A Study and Forecast of MCX Comdex Commodity Index Using ARIMA Model

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Abstract - The purpose of this research paper is to understand the MCX Comdex index, the paper also attempts to forecast the index level, the level of index reflects the change in commodity prices. The index is based on commodity futures prices of an exchange. To study the same daily closing prices of Comdex for last twelve years has been considered. The data are taken from MCX website. Analysis shows that commodities prices have changed substantially since 2007. To forecast the MCX Comdex value ARIMA model has been used. It indicates the range bound or constant increase in commodity prices in near future considering 95% of confidence interval.

Keywords: Commodities, MCX, Comdex, ARIMA, Forecast etc.

I.   INTRODUCTION

Multi Commodity Exchange of India limited (MCX) is an online national level commodity exchange established in year 2003 and first exchange in India to list. MCX offers futures trading in non-ferrous metals, bullion, energy, and a number of agricultural commodities and option trading in gold. Apart from all these commodities study if focused on commodities included in COMDEX index. The Comdex is an index of Multi Commodity Exchange limited comprises of 12 liquid commodities traded on the exchange. The index is computed using real-time data of near month traded futures contracts of all twelve commodities. Currently Comdex indexcomprises of following components,

1.   Gold
2.   Silver
3.   Aluminium
4.   Nickel
5.   Zinc
6.   Lead
7.   Crude Oil
8.   Natural Gas
9.   Cardamom
10.   Mentha Oil
11.   Crude Palm Oil
12.   Cotton

The index has risen substantially for past twelve years of time period of study. The value of index has risen to 4689.60 in September 2013 against 1654.59 in December 2008. The major rise can be seen in the year 2013-14. The same can be observed in graph given below.

Figure 1 MCX COMDEX Historical Price
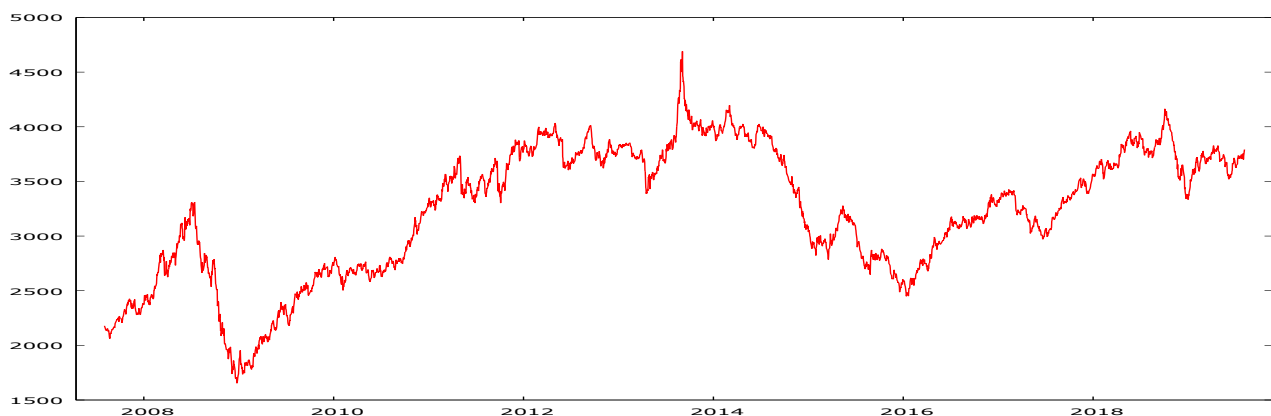
Source: www.mcxindia.com

The clear uptrend in agricultural commodity price can be observed throughout last decade. Particularly commodity

prices have risen sharply from year 2009 till date. However the volatility in prices can be seen due to global factors affecting the commodity prices.

OBJECTIVES

The objective of the study is to understand the Comdex index of MCX and its composition. Also the objective is to estimate the model and forecast the level of MCX Comdex index.

