THE BEARING ON INDIAN FRUGALITY AND PREDICTING OF AVERAGE CRUDE OIL RATES SINCE 1991 – A STUDY

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ABSTRACT

In the past few years, the crude oil industry has seen so much volatility in terms of crude oil prices in the international oil market. In this research paper, we explore many aspects of the overall crude oil industry and its impact on the Indian economy, it is crucial to have an idea about price movements in order to ascertain demand and supply of crude oil. In this research paper researchers focus on the Box-Jenkins approach along with normal regression model required used for forecasting crude oil prices and its significant impact on the Indian economy (GDP) since LPG reforms post 1991 through time-series data available for the specific time period from 1991 to 2018.

ARIMA model based on the Box-Jenkins approach is further evidence to check the feasibility of time series data and on the basis of that forecasting of the future trends of crude oil prices are shown. The historical crude oil prices predict future trends of crude oil prices and results on the basis of the proposed model are found to be very conclusive and genuine. Before applying the ARIMA model normality of data is assured followed by unit-roots are checked to make residuals stationary at a desired level of significance in order to have significant forecasting through the ARIMA model used in this research.

Keywords: *ARIMA, LPG, Crude oil, , Unit Roots, GDP*

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INTRODUCTION

India is known as the world's third main Oil importing country and the world's seventh-largest economy as far as the present scenario is concerned. It is found to be a key looser in the case of rising crude oil prices and a beneficiary in the event of falling crude oil prices. The rapidity, at that the economy is mounting, additional increases the need of the country to import more and more of crude oil to meet the country's industrial as well as domestic requirements.

With the latest development seen as U.S striking sanctions to purchase crude oil from Iran, India stands to face the powerful and unpleasant effects of increasing crude oil prices as well as a weaker trend of Indian rupee. India's crude oil import bill for 2018-2019 witnesses rising trend sharply in March 2018 as India is reliant for 80% of its consumption needs on its crude oil Imports. The CAD (Current Account Deficit) and fiscal as well as economic deficits are getting bigger in the event of trade imbalance in the economy.

The Oil Ministry in India has recently pointed out that India is more relaxed and comfortable if crude oil prices continue near to $50 per barrel, although $70 is way too much and would squeeze India's economy in a big way going forward if Saudi's drive crude oil prices tend to move further to $80 per barrel. To counterbalance and offset higher crude oil prices the government either has to cut excise duty to impact state finances or reconsider fuel price to control inflation rate thus dent margins of oil refiners.

The Indian Oil Ministry has been promoting to bring fuel price under the GST (Goods and Service Tax) domain that would decrease oil prices and make available immediate relief to the vast majority of people, therefore, reducing sharpened Inflation as currently, taxes build up 50% of the crude oil price collection.

The fall in crude oil prices has helped the Indian government to elevate excise duty by INR 12 on petrol per liter and INR 13.77 on diesel per liter since April 2014 and also helped reduced (CAD) Current Account Deficit, therefore, raising GDP expectations to new heights.

Morgan Stanley in its analysis has mentioned that the fiscal deficit in India is possible and expected to further rise to 3.5% of India's GDP in the fiscal year 2018-2019 owing to trade imbalance in the economy. As per renowned financial giant has mentioned that every $10 increase in oil prices to affect India's CAD by 0.4% of India's GDP.

Ahead of the general election in the year 2019, distinguished economist has predicted decreased India's GDP growth to 6.9% from 7.8%. Also, Deutsche Bank lowered its GDP forecast for India instead of extending CAD to 7.3% from 7.5%.

Going to elections India is struggling with the unconstructive and to an extent the negative impact of the highest fuel prices in the country in current years. India is stumbling under the toughest assessment to fight against shocks of economic growth and Inflation under ever-rising crude oil prices.

