

Multivariate Time Series Modelling Of Ex-Pump Prices Of Petroleum Products In Ghana

Chapter 4: Results and Discussions

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Objective

The purpose of the study is to obtain a suitable model for the ex-pump prices of petroleum products in Ghana.

To examines how changes in the prices of one product cause changes in the price of others in both the short and long terms.

Data spanning January, 2007 to June, 2015 are obtained from the National Petroleum Authority of Ghana, covering four petroleum products; Gasoline, Gasoil, Kerosene, and Liquefied Petroleum Gas (LPG) .



Chapter 4: Result And Discussion

This chapter analyses and discusses the results. It presents results of the association between the prices of the products considered, namely;

- Gasoil

- Gasolin

- Kerosene

- Liquefied Petroleum Gas (LPG)

All associated tests and models are generated with R



Start Up

- ◇ Plotting and Descriptive Statistics
- ◇ Stationarity Test
- ◇ Differencing If Not Stationary
- ◇ Plotting of ACF and PACF



Estimation Of Model

- ◇ Lag Length Selection (LLS)
- ◇ Cointegration Test
- ◇ Long Term Equilibrium
- ◇ Short Term Equilibrium
- ◇ Estimation of VEC Model (If There is cointegration)
- ◇ Model Validation
- ◇ Forecast of Ex-Pump prices of Products



Descriptive Statistics

In all, 204 observations are used (January, 2007 to June, 2015).

Training data of 144 observations (January 2007 to December 2012) for modelling

Testing data of 60 data points (January 2013 to June 2015) for model validations.

The descriptive statistics of the products are shown in Table 1 on page 8



Summary Statistics

Table: 1 Summary Statistics

Statistics	GASOIL	GASOLINE	KEROSENE	LPG
Mean	122.445	123.570	82.989	94.766
Maximum	175.480	177.090	120.420	136.190
Minimum	11.600	49.170	6.470	58.500
Standard Deviation	32.306	31.817	27.186	20.609
Skewness	-0.201	0.1307	-1.988	0.413
Kurtosis	3.374	2.123	6.293	2.292
Number of Observations	144	144	144	144



Plot of Original Series

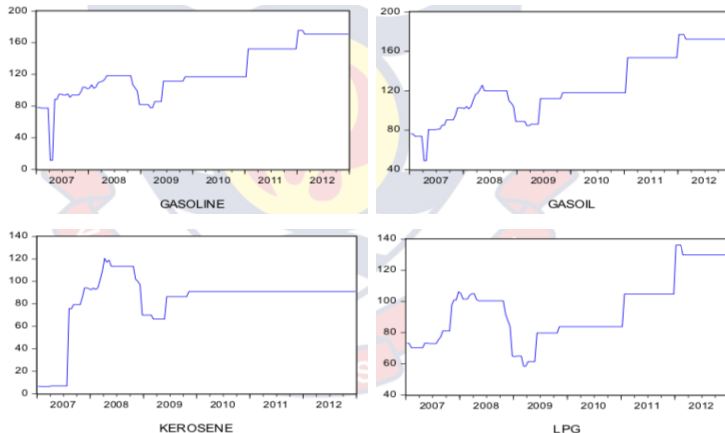


Figure: 1 Time Series Plot of the Original Series



Stationarity Test

We have numerous ways of testing for the presence of a unit root. We have chosen to apply

Augmented Dickey-Fuller Test

H0 : The series is not stationary

H1 : The series is stationary.

Phillips-Perron Unit Root Test

H0 : The series is not stationary

H1 : The series is stationary.

KPSS Test for Level Stationarity

H0 : The series is stationary

H1 : The series is not stationary.

Stationarity of Original Series

Table: 2 Univariate URTs of the Original Series

SERIES	LAG ORDER	(Test Statistics)		(P-Values)	
		ADF	KPSS	ADF	KPSS
GASOLINE	5	-2.738	2.370	0.269	0.010
GASOIL	5	-2.450	2.437	0.389	0.010
KEROSENE	5	-3.106	0.709	0.166	0.010
LPG	5	-1.975	1.497	0.587	0.010

Is Stationary ?

It is observed that for ADF, all the p-values of the series are greater than 0.05 and this indicates non stationarity. The KPSS test also showed the same results. We now difference the series since the series are not stationary.

First Difference

Since all the series (Gasoline, Gasoil, Kerosene, LPG) are not stationary we perform 1st differencing in order to achieve stationarity; The figure 2 below is a plot after the first differencing .



Plot of First Differenced Series



Figure: 2 Time Series Plot of the Original Series



Stationarity of First Differenced Series

Table: 3 Univariate URTs of the Differenced Series

SERIES	LAG ORDER	(Test Statistics)		(P-Values)	
		ADF	KPSS	ADF	KPSS
GASOLINE	5	-7.781	0.031	0.010	0.10
GASOIL	5	-5.537	0.045	0.010	0.10
KEROSENE	5	-4.493	0.263	0.010	0.10
LPG	5	-4.473	0.063	0.010	0.10

Is Stationary ?