II. RESEARCH METHODOLOGY

Sample and Data Collection: The research is carried out through secondary data sources. The data for benchmark index Comdex are taken from Multi Commodity Exchange website and sources from government websites of India and some and some other authenticated sources are used for data collection. The 3405 observations based on closing price of Comdex from August 2007 to August 2019 were taken into consideration.

Research Tools: Comparative analysis, graphical representations are used to understand the pattern of Comdex index, while ARIMA model has been adopted to forecast the time series.

Limitations: The composition of Comdex is been reviewed by MCX to include most liquid commodity futures into index, hence Comdex rebalancing may affect Comdex index performance from time to time. Also the research focuses on futures prices of commodity index rather than demand, supply and spot prices etc. of commodities.

III. LITERATURE REVIEW

In order to understand the Comdex index literature published by Multi commodity Exchange is mainly used. Research paper published by Thabani Nyoni in year 2019 has studied Consumer price index of Germany and forecasted the same using ARIMA model. Another research paper published in 2017 by Priyanka solanki has estimated the mustard prices using ARIMA model. Whereas the volatility of return has been examined by Matei in year 2009 and suggest the suitability of GARCH class of model, Thiyagarajan, Naresh and Mahalakshmi also suggested the suitability of such models to forecast

volatility of returns. Bose (2008) studied some of the characteristics of Indian commodity futures market in order to understand the efficient functioning of market. Study was focused on commodity indices and its correlation. In a recent paper Nyoni and Nathaniel (2019), based on ARMA, ARIMA and GARCH models; examined inflation in Nigeria using time series data on inflation rates from 1960 to 2016 and found out that the ARMA (1, 0, 2) model. Research work published by Mohamed Ashik in year 2017 also has suggested ARIMA model for forecasting national stock prices Nifty 50 and bank nifty in two separated papers.

IV. ANALYSIS & INTERPRETATION

The commodity index is constituted by top twelve liquid commodities traded on MCX platform. Considering the physical market size and their liquidity on the exchange the weights to the constituents within sub-indexes are assigned. The rebalancing of index is done annually or as and when deemed necessary by the index management team. The MCX COMDEX is the simple weighted average of the three group indices – MCX AGRI, MCX METAL & MCX ENERGY. The group indices are computed based on Geometric Mean. Currently Comdex comprises of Gold, Silver, Aluminium, Nickel, Zinc, Lead, Crude oil, Natural gas, cardamom, Mentha oil, Crude palm oil and Cotton.

The table 1 summarizes the components of Comdex along with weightages assigned for the period of June 2019 to June 2020. Considering the liquidity and production Gold in metal index, Crude oil in energy index has been assigned higher weightages in index. Both the components together consist of more than 50 percent of the index. Including Natural gas, Cotton and crude palm oil, all five key components together consists 72 percent of the index. The 40 percent weight is assigned to energy index consists of Crude oil with 33.25 per cent and Natural gas together while 40 percent weight is assigned to metal index with 17.09 percent to gold considering the liquidity of the commodity.

Table 1 MCX Comdex Components June 13, 2019

Sr. No.	MCX Comdex	Component	Weight %	Group Adjusted Weight.
1	MCX Metal Index	Gold	17.09%	40.0%
2		Silver	4.12%	
3		Aluminium	3.72%	
4		Nickel	7.49%	
5		Zinc	4.80%	
6		Lead	2.78%	
7	MCX Energy Index	Crude Oil	33.25%	40.0%
8		Natural Gas	6.75%	

9	MCX Agri Index	Cardamom	2.0%	20.0%
10		Mentha Oil	2.84%	
11		Crude Palm Oil	6.67%	
12		Cotton	8.49%	

Source: https://www.mcxindia.com/market-data/index-history/about-comdex

Table 2 Change in Comdex over Previous Year

Date	Closing Price	% Change Over Previous Year
1-Jan-08	2376.79	8.17
1-Jan-09	1827.17	-23.12
1-Jan-10	2754.68	50.76
1-Jan-11	3324.99	20.70
2-Jan-12	3806.10	14.47
1-Jan-13	3809.96	0.10
1-Jan-14	3999.42	4.97
1-Jan-15	3046.02	-23.84
1-Jan-16	2595.93	-14.78
2-Jan-17	3335.56	28.49
1-Jan-18	3554.83	6.57
1-Jan-19	3336.43	-6.14
1-Aug-19*	3701.43	10.94