Impact on Current Account Deficit (CAD)

As we are aware that the current account deficit of an economy gets broadened when the total worth of imported goods exceeds the total worth of exported goods, indicating that how much India owes foreign currency to the world. With India's ever-increasing need for crude oil to meet its spending needs that have developed from 77.3% approximately in 2014 to 87.3% in 2018, the current account deficit also is expanding at a faster rate thus inflating its import bill.

Therefore widening CAD also puts pressure on the value of Indian rupee and weakens it against key

bunch of currencies. As per SBI reports suggest that Indian's CAD could further cross 2.5% of GDP for FY 2019 providing oil price continues at $80 per barrel. At present CAD is estimated at 1.9% for 2017-18.

Impact on Fiscal deficit

Rising and mounting crude oil prices thus unfavorably and adversely affect India's fiscal deficit too that is the major difference between the government's total profits and total expenses. India imports as per our analysis during our research in this paper moves around 80% of its annual crude oil constraint that is approximately 1.5 billion barrels a year from the global markets. Also, the rising trend in crude oil prices increases the government's entire outflow, therefore, impacting and affecting its financial or fiscal deficit negatively. Fiscal shortfall gives impending into the amount of money the government has to have a loan to meet its outflows.

Impact on Valuation of Indian Currency

Faisal, S M (2016), Rising trend in crude oil prices affect rupee also adversely and negatively, as more money flows out of the system to buy more dollars for making crude oil payments. Therefore sometimes it is evident that RBI moves in to curtail rupee fall. Depreciating rupee has a waning and weakening effect on the countries overall economy. Rupee is at its lifetime low as mentioned too in our past research paper Valuation of Currency and Its Impact on Investment: A Study in the Context of Many Confounding Factors published in International Journal of Management and Commerce Innovations ISSN 2348-7585.

Khan, S M (2019) in their another paper on depreciation of Indian currency titled "Depreciation of Indian Currency in the Current Economic Scenario" accepted for publish in International Journal of Economic Research, (2019), India in a helpless and weaken spot in the result and deteriorating of Indian currency and therefore benefits the exporters as a whole and is thus a big obstruction on the importers due to depreciation of Indian rupee.

LITERATURE REVIEW

Crude oil rate dynamic forces and progression can be premeditated employing a stochastic modeling approach that seizures the time-dependent structure rooted in the time series crude oil amount numbers. Autoregressive Integrated Moving Average (ARIMA) generally recognized as Box-Jenkins Methodology (G. P. E. Box and G. M. Jenkins (1978) and the autoregressive conditional heteroscedasticity (ARCH) models, with its addition to universal autoregressive conditional heteroscedasticity (GARCH) models as familiarized by Engle (1982) and Bollerslev (1986) respectively billets the dynamic forces of conditional heteroscedasticity (the changing variance nature of the data). The advantages of ARIMA models are twofold. Primarily, ARIMA models are a set of classic linear models that are anticipated for the linear time series and bagged linear characteristics in the time series (Wang et al., 2005).

Though there is a current trend from many years ago to start using renewable sources of energy, crude oil is still the focus of many studies, due to the relationship between the oil price, and some macro-economic variables. Researchers as Basak and Pavlova (2016) imply that the activity of financial investors in the oil futures market amplifies earlier realized and expected shocks.

The above literature can be established moreover by Taghizadeh-Hesary et al. (2013) estimated the effect of oil price surprises on oil-producing and consuming markets; the study recycled a concurrent reckoning basis for unlike countries with commercial dealings. As predictable, the outcomes exhibited that oil producers (Iran and the Russian Federation) assistance from oil price surprises; analogous to

(Huseynov and Ahmadov, 2013), who endorse that an upsurge in oil prices is a constructive surprise which lifts the national economy, but in over-all leads to greater inflation.

Oil price escalations are estimated to shake net oil importers nations adversely, over and done with growing import bills leading to inflation, decreasing productivity and joblessness (Bacon and Kojima, 2008). Similar to Chang and Wong (2003) indicated that the impact of oil volatilities on GDP, inflation, and unemployment has been significant. Pérez de Gracia (2005) accomplish that oil prices have a noteworthy effect on both fiscal activity and amount indexes although the bearing is restricted to the short-run for some Asian countries.

