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MODELLING SRI LANKAN OIL DEMAND: AN ECONOMETRIC APPROACH

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ABSTRACT

This study examines the effect of economic variables, Goss Domestic Product (GDP), Foreign Direct Investment (FDI), Population and Oil Price on oil consumption in Sri Lanka using an Error Correction Model. Yearly data of oil consumption, Goss Domestic Product (GDP), Foreign Direct Investment (FDI), Sri Lankan population and crude oil price during the period 1988 – 2013 were used in the analysis. All the data have been obtained by the online data sources of World Bank and United States energy information administration. This research involves estimating the elasticity of Goss Domestic Product (GDP), Foreign Direct Investment (FDI), Sri Lankan population and crude oil price on crude oil consumption in Sri Lanka.

Unit root test confirmed that series are not stationary in its levels but they are stationary in first difference. Therefore the study uses the Engle-Ganger cointegration method to create a dynamic short run model. Also Chow - break point test was used to test the significance of a structural break down in the data set and the dummy variable was significant in allowing for the structural change.

The Vector Error Correction (VEC) model finds that Goss Domestic Product (GDP), Foreign Direct Investment (FDI), population and oil price are determinants of the oil demand. It shows that in the long run only FDI increases the overall oil demand while GDP and population increase the oil demand in the short run.

By using the selected model, oil demand was forecasted and the Mean Absolute Percentage Error (MAPE) of the fitted model was found less than 5 percent. Therefore the fitted model is recommended as the suitable model to forecast oil demand. As the crude oil storage is a common problem in Sri Lanka, forecasting oil demand can be used to find the solutions for the challenges in the petroleum sector.

Key words: Crude oil, Demand, Determinants, Petroleum Sector, Sri Lanka

1.Introduction

Crude oil is considered as an unrefined oil product composed of organic compound which consists of different organic materials. Crude oil is used to refine usable products like hydrocarbon, solvents, gasoline, kerosene, diesel and various kinds of petrochemicals. It is an unrenewable resource, which implies that it cannot be replaced naturally at the speed of consumption. Hence it is considered as a limited resource.

Global crude oil demand is around 90 million barrels per day (Mbd), from that 50% is consumed by the countries who are members of Organization for Economic Corporation and Development (OECD) [16]. Sri Lanka's crude oil consumption is very small compared with the world demand. Sri Lanka has been an importer of crude oil for a long time and the country spends 24% of the import price on it. The Ceylon Petroleum Corporation (CPC) has been a monopoly supplier of fossil oil to the native market. However, Lanka Indian Oil Corporation (LIOC) was added to the market to form a duopoly within the fossil oil product distribution in 2003.

Sri Lanka is importing refined products since many years for domestic consumption. Hence the demand of the petroleum products are increasing in both volume and value terms. CPC was ready to meet the overall fossil oil product demand of the country through its solely plant within the nineteen seventies. As the emerging need of crude oil demand, now Sri Lanka depends on foreign refined product sources because the provide capability of the CPC's plant remained as a constant. In 2011 local petroleum demand was 4200 million (Mn) liters per year and from that only one third is provided by local refined imported crude oil. The remaining amount is imported as refined products. Consequently the country is spending a large amount of money for importing crude oil products. From 2009- 2011 the petroleum bill has more than doubled. If the trend keeps on continuing like this we have to arrange a considerable proportion of resources to import crude oil.

Currently Sri Lanka is facing for several challenges in petroleum industry. Among them uncertainty of supply due to current tension in the middle east and diversification of the resources due to technological issues are main concerns. The recent crude oil crisis in Sri Lanka is also attributed to the limited supply of crude oil. Although we have a duopoly market for crude oil in Sri Lanka, both are import dependent to a lager extent. Hence the challenges remain the same as the overall demand for crude oil is rapidly increasing.

As in 2011 petroleum accounts for 24% of import bill and 45% of exports. Hence more resources will be required for imports in absolute and relative terms in future (Samaratunga, 2014).

