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FORECASTING NATURAL GAS SPOT PRICES USING TIME SERIES SEASONAL AUTOREGRESSIVE INTEGRATED MOVING AVERAGE MODEL

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ABSTRACT
Natural gas is a flammable gas, consisting mainly of methane (CH4), occurring in underground reservoirs often with oil. Natural gas is mostly used for domestic or industrial heating and to generate electricity, a spot price is the current price in the market place at which a given asset such as a security, commodity or currency can be bought or sold for immediate delivery Spot prices tend to be subject to extreme volatility. While the spot price of security, commodity or currency is important in terms of immediate buy and sells transactions, it perhaps has more importance in regard to the multi-trillion-dollar derivatives markets. Hence, forecasting spot price of a natural gas is focused in this paper.

KEYWORDS
SARIMA, natural gas, forecasting.

JEL CODES
C50, C53.

INTRODUCTION
Commodity refers to any good that possesses a physical attribute. It is a thing of value, with uniform quality, produced by different producers, but will be considered equivalent. The commodity can be produced by different producers, but will still be considered equivalent. Commodities are frequently used as inputs in the production of the other goods or services.

Natural gas is a flammable gas, consisting mainly of methane (CH4), occurring in underground reservoirs often with oil. It was formed millions of years ago when dead marine organisms sunk to the bottom of the ocean and were buried under deposits of sedimentary rock. Subject to intense heat and pressure, these organisms underwent a transformation in which they were converted to a gas over millions of years.

Natural gas is found in underground rocks called reserviors. The rocks have tiny spaces in them (called pores)that allow them to hold water, natural gas and oil. The natural gas is trapped underground by impermeable rock (called caprock), and stays there until it is extracted.

Conventional natural gas can be extracted through drilling wells. Unconventional forms of natural gas like shale gas, tight gas, sour gas, coalbed methane and gas hydrates have specific extraction techniques.

Natural gas can also be found in reservoirs with oil and is extracted alongside oil, and this is called associated gas. In the past, this gas was commonly flared or burned as a waste product but in most places today it is captured and used.

There are two general types of natural gas, defined by their methane content, that reflect differences in the formation processes:
- Biogenic gas
- Thermo genic gas

Biogenic gas, or ‘dry’ gas, which was formed by bacterial decay at shallow depth.

Thermo genic gas, or ‘wet’ gas, which is a lower quality gas formed at high temperatures. Wet gas on the other hand contains compounds such as ethane and butane, in addition to methane.

These natural gas liquids can be separated and sold individually for various uses, such as refrigerants and to produce petrochemical products, like plastic.

Natural gas is mostly used for domestic or industrial heating and to generate electricity. It can also be compressed and used to fuel vehicles and as a feedstock for fertilizers, hydrogen fuel cells and other chemical processes

SPOT PRICE
A spot price is the current price in the market place at which a given asset such as a security, commodity or currency can be bought or sold for immediate delivery. While spot prices are specific to both time and place, in a global economy the spot price of most securities or commodities tends to be fairly uniform worldwide. In contrast to spot price, a security, commodity or currency’s futures price is its expected value at a specified future time and place.

BREAKING DOWN SPOT PRICE
In financial markets, spot prices are most frequently referenced in relation to the price of commodity futures contracts, such as contracts for oil, wheat or gold.

A futures contract price is commonly determined using the spot price of a commodity, expected changes in supply and demand, the risk-free rate of return for the holder of the commodity, and the costs of transportation or storage in relation to the maturity date of the contract. Futures contracts with longer times to maturity normally entail greater storage costs than contract with nearby expiration dates.

Spot prices tend to be subject to extreme volatility. While the spot price of security, commodity or currency is important in terms of immediate buy and sells transactions, it perhaps has more importance in regard to the multi-trillion-dollar derivatives markets.

Options, futures contracts and other derivatives allow buyers and sellers of securities or commodities to lock in a specific price for a future time when they expect to make a transaction. Through derivatives, buyers and sellers can partially mitigate the risk posed by constantly fluctuating spot price.

Future contracts also provide an important means for producers of agricultural commodities to hedge the value of their crops against future price fluctuation.