Tang et al. (2010) who studies small and elongated run special effects of oil fee in China; by using the SVAR model, displayed that upsurges of oil price destructively affect yield and investment but affect inflation and interest rate.

Lescaroux and Mignon 2008 & Berument, et al., 2010 established the price of oil could be measured as wicked for oil-importing countries but worthy for oil-exporting countries, as it was verified as well, by Ayd n and Acar (2011) who established there is an adverse effect on GDP in terms of variations in the price of oil in Turkey. In line with Burbidge and Harrison (1984), who debated based on a VAR model, that oil price has contrary and sound effects on the macroeconomic variables in five Establishments for Economic Co-operation and Development (OECD) countries.

The most significant literature about oil price astonishment on macroeconomic variables for this study, was Kilian (2008) who presented proof that the recent rise in crude oil prices was motivated mainly by global aggregate demand surprises aids explain why this oil price surprise so far has unsuccessful to cause a chief depression in the U.S. Using an SVAR model decaying the real oil price.

Recessions were also studied by Blanchard and Gali (2007) that pigeonholed the macroeconomic performance of a set of industrialized economies in the aftermath of the oil price shocks of the 1970s and the previous epoch, using a six-variable VAR model. They found a substantial part of oil prices in the economy declines. Besides they concluded these impacts may be reducing with time due to the flexibility of the labor market.

Hamilton (1996) concluded that US recessions after World War II were preceded by increases in the oil price, firm correlation between the influence of oil rates and slumps on the US economy. And Brown and Yüce (2002) concluded related results.

RESEARCH GAP

Literature Review is ostensible that no study has been done on the aforementioned topic and there is a research gap; therefore, the investigators did daring to undertake this topic titled "The Bearing on Indian Frugality and Predicting of Average Crude Oil Rates since 1991 – A Study" for investigation.

OBJECTIVE OF THE STUDY

- To ascertain the present scenario of international crude oil prices.
- The build an optimum Autoregressive Integrated Moving Averages (ARIMA) model for crude oil prices.
- To forecast the crude oil prices by using Box-Jenkins Method of forecasting (ARIMA Model)

RESEARCH METHODOLOGY

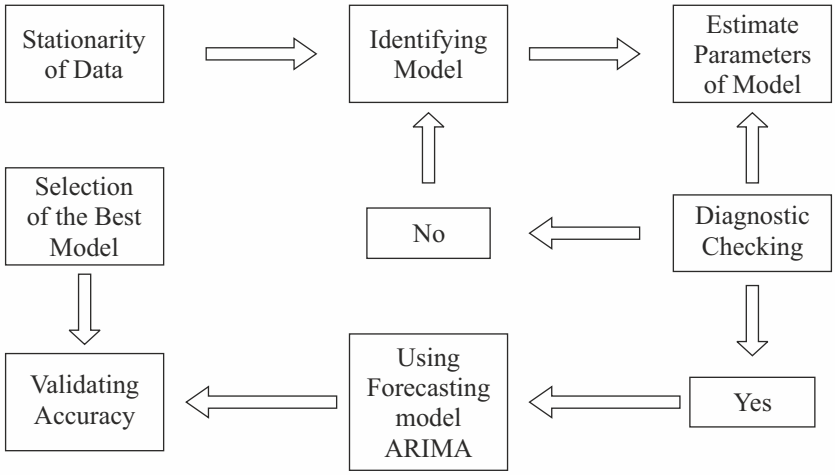
Data used in the present study consist of yearly data collected from the international crude oil market

from 1991 to 2018. For the diagnostic test of residuals unit root which is necessary before applying ARIMA, a time series of single variable and multiple variable were also used for the approximate forecasting approach and normality of residuals which is not essential but preferred for the purpose of accuracy were tested before applying actual application of ARIMA for the purpose of forecasting of crude oil prices. By using the Box-Jenkins approach trend of forecasting with a suitable model, figures and graphs represented. Careful study of the autocorrelation function (ACF) and partial correlation function (PACF) also used for optimum model selection in the case of the ARIMA forecasting approach.

