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RESEARCH ARTICLE

FORECASTING STOCK MARKET PRICES OF BENUE AND ASHAKA CEMENT INDUSTRIES USING THE BOX-JENKINS APPROACH

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Abstract

This study used Box-Jenkins approach to forecast stock market prices of Benue cement and Ashaka cement.Weekly data were collected for five months periods. Time series plot of the data for each of the companies under investigation was created. The time series indicated that there are possibly some events that influenced the price per share for cement because of the inconsistency of the behavior of the stock which displayed lowest price in week 26. The autocorrelation function for Benue cement stock prices tails off while the partial autocorrelation function cuts off after lag one thereby suggesting an autoregressive process of order 1, AR(1) for Benue cement stock prices. The model for the Benue cement stock prices sampled was $\mathbf{Zt = 1.7759 + 0.9632Z_{t-1} + a_t}$.This shows that this week's price is a function of last week with a coefficient of 0.9632 and a constant of 1.7759 and some random error. The output result showed that all the parameters including the constant are significantly different from zero, because they have p-values that are significantly smaller than 0.05. The probability plot of the residuals reveals that they are essentially normal and the time series plot of the residuals contain only noise. These diagnostics indicate that a reasonable model has been found.The resulting models for Ashaka Cement sampled was AR (1). The model for sampled Ashaka cement is $\mathbf{Zt = 0.2723 + 0.9916z_{t-1} + a_t}$. The output result showed that the p-values are significantly smaller than 0.05 which implied that the parameters are significantly different from zero. The probability plot of the residuals also reveals that they are essentially normal and the time series plot of the residuals contain only noise.When examining the forecasts for Benue cement, for the data sampled, we noticed that the fits were very close to the actual. For the five months periods, the fits had a range of 49.50- 48.87. However, the actual prices had a range of49.50- 43.23. There was not much change in the fits because the coefficient of the autoregressive terms is 0.963 and a constant of 1.776.The fits of the model show slight downward trend because only a portion (0.963) of the last week prices is used to predict the forecasts. This is the same in behavior with the actual values, which also decreased during this time frame. The model can therefore be concluded to be an appropriate fit statistically; the results would be

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desirable for an investor. Examining the actual versus the fits for the sampled data, their behavior was the same. The fits increased, while the actual values also increased. This model would also be desirable for an investor.

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Introduction:-

The Nigerian Stock Exchange is a Self –Regulatory Organization (SRO), making and enforcing rules for its members. It is regulated by the Securities and Exchange Commission, which has the mandate of surveillance over the exchange to forestall breaches of market rules and to deter and detect unfair manipulations and trading practices. It maintains surveillance over the securities market to ensure orderly, fair and equitable dealings in securities, protecting the integrity of the securities market against abuses arising from the practice of insider trading.NSE has been operating an Automated Trading System (ATS) since April 27, 1999. Dealers now trade through a network of computers connected to a server (Hossian and Kamal, 2010).

Worthy of note is that at the Nigerian stock exchange (NSE), buyers and sellers are the same people. So the market is no more than a manipulative institution; where corruption and lack of transparency have brought misery and poverty to investors. (Alile and Anorno, 1986)

According to Yandal (2007), by buying shares of ownership and selling them, the investors stand to possibly gain money. However, not all investors are successful in gaining return on their investment, and even fewer are successful in making a lot of money because they do not know the 'best' or optimal time to either buy or dispose shares. In view of this we set out to obtain the 'best' or optimal time to either buy or sell shares in order to maximize profits. The work also will determine whether stocks of the same industry are equally predictable.

Times series modeling comprises method of modeling time series data in order to extract meaningful characteristics of data and forecast future values (Box et al.,2008). The hope and aspiration of every investor is to make profit, and in order to predict markets, various technical, fundamental and statistical methods are proposed and used with varying results.

Sadar and Nick, (2004)applied econometric analysis to validate the Thailand stocks.They applied various techniques such as the unit root test, augmented Dicky Fuller, augmented Engle-Ganger and multi -factor model to identify the long run relationship between macroeconomic factors and stock prices. Their result showed the empirical characteristics of the Stock Exchange of Thailand, that market index prices are determined by the interest rate, foreign exchange rate, bond rate, market capitalization and consumer price index in both short and long run.

It is clear that time series analysis can be applied in virtually all fields of human endeavour so long as the data are collected in specified time intervals or chronological order. Hence, time series analysis is applied in modeling the stock market prices using the Box- Jenkins approach.(Yandal, 2007).

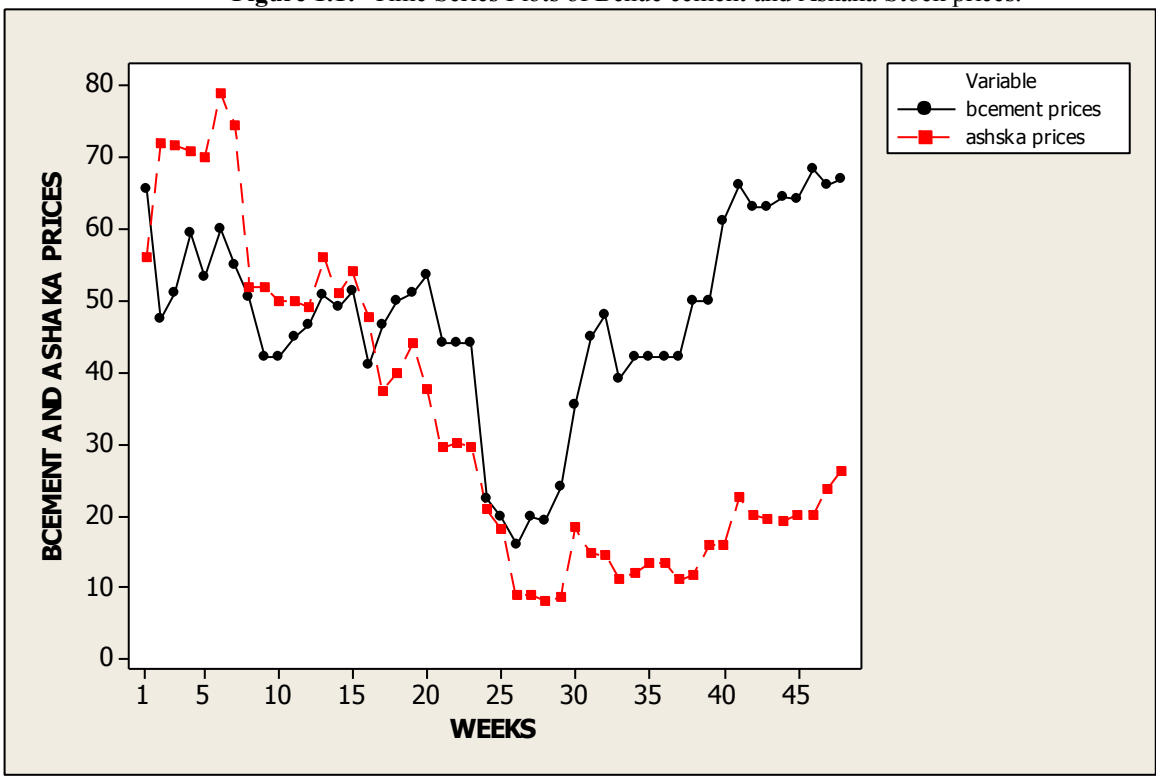
In this paper, the Autoregressive Integrated Moving Average (ARIMA) models, or Box-Jenkins methodology are applied to find the best fit of a time series to past values of stock prices in order to make forecast and possibly help the investors determine when to buy or sell their shares as well as to test whether the mean value of stocks prices for the companies are the same.