Source: www.mcxindia.com

Table 2 shows the percentage change over previous year based on closing price of the given date. The significant fluctuation can be observed in year 2010, 2015 and year 2017 due to sharp change in individual commodities prices and global factors. Index changed by 50.76 percent from January 2009 to January 2010. Also the major changes were observed during year 2015 and 2017 due to sharp change in crude oil and gold prices, index seems to be steady after that year. At the beginning of January 2017 Comdex index value was around 3,335. Since then the value has decreased by increase by mere 6.57 percent, reaching a minimum of 3,554.83. Consolidation of prices of commodities since April 2017 can be seen in the key reason for the moderation in Comdex in recent years. However it declined marginally in year 2019 due to change in trend in commodity prices. Comdex Annualized CAGR returns stands at 3.76% over the period of twelve years.

Summary statistics for Comdex observations

During the period of August 2007 to August 2019 of Comdex index, there are no outliers identified, in Table 3 summary statistics results for Mean, Median, Standard deviation, minimum and maximum are computed for Comdex index on closing prices.

ARIMA Model

An ARIMA model is usually stated as ARIMA (p,d,q) this represent the order of the autoregressive component (p), the number of differencing operators (d), and the highest order of the moving average terms (q). The basic idea of ARIMA model is to view the data sequence as formed by a stochastic process on time. Once the model has been identified, the model can be used to estimate the future value based on the past and present value of the time series. ARIMA models form an important area of the Box {Jenkins approach to time-series modeling. It is also known as Box-Jenkins method. Stationary can be modeled as a combination of the past values and the errors which can be denoted as ARIMA (p, d, q) are can be expressed as,

$$y_t = c + \varphi_1 y_{t-1} + \varphi_2 y_{t-2} + \ldots + \varphi_p y_{t-p} + e_t - \theta_1 e_{t-1} - \theta_2 e_{t-2} - \ldots - \theta_q e_{t-q}$$

Table 3 Summary Statistics, using the observations 2007-08-02 - 2019-08-05

Variable	Mean	Median	S.D.	Min	Max
Closing Price	3216.7	3309.7	599.53	1654.6	4689.6

Stationarity Check of data

Time series diagram is firstly used of Comdex index data based on closing price for August 2007 to August 2019. The clear non stationary trend can be identified from figure 2 (a) the fluctuation trend breaks the hypothesisi of weaker stationary. In
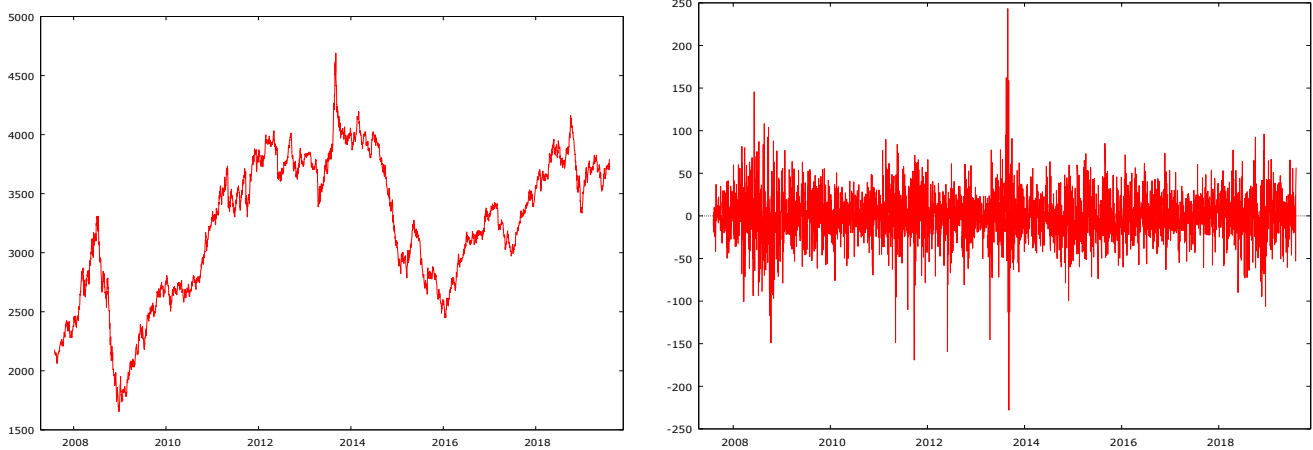
Box-Jenkins method, a first order defferencing is computed for the time series data. The time plot of the same differencing data is shown in figure 2(b) The differencing data shows the stationarity of the data and hence the value of d(I) is 1.