Estimation

Researchers used maximum likelihood estimation (MLE). This estimation facilitated a smooth, assured and efficient model with optimal lags.

Fig 1



BOX - Jenkins Approach of Forecasting

ARIMA (AR & MA)/Box-Jenkins - Mathematical Model of Forecasting

Autoregressive (AR) Model

A common approach for representation univariate time series is recognized as Autoregressive (AR) representation as shown below:

$$Y_t = \sigma + \partial 1 Y_{t-1} - \partial 2 Y_{t-2} + \cdots + \partial p Y_{t-1} + W_t$$

In which Yt is the time series, Wt is white noise (an error term of residuals), And

$$\sigma = \left(1 - \sum_{i=1}^{n} \partial i\right)\delta$$

With ∂ is known as process mean as mentioned in the model. An autoregressive model or representation in doing econometrics is usually described as a linear regression of present values of the series aligned with one or more previous values of the time series residuals.

AR (Auto-Regressive) model can be analyzed with one of a range of different methods, including a model known as the Least Squares Method. They too have simple and uncomplicated analysis as well as an interpretation as shown in the analysis part of the research.

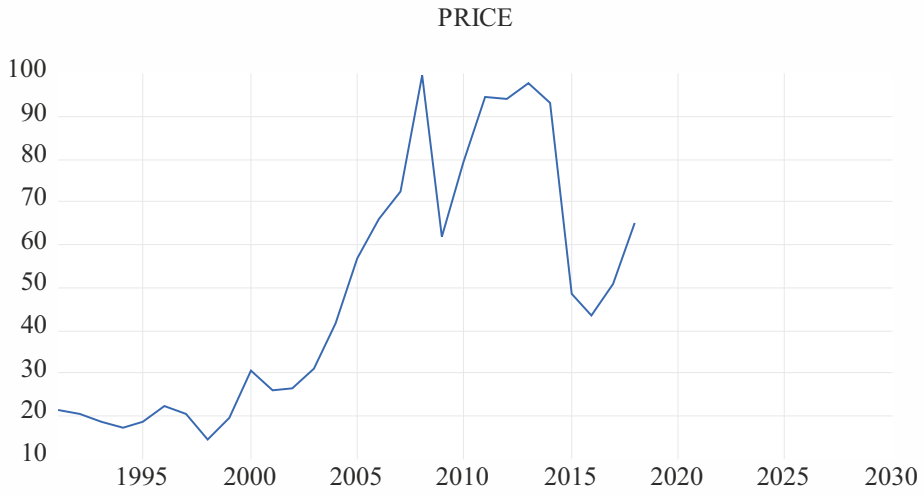
Moving Average (MA) Model

An added general approach for the representation of any time-series data or econometrics model is commonly known as a Moving Average (MA) model as mentioned below:

$$Y_t = \partial + A_t - \beta_1 A_{t-1} - \beta_2 A_{t-2} - \cdots - \beta_q A_{t-q}$$

Where Yt is the time series, ∝is the mean of the series, At i are white noise terms, and 1,…, q are the considerable constraints and parameters of the mathematical model. In this model, the value of q is known as the array of the MA (Moving Average) model.

Fig - 2



HYPOTHESIS TESTING FOR RESIDUALS (DIAGNOSIS TESTING)

H0: Residual (Price) has unit roots

H1: Residual (Price) is stationary

Table - 1

Particulars		**t-Statistic**	**Prob.***
Augmented Dickey-Fuller test statistic		-1.395289	0.5696
Test critical values:	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation

Table - 2

Particulars		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.226185	0.0003
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

*MacKinnon (1996) one-sided p-values.
Augmented Dickey-Fuller Test Equation

Analysis

As per results, it is evident that our null hypothesis for diagnosis of residual (price) was accepted as residual contained unit root at level as shown in table 1 but later on by applying same Augmented Dicky-Fuller Test concerned residual is found to be significant for further analysis of data as shown in table 2.

