deposits, mutual funds etc. The inflation of the economy is measured majorly by the best reflection of trend in the stock market. In order to understand the market depth there are more relevant analysis are

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available based on the stock price variations. Forecasting is one of the best methods to solve the real life situation and analyze the problem in different ways and gives appropriate solution. Thus forecasting models plays an important domain in solving financial and economic problems.

The various statistical technique which are used to analyze and forecast the stock market are Auto Regressive Moving Average (ARMA), Auto Regressive Integrated Moving Average (ARIMA), Auto Regressive Conditional Heteroscedasticity (ARCH), Generalized Auto Regressive Conditional Heteroscedasticity (GARCH), ARMA-EGARCH, Box and Jenkins approach along with the various soft computing and evolutionary computing methods. Predictive analysis is one of the most interesting area of research in stock market, where the researchers predict the various company's stock prices and also tries to improve the existing predictive models.

Stock prices are treated as a discrete time series model in which the trend can be analyzed randomly. Based on the discrete time series model only the stock prices can be forecasted and a suitable forecasting technique can be adopted. The financial gain obtained is the motivation for forecasting the stock market (Liang et al., 2011). Having good knowledge in share prices will build a proper system for the company as well as for investors in dynamic market scenario. Also it helps the investors or market or finance professional to make appropriate decisions (Devi, 2014). To identify suitable model for predicting stock prices, ARIMA is one of the better method than other forecasting techniques as it gives more accurate results (Alwadia and Ismail, 2011). The impact of Covid-19 pandemic on world economy is very unsettling. According to International Monetary Fund (IMF), the world economy is expected to decline by 3 percent in 2020 due to Covid-19. It is the lowest slow down ever since the worst depression of the 1930's. Therefore present research is an attempt to conduct a short term prediction using ARIMA Model on top 4 banking stocks in India in order to understand the impact of Covid-19 pandemic on stock market

Literature review

Overview of ARIMA model in Forecasting Stock Market

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Decision making and strategy of the future business scenario can be done with most popular analysis called predictive analysis. The banking and financial time series data is highly difficult to decompose and forecast because of its non-stationary and non-linear with high heteroscedasticity. (Pai & Lin, 2005; Wang et al., 2012; Wei, 2013). In order to enhance the investors profit with less risk, the researchers had come with an idea to develop many predicting models such as artificial neural network, hybrid models and ARIMA models (Atsalakis & Kimon, 2009; Mitra, 2009). In stock market, ARIMA model is one of the traditional model with wide applications for analyzing the stock market data. (Wang, 2011; Awajan et al., 2017a). This model mainly focused on two approaches which are statistical and artificial intelligence techniques (Wang, 2011; Awajan et al., 2017b). To capture time correlation ARIMA model has been developed in many fields (Yunus et al., 2016). ARIMA model has been implemented in software program reliability analysis which critically evaluated in developing predicting models such as exponential method. (Lee and Ho, 2011). Kaur (2004) found that asymmetrical GARCH models outperform the conventional OLS models and symmetrical GARCH models by the application of asymmetrical GARCH models EGARCH (1,1) to Sensex and TARCH (1,1) to Nifty returns.

Regression model, GARCH approaches and other models has been used exclusively for predicting the future business scenario. But ARIMA model is used only for few related works for predicting stock market data (Meyler et al., 1998; Javier et al., 2003; Khashel et al., 2009; Khashel et. al., 2012; Lee & Ho, 2011; Wang, 2011). Alwadi (2015) opined that there isn't any research conducted on Amman Stock Exchange using ARIMA model.

Autoregressive Moving Average (ARMA) model is one of the imperative method to study the time series data. Autoregressive Integrated Moving Average (ARIMA) is based on ARMA Model. ARIMA model converts a non-stationary data to a stationary data to predict linear time series data (Box et al., 1975). The ARIMA models are often referred to as Box-Jenkins models as ARIMA approach was first popularized by Box and Jenkins.

Existing studies using ARIMA model for Forecasting Banking Stocks

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Murari (2012) has studied on the short term price changes of the banking stocks in India. He measured the 12 most liquid and large capitalized banking stocks from CNX bank index of NSE. More than 3122 observations were included to measure the volatility of the banking returns using ARIMA model. The study suggested that ARIMA (1, 0, 2) was considered to be the best fit in predicting the stock returns of the bank. Almasarweh and Wadi (2018) have used ARIMA model for short term forecasting on banking data from Amman Stock Market (ASE) in Jordan. The study computed the prediction using the daily data from the year 1993 to 2017. The results confirms that ARIMA model produced accurate results for short time prediction. Volatility of the stock price is due to its unpredictability and uncertainty of the price movements in the stock market. So it is often used in exchange for risk. Meaning the higher the volatility, higher the risk in the stock market trading (Kumar and Gupta, 2009). Ashik and Kannan (2017) have examined the forecasting of banking sectors on private bank and public sector unit bank using the Box-Jenkins approach i.e. using the ARIMA. The result concluded that the Mean Absolute Percentage Error (MAPE) is less when compared with the other bank sector. Thus the study suggested that private banks would be a worthy investment as it possess less risk for the investors.