Population And Sample Size

The study covers all the Nigerian stock market. Out of which two building industries namely; Benue and Ashaka cement industries were selected using stratified random sampling.

Data Analysis

Figure 1.1:- Time Series Plots of Benue cement and Ashaka Stock prices.

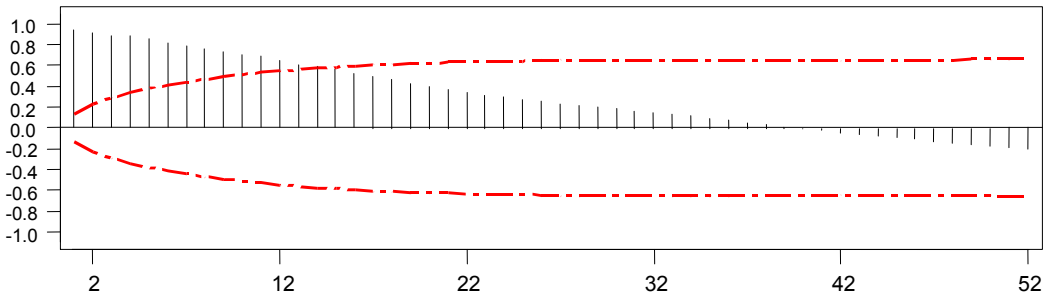


The time series indicated that there are possibly some events that influenced the price per share for Benue Cement because of the inconsistency of the behavior of the stock. The time series plot did not show any extreme outliers but there were drastic fluctuations in the price per share between the month of October, 2017 and March, 2018 when looking at the data sampled weekly.

Ashaka Cement showed the lowest stock price from week 25 to 30 and started rising again.

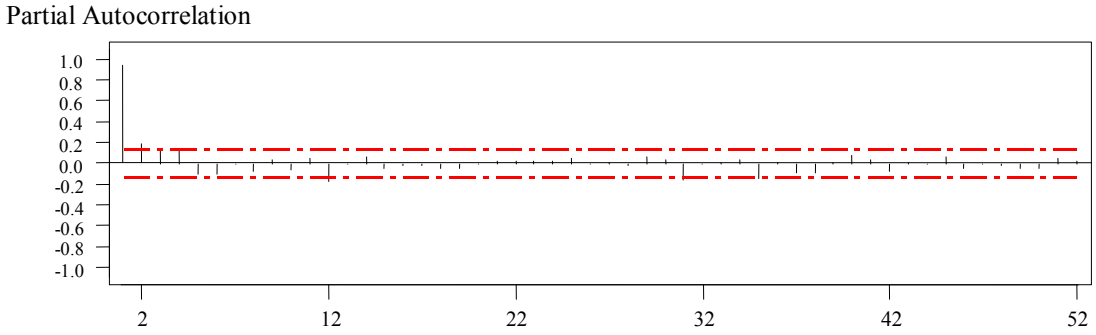
Comparing Benue Cement and Ashaka Cement Company on the same interval, we noticed that while the price for both continued to fluctuate, Ashaka fluctuated at a much faster rate. The price for Ashaka was higher (56.12) at the beginning but later came down to 25.01 by the end of December 2019. The price per share for both increased and decreased though at different rate during the same time frame.

Figure 1.2:- Plot of the sample autocorrelation function of Benue cement.



Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ
1	0.95	13.67	189.50	13	0.61	2.16	1790.20	25	0.28	0.86	2317.01	37	0.05	0.16	2402.88	49	-0.16	-0.48	2429.22
2	0.92	7.91	368.01	14	0.59	2.03	1868.71	26	0.26	0.79	2333.00	38	0.03	0.09	2403.09	50	-0.18	-0.54	2438.05
3	0.90	6.10	538.91	15	0.56	1.90	1940.33	27	0.24	0.73	2346.63	39	0.01	0.02	2403.10	51	-0.19	-0.57	2448.23
4	0.88	5.17	706.09	16	0.53	1.76	2004.33	28	0.22	0.66	2357.95	40	-0.01	-0.02	2403.12	52	-0.20	-0.61	2459.66
5	0.86	4.46	863.52	17	0.50	1.63	2060.82	29	0.21	0.62	2368.21	41	-0.02	-0.06	2403.23				
6	0.82	3.93	1009.84	18	0.47	1.51	2110.98	30	0.19	0.59	2377.41	42	-0.05	-0.15	2403.85				
7	0.80	3.55	1147.39	19	0.43	1.38	2154.32	31	0.17	0.51	2384.35	43	-0.07	-0.20	2405.02				
8	0.77	3.23	1275.50	20	0.40	1.28	2192.15	32	0.15	0.45	2389.79	44	-0.08	-0.25	2406.82				
9	0.74	2.98	1396.41	21	0.37	1.17	2224.79	33	0.13	0.41	2394.27	45	-0.09	-0.26	2408.86				
10	0.71	2.74	1507.66	22	0.35	1.09	2253.32	34	0.13	0.38	2398.24	46	-0.11	-0.33	2412.16				
11	0.69	2.56	1612.42	23	0.32	1.00	2277.64	35	0.10	0.29	2400.63	47	-0.13	-0.38	2416.55				
12	0.65	2.33	1705.50	24	0.30	0.92	2298.47	36	0.08	0.23	2402.16	48	-0.14	-0.43	2422.14				

Figure 1.3:- Plot of the partial autocorrelation function of Benue cement.