Figure 2 (a) Time plot of Comdex, Figure 2 (b) Time plot of first order differencing on Comdex

Further on, unit root also has been tested using ADF test with the lag order of 28. The output of the same has been shown below,

*Table 4 the result of Augmented Dickey Fuller Unit Root Test is shown in table*

	ADF Test Statistics		P value	
	C	C&T	C	C&T
At Level	-1.9115	-1.9855	0.3273	0.6087
At First Difference	-38.8894	-38.8877	0.000	0.000

C represents constant and C&T represents constant and trend

The unit root is present at the level of existing series and series is non-stationary in nature, but the series is found to be stationary at first level of difference as suggested in above table. The p value of both constant and constant & trend is below 0.05 at first level of difference. Hence first order of differencing is considered to make the series stationary.

Once the Comdex series has become stationary after first differencing then different model of AR and MA combinations can be estimated. Plotting of ACF and PACF suggest the value of p and q is almost 1 and hence AR (1) and MA (1) model was established.After comparing various ARIMA models, ARIMA (1,1,1) model was selected. Figure 3(a) shows the correlogram for ACF and PACF. This indicates the random non seasonality of series while the first order differencing of Comdex is show in figure 3(b),as given below.

Figure 3 (a) Time plot of Comdex, Figure 3 (b) Time plot of first order differencing on Comdex
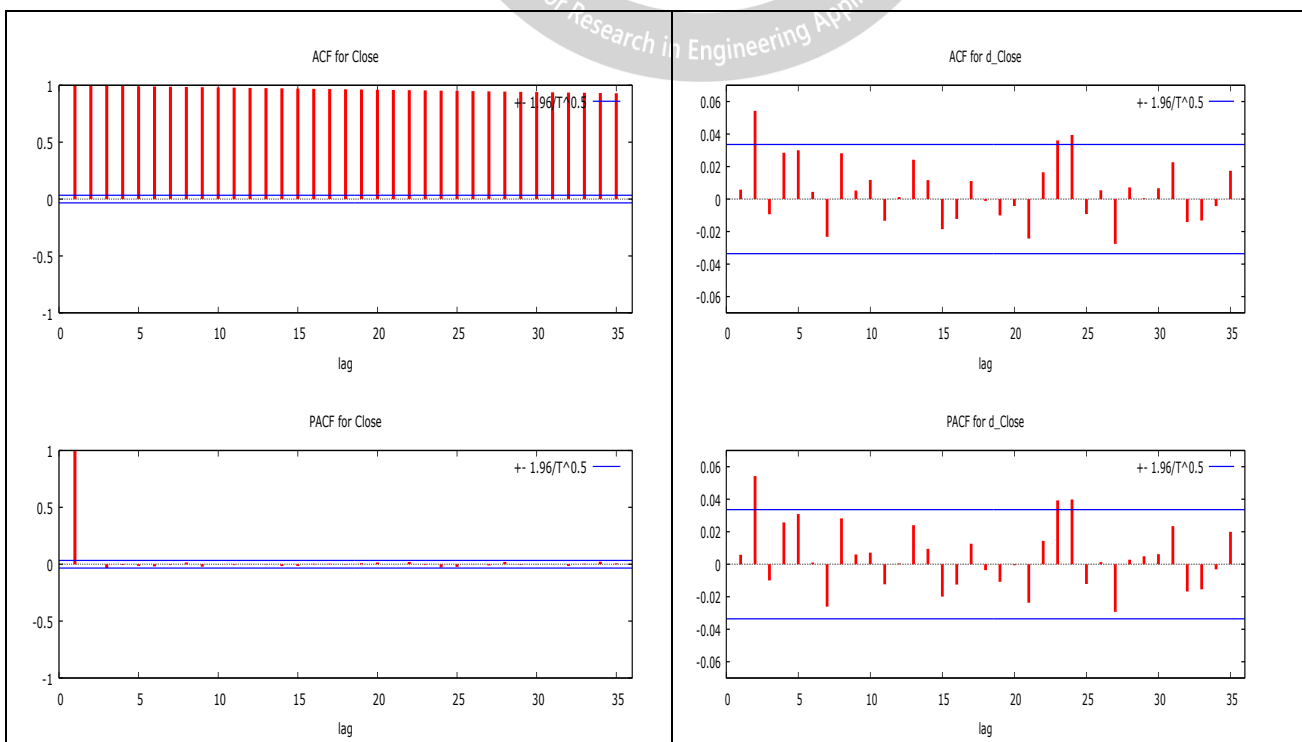
Considering all 3405 observations (daily closing price of Comdex) the coefficient for AR is 0.8554 with p value less than 0.0001 and -0.8335 coefficient for MA and p-value 0.0001. This shows the best fit model ARIMA (1, 1, 1). Also the Akaike criterion also observed to be lowest at 32471.67 for ARIMA (1,1,1) as against all other different combinations.