As it is an emerging need to get an idea about the future crude oil demand and also its determinants, the objective of this study is to explore several important factors that cause for Sri Lankan crude oil demand. Also this study aims to forecast the crude oil demand using a suitable model. Hence this thesis comprises a long run and short run models using data from 1988 – 2013. This will have significant policy implications on planning the future Sri Lankan economy and oil demand in Sri Lanka.

2. Materials and methods

2.1 Data Description

In this study Goss Domestic Product (GDP), Foreign Direct Investment (FDI), Sri Lankan population and crude oil price were used to find out the effect on Sri Lankan oil demand. Since problems can occur in the interpretation of variables when they are different units, the log form of the variables have been used for this study.

The oil demand was measured by the consumption of crude oil. The stationary condition of the first difference series was checked using the Augmented - Dickey Fuller test.

Chow - break point test was used to test the significance of a structural break down in the data set. Hence a dummy variable was used to indicate the structural break down. Cointegration was checked with the use of Trace statistic test. The Vector Error Correction Methodology was used to find a model for Sri Lankan crude oil consumption.

Then the stationary condition of the error term of the Vector Error Correction Model was checked using the Augmented - Dickey Fuller unit root test and a residual analysis was carried out to check the validity of the model. Stability of the coefficients of the model is checked by Cusum test. Impulse response function was used to study the dynamic effects of shocks of macroeconomic variables on oil demand. Variance decomposition method was used to evaluate dynamic interactions and strength of casual relations among variables in the system.

All the data have been collected using online resources of World Bank and United States Energy Information Administration. The sample period for this study is 1988 through 2013. The software employed in this research is EViews 8.0. The description of variables used in this research study is given below.

LNCON – Log of Oil Consumption in Sri Lanka

LNGDP –Log ofGross Domestic Product (GDP)

LNFDI –Log ofForeign Direct Investment (FDI)

LNPOP –Log of Sri Lankan Population

LNOILPRICE –Log ofCrude Oil Price

2.2 Stationary Test

The most widely used test to check the stationary condition is the unit root test. The presence of unit root indicates that the data series is non stationary. There are two standard procedures of unit root test namely the Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test. This study has used the Augmented Dickey Fuller (ADF) test to check the stationary condition of the series.

2.2 Vector Error Correction Modeland Cointegration Test

Engle and Granger (1987) point out that a linear combination of two or more non stationary series may be stationary. The stationary combination may be interpreted as the cointegration, or equilibrium relationship between the variables

A Vector Error CorrectionModel (VECM) is a restricted Vector Auto Regression (VAR) model. The Vector Error Correction specification restricts the long run behavior of the endogenous variables to converge to their long run equilibrium relationships and allow the short run dynamics.

The VAR model is a general framework used to describe the dynamic interrelationship among stationary variables. So, the first step in time-series analysis should be to determine whether the levels of the data are stationary. If not, take the first differences of the series and should try again. Usually, if the levels of the time series data are not stationary, the first differences will be.

If the time series are not stationary then the VAR framework needs to be modified to allow consistent estimate of the relationships among the series. The Vector Error Correction (VEC) model is just a special case of the VAR for variables that are stationary in their differences (i.e. I(1)). The Vector Error Correction Model can also take into account any cointegrating relationships among the variables.

Suppose x_t and y_t are I(1) and cointegrated. Then $\in_t$is I(0) in the cointegrating equation

$$y_t = \alpha + \beta x_t + \in_t$$

These equations often are interpreted as long-run or equilibrium relationships between x_t and y_t. A researcher will also be interested in the short-run dynamics - the way that x_t and $y_t$fluctuate around this long-run relationship, as in a business cycle. This is done by estimating an error correction model, which contains first differences of x_t and y_t , their lags, and an error correction term. An Error Correction Model is

$$\Delta y_t = \mu + \gamma_1 \Delta y_{t-1} + \cdots + \gamma_p \Delta y_{t-p} + \omega_1 \Delta x_{t-1} + \cdots + \omega_r \Delta x_{t-r} + \lambda EC_{t-1} + u_t$$

where $\mu, \gamma_i, \omega_j, \lambda$ are the parameters of the model and $EC_{t-1} = y_t - (a + bx_t)$, the error correction term, is the lagged OLS residual from the cointegrating equation. Normally λ is expected to be negative. Then λEC_{t-1} represents a force pulling y_t toward its long-run relationship, being negative when $EC_{t-1} > 0$, and positive when $EC_{t-1} < 0$. u_t is the random error. The cointegrating equation and ECM can be shown to follow from a single dynamic regression model in levels when y_t andx_t are cointegrated.