Lag	PAC	T	Lag	PAC	T	Lag	PAC	T	Lag	PAC	T	Lag	PAC	T
1	0.95	13.67	13	-0.00	-0.07	25	0.04	0.64	37	-0.09	-1.32	49	-0.05	-0.76
2	0.19	2.76	14	0.06	0.93	26	-0.00	-0.02	38	-0.10	-1.39	50	-0.05	-0.73
3	0.11	1.64	15	-0.04	-0.64	27	0.00	0.01	39	0.01	0.20	51	0.04	0.63
4	0.14	2.00	16	-0.01	-0.21	28	-0.02	-0.26	40	0.07	1.06	52	0.02	0.30
5	-0.11	-1.52	17	-0.02	-0.32	29	0.06	0.91	41	0.03	0.44			
6	-0.10	-1.42	18	-0.05	-0.72	30	0.03	0.50	42	-0.07	-1.06			
7	-0.01	-0.11	19	-0.05	-0.76	31	-0.16	-2.30	43	0.00	0.04			
8	-0.07	-1.06	20	-0.00	-0.06	32	-0.00	-0.01	44	-0.01	-0.15			
9	0.04	0.59	21	0.02	0.28	33	0.01	0.19	45	0.07	0.97			
10	-0.06	-0.82	22	0.02	0.26	34	0.03	0.48	46	-0.04	-0.62			
11	0.05	0.77	23	0.02	0.24	35	-0.15	-2.14	47	-0.00	-0.02			
12	-0.17	-2.44	24	0.01	0.21	36	0.00	0.04	48	-0.02	-0.23			

Figure 1.4:- Trend Plot for Benue Cement.

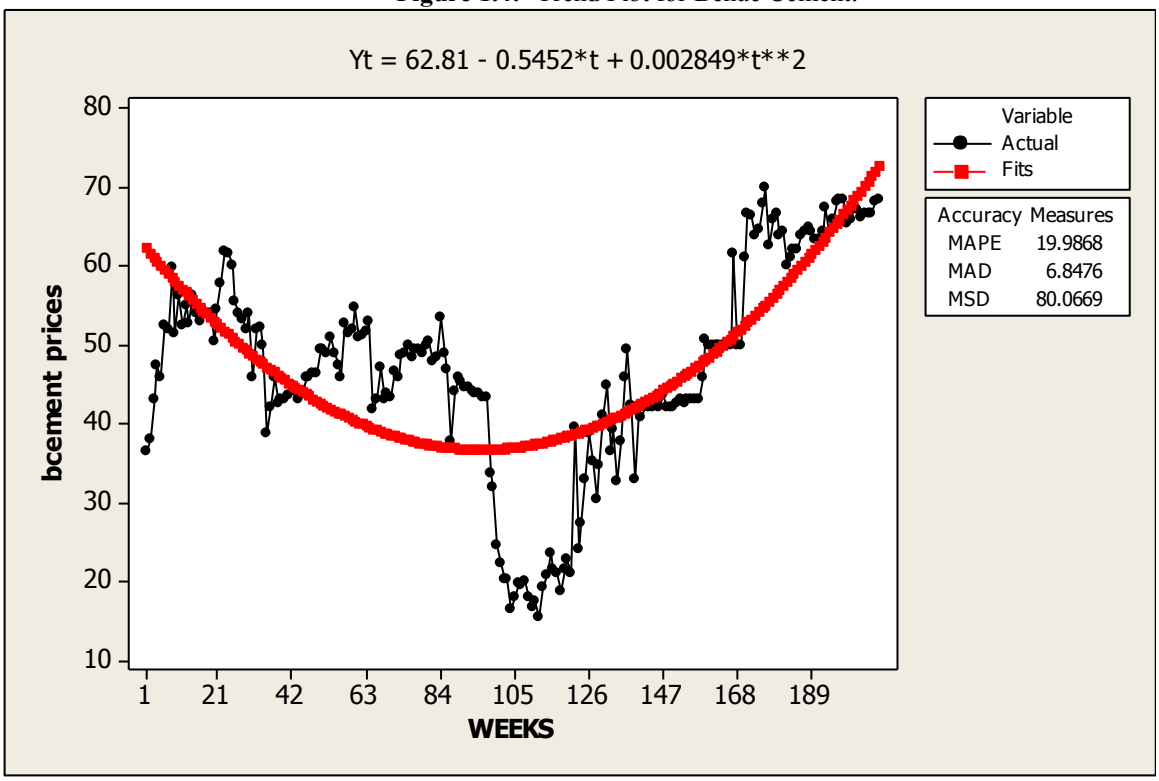
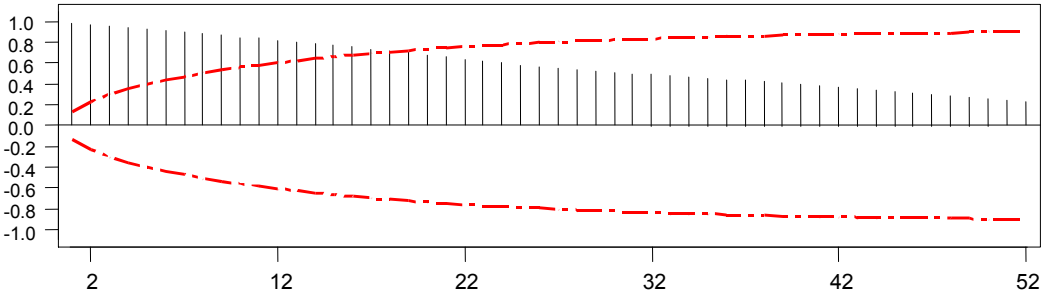
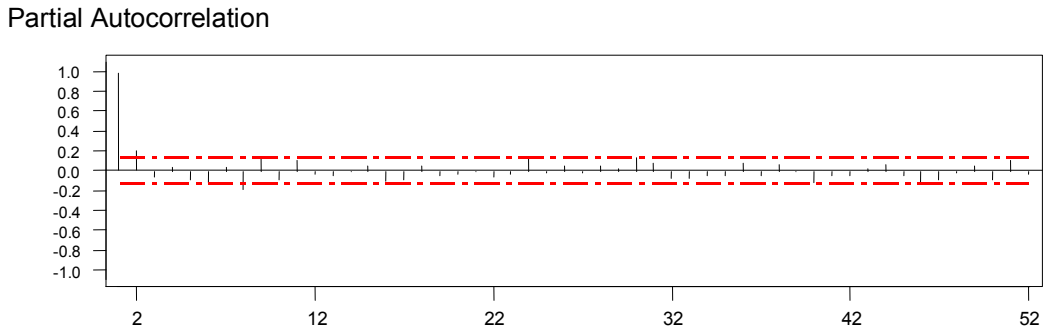