Model 1: ARIMA, using observations 2007-08-03:2019-08-05 (T = 3404)

Dependent variable: (1-L) Close

Standard errors based on Hessian

	Coefficient	Std. Error	Z	p-value	
phi_1	0.855470	0.0576176	14.85	<0.0001	***
theta_1	−0.833575	0.0614348	−13.57	<0.0001	***

Mean dependent var	0.473848	S.D. dependent var	28.51870
Mean of innovations	0.001418	S.D. of innovations	28.48905
Log-likelihood	−16231.84	Akaike criterion	32471.67
Schwarz criterion	32496.20	Hannan-Quinn	32480.44

Best fit ARIMA (1,1,1) Model
**Significance between 1 and 5 percent
*** Statistical significance at the 1 percent level

Now from estimated ARIMA (1,1,1) model the value of Comdex can be forecasted. The output for 95% confidence interval prediction, standard error and 95% interval can be generated for next 15 observations; the same can be seen from table below.

Table 5 For 95% confidence intervals, z(0.025) = 1.96

Obs	Closing Price	prediction	std. error	95% interval
3406	Undefined	3793.75	28.4891	(3737.92, 3849.59)
3407	Undefined	3795.46	40.7331	(3715.62, 3875.29)
3408	Undefined	3796.99	50.3795	(3698.24, 3895.73)
3409	Undefined	3798.36	58.6880	(3683.33, 3913.39)
3410	Undefined	3799.61	66.1373	(3669.98, 3929.23)
3411	Undefined	3800.74	72.9690	(3657.72, 3943.76)
3412	Undefined	3801.78	79.3254	(3646.30, 3957.25)
3413	Undefined	3802.74	85.2985	(3635.55, 3969.92)
3414	Undefined	3803.62	90.9522	(3625.36, 3981.89)
3415	Undefined	3804.45	96.3333	(3615.64, 3993.26)
3416	Undefined	3805.23	101.477	(3606.34, 4004.12)
3417	Undefined	3805.96	106.412	(3597.40, 4014.53)
3418	Undefined	3806.66	111.161	(3588.79, 4024.53)
3419	Undefined	3807.32	115.741	(3580.48, 4034.17)
3420	Undefined	3807.96	120.169	(3572.43, 4043.49)

ARIMA (1,1,1) Forecasts Value

From the above table observation 3406-3420 can be forecasted as seen in predication value with 95% of confidence interval. The same can be understood from the figure given below, which give the comparison between actual and forecasted values for past 100 observations.