To capture the cointegration the trace test was used. The trace test examines the number of linear combinations (i.e. K) to be equal to a given value K_0 (where$K_0 = 0,1,2 \ldots$) , and the alternative hypothesis for K to be greater than K_0

$$H_0: K = K_0$$

$$H_0: K > K_0$$

To test for the existence of cointegration using the trace test, we set $K_0 = 0$ (no cointegration), and examine whether the null hypothesiscan be rejected. If this is the case, then we conclude there is at least one cointegration relationship.

In this case, we need to reject the null hypothesis to establish the presence of cointegration between the variables.

2.3 Impulse Response Function and Variance Decomposition

Since the cointegration analysis only captures the long run relationship among the variables, Impulse Response Function and Variance Decomposition method were used to find how the oil demand responds to shocks in the macroeconomic variables.

2.4 ARCH Test for Heteroscedasticity

Engle's ARCH test is used to test the Heteroscedasticity among the residuals of a given model. The null hypothesis of the test is that a series of residuals (r_t) exhibits no conditional heteroscedasticity (ARCH effects), against the alternative that an ARCH(L) model describes the series.

H_0: residuals (r_t) exhibits no heteroscedasticity(variance of the error term (σ^2) is a constant)

H_1: residuals (r_t) exhibits heteroscedasticity (variance of the error term (σ^2) is not a constant)

The ARCH(L) model has the following form:

$$r_t^2 = a_0 + a_1 r_{2t-1+\cdots+} a_L r_{2t-L} + e_t \qquad (1)$$

where r_t denotes the residuals and$e_t$denotes the random error. Also a_js are parameters of the model wherethere is at least one $a_j \neq 0, j = 0 \ldots L$

The test statistic is the Lagrange multiplier statistic;

$$TR^2 \sim \chi_L^2$$

where: T is the sample size and R^2 is the coefficient of determination from fitting the ARCH(L) model for a number of lags (L) via regression.

Under the null hypothesis, the asymptotic distribution of the test statistic is chi-square with L degrees of freedom.

To test the null hypothesis that there is no ARCH up to order L in the residuals, we run the regression denoted by equation (1). Then the R^2value has to be calculated and then the test statistic value can be obtained by multiplying the R^2value by sample size. The null hypothesis can be rejected if the calculated value of the test statistic is greater than the chi square critical value

2.5 LM test for Serial Correlation

This test is an alternative to the Q-statistics for testing serial correlation. The test belongs to the class of asymptotic (large sample) tests known as Lagrange multiplier (LM) tests.

H_0: No serial correlation up to lag order p, where p is a pre-specified integer.

H_1: There is serial correlation up to lag order p, where p is a pre-specified integer.

The test statistic for this test is computed by an auxiliary regression as follows. First, suppose we have estimated the regression;

$$y_t = \beta x_t + \epsilon_t$$

where β are the estimated coefficients and $\epsilon_t$are the errors. The test statistic for lag order p is based on the auxiliary regression for the residuals $\epsilon_t = y_t - \beta x_t$

This is a regression of the residuals on the original regressors X and lagged residuals upto order p. To test the hypothesis we use the Breusch-Godfrey LM test statistic.

$$n * R^2 \sim \chi_{df}^2$$

This is computed as the number of observations, times the R^2 from theauxiliary regression. Under quite general conditions, the LM test statistic has a chi square distribution with degrees of freedom equals to p.