THE RELATIONSHIP BETWEEN SPOT PRICES AND FUTURES PRICES

The difference between spot prices and future contract prices is usually significant. The most common relationship between spot prices and future prices, referred to as a normal market, is one where futures contract prices are increasingly higher over time as compared to the current spot price. The higher futures prices reflect carrying costs such as storage, the additional risk posed by the uncertainty of future supply and demand conditions in the market place, and the fact that prices for goods generally tend to increase over time.

In an inverted market, futures prices decrease in comparison with the current spot price. Inverted markets are most frequently caused by extreme demand pressures in the current market place that enable sellers to command premium prices for immediate sale and delivery

COMMODITY MARKETS

Every commodity that is produced (or grown) must eventually come to a market where it can be bought and sold. It is in this market place that all the elements of commerce will come together to settle a price at which the commodity will get traded. The market where a commodity is traded can be either the spot market or the forward market or futures market. The spot price or spot rate of a commodity is the price that is quoted in the physical market for immediate or spot settlement. Spot settlement is normally one or two business days from trade date. This is in contrast with the forward price establishment in a forward contract or future contract, where contract terms (price) are set now, but delivery and payment will occur at a future date.

Hence, forecasting spot price of a natural gas is focused in this paper.

REVIEW OF LITERATURE

John T. Cuddington · Zhongmin Wang (2006)this paper talks about the daily spot prices at seventy six market locations to examine the geographical extent of the market the speed with which forces will the prices to equilibrium during price shocks. They found east and central regions form a highly integrated market.

JC Cuaresma, J Hlouskova, S Kossmeier (2004)they studied forecasting abilities of univariate model on early electricity spot prices The results show that specifications, where each hour of the day is modelled separately present uniformly better forecasting properties than specifications for the whole time-series, simply inclusion of probability of extreme price events can lead to improvements in forecasting abilities.

SJ Koopman, M Ooms (2007) the daily prices are very persistent the Nord Pool power exchange of Norway are effectively modelled The daily log prices of the other three electricity markets—EEX in Germany, Powernext in France, and APX in The Netherlands—are less persistent, but periodicity is also highly significant. The dynamic behaviour differs from market to market and depends primarily on the method of power generation: hydro power, power generated from fossil fuels, or nuclear power.

Arthur S.De Vany, W.DavidWalls (1991) estimate a vector error correction model using peak and off-peak electricity spot prices during 1994–1996 covering 11 regional markets in the western United States and test these prices for evidence of market integration. The results show evidence of an efficient and stable wholesale power market.

Kalok Chan Y. Peter Chung (1993) author examines the intraday relationship among cash and future volatility, and cash trading voume, arbitrage spread changes in the spread have a significant impact on cash and futures price volatility as well as on cash trading volume. The impact of the spread, however, is attenuated by the short-sale restriction in the cash market. Contrary to popular beliefs, a more volatile market leads to subsequent *decreases* in the spread,

OBJECTIVES

1. To develop time series model to study the behaviour of spot price over the years 2014-2017.
2. To predict the spot price for the future years using the best fitted time series model

METHODOLOGY ADOPTED

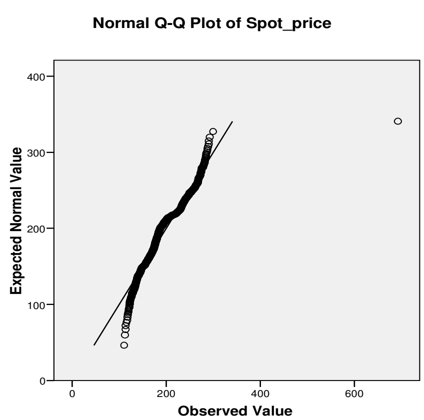
The study is mainly analytical and descriptive in nature, the secondary data has been collected from MCX website, seasonal autoregressive integrated moving average (SARIMA) model has been used to fit the Data and forecasting spot price by using the fitted model.

ANALYSIS AND DISCUSSION

Normality Assumption

To check for normality of the spot price the Q – Q plot is used.

