Long run/Short run Relationship between Inflation and Oil Price in Sri Lanka

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Abstract

The volatility in the oil prices has the implications towards the macro economic variables of developed and developing countries. Recent highs in the world oil market are causing for possible slowdowns in the economic performance of countries. This study examines the long run / short run relationship between inflation and crude oil prices to give some guidelines for possible economic implications. Colombo Consumer Price Index was used as the proxy for inflation. Deductive approach has employed using the secondary data over the period from January 2008 to April 2018. Augmented Dickey Fuller Test was used to identify the stationary of the data set. Results suggested that there is a unit root in level series and thus the first difference series of both variables were used for the analytical purposes. Initially, to identify the long run relationship, Johansen-Juselius (1990) cointegration test was used and the results revealed that there is a significant long run negative relationship between Colombo Consumer Price Index and crude oil prices. Furthermore, to identify the short run relationship, Impulse Response Analysis and Variation Decomposition Analysis were used. Results suggested that there is a short run relationship between above variables too. Further, Impulse Response Analysis suggested that the shock of the oil prices impact to the Sri Lankan economy through the Colombo Consumer Price Index was started after 3 months and more than 8 months goes to become to the normal situation. The empirical findings of this study is helpful for government policy makers, financial managers, financial analysts and other interested parties who is dealing with the Sri Lankan economy. Very recently, the government policy makers have taken steps to revise the fuel pricing formulae on a bimonthly basis. But there want to be a much issue if those formulae were revised on a trimonthly basis.

Keywords: Inflation, Oil price, Cointegration

INTRODUCTION

The behavior patterns of an economy can be studied under two general fields as micro economics and macroeconomics. Macro economy is mainly used to focus on the aggregate changes in the economy such as GDP, unemployment rates, growth rate, inflation, savings, investment, international trade and international finance. Among these macro-economic variables, more consideration should be drawn towards the factor "inflation" due to its vast impacts.

The inflation is a most important factor that can affect the people's living state. In Sri Lanka, there are four indicators which is used to measure the price stability as Colombo consumer price index (CCPI), Greater Colombo consumer price index (GCPI), Wholesale price index (WPI) and Implicit Gross Domestic Products Deflator (GDPD). Maintenance of price stability is needed for an economy because it can lead to harmful effects. Due to a high inflation, an unfavorable expansion of income, discouragement of savings, unfavorable condition in balance of payments, decrease in economic growth, increase of budget balance and appreciation of foreign exchange would occur.

There are many causes for inflation. Among them, increase in the money supply, high national debt, increase in wages (demand pull effect), increase in production cost (cost push effect) and fluctuation of exchange rates play a vital role. Cost push inflation occurs when the prices of production inputs increase. A price increase in raw materials and rise in energy price (a sharped rise in imported Brent oil) can lead to increase the cost of production. A high production cost can lead to a decrease in aggregate supply and it can lead to an increase in price for commodities. Based on this theory, it can drive that crude oil (Brent oil) has some kind of an effect towards the inflation.

As Sri Lanka does not produce petroleum, it has to import petroleum products which are required for the various purposes of the nation. In the year 2014, the total cost of importation of petroleum products (Brent oil and refined products) amounted to Rs.600 billion and it represented approximately 6.1 percent of the Gross Domestic Products (GDP) of Rs.9,785 billion in the year 2014 valued at current prices. Further it was equal to approximately to 24 percent of the total imports of Rs.2,535 billion in the year 2014. (Annual Report of Ceylon Petroleum Corporation, 2014). Sri Lanka mainly imports crude oil, refined products, coal and L.P Gas. Main sectors like transport, power generation, aviation, industries, domestic and farmer community, banking sector and export sectors will be mainly powered by Brent oil. In

Sri Lanka, use of Brent oil for power or energy generation marks a significant milestone due to the prevailing bad weather conditions and increase in demand for electricity in the country.

A volatility in the crude oil price (Brent) can affects every micro unit of typical oil importing under developed or developed countries. Unlike in the case of stable investments such as stocks and bonds, Brent oil can be subject to greater fluctuations. The activities done by the U.S government and OPEC (Organization of Petroleum Exporting Countries), future contracts for oil in the commodity market, change of the demand and supply of the crude oil (Brent) in the international