Figure 1.5:- Plot of the Sample Autocorrelation function of Ashaka Cement



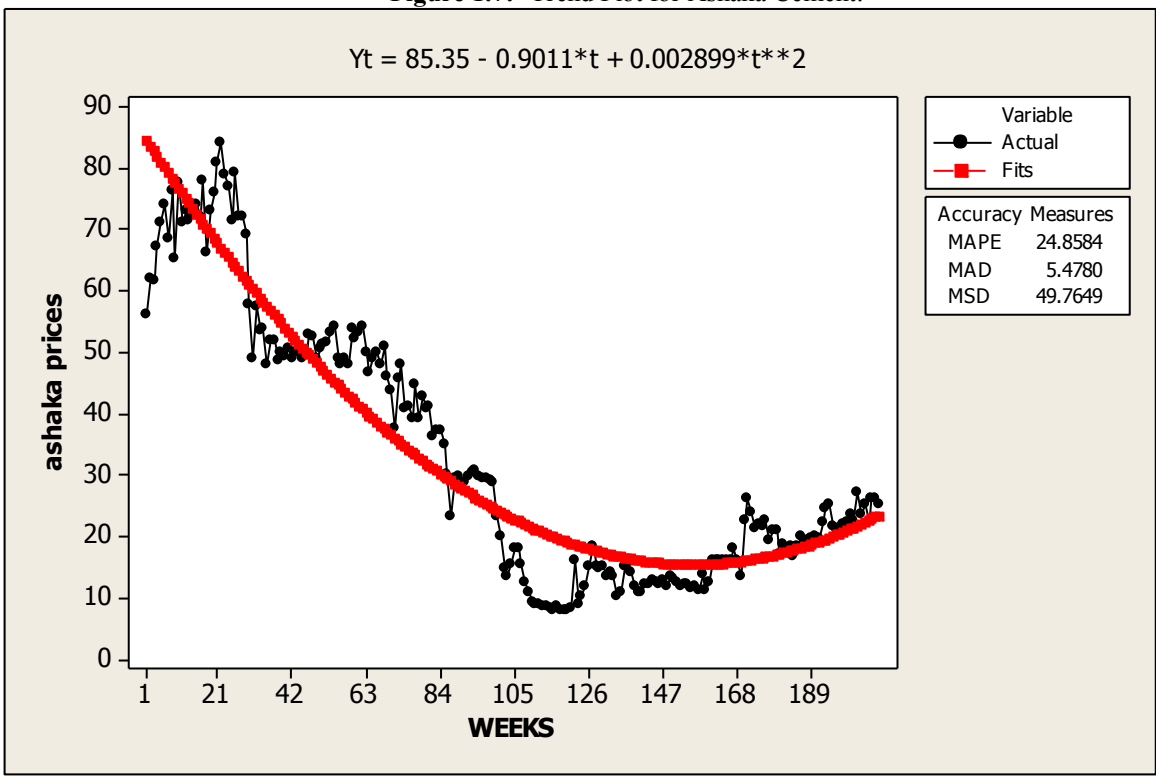
Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ	Lag	Corr	T	LBQ
1	0.98	14.19	204.18	13	0.81	2.55	2303.22	25	0.59	1.47	3641.09	37	0.43	1.00	4377.93	49	0.27	0.61	4779.13
2	0.97	8.20	405.40	14	0.79	2.42	2444.12	26	0.57	1.41	3718.94	38	0.42	0.97	4424.23	50	0.26	0.57	4797.51
3	0.96	6.31	602.33	15	0.78	2.31	2580.36	27	0.55	1.36	3792.63	39	0.41	0.94	4468.36	51	0.24	0.54	4814.11
4	0.95	5.31	796.03	16	0.76	2.20	2711.53	28	0.54	1.31	3862.42	40	0.40	0.91	4510.08	52	0.23	0.50	4828.76
5	0.94	4.64	985.10	17	0.74	2.10	2836.27	29	0.52	1.26	3928.80	41	0.39	0.87	4549.06				
6	0.92	4.15	1168.78	18	0.72	2.01	2956.36	30	0.51	1.22	3992.79	42	0.37	0.84	4585.61				
7	0.91	3.79	1347.83	19	0.70	1.92	3070.55	31	0.50	1.20	4055.15	43	0.36	0.81	4619.98				
8	0.89	3.47	1519.87	20	0.68	1.84	3179.55	32	0.49	1.16	4114.91	44	0.35	0.78	4652.30				
9	0.87	3.24	1687.51	21	0.66	1.75	3282.73	33	0.48	1.13	4172.28	45	0.34	0.75	4682.51				
10	0.85	3.02	1848.66	22	0.64	1.68	3380.29	34	0.47	1.09	4226.95	46	0.32	0.71	4710.32				
11	0.84	2.85	2005.68	23	0.62	1.60	3471.89	35	0.46	1.06	4279.27	47	0.31	0.68	4735.57				
12	0.82	2.69	2157.06	24	0.61	1.53	3558.82	36	0.45	1.03	4329.69	48	0.29	0.64	4758.38				

Figure 1.6:- Plot of the Partial Autocorrelation function of Ashaka Cement



Lag	PAC	T	Lag	PAC	T	Lag	PAC	T	Lag	PAC	T	Lag	PAC	T
1	0.98	14.19	13	-0.04	-0.61	25	-0.01	-0.21	37	-0.05	-0.75	49	0.04	0.61
2	0.20	2.93	14	-0.00	-0.03	26	0.05	0.77	38	0.06	0.85	50	-0.10	-1.41
3	-0.07	-0.95	15	0.06	0.81	27	-0.02	-0.29	39	-0.01	-0.19	51	0.11	1.56
4	0.04	0.60	16	-0.11	-1.57	28	0.06	0.80	40	-0.12	-1.72	52	-0.03	-0.48
5	-0.09	-1.25	17	-0.09	-1.35	29	0.02	0.24	41	-0.05	-0.66			
6	-0.12	-1.70	18	0.04	0.64	30	0.14	2.02	42	-0.05	-0.79			
7	0.03	0.46	19	-0.05	-0.66	31	0.08	1.17	43	0.03	0.38			
8	-0.19	-2.77	20	-0.03	-0.42	32	-0.08	-1.08	44	0.06	0.83			
9	0.13	1.89	21	-0.01	-0.09	33	-0.08	-1.20	45	-0.05	-0.76			
10	-0.09	-1.27	22	-0.07	-0.97	34	-0.05	-0.70	46	-0.12	-1.79			
11	0.11	1.57	23	-0.03	-0.46	35	-0.05	-0.71	47	-0.09	-1.26			
12	-0.03	-0.43	24	0.13	1.91	36	0.07	1.07	48	-0.03	-0.38			

Figure 1.7:- Trend Plot for Ashaka Cement.