GRAPH 1

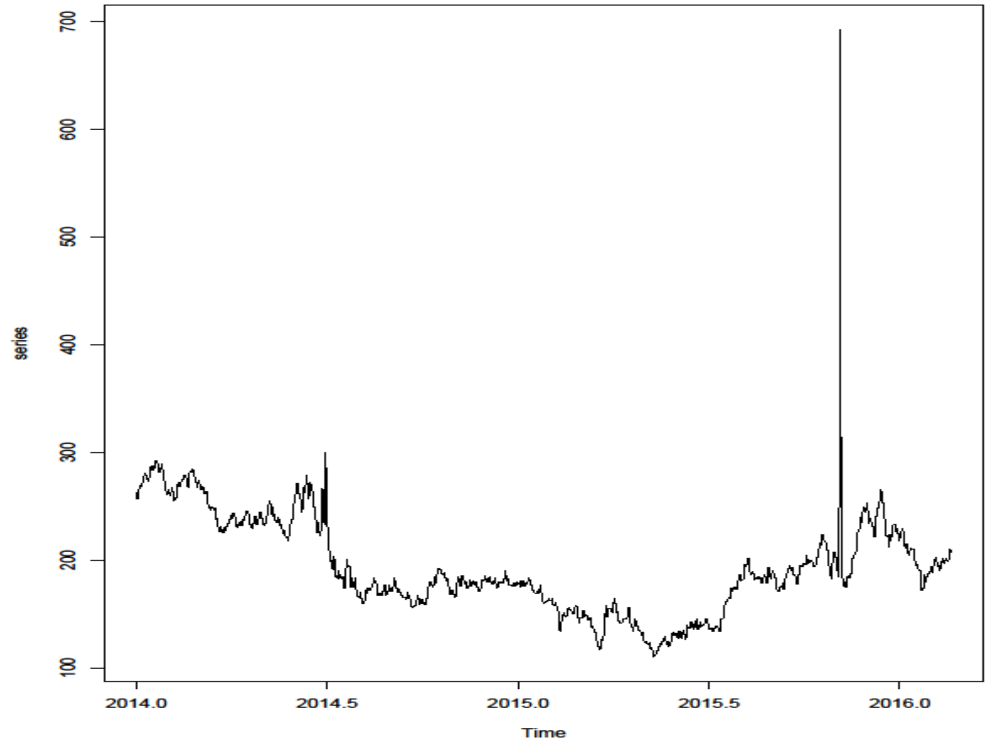


Comment: Since most of the observations lie along straight line, it indicates normality

PLOT OF SPOT PRICE VERSUS DATE

Comment: From the graph we observe that price varies differently over time hence the series is not stationary

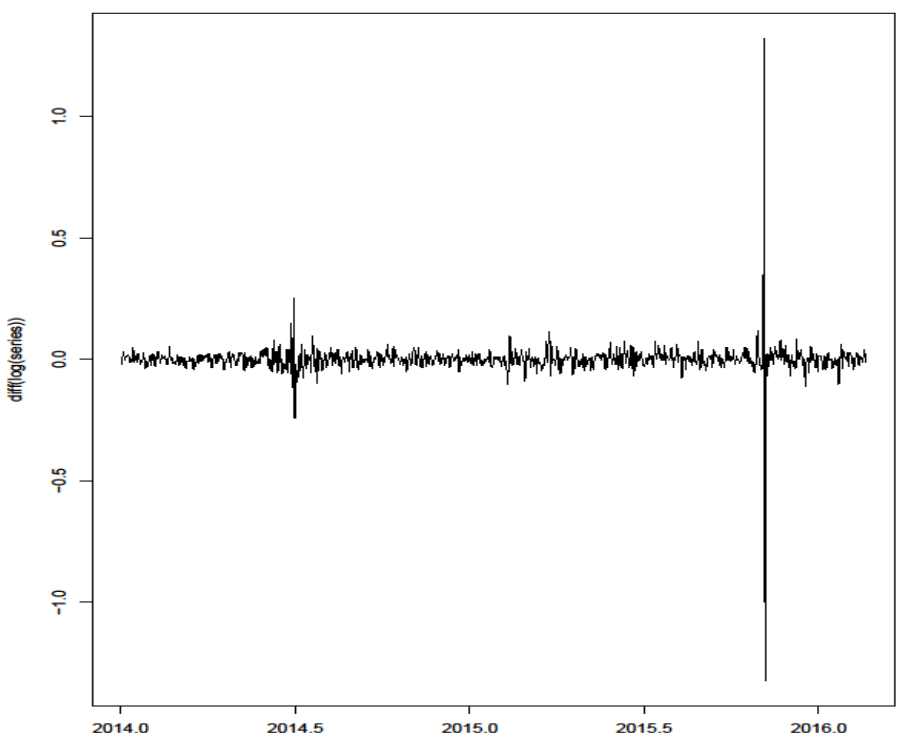
GRAPH 2



Comment: From the graph we observe that price varies differently over time hence the series is not stationary