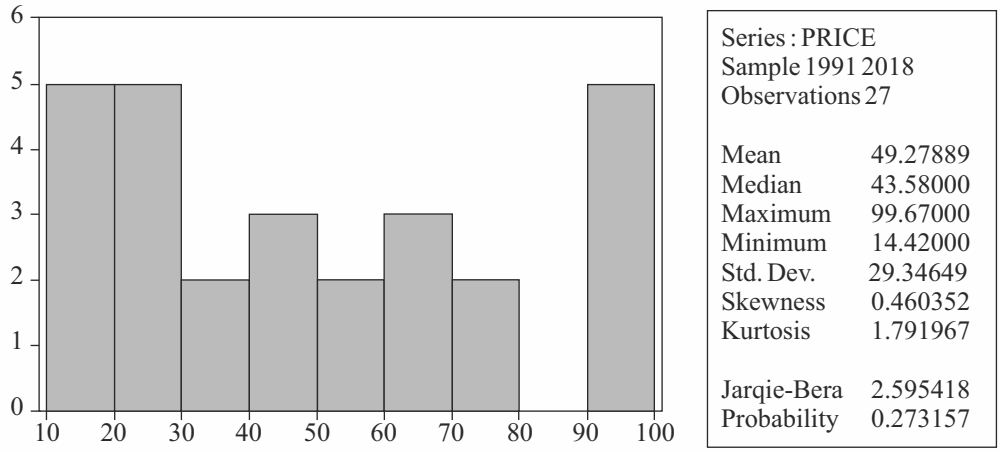
Results clearly showing 0.0003 to be rejected at a 5% level of significance; hence our null hypothesis can't be accepted which is desired for further analysis of data to conclude.

Hypothesis testing for residuals (diagnosis testing)

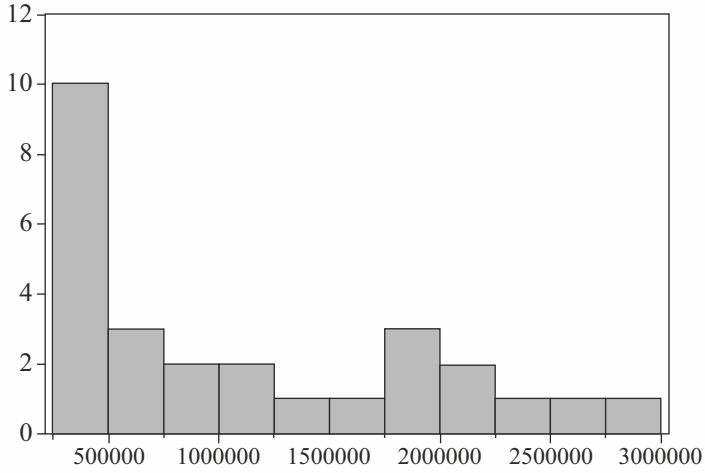
H0: Price is normally distributed

H1: GDP is not normally distributed

Graph - 1



Graph - 2



Analysis

According to our model as depicted in Fig1(Box-Jenkins approach of forecasting) it is further suggested to carry out normality test for our residuals (price and GDP) in order to analyze and predict accuracy of results, we applied Jarque- Bera test and found data appropriately fit for applying forecasting test ARIMA ,as shown in Graph 1 and Graph 2 where probabilities are found to be greater than 5 % level of significance, hence our null hypothesis is accepted that residuals are normally distributed, accepted to carry out further tests and forecasting by applying ARIMA.