Al-Zeaud and Ali (2011) has developed ARIMA (2, 0, 2) model for banking sector by considering weekly data from Amman Stock Exchange (ASE) for a period of 2005 to 2010. Kaur (2004) examined the nature and characteristics of the volatility of stock market in India which emphasis more on ‘day of the week effect’ or the ‘weekend effect’ using volatility cluster modeling. Sohail C. et al. (2012) identified and forecasted the mean and variance components of the daily closing share price using ARIMA-GARCH type models by explaining the volatility structure of the residuals obtained under the best suited mean models for the time series. Similar works have also been carried out in order to know the stock return behavior and time series volatility modeling in various countries (Abdalla & Suliman, 2012); (Poon & Granger, 1992); (Ocran & N., 2007); (Gokcan, 2000); (Bollerslev, 1976); (Faisal, 2012); (Alberg, Shalit, & Yosel, 2008); (Kumar S. S.,2006); (Tripathy, 2010).

Statement of the Problem

Due to Covid-19 pandemic, the economic forecast of the world countries looked dismal and sentiments among the investors are very negative when compared with the past. Bank stocks are

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considered to be the safest bet among investors as they less volatility and pay better dividends among other stocks in India. But there is a paucity of research or no studies conducted during this Covid-19 pandemic period of banking stocks in India. In this context the aim of the study is to build a model and predict the volatility of stock prices among the top four banking firms using Autoregressive moving average method (ARIMA). The contribution of the study is immense as it provides an insight on the short term investment decision making. Thus the present paper investigates the banking stock price during the Covid-19 affected pandemic period of the Indian banking sector.

Objective of the Study

The main objective of the study is to build a model and perform a short-term prediction of stock price on the Indian banking sector during the Covid-19 pandemic. To accomplish this goal the historical stock price data for the month of 25th January, 2020 to 25th May 2020 has been considered for research study. Further the research has concentrated especially the best four performing banking stocks in the Indian banking sector for prediction by using the Box-Jenkins time series method and in particular the ARIMA model.

Research Design

Period of the study

The sample data is based on the secondary source which is obtained from the National Stock Exchange of Nifty bank Indices. Bank Nifty signifies the 12 utmost liquid and huge capitalized stocks from the banking sector which has been traded on the National Stock Exchange (NSE). Thus it provides a bench mark for capital market performance among the banking sector in India. The historical stock price data covers the period of Covid pandemic from the month of January25, 2020 to May 25, 2020 (Four months) these four months have taken as the study period for model building and prediction. The top four performing banking stocks in Nifty 50 bank Indices such as Axis bank, ICICI bank, IndusInd bank, and State bank of India has been taken for short term forecasting. The data composed of four elements, namely: open price, low price, high price and close price respectively. In this study the closing price is chosen to represent the price of the index to be predicted. Closing price is chosen because it reflects all the activities of the index in a day to day trading. Statistical Package for Social Science (SPSS 20)

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package has been used for analyzing the data and to predict the next four months of banking stock price.

Methodology

ARIMA Model

The present study has adopted the Box-Jenkins methodology (Box and Jenkins, 1976) as a suitable technique for short term forecasting. This model is based on mathematical algebra which is normally used in forecasting. It is the methodology is the most common time series method found in the academic research. Box and Jenkins(1976) has developed Auto Regressive(AR) and Moving Average(MA) model in the formulation of set of activities for identifying, estimating and diagnosing ARIMA models with time series data (Tabachnick and Fidell, 2001). The model has an efficient capability in generating short-term forecasting for business performance. It also constantly outperformed complex structural models in short-term prediction (Meyler, et al., 1998). In ARIMA model, the future value of a variable is a linear combination of past values and past errors, expressed as follows:

$Yt = \mu$ or $\phi 0 + \phi 1\ Yt\text{-}1 + \phi 2\ Yt\text{-}2 + ... + \phi p Yt\text{-}p + \varepsilon t - \theta 1\ \varepsilon t\text{-}1 - \theta 2\ \varepsilon t\text{-}2 - ... - \theta q\ \varepsilon t\text{-}q$. (1)

Where, Yt is the actual value, μ or $\phi 0$ is a constant, εt is the random error at t, ϕi and θj are the coefficients of p and q which are integers that are often referred to as autoregressive and moving average parameters, respectively.