PLOT OF DIFF [LOG(SERIES)] VERSUS DATE

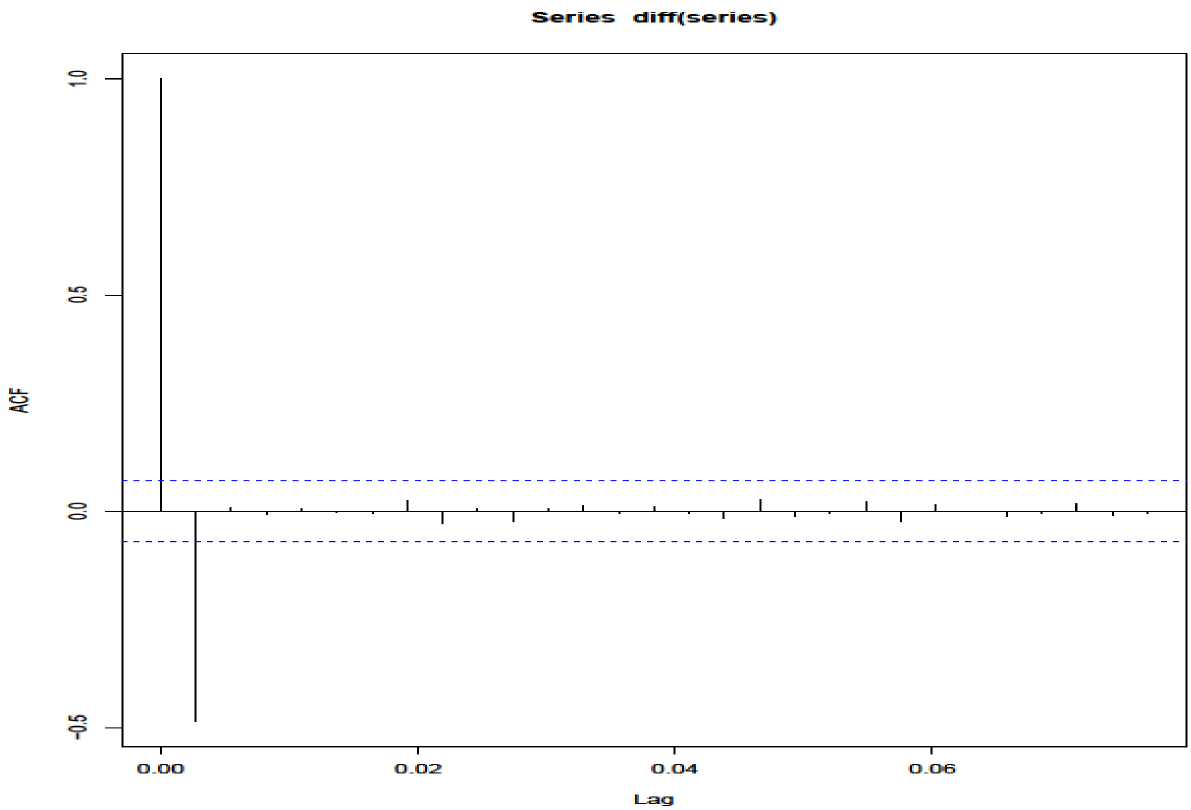
GRAPH 3



Comment: Since the time series plot is not stationary we have transformed the observations by taking log transformation and then by taking the difference of the transformed observations. Now the series is stationary.