Table – 3

Method: Least Squares
Sample (adjusted): 1991 2017 (Actual 1991 to 2018)
Included observations: 27 after adjustments

Variable	**Coefficient**	**Std. Error**	**t-StatisticProb.**
PRICE	18824.69	3979.306	4.7306450.0001
C	206459.8	227124.9	0.9090140.3720
R-squared	0.472340	Mean dependent var	1134119.
Adjusted R-squared	0.451234	S.D. dependent var	803815.7
S.E. of regression	595456.7	Akaike info criterion	29.50323
Sum squared resid	8.86E+12	Schwarz criterion	29.59922
Log likelihood	-396.2936	Hannan-Quinn criter.	29.53177
F-statistic	22.37900		
Prob (F-statistic)	0.000075		

Furthermore, to find out relationship between residuals, researchers have conducted Least Square Test and found some noticeable results as per table 3 that our residuals (Price & GDP) are significant and found to appropriately related as per R- Squared value is concerned i.e. approximately more than 47 %, although little deviation from recommended values. The deviation is found in R-Squared since oil prices are taken internationally and compared with the dependent variable GDP of India.

But researchers believe that it has nothing or very minor impact (almost negligible) on forecasting ARIMA.

Hypothesis testing for residuals (diagnosis testing)

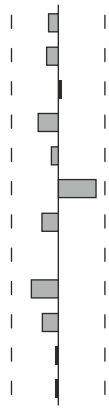
H0: There is no serial correlation amongst residuals

H1: There is serial correlation amongst residuals

Table - 4

Auto correlation function at first difference

Sample : 1991 2018
Included observations : 27

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.076	-0.076	0.1758	0.675
		2	-0.088	-0.095	0.4209	0.810
		3	0.009	-0.006	0.4237	0.935
		4	-0.170	-0.181	1.4133	0.842
		5	-0.063	-0.097	1.5546	0.907
		6	0.306	0.272	5.0520	0.537
		7	-0.126	-0.108	5.6701	0.579
		8	-0.003	-0.002	5.6706	0.684
		9	-0.218	-0.289	7.7432	0.560
		10	-0.119	-0.072	8.4005	0.590
		11	-0.012	-0.077	8.4077	0.676
		12	-0.011	-0.164	8.4145	0.752

Initially researchers analyzed results in two parts , first part residuals were partially correlated therefore at level null hypothesis was rejected, which was not desired at 5 % level of significance and then it was analyzed at first difference with the help of statistical data and found appropriate to apply Box- Jenkins model of forecasting ARIMA as per Table 4.

Table – 5

Automatic ARIMA Forecasting

Selected dependent variable: DLOG(PRICE)

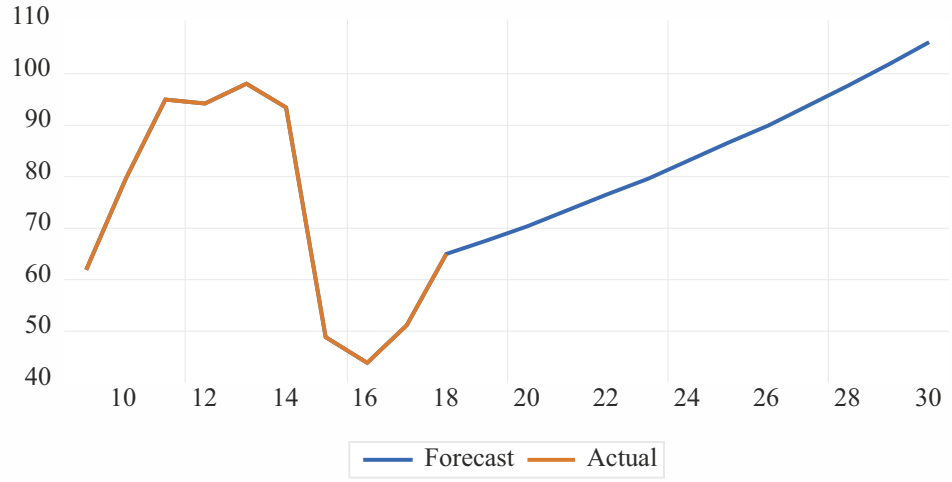
Included observations: 27

Forecast length: 12 Years from 2018

Number of estimated ARMA models	:	25
Number of non-converged estimations	:	0
Selected ARMA model	:	(0,0)(0,0)
AIC value	:	0.186932