Interpretation:

Although Benue and Ashaka Cement are in the same industry, the two stocks behave differently; autocorrelation for Benue Cement are large for short lags but die out rapidly as the lag increases suggesting stationarity while the autocorrelation for Ashaka are large and positive for short lags but decrease slowly as the lag increases. This may largely be due to the frequent change in users taste and constant introduction of similar products in the market.

Table 1:- Output for Benue Cement.
Minitab Output for ARIMA Model for Benue Cement

Final Estimates of Parameters

Type	Coef	StDev	T	P
AR 1	0.9632	0.0207	46.54	0.001
Constant	1.7759	0.2725	6.52	0.000
Mean	48.254	7.403		

Number of observations: 208
Residuals: SS = 1155.25 (backforecasts excluded)
MS = 1.32 DF = 875

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	44.7(DF=11)	50.4(DF=23)	76.4(DF=35)	96.2(DF=47)
P-Value	0.913	0.868	0.972	0.842

Forecasts from period 50

		95 Percent Limits		
Period	Forecast	Lower	Upper	Actual
51	49.5023	41.8300	57.1746	49.5000
52	49.4564	38.8039	60.1089	48.9800
53	49.4122	36.6004	62.2239	51.0000
54	49.3696	34.8387	63.9005	49.0100
55	49.3285	33.3674	65.2896	47.5000
56	49.2890	32.1072	66.4708	46.0000
57	49.2509	31.0095	67.4923	52.8400
58	49.2142	30.0421	68.3864	51.5000
59	49.1789	29.1819	69.1759	52.0000
60	49.1449	28.4120	69.8778	54.7000
61	49.1121	27.7191	70.5051	51.0000
62	49.0806	27.0929	71.0683	51.3100
63	49.0502	26.5248	71.5755	51.8400
64	49.0209	26.0079	72.0339	53.0000
65	48.9927	25.5363	72.4490	41.7300
66	48.9655	25.1053	72.8257	43.0000
67	48.9393	24.7104	73.1683	47.2500
68	48.9141	24.3480	73.4802	43.0200
69	48.8898	24.0151	73.7646	43.8600
70	48.8665	23.7087	74.0242	43.2300

Figure 1.8:- Histogram of the Residuals for Benue Cement.

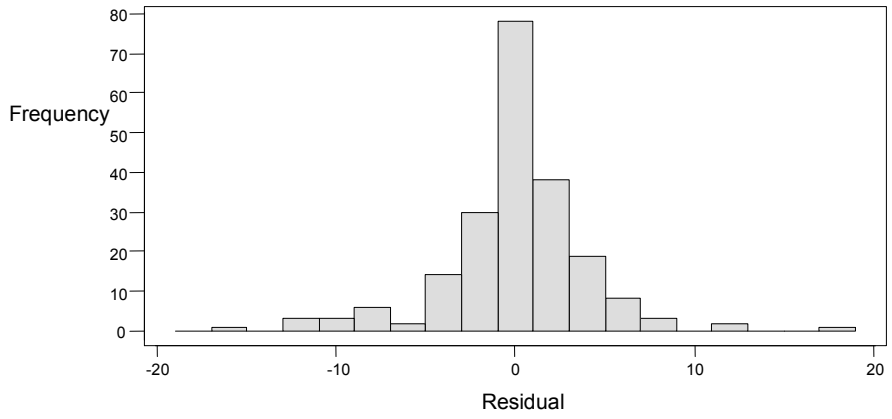


Figure 1.8:- Residual versus Fitted values for Benue Cement.

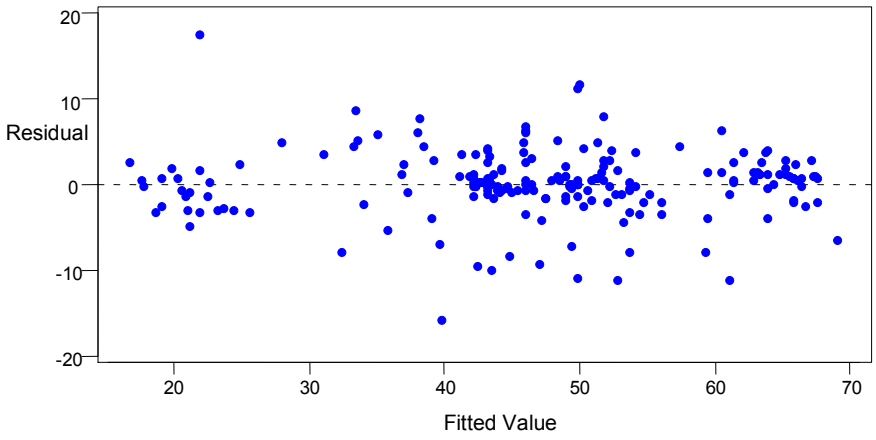


Figure 1.9:- Residual versus Order of the data for Benue Cement.

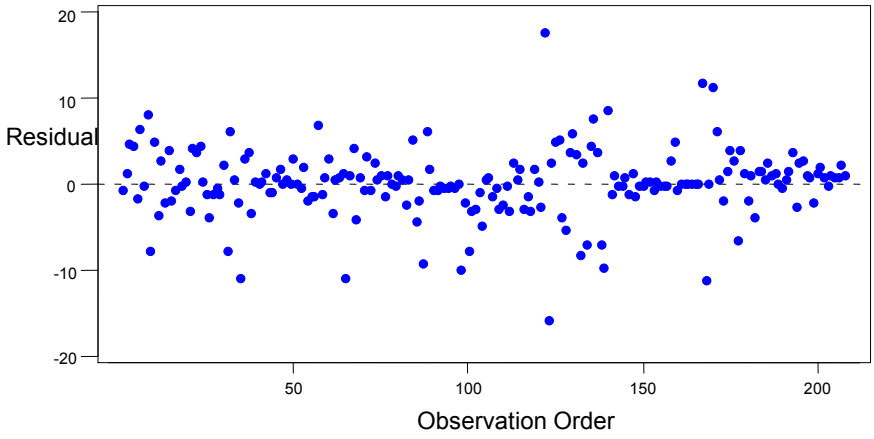


Figure 1.10:-Normal probability plot of the Residuals.