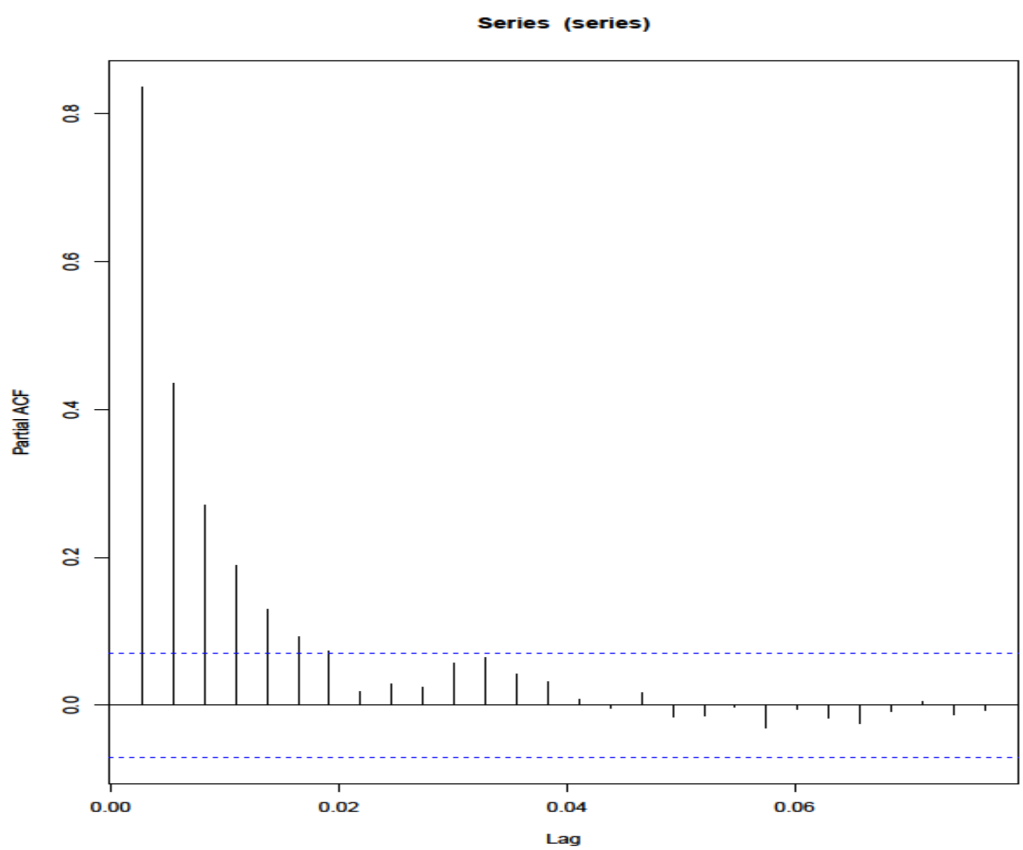
ACF PLOT

GRAPH 4



PACF PLOT

GRAPH 5



Comment: From differenced data ACF and PACF can be observed that after differencing once ACF and PACF declines exponentially but not at a gradual rate, thus the seasonal component is removed and the process becomes stationary