ARIMA model is derived from the autoregressive moving average (ARMA) model. It has classified as ARIMA (p, d, q), where *p* denotes the autoregressive parts of the data set, *d* refers to integrated parts of the data set and *q* denotes moving average parts of the data set and p, d, q is all nonnegative integers. ARIMA models are usually used to forecast and analyze the time series data for business performance. Initially, the appropriate ARIMA model is used to forecast using suitable datasets which analyzes the data and does forecasting appropriately (Yang, 2005).

Result Analysis

The descriptive statistics on data collected from the NSE on Nifty bank Indices is summarized in the table 1. The mean for the Indus Ind bank has the highest closing price and it has the high

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standard deviation when compared with the other bank stock price. On the contrary, ICICI bank has the very low standard deviation of 96.60, which indicates the less volatility of stock price.

Table 1: Descriptive Statistics

		Axis Bank Closing Price	ICICI Bank Closing Price	INDUSIND Closing Price	State Bank Closing Price
N	Valid	78	78	78	78
	Missing	0	0	0	0
Mean		533.5429	413.4558	737.4801	235.0821
Median		455.7000	364.2750	468.1000	200.2500
Std. Deviation		161.57627	96.60125	381.96735	64.17470
Skewness		.224	.255	.365	.332
Std. Error of Skewness		.272	.272	.272	.272
Kurtosis		-1.720	-1.736	-1.719	-1.653
Std. Error of Kurtosis		.538	.538	.538	.538

Source: Author's Computation

An ARIMA (p, d, q) Model for Banking Stock Index

Model Identification

The model identification stage is carried out to measure whether the banking stock data is stationary or not. Further the calculated Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) is compared to find a match. To find the time series data stationary, a graphical chart based on its original pattern of the time series data is plotted.

Figure 1: Graphical presentation of the stock closing price

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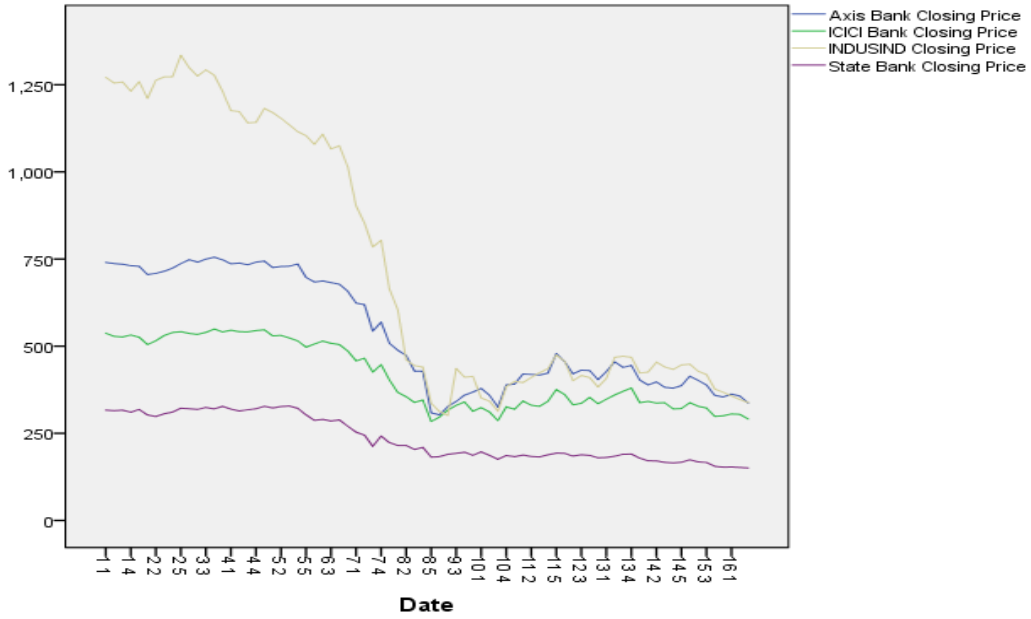
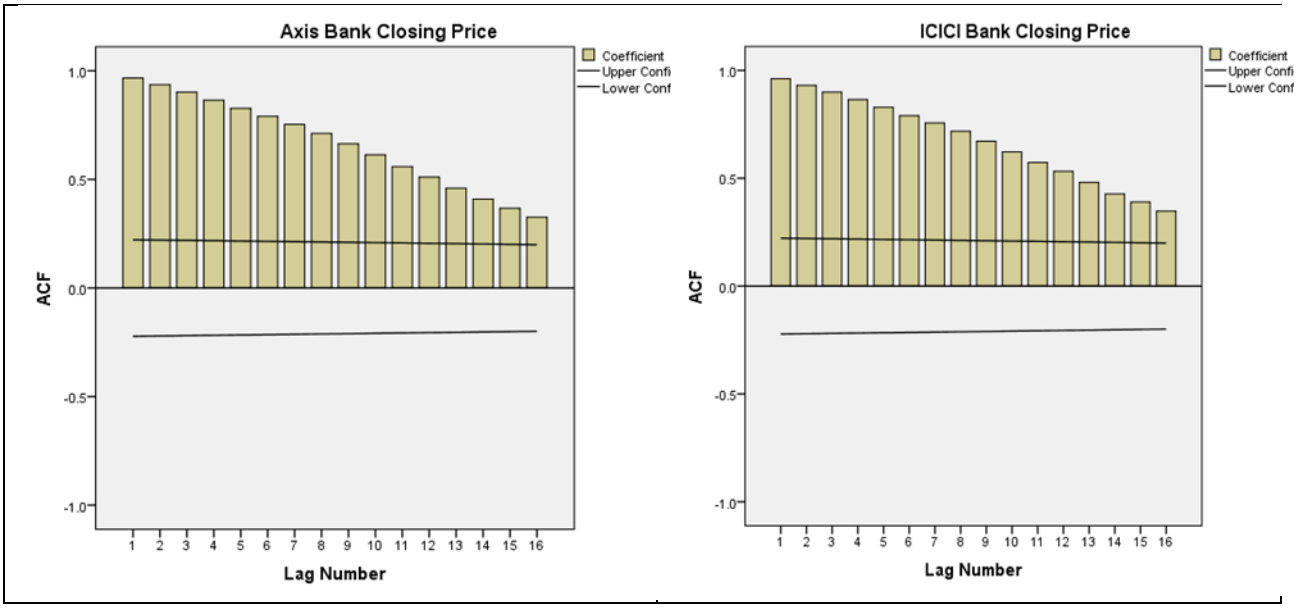