2.6 Normality test for residuals

H_0: Residuals follow a normal distribution

H_1: Residuals do not follow a normal distribution

The normality test of residuals is expressed as a P value. That is if the fitted model is correct and all scatter around the model follows a Gaussian population, what is the probability of obtaining data whose residuals deviate from a Gaussian distribution.If the P value is large, then the residuals pass the normality test. If the P value is small, the residuals fail the normality test and we have evidence that your data do not follow one of the assumptions of the regression.

3. Results and discussion

This section describes the results of this research. All the data outputs and statistical tests are included in this section.

3.1 Augmented Dickey Fuller (ADF) test

Augmented Dickey Fuller (ADF) test is used to find out whether the time series variables are stationary. Augmented Dickey Fuller (ADF) test was performed on the examined variables at level and also at first difference series. The Augmented Dickey Fuller (ADF) test results are presented in table 1.

Table 1: Augmented Dickey Fuller (ADF) test results

Variables	Augmented Dickey Fuller test statistic			
	H0: Variable is non stationary			
	Level		First Difference	
	Test Statistic	P-Value	Test Statistic	P-Value
LNCON	-0.80244	0.8011	-5.760107	0.0001
LNFDI	-1.202924	0.655	-3.991209	0.0064
LNGDP	1.34889	0.9981	-4.292683	0.0028
LNOILPRICE	-0.302531	0.9113	-4.4720441	0.0011
LNPOP	-0.987396	0.74	-2.957545	0.00542

The ADF test shows that all variables are non-stationary in levels, but stationary in first difference form. Hence we can conclude that all the variables are integrated of order one, i.e. I(1) and thus we may proceed with testing of cointegration.

3.2 Chow breakpoint test to test the structural breaks

According to the results of the ADF tests all the variables are not stationary before applying the differencing concept. Hence the Engle – Granger two step estimator was used in the analysis.. In order to test the significance of the structural break chow breakpoint test is used.

Table 2: Chow breakpoint test using the selected variables for the model

Chow Breakpoint Test: 22
Null Hypothesis: No breaks at specified breakpoints
Varying regressors: All equation variables
Equation Sample: 2 26

F-statistic	4.897459	Prob. F(5,15)	0.0074
Log likelihood ratio	24.19822	Prob. Chi-Square(5)	0.0002

As the p value of the Chow breakpoint test is less than 0.05, we reject the null hypothesis at 5% level of significance. Hence the data set contains a structural break at the 22nd data point. Therefore a dummy variable was used in the analysis.

3.3 Determining the order of lags in Vector Error Correction Model (VECM)

The number of lags to be used in the Vector Error Correction Model (VECM) should be determined before conduct the cointegration test.

Table 3: Lag selection Criteria

Lag length	Adj. R-squared	Akaike (AIC)	Schwarz Criterion (SC)	Standard Error
1	0.849	-4.511515	-4.069745	0.022044
2	0.659542	-3.72514	-3.033969	0.032677

According to table 3 lag 1 gives the values that minimize the Akaike Information Criterion, Schwarz Criterion and Standard Error. Also lag 1 model gives the maximum value for adjusted R squared. Hence Vector Error Correction model was fitted by considering up to lag 1 of all endogenous variables.

3.4 Cointegration Analysis

Table 4: Johansen cointegration test

Date: 11/23/17 Time: 14:20
Sample (adjusted): 3 26
Included observations: 24 after adjustments
Trend assumption: Linear deterministic trend
Series: LNCON LNFDI LNGDP LNPOP LNOILPRICE
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**

None *	0.929030	127.5967	69.81889	0.0000
At most 1 *	0.805442	64.10492	47.85613	0.0008
At most 2	0.412280	24.81626	29.79707	0.1681
At most 3	0.267806	12.06014	15.49471	0.1541
At most 4 *	0.173698	4.579087	3.841466	0.0324

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

According to table1 all variables are integrated in same order. Hence Johansen cointegrated test was used to explore the long run relationship among the variables. As for the results of table 4, trace test indicates that there are two cointegration equations between log values of Consumption, Gross Domestic Product (GDP), Foreign Direct Investment (FDI), Oil Price and Population at 5% level of significance. Hence we can conclude that a Vector Error Correction model can be used to model the relationship between these variables.