Figure 4: Comdex forecast value for 95% confidence.
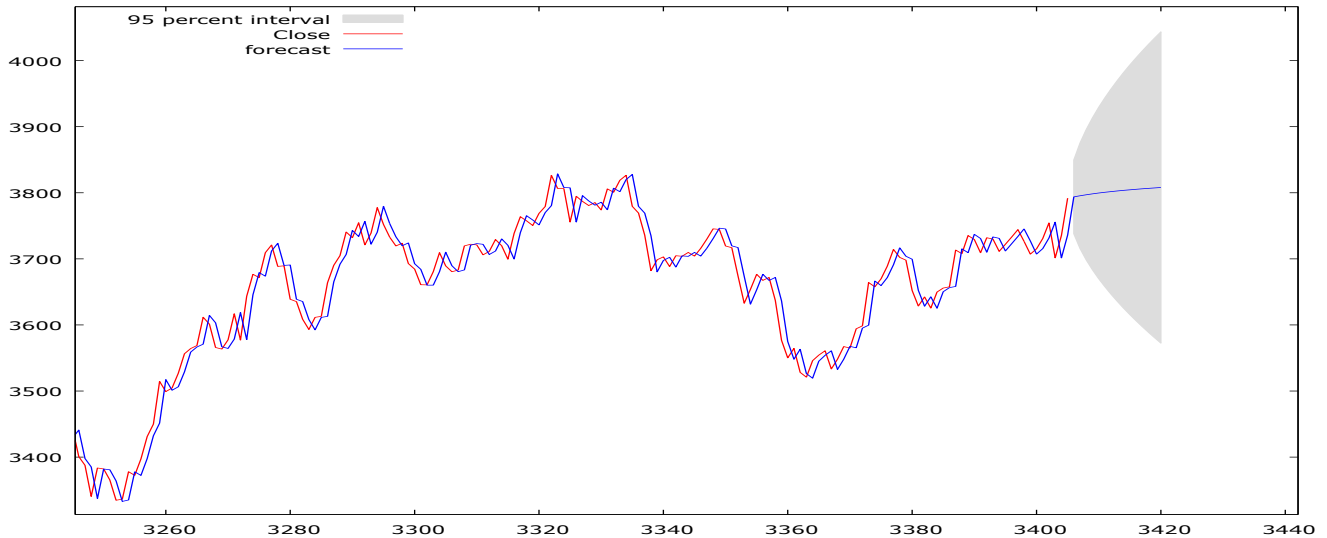
V. FINDINGS

The Comdex MCX is the simple weighted average of three group indices of MCX Agri, MCX Metal and MCX Energy. The group indices are computed based on geometric mean. Index is rebalanced and maintained by Multi Commodity Exchange. Comdex index is computed on real time basis. The data series is found to be non-stationary and hence the series is differentiated of first order to make it stationary. Also correlogramof ACF and PACF suggest the lag of 1 for AR and MA hence AR(1) and MA(1) are recommend. Hence ARIMA (1,1,1) model for series is suggested to estimate time series.The series can be forecasted using the ARIMA model. Here observations from 3404 to 3420 are forecasted values indicated in table 5. The same can be depicted from figure 4.

VI. CONCLUSIONS

With the help of the above research following can be concluded,

Comdex index of MCX comprises of 12 key agricultural commodities selected based on liquidity. All five key components of index together consists more than 72 percent of the index. The index is rebalanced by MCX on annual basis. This also contributes to the changes in the value of index.The annualized CAGR change in value of Comdex is nearly 15% over the period of twelve years.

Time series observed to be non stationary in nature; However the series is stationary at first order of differencing. Further on ARIMA model can be used to estimate the time series and the same can be used to forecast Comdex Index. Analysis shows the movement of actual prices as well as forecasted value through ARIMA model. ARIMA (1,1,1) model for series is suggested to estimate time series. Also the future projections can be made considering 95 percent confidence interval.

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