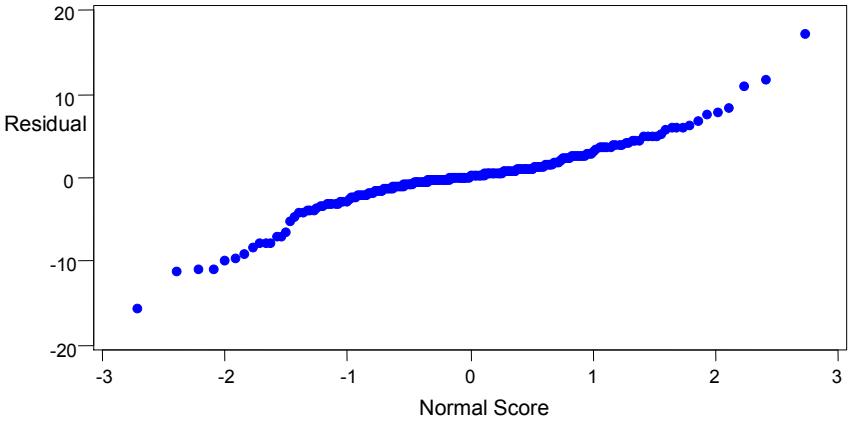
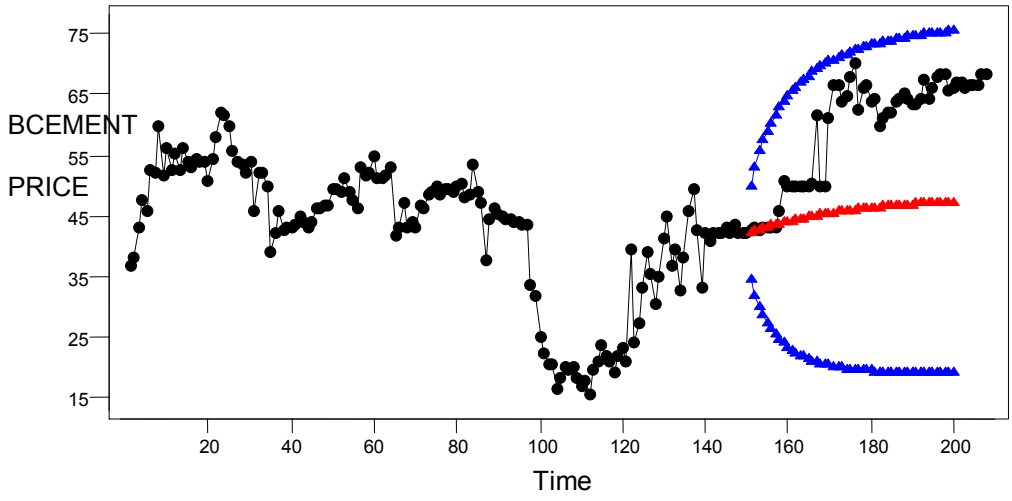


Figure 1.11:- Plot for Benue Cement with Forecast.



Observing the output, we can see that the P- values are much less than 0.05 and the behavior of the residuals are normal. We can conclude that AR (1) is a reasonable fit for the Benue Cement data that was sampled.

The ACF for the series that was sampled weekly behaves differently from the other two. They are similar because the autocorrelations are highly correlated for lower lags and then decrease as the lags increase. The Minitab Outputs also support this claim. The MSE for each of the series is very minimal but the least is that of Benue Cement that was sampled weekly and therefore showing a better fit than that of first and fifteenth day of the month. The histogram and the probability plots of the residuals suggest that the residual are Normal.

Table 2:- ARIMA Model for Ashaka Cement.

Final Estimates of Parameters

Type	Coef	StDev	T	P
AR 1	0.9916	0.0113	88.14	0.001
Constant	0.2723	0.2397	1.14	O.001
Mean	32.59	28.69		

Number of observations: 208
Residuals: SS = 364.62 (backforecasts excluded)
MS = 1.77 DF = 206

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	54.2(DF=11)	73.1(DF=23)	82.1(DF=35)	87.2(DF=47)
P-Value	0.237	0.438	0.634	

Forecasts from period 50

		95 Percent Limits		
Period	Forecast	Lower	Upper	Actual
51	50.3999	43.6279	57.1720	51.2000
52	50.2511	40.7139	59.7884	51.5000
53	50.1036	38.4714	61.7357	53.1200
54	49.9572	36.5813	63.3332	54.0000

55	49.8121	34.9192	64.7051	49.0000
56	49.6682	33.4211	65.9154	48.0000
57	49.5255	32.0488	67.0023	48.9000
58	49.3840	30.7771	67.9909	48.0000
59	49.2437	29.5888	68.8986	53.9200
60	49.1046	28.4709	69.7382	52.0000
61	48.9666	27.4137	70.5194	53.0600
62	48.8297	26.4098	71.2497	53.9900
63	48.6941	25.4529	71.9352	50.0100
64	48.5595	24.5382	72.5808	46.5100
65	48.4261	23.6615	73.1906	49.0500
66	48.2938	22.8195	73.7681	49.9100
67	48.1625	22.0091	74.3160	48.0000
68	48.0324	21.2279	74.8369	51.0000
69	47.9034	20.4738	75.3331	46.0000
70	47.7755	19.7446	75.8063	43.7000

Figure 1.11:- Plot for Benue Cement Prices with Forecast.