3.5 Long Run Relationship

After normalization, the cointegration vectors on LNCON and normalized integrated coefficients were estimated as reported in table 5.

Table 5: Normalized cointegration coefficients

Cointegrating Eq:	CointEq1	CointEq2
LNCON(-1)	1.000000	0.000000
LNFDI(-1)	0.000000	1.000000
LNGDP(-1)	-1.115634 (0.11975) [-9.31647]	3.023796 (0.86638) [3.49014]
LNPOP(-1)	-6.805764 (1.08856) [-6.25209]	-7.455268 (7.87574) [-0.94661]
LNOILPRICE(-1)	1.032864 (0.07631) [13.5345]	-3.916814 (0.55213) [-7.09401]
C	126.7457	47.67044

The first normalized equation was estimated as below:

LNCON (-1) = 126.75 + 1.03 LNOILPRICE (-1) -6.81 LNPOP (-1) -1.12 LNGDP (-1)

As it can be seen in the first normalized equation, Sri Lankan population and Gross Domestic Product (GDP) is having a negative relationship with the oil demand in the long run while price of oil is having a significant positive relationship with the demand of oil.

The second normalized equation was estimated as below:

LNFDI (-1) = 47.67 + 3.02LNGDP (-1) -7.46 LNPOP (-1) -3.92 LNOILPRICE (-1)

According to the second normalized equation, Foreign Direct Investment (FDI) is having a significant negative relationship with the population and oil price whereas Gross Domestic Product (GDP) is having a positive relationship with Foreign Direct Investment (FDI)

3.6 Vector Error Correction Model (VECM)

The Vector Error Correction Model (VECM) provide the correction terms that reflect the influences of deviation of the relationship among the variables from long run equilibrium and short run parameters. The relationship between oil demand and other macroeconomic variables can be given in the following model.

$$(lncon_t) = -0.1(lncon_{t-1}) + 0.6(lncon_{t-2}) + 0.13 * lnGDP_{t-1} + 0.32 * lnGDP_{t-2} - 19.97 * lnpop_{t-2} + 23.81 * lnpop_{t-1} - 0.13 * lnOilPrice_{t-1} - 0.2 * lnOilPrice_{t-2} + 0.01 * lnFDI_{t-1} - 0.06 * lnFDI_{t-2} + 67.19 - 0.11 * dummy$$

The parameters of this model were estimated and shown in table 5. Table 5 consists vector error correction model for oil demand with significant error correction terms, showing explicit information on the long run and short run dynamic interactions. As it can be seen in table 6 both error correction terms are significant with negative sign. This implies that long run movements of the variables are determined by both equilibrium relationships.

According to table 6, the estimate of C(1) which is the adjustment coefficient associated with oil demand is -0.51 and it is statistically significant. This implies that with absence of changes in oil price, population and Gross Domestic Product (GDP), deviation of the model from the long run path is corrected by 51% increase in LNCON annually. This means that the deviation from the long run relationship takes approximately 2 years (1/0.51) to eliminate the disequilibrium.

C(2) is the adjustment coefficient associated with Foreign Direct Investment (FDI). It is -0.047 and statistically significant. This implies that with absence of changes in oil price, population and Gross Domestic Product (GDP), deviation of the model from the long run path is corrected by 4% increase in LNFDI annually.