Source: Author's Computation

Figure 2: ACF plot of Axis bank and ICICI bank stock price



From the figure 1, it is displayed that the stock prices data follows a random walk. Thus the figure 1 visually examines the stationary which is the first assumption for using the ARIMA modelling. It is found in the graph that all the banking stocks have different average values and variances during the pandemic period. Further to test the stationarity, Autocorrelation function

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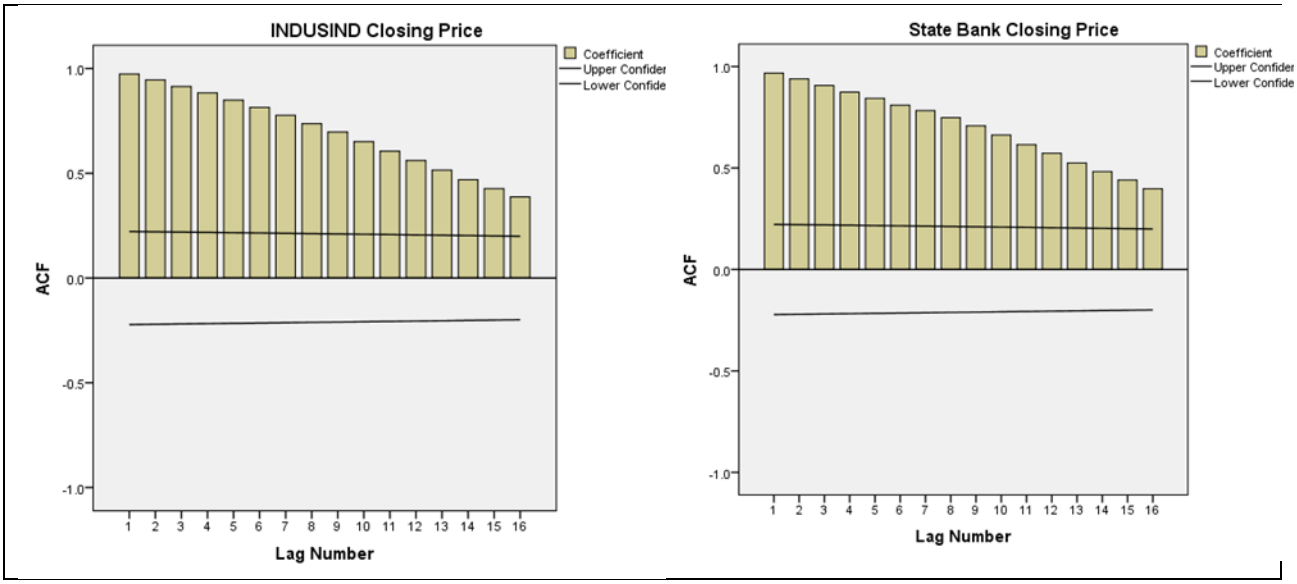
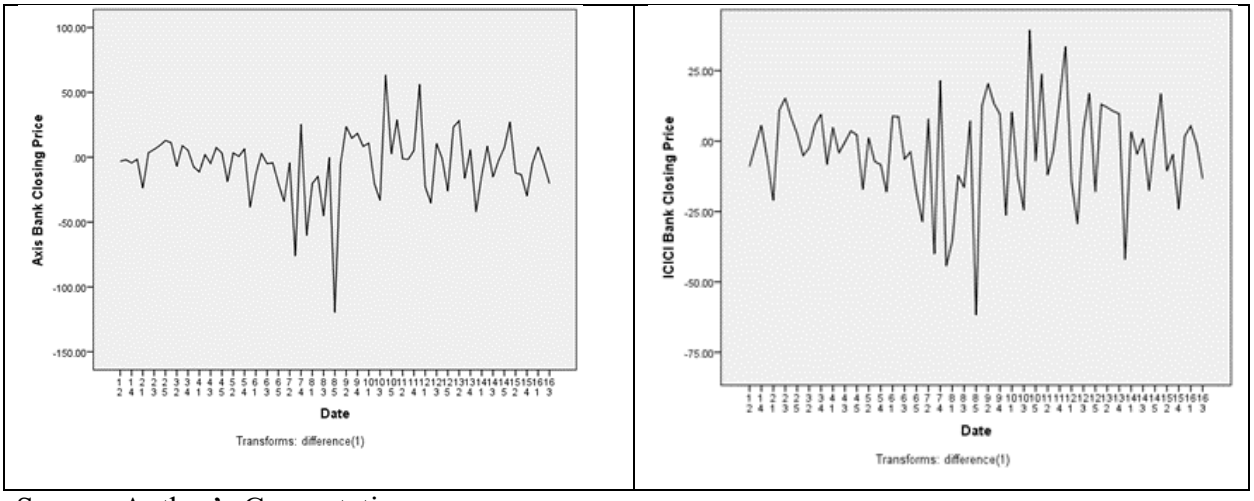
(ACF) plot is used to measure the stationarity on the banking stocks. Since the ACF plots of all the stock prices of the firms are slowly decreasing, it is confirmed that the time series data is non-stationary.