Graph - 3

Actual and Forecast



Graph - 4

Forecast Comparison Graph

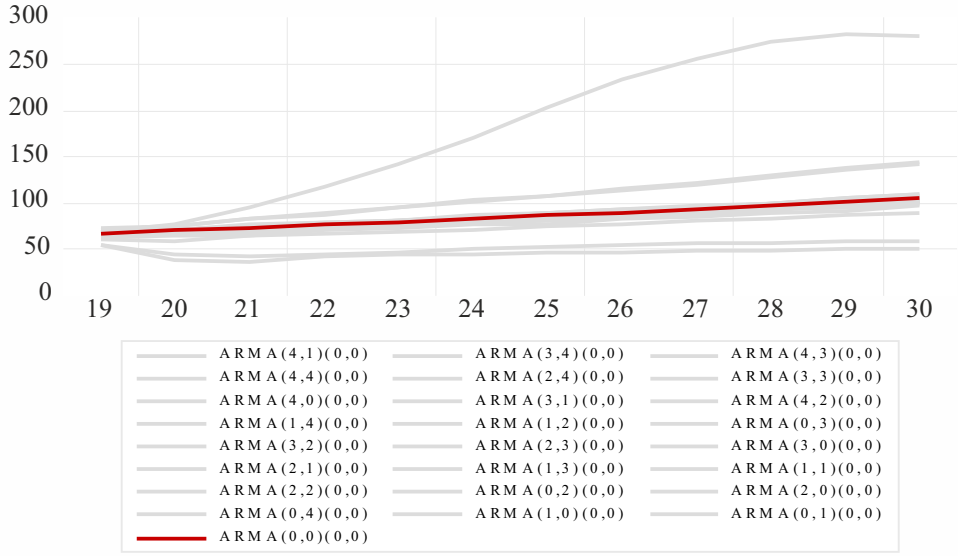


Table – 6

Model Selection Criteria Table
Dependent Variable:
DLOG(PRICE)
Sample: 1991 2018
Included observations: 27

Model	LogL	AIC*	BIC	HQ
(0,0)(0,0)	-0.523581	0.186932	0.282920	0.215474**
(0,1)(0,0)	-0.468527	0.256928	0.400910	0.299741
(1,0)(0,0)	-0.494591	0.258859	0.402841	0.301672
(0,4)(0,0)	2.314450	0.273004	0.560967	0.358630
(2,0)(0,0)	0.279641	0.275582	0.467558	0.332667
(0,2)(0,0)	0.222841	0.279790	0.471765	0.336874
(2,2)(0,0)	1.812026	0.310220	0.598184	0.395847
(1,1)(0,0)	-0.224898	0.312955	0.504931	0.370040
(1,3)(0,0)	1.482068	0.334662	0.622625	0.420288
(2,1)(0,0)	0.297328	0.348346	0.588316	0.419702
(3,0)(0,0)	0.295449	0.348485	0.588455	0.419841
(2,3)(0,0)	2.267772	0.350535	0.686493	0.450433
(3,2)(0,0)	2.255665	0.351432	0.687390	0.451330
(0,3)(0,0)	0.233278	0.353091	0.593060	0.424446
(1,2)(0,0)	0.228568	0.353439	0.593409	0.424795
(1,4)(0,0)	2.122210	0.361318	0.697275	0.461216
(4,2)(0,0)	2.705844	0.392160	0.776111	0.506329
(3,1)(0,0)	0.494753	0.407796	0.695760	0.493423
(4,0)(0,0)	0.300213	0.422206	0.710170	0.507833
(3,3)(0,0)	2.269140	0.424508	0.808460	0.538677
(2,4)(0,0)	2.268501	0.424556	0.808507	0.538724
(4,4)(0,0)	4.015068	0.443328	0.923268	0.586039
(4,3)(0,0)	2.916079	0.450661	0.882606	0.579101
(3,4)(0,0)	2.886358	0.452862	0.884808	0.581302
(4,1)(0,0)	0.300560	0.496255	0.832213	0.596153