Table 6: Significance of the coefficients of Vector Error Correction Model (VECM)

Dependent Variable: D(LNCON)
Method: Least Squares
Date: 11/30/17 Time: 14:03
Sample (adjusted): 3 26
Included observations: 24 after adjustments
D(LNCON) = C(1)*(LNCON(-1) - 1.11563358287*LNGDP(-1) - 6.80576412931*LNPOP(-1) + 1.03286420496*LNOILPRICE(-1) + 126.745741569) + C(2)*(LNFDI(-1) + 3.02379581871*LNGDP(-1) - 7.45526834643*LNPOP(-1) - 3.91681398669*LNOILPRICE(-1) + 47.6704440648) + C(3)*D(LNCON(-1)) + C(4)*D(LNFDI(-1)) + C(5)*D(LNGDP(-1)) + C(6)*D(LNPOP(-1)) + C(7)*D(LNOILPRICE(-1)) + C(8) + C(9)*DUMMY

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.506850	0.059477	-8.521846	0.0000
C(2)	-0.047457	0.013460	-3.525756	0.0031
C(3)	-0.591575	0.115821	-5.107665	0.0001
C(4)	0.062771	0.012959	4.843718	0.0002
C(5)	-0.320174	0.080219	-3.991242	0.0012
C(6)	19.97319	2.734885	7.303119	0.0000
C(7)	0.201533	0.034924	5.770664	0.0000
C(8)	-0.173734	0.028277	-6.143920	0.0000
C(9)	0.110398	0.021858	5.050750	0.0001

R-squared	0.901522	Mean dependent var	0.052006
Adjusted R-squared	0.849000	S.D. dependent var	0.056730
S.E. of regression	0.022044	Akaike info criterion	-4.511515
Sum squared resid	0.007289	Schwarz criterion	-4.069745
Log likelihood	63.13818	Hannan-Quinn criter.	-4.394313
F-statistic	17.16479	Durbin-Watson stat	1.714811
Prob(F-statistic)	0.000003		

3.7 Test of Short Run Relationship Between the Variables

Wald test was used to identify any significant short run relationship between each macroeconomic variable and Sri Lankan oil demand. The results are presented as follows.

Table 07: Wald test for the relationship between Foreign Direct Investment and Oil Demand

Test Statistic	Value	df	Probability
t-statistic	4.843718	15	0.0002
F-statistic	23.46160	(1, 15)	0.0002
Chi-square	23.46160	1	0.0000

According to the results in table 7, the p value of the Chi-square test statistic is 0.0002 < 0.05. Therefore H_0: C(4) = 0 is rejected at 5% level of significance and can be concluded that there is a short run relationship from LNFDI (Foreign Direct Investment) to Sri Lankan oil demand.

Table 08: Wald test for the relationship between Gross Domestic Product and Oil Demand

Test Statistic	Value	df	Probability
t-statistic	-3.991242	15	0.0012
F-statistic	15.93002	(1, 15)	0.0012
Chi-square	15.93002	1	0.0001

As it can be seen in table 8, the p value of the Chi-square test statistic is 0.0012 < 0.05. Therefore H_0: C(5) = 0 is rejected at 5% level of significance and can be concluded that there is a short run relationship from LNGDP (Gross Domestic Product) to Sri Lankan oil demand.

Table 09: Wald test for the relationship between Population and Oil Demand

Test Statistic	Value	df	Probability
t-statistic	7.303119	15	0.0000
F-statistic	53.33554	(1, 15)	0.0000
Chi-square	53.33554	1	0.0000

According to the results in table 9, the p value of the Chi-square test statistic is 0.00 < 0.05. Therefore H_0: C(6) = 0 is rejected at 5% level of significance and can be concluded that there is a short run relationship from LNPOP (Population) to Sri Lankan oil demand.

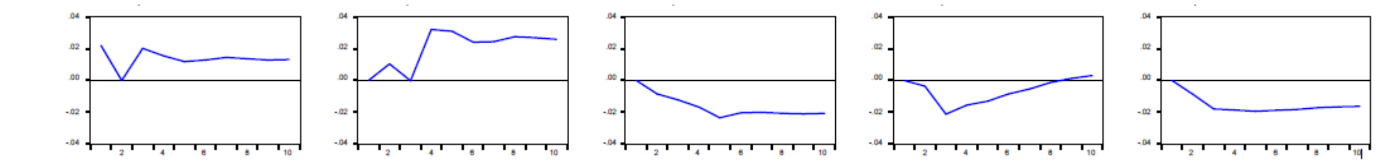
Table 10: Wald test for the relationship between Oil Price and Oil Demand

Test Statistic	Value	df	Probability
t-statistic	5.770664	15	0.0000
F-statistic	33.30056	(1, 15)	0.0000
Chi-square	33.30056	1	0.0000

As it can be seen in table 10, the p value of the Chi-square test statistic is 0.00 < 0.05. Therefore H_0: C(7) = 0 is rejected at 5% level of significance and can be concluded that there is a short run relationship from LNOilPrice (Oil Price) to Sri Lankan oil demand.