Figure 3: ACF plot of IndusInd bank and State bank closing price



Source: Author's Computation

Figure 4: Stationary after first differencing for Axis and ICICI bank



Source: Author's Computation

Model Estimation

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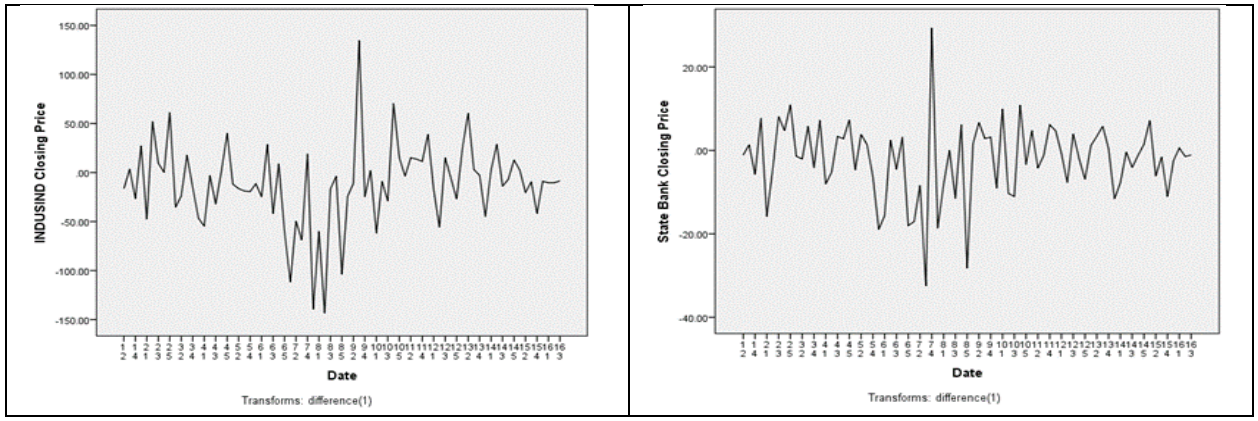
It is observed from the correlogram that time series data of stock prices doesn't show stationarity. If the time series is non-stationary, it is converted to a stationary series data by differencing. By making a first difference, the stock prices shows stationarity as illustrated in the figures 4 and 5 for Axis bank, ICICI bank, IndusInd bank, and State bank of India.