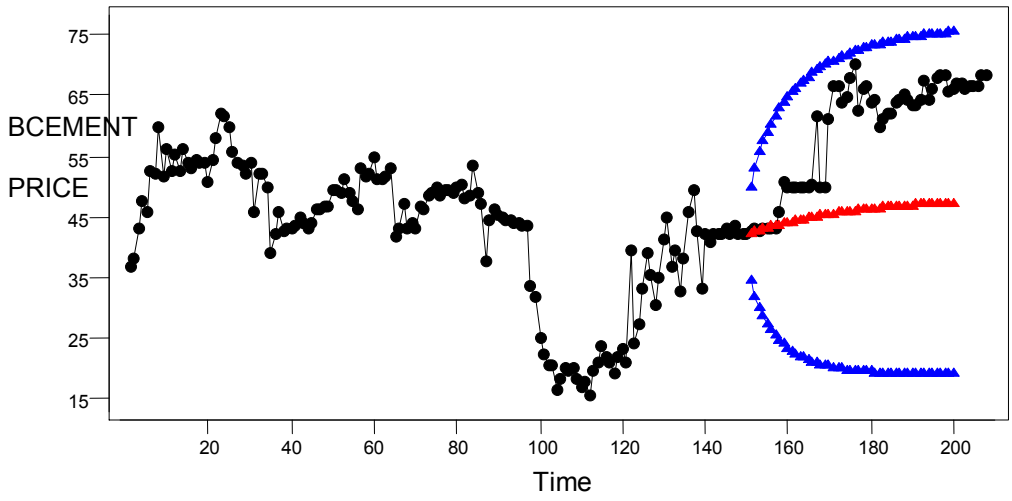


Figure 1.12:- Plot of the Histogram of Residuals.

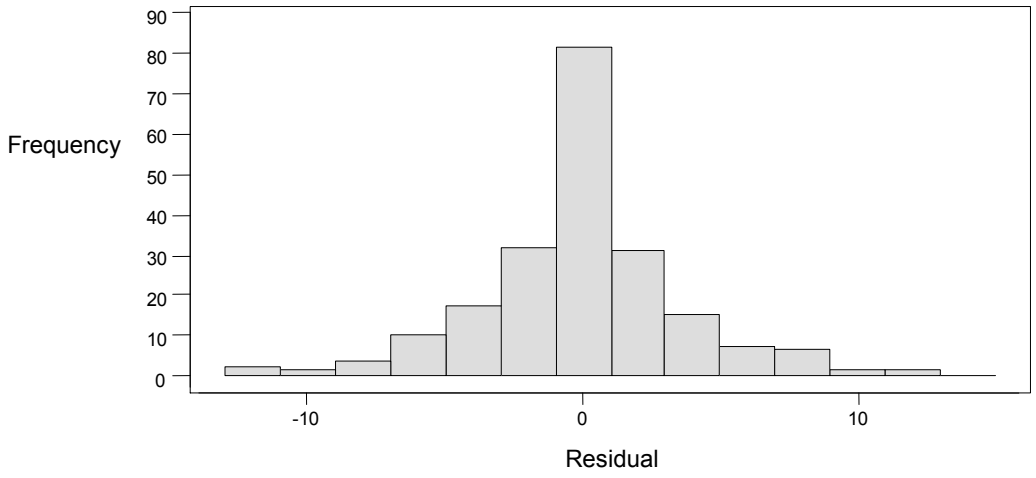


Figure 1.13:- Normal Probability Plot of the Residuals

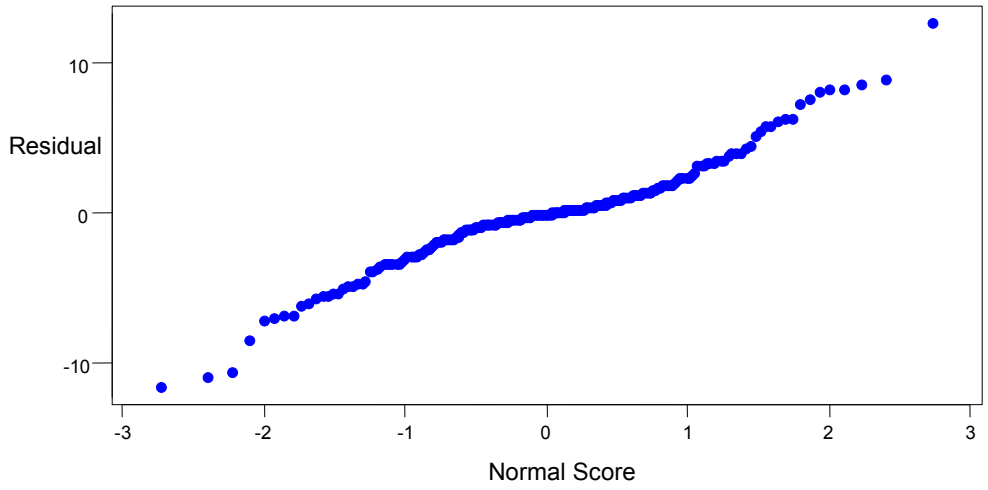


Figure 1.14:- Plot of the Residuals versus the Fitted Values for Ashaka Cement.

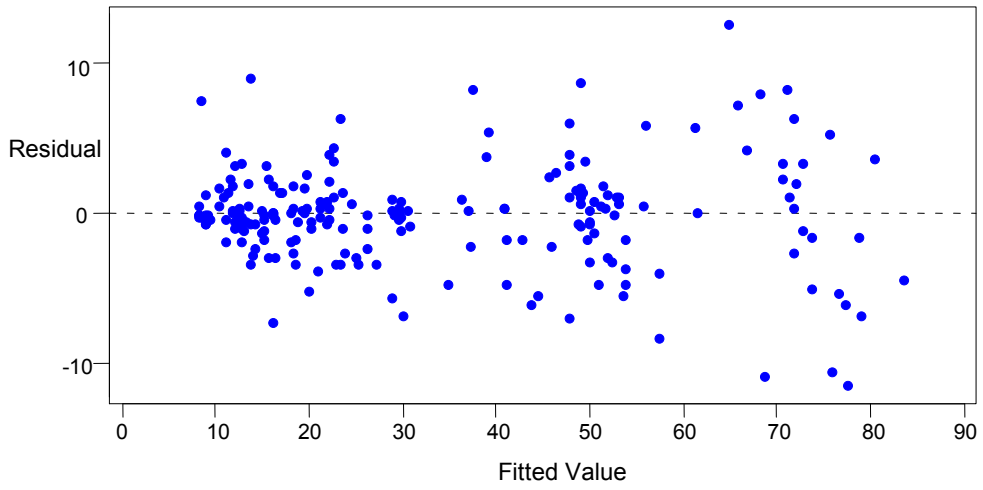


Figure 1.15:- Plot of the Residuals Versus the Order of the Data for Ashaka Cement.