TABLE 1: ESTIMATION AND MODEL ADEQUACY

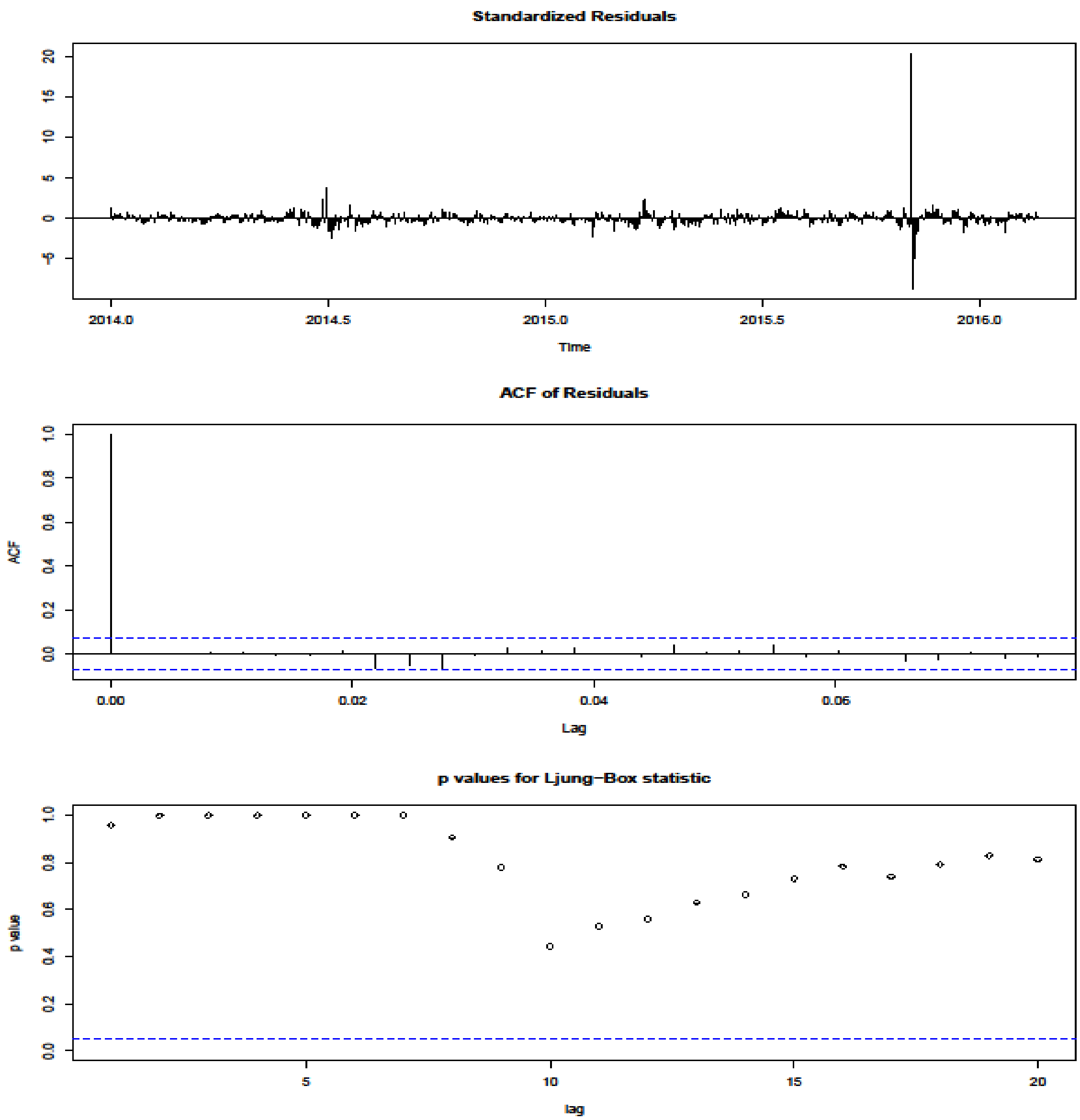
(p,d,q)	Coefficients	Standard error	AIC Value	Sigma square
(1,0,3)	**0.9932**	0.0040	0.004065	-2065.67
	-0.5486	0.0361		
	0.0068	0.0415		
	-0.0143	0.0374		
	5.2789	0.1171		
(2,0,3)	**0.5579**	1.3686	0.004065	-2063.64
	0.4322	1.3586		
	-0.1492	1.3696		
	-0.2494	0.8098		
	-0.0107	0.0424		
	5.2968	0.1198		
(2,0,2)	**0.3301**	0.0897	0.004066	-2065.55
	0.6583	0.0998		
	0.0772	0.1058		
	-0.3851	0.1165		
	5.2967	0.1171		

Comment: Based on the estimation and model selection criterion AIC values are compared and the model with least AIC value is preferred

Diagnostic checks

Diagnostic plots of the model (1,0,3)