Figure 5: Stationary after first differencing for IndusInd and State bank



Source: Author's Computation

To identify the best ARIMA models among the various experiments the study has used the following criteria

a) Lesser value of Bayesian Information Criteria (BIC)

b) Comparatively small standard error of regression (S.E of regression)

c) Q statistics is not significant

d) Correlogram shows that the Autocorrelation Function (ACF) and the Partial Autocorrelation Function (PACF) of the residuals follows white noise

Diagnostic Checking

Diagnostic Checking indicates the parameter estimates of the various models tested. Ljung-Box statistics, Root mean square error (RMSE), Mean absolute percentage error (MAPE), Normalized Bayesian information criteria (BIC), standard error of regression have been deployed for each stock index to validate the model. The table 2, 3, 4 and 5 illustrates the various parameters of auto regressive (p), moving average (q) and differencing (d) among the many ARIMA model trialed among bank stocks such as Axis bank, ICICI bank, IndusInd bank, and State bank of India. Amongst the numerous ARIMA models tested (0,1,0) is considered to best

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fit model for Axis bank, (0,1,5) for ICICI, (0,1,0) for IndusInd, and (0,1,5) for State bank of India.

Table 2: Axis Bank Estimation Parameters

ARIMA	RMSE	MAPE	MAXPE	Normalized BIC	Ljung-Box (Q) Sign.	SE	t	Sig.
(0,1,0)	25.642	3.880	37.020	6.545	0.171	2.922	-1.792	0.77
(0,1,5)	26.066	3.887	35.212	6.860	0.308	0.080	-1.450	0.152
(1,1,0)	25.789	3.909	36.952	6.613	0.138	2.821	-1.854	0.068
(1,1,1)	25.930	3.939	36.689	6.680	0.120	2.831	-1.847	0.069
(2,1,1)	25.779	3.977	34.189	6.725	0.295	4.306	-1.298	0.198
(2,1,2)	25.956	3.975	34.194	6.795	0.232	4.085	-1.284	0.203

Source: Author's Computation

Table 3: ICICI Bank Estimation Parameters

ARIMA	RMSE	MAPE	MAXPE	Normalized BIC	Ljung-Box (Q) Sign.	S.E	t	Sig.
(0,1,0)	17.733	3.667	20.600	5.807	0.001	2.021	-1.582	0.118
(0,1,5)	17.397	3.434	17.877	5.741	0.132	0.055	-1.494	0.139
(1,1,0)	17.681	3.532	20.112	5.858	0.005	1.776	-1.787	0.078
(1,1,1)	17.800	3.532	20.123	5.928	0.003	1.783	-1.779	0.079
(2,1,1)	17.797	3.502	21.018	5.984	0.002	1.122	-2.951	0.004
(2,1,2)	17.797	3.470	18.362	6.040	0.006	1.724	-1.840	0.070

Source: Author's Computation

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Table 4: IndusInd Bank Estimation Parameters

ARIMA	RMSE	MAPE	MAXPE	Normalized BIC	Ljung-Box (Q) Sign.	SE	t	Sig.
(0,1,0)	42.712	5.099	33.658	7.565	0.228	4.868	-2.489	0.015
(0,1,5)	42.709	5.151	31.621	7.847	0.600	0.133	-1.642	0.105
(1,1,0)	42.726	5.102	33.631	7.622	0.195	5.465	-2.217	0.030
(1,1,1)	42.174	5.070	36.397	7.653	0.356	8.094	-1.466	0.147
(2,1,1)	42.159	5.195	33.021	7.709	0.421	6.553	-1.837	0.070
(2,1,2)	42.338	5.123	35.899	7.773	0.429	8.146	-1.460	0.149

Source: Author's Computation

Table 5: State Bank Estimation Parameters

ARIMA	RMSE	MAPE	MAXPE	Normalized BIC	Ljung-Box (Q) Sign.	SE	t	Sig.
(0,1,0)	9.268	3.041	14.374	4.509	0.000	1.056	-2.033	0.046
(0,1,5)	8.634	2.881	14.283	4.368	0.120	0.032	-2.359	0.021
(1,1,0)	9.141	3.003	14.849	4.538	0.000	0.872	-2.467	0.016
(1,1,1)	9.191	3.014	14.673	7.653	0.356	0.897	-2.396	0.019
(2,1,1)	9.202	3.011	13.833	4.664	0.001	1.179	-1.793	0.077
(2,1,2)	8.427	2.723	12.425	4.545	0.172	0.886	-2.447	0.017