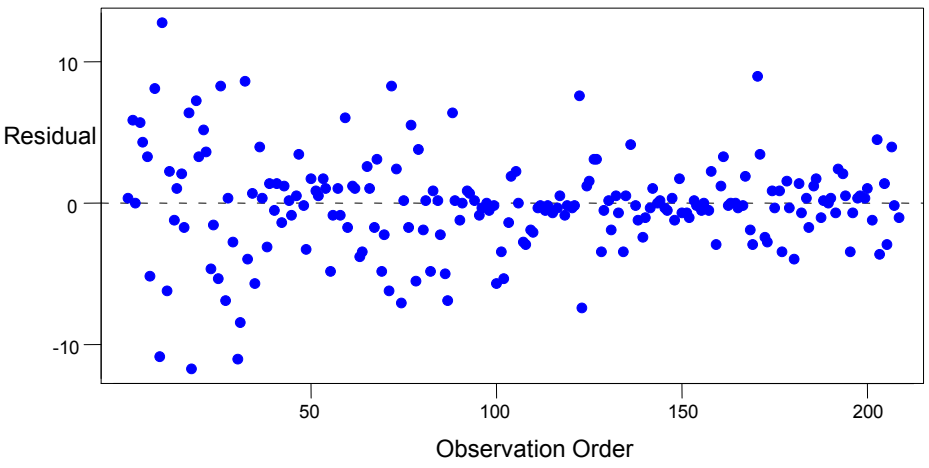
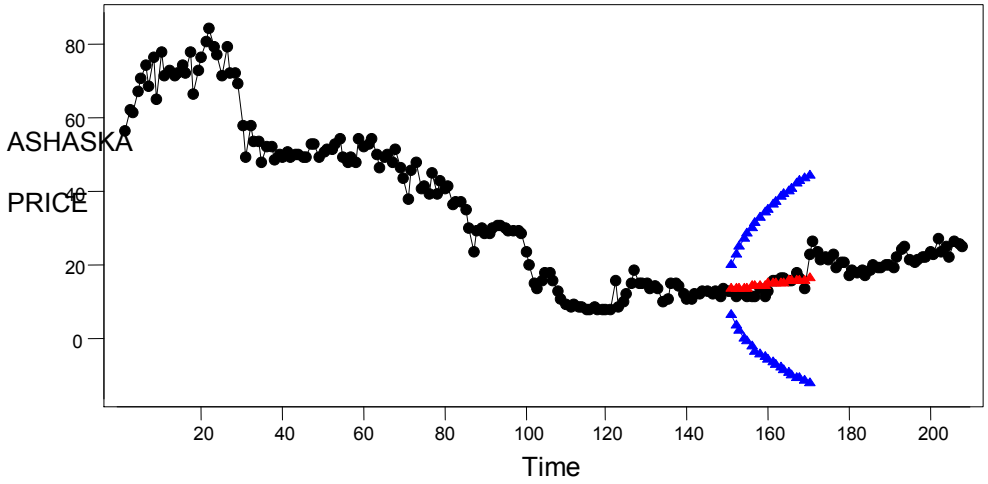


Figure 1.15:- Plot for Ashaka with Forecast.



Discussion:-

The first step in the process was to create a time series plot of the data for each of the companies under investigation. The time series indicated that there are possibly some events that influenced the price per share for cement because of the inconsistency of the behavior of the stock which displayed lowest price in week 26. The autocorrelation function for Benue cement stock prices tails off while the partial autocorrelation function cuts off after lag one thereby suggesting an autoregressive process of order 1, AR(1) for Benue cement stock prices. The model for the Benue cement stock prices was $\mathbf{Zt = 1.7759 + 0.9632Z_{t-1} + a_t}$.This shows that this week's price is a function of last week with a coefficient of 0.9632 and a constant of 1.7759 and some random error. The output result showed that all the parameters including the constant are significantly different from zero, because they have p-values that are significantly smaller than 0.05. Furthermore, the model contains minimal parameters. The probability plot of the residuals reveals that they are essentially normal and the time series plot of the residuals contain only noise. These diagnostics indicate that a reasonable model has been found.

The resulting models for Ashaka Cement sampled was AR (1). Autoregressive models are used when the current level of the series is thought to depend on the recent history of the series. The ACFs are similar and therefore it is expected that the model for the series will also be the same. The model for sampled Ashaka cement is $\mathbf{Zt = 0.2723 + 0.9916z_{t-1} + a_t}$. The output result showed that the p-values are significantly smaller than 0.05 which implied that the parameters are significantly different zero. The probability plot of the residuals also reveals that they are essentially normal and the time series plot of the residuals contain only noise.

When examining the forecasts for Benue cement, for the data sampled, we noticed that the fits were very close to the actual. For the five months periods, the fits had a range of 49.50- 48.87. However, the actual prices had a range of49.50- 43.23. There was not much change in the fits because the coefficient of the autoregressive terms is 0.963 and a constant of 1.776.

The fits of the model show slight downward trend because only a portion (0.963) of the last week prices is used to predict the forecasts. This is the same in behavior with the actual values, which also decreased during this time frame. The model can therefore be concluded to be an appropriate fit statistically; the results would be desirable for an investor.

Examining the actual versus the fits for the data sampled, their behavior was the same. The fits increased, while the actual values also increased. This model would also be desirable for an investor.

Conclusion:-

The resulting models for all the series were AR (1) models. The stock belonging to the same class of ARIMA models only indicates that the ACF and PACF for the stocks behave similarly. But the analysis also revealed that even though the ACF and PACF may behave similarly overall, differences within each particular series can heavily impact whether or not the model will be adequate for forecasting the series. Within the same stock there were also instances when the models varied greatly. The adequacy of the forecasts and the model was determined by examining residual plots and analyzing how the actual prices compared to the predicted values.

When examining the ACFs and PACFs for the stocks, with regards to industry, there is no similarity in behavior among stocks within the same industry. The only similarities are those that exist because the stocks could be fitted using the same type of ARIMA models.

We can conclude that stocks do not behave a certain way based on the industry they are in. Their behavior has more to do with that particular company and how much their stock prices are influenced by factors that cannot be quantified.

Recommendations:-

The use of the Box-Jenkins approach to forecast stock prices could be made better by incorporating covariates into the models. A covariate is a secondary variable that can affect the relationship between the dependent variable and other independent variables of primary interest, and our primary variable is time. The covariates in this case can be events that may be occurring in politics, Natural disasters, Speculations that are being made about the company in the market. By addressing the fact that there are outside components that influence the price per share, we can modify the model to try and anticipate the effects these events will have on the forecasts.

In addition to incorporating covariates we could also expand on the topic by looking at more stocks within each industry to determine if the behavior that we observed was the norm, or an exception. We can also examine whether or not the behavior in different industries are codependent.

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