GRAPH 6

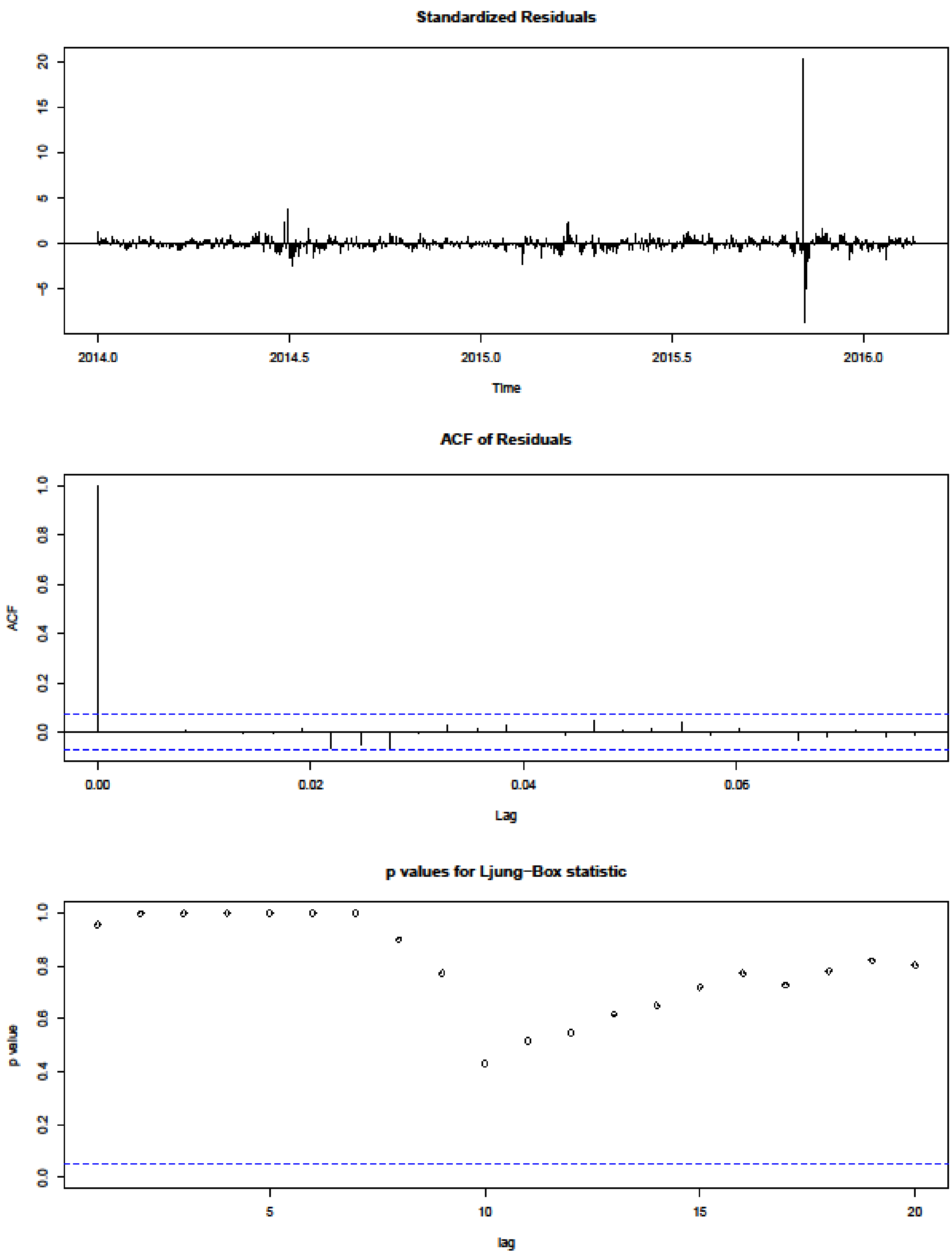


Comment: From the ACF of residuals for fitted model, we observed that none of the lag coefficients are significant (the points doesn't fall outside the boundary) also from the p values for Ljung-Box statistic, we conclude that the auto correlation coefficients of the residuals is significant. Hence we conclude that the residuals follow white noise process and hence the fitted model is appropriate.

Diagnostic checks

Diagnostic plots of the model (2,0,3)