3.8 Variance Decomposition and Impulse Response Function Analysis

Variance decompositions was used as a tool for evaluating the dynamic interactions and strength of casual relations among variables in the system. It is used to analyze how much of a change in a variable is due to its own shock and how much due to shocks to other variables. Impulse Response Function analysis was used as graphical method to study the dynamic effects of shocks of macroeconomic variables on the selected response variable.



Response of LNCON to LNCON Response of LNCON to LNFDI Response of LNCON to LNGDP Response of LNCON to LNPOP Response of LNCON to LNOILPRICE

Figure 1: Impulse Response Function

The impulse response function shows that when oil consumption has a positive shock Foreign Direct Investment (FDI) goes up and then again it goes down. From the third year it is increasing and after the fifth year it seems to be steady. Impulse response function also shows that consumption of oil has a negative respond to Gross Domestic Product (GDP) and oil price. Consumption of oil responds negatively to population but from the 10^{th} year it has a positive response.

Table11: Variance Decomposition of Oil Demand

Period	S.E.	LNCON	LNFDI	LNGDP	LNPOP	LNOILPRICE
1	0.022044	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.027558	63.99330	14.26846	9.677846	1.825875	10.23452
3	0.045922	42.49715	5.142014	10.73176	22.49813	19.13095
4	0.065330	26.61656	26.73525	12.06626	16.82464	17.75729
5	0.080579	19.69353	32.43079	16.52145	13.74706	17.60717
6	0.089987	17.82904	33.18837	18.50866	11.94351	18.53043
7	0.098420	17.07400	33.93398	19.72275	10.29700	18.97227
8	0.106689	16.16231	35.62095	20.63801	8.781209	18.79752
9	0.114056	15.41708	36.72855	21.54159	7.695846	18.61694
10	0.120729	14.96034	37.39280	22.23204	6.929081	18.48574

Results in table 11 shows that oil demand (LNCON) is relatively less exogenous in relation to the shocks of macroeconomic variables in the short run because if considering only two years, the oil demand or the consumption of oil (LNCON) is the most important variable to account for its own innovation, which is nearly 64%. Contribution of Foreign Direct Investment (FDI), Gross Domestic Product (GDP), population and oil to the forecast error variance is 14.26%, 9.68%, 1.82% and 10.23% respectively.

At the end of the 10^{th} year, only 14.96% of variance of consumption is explained by its own shock. Foreign Direct Investment (FDI), Gross Domestic Product (GDP) and population are the next most important variables to be considered in explaining the forecast error variance, which accounts 37.39%, 22.23% and 18.48% impact on consumption of oil respectively. This implies that Foreign Direct Investment (FDI), Gross Domestic Product (GDP) and population prove to be the most significant factors that explain the movement in oil demand in the long run.

3.9 Diagnostic check for the residuals of the selected model

3.9.1 Normality assumption

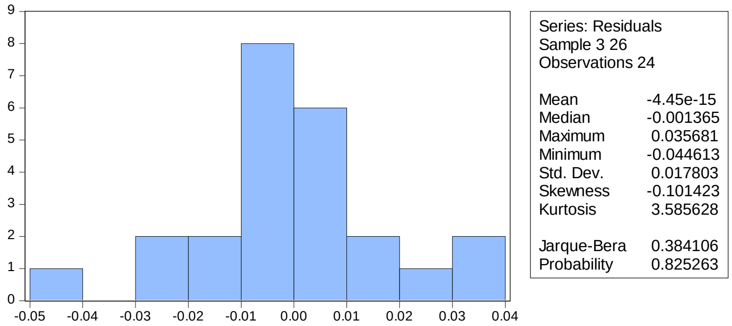


Figure 2: Histogram for the residuals of VECM model

As it can be seen in figure 2, residuals of the Vector Error Correction model are normally distributed at 0.05 level of significance.