Source: Author's Computation

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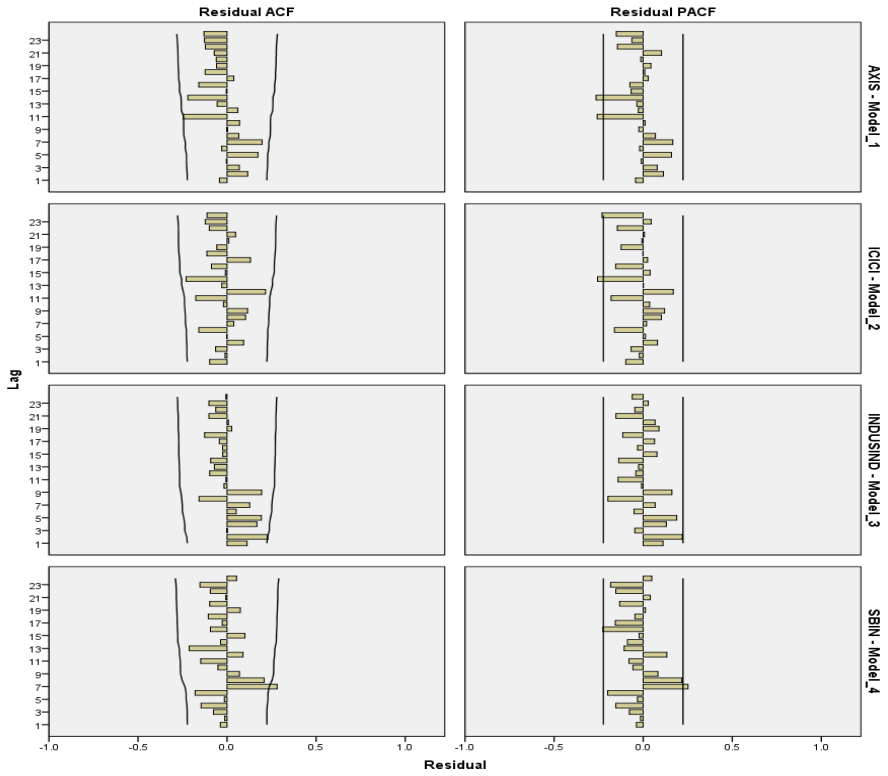
Figure 6: Correlogram of residuals – Banking stocks



Source: Author's Computation

The figure 6 explains the correlogram of residuals of the various banking stocks. If the model is considered to be a good fit the random errors will be the residuals of the data. From the models identified there are no significant spikes of ACF and PACF, it means that the residuals follow white noise. Thus the models selected are the best and no other AR (p) and MA (q) to be considered further.

Forecast

Once the best fit ARIMA model of the banking stocks has been identified the next step is to forecast the stock prices. Based on the historical data of the past four months from Jan25, 2020 to May 25, 2020, the ARIMA model has been used for the short term prediction for the next four months of the banking stocks. The predictions attained will facilitate for effective investment decision making among the investors.

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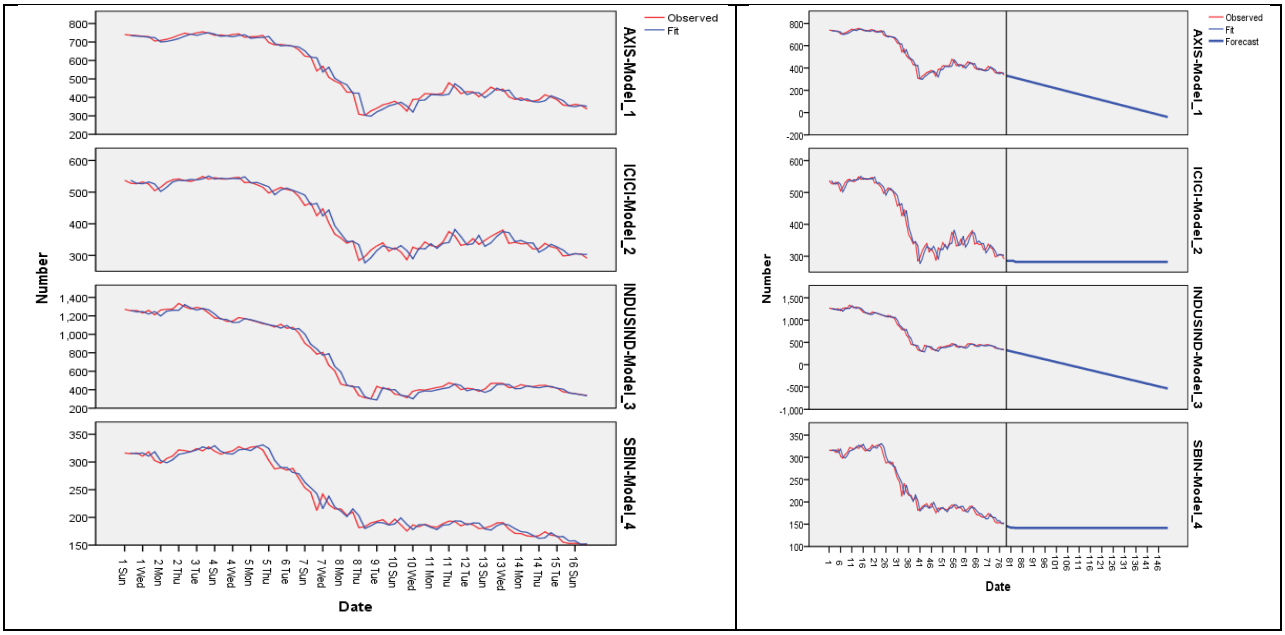
Table 6: Forecast of banking stocks from June 2020 to September 2020