It is observed that for ADF, all the p-values of the series are less than 0.05 and this indicates the stationarity. The KPSS test also showed the same results. We now estimate the models since the series have attained stationarity.

ACF Plot of First Differenced Series

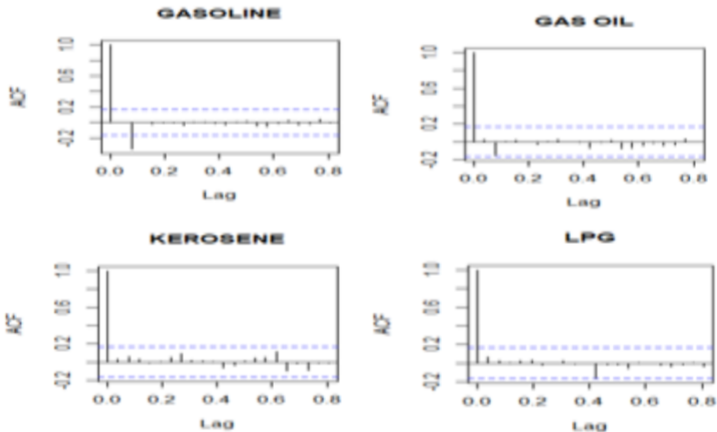


Figure: 3 ACF of the Differenced Series



PACF Plot of First Differenced Series

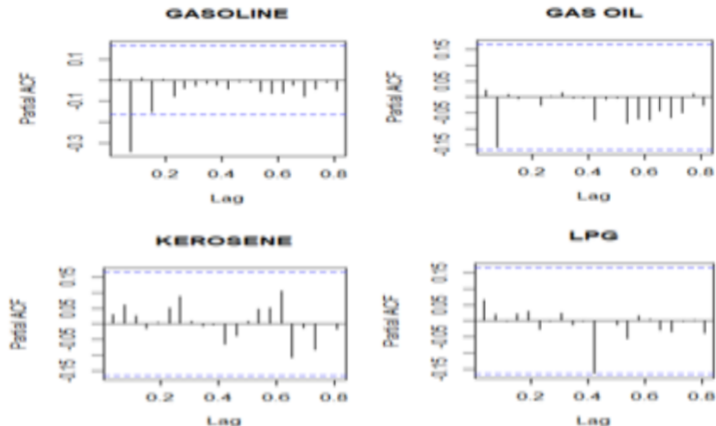


Figure: 4 PACF of the Differenced Series



What Next After Series is Stationary ?

Estimation of VAR/ VEC Models

- ◇ Lag Length Selection (LLS)
- ◇ Cointegration Test
- ◇ Long Term Equilibrium
- ◇ Short Term Equilibrium
- ◇ Estimation of VEC Model (If There is cointegration)
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Estimation of VAR/ VEC Models

Estimating parameters of **Vector Autorelation** (VAR) or **Vector Error Correlation** (VEC) models require that variables are covariance stationary

VAR for instance cannot be used if the variables are not stationary. Also, if the data is non-stationary, the forecast cannot be done because **VAR assumes stationarity**

We then test for the long run relationship using **Johansen's cointegration test**.

That is if the result confirms that there is a long-run relationship among the variables, we can proceed to the VEC model.

The first step involved in estimating is to first determine the lag Length or order.

Lag Length Selection (LLS) Criteria

LLS is significant for VAR/VEC models since selecting too few intervals to result in a cointegrated error and selecting too many intervals may lead to unnecessary loss of degrees of freedom

Three of the LLS criteria are used, namely ;

FPE (Final Prediction Error)

AIC (Akaike Information Criterion)

BIC (Bayesian Information Criterion), aka SC (Schwarz Criterion)

FPE, AIC, and BIC support the inclusion of lag 1 as italicized, and starred in Table 4.



Table: 4 Lag Length Selection Criteria

Lag	FPE	AIC	BIC
0	1.03×10^9	32.107	32.192
1*	117944.1*	23.029*	23.454*
2	127300.7	23.105	23.869
3	142926.7	23.219	24.3224
4	149122.0	23.259	24.701
5	169942.3	23.385	25.167
6	156708.8	23.297	25.419

From Table 4, we can rely on information criteria as only one of these three tests; FPE, AIC, and BIC obtained minimum values at the indicated lag. The test displays **lag 1** as the optimum. Thus, the lag length for the estimation is 1.



What Next After Lag Length Selection

Once the unit roots and lag length selections are determined for a time series data, the next step is to inspect whether there exists a **Cointegration (Long term relationship)** among the variables or not.



Cointegration : Long Term Relationship

Cointegration analysis is important because, if two or more non-stationary variables are cointegrated, a VAR model in the first difference is mis-specified due to the effects of a common trend. The cointegration test determines the type of the regression model to be applied i.e. VAR or VEC

Cointegration Test

H_0 : There is no cointegration equation.

H_1 : There is a cointegration equation