GRAPH 7

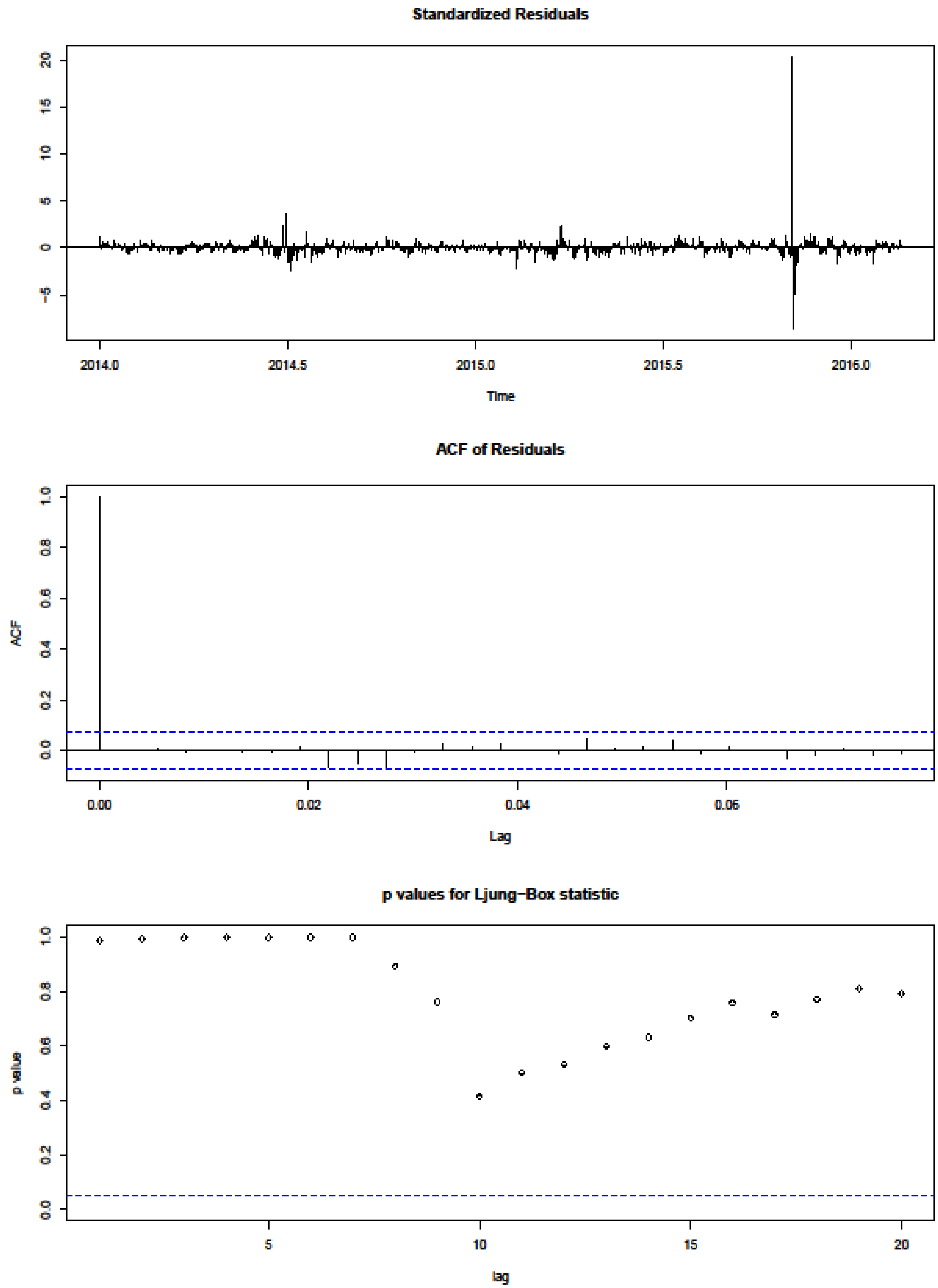


Comment: From the ACF of residuals for fitted model, we observed that none of the lag coefficients are significant (the points doesn't fall outside the boundary) also from the p values for Ljung-Box statistic, we conclude that the auto correlation coefficients of the residuals is significant. Hence we conclude that the residuals follow white noise process and hence the fitted model is appropriate.

Diagnostic checks

Diagnostic plots of the model (2,0,2)

GRAPH 8



Comment: From the ACF of residuals for fitted model, we observed that none of the lag coefficients are significant (the points doesn't fall outside the boundary) also from the p values for Ljung-Box statistic, we conclude that the auto correlation coefficients of the residuals is significant. Hence we conclude that the residuals follow white noise process and hence the fitted model is appropriate.

TABLE 2: FORECAST VALUES OF SPOT PRICE FOR FITTED MODEL (1,0,3) FROM 1/4/2017 TO 20/4/2017

Date	Spot Price(Rs)
1/4/2017	205.2206
2/4/2017	205.0386
3/4/2017	204.9316
4/4/2017	204.8696
5/4/2017	204.8081
6/4/2017	204.7470
7/4/2017	204.6864
8/4/2017	204.6262
9/4/2017	204.5664
10/4/2017	204.5070
11/4/2017	204.4481
12/4/2017	204.3895
13/4/2017	204.3314
14/4/2017	204.2737
15/4/2017	204.2164
16/4/2017	204.1595
17/4/2017	204.1031
18/4/2017	204.0470
19/4/2017	203.9913
20/4/2017	203.9360

CONCLUSIONS

From ACF and PACF of the data we conclude that ARIMA model is to be fitted for data.

Several potential models were fitted and compared based on AIC, sigma square, standard error of the estimates and Ljung – Box statistic. Comparing the AIC values we observe that it is least for ARIMA model (1,0,3).In view of all these potential models we can conclude that the ARIMA (1, 0, 3) model is best fitted model for the given data and useful for forecasting the future values using given data.

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