Model		79	85	90	95	100	105	110	120	125	130
Axis Bank Closing Price-Model_1	Forecast	331.71	300.29	274.10	247.91	221.72	195.53	169.34	116.97	90.78	64.59
	UCL	382.78	435.41	451.01	458.48	461.26	460.90	458.24	447.94	440.90	432.87
	LCL	280.64	165.17	97.18	37.34	-17.82	-69.84	-119.55	-214.01	-259.34	-303.68
ICICI Bank Closing Price-Model_2	Forecast	285.61	282.02	282.02	282.02	282.02	282.02	282.02	282.02	282.02	282.02
	UCL	319.73	380.54	421.37	452.69	479.10	502.36	523.39	560.74	577.64	593.64
	LCL	251.49	183.50	142.68	111.35	84.95	61.68	40.65	3.31	-13.60	-29.59
INDUSIND Closing Price-Model_3	Forecast	326.24	253.55	192.97	132.40	71.82	11.25	-49.33	-170.48	-231.05	-291.63
	UCL	411.30	478.62	487.66	483.14	470.83	453.28	431.89	380.83	352.15	321.81
	LCL	241.17	28.47	-101.72	-218.35	-327.19	-430.78	-530.55	-721.79	-814.25	-905.07
State Bank Closing Price-Model_4	Forecast	146.25	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69	141.69
	UCL	163.34	193.58	217.65	235.75	250.89	264.17	276.15	297.36	306.95	316.01
	LCL	129.16	89.81	65.74	47.64	32.50	19.22	7.24	-13.97	-23.56	-32.62

UCL – Upper control limit; LCL- Lower control limit

Source: Author's Computation

Figure 7: Observed values Vs. Fit values and **Forecasted plots of the Banking Stocks**



Source: Author's Computation

The figure 7 demonstrates the accuracy level of the estimated stock price with the actual stock price observed using the ARIMA model of forecasting. The graph indicates that the ARIMA model used have closely forecasted with the observed and the fit values of the stock data.

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Thus the performance of the model is quite satisfactory. Both the Axis bank and Indus Ind bank shows a declining trend in the projection of stock prices. However the banking stocks of ICICI and SBIN remains constant.

Discussions and Conclusion

Forecasting the banking stock price is a paramount challenge faced by the investors these days. Buying and selling of stocks is based on the volatility of the financial securities that they expect to happen in the future. The covid-19 pandemic has led to the financial crisis of many people across the globe. This is due to lock down across world countries, pay cuts, job retrenchment, and lack of demand in the market. The present study makes an attempt to predict the banking stock prices of India during the Covid-19 pandemic period. The banking stocks of Axis bank, ICICI bank, IndusInd bank, and State bank of India were tested to identify the best ARIMA models. Performance metrics such as AIC, Standard error, RMSE, MAPE, Q statistics and correlogram were used to measure the performance of stock market. The research has identified that the ARIMA models (0,1,0), (0,1,5), (0,1,0) (0,1,5) were the best fit models as it follows all the performance criteria to validate the models. The outcome of the results obtained with the ARIMA model are very satisfactory to predict the short term estimation on banking stocks. It has been concluded that the present research will serve as a guide for investors to make sound investment decisions of buying or selling the selected banking stocks in India. The future directions of the study could use comparison of stocks among various sectors and could use a combination of quantitative methods to predict better accuracy.

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