3.9.2 Serial Correlation

Table12: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.000667	Prob. F(1,14)	0.9798
Obs*R-squared	0.001143	Prob. Chi-Square(1)	0.9730

According to table 12 p value of the LM test is greater than 0.05, which indicates that there is no serial correlation among the residuals of the VECM model.

3.9.3 Heteroscedasticity

Table 13: ARCH test to check Heteroscedasticity of the residuals

Heteroskedasticity Test: ARCH			
F-statistic	0.359142	Prob. F(1,21)	0.5554
Obs*R-squared	0.386732	Prob. Chi-Square(1)	0.5340

As it can be seen in table 13 p value of the ARCH test is greater than 0.05, which indicates that there is no heteroscedasticity among the residuals of the VECM model.

3.9.4 Stationary Condition

Table 14: Unit Root test

Null Hypothesis: RESIDUALS has a unit root

Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.685488	0.0000
Test critical values:	1% level	-3.788030	
	5% level	-3.012363	
	10% level	-2.646119	

*MacKinnon (1996) one-sided p-values.

As the p value of the unit root test is less than 0.05, we can conclude that the residuals are stationary. Hence a cointegration relationship exists between variables and the long run model parameters are consistent and highly efficient.

4. Conclusions

FDI has a huge impact on oil demand in the long run. It has a unitary elastic effect in the long run and FDI has a small effect in increasing the overall demand for oil in the short run, with one percent rise in FDI there is only 0.06 increment in demand. FDI is a long term strategic investment by multinational companies and it may take many years to have an influence in the country's oil demand. Hence it is unsurprising to have a small effect in the short run.

Crude oil price has a huge effect in reducing oil demand in the long run, with one percent increase in oil price there is 3.9 percent reduction in overall demand. In the short run oil demand will increase by 0.2 percent when price increase by one percent. It seems to be that when the oil price remain increased for a long period people and the industry may find alternatives to cut down the expenses by buying less amount of oil.

In the short run one percent rise in population is estimated to have 19 percent increment in oil demand and in the long run there is a reduction, with one percent rise in population there is 7 percent reduction in overall oil demand. Although population is a significant factor in the short run, there may be other factors which have more effect on oil demand. For example, even though the population increases, if the price of the oil is high the demand will reduce in the long run.

In both long run and short run models for one percent increment in GDP, it is estimated to have a 1.11 percent and 0.32 percent reduction in the oil demand respectively. Sri Lanka's GDP mainly depends on tourism, tea export, apparel, textile, rice production and other agricultural products. These industries mainly depending on electricity and over the years proportion of electricity production by coal and hydo has increased while the proportion of electricity produced by oil has reduced significantly. Hence the industrialization in Sri Lanka which has increased the GDP has reduced the oil demand in both short run and long run.

According to variance decomposition, oil demand (LNCON) is relatively less exogenous in relation to the shocks of macroeconomic variables in the short run because if considering only two years, the oil demand or the consumption of oil (LNCON) is the most important variable to account for its own innovation, which is nearly 64%. Contribution of Foreign

Direct Investment (FDI), Gross Domestic Product (GDP), population and oil to the forecast error variance is 14.26%, 9.68%, 1.82% and 10.23% respectively.

At the end of the period, only 14.96% of variance of consumption is explained by its own shock. Foreign Direct Investment (FDI), Gross Domestic Product (GDP) and population are the next most important variables to be considered in explaining the forecast error variance, which accounts 37.39%, 22.23% and 18.48% impact on consumption of oil respectively. This implies that Foreign Direct Investment (FDI), Gross Domestic Product (GDP) and population prove to be the most significant factors that explain the movement in oil demand in the long run.

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