Analysis

Our major concern was to forecast crude oil prices internationally, and researchers truly focused on historical trends of crude oil prices as depicted in Graph 3.

As per Table 5 researchers have selected Price as a dependent variable and forecast for the period of 12 years up to 2030 our selected analysis from 1991 to 2018.

Furthermore, it has been found sharp increase in crude oil prices internationally as per forecasting through the model of ARIMA as shown in Graph 3, where it is crystal clear that on account of previous ups and downs crude oil prices foresee a smooth rising trend from 2018 to 2030 i.e. forecasting length of 12 years post 2018.

Also model selection criteria Table 6 where various models were formed and the best one (0,0)(0,0) with its logL value -0.523581 and AIC value (The Akaike Information Criteria (AIC) which is one of mainly and widely used measures of a statistical model of forecasting ARIMA as per Box-Jenkins model) 0.186932 selected.

CONCLUSION

During our research, we have found that crude oil prices have been too volatile that not only affected the economy as a whole but also affected the Indian economy time by time as depicted and analyzed in our empirical research. The price movements have never been static and fluctuated throughout the period as monitored and analyzed during forecasting by applying the ARIMA model, for that different hypotheses were formed and made suitable data by diagnostic of residuals (price and GDP) as a part of our study and research.

Since our entire study and research revolved around crude oil prices post-liberalization from the period of 1991-2018, we have applied the Box-Jenkins Model of ARIMA and based on that forecasting was done as far as crude oil prices were concerned and also elaborated its impact on the Indian economy.

Rising in crude oil prices unfavorably affecting the economy and denting its overall growth prospects considering into account all the above-mentioned factors during our research. The majority of all Indian industries need crude oil for its industrial as well as business requirements for the production of its end product thus raise in crude oil increases their key and major costs and decreases therefore margins. Therefore some of the sectors getting negatively impacted would be Tyre, Paints, Plastics, Airlines and of course oil & Lubricants, etc. The effectiveness of these Industries has to be adversely affected due to increase in input costs.

On the other hand, researchers carefully monitored before doing forecasting in this paper that the oil exploration companies stand to have gained out of it. The stock markets, the country's one of the major trade and industry revitalization barometers to deteriorate owing to negative impacts on the Indian financial system due to rising crude oil prices. As noticed and monitored by eminent researchers Faisal, A. K. (2018) that the midcaps and small caps are the most terribly hit as they must encounter so many problems passing on the input costs to the end-users. The economic revitalization as well revival, therefore, would be very delicate with ever-increasing CAD (Current Account Deficit), weakening down Indian rupee and rising continuous fiscal deficits.

During analysis, significant results were found with the help of various figures and graphs depicted aforementioned. Researchers faced some complexities during the diagnosis of residuals to test unit roots at a level for further application of actual tests which were desired for applying the ARIMA model of forecasting.

Bypassing through researchers have applied their best expertise skills and knowledge by showing the best suitable model of ARIMA and also predicted expected future prices that move upward in various above mentioned graphs and figures.

LIMITATION AND FURTHER SCOPE OF THE STUDY

Many different versions, tests, and experiments have been left for the future due to paucity of time (i.e. the experiments with real data are usually very strenuous and time taking, needful sundry hours to complete a single run). Prospect effort concerns a thorough analysis of particular tools, new proposals to try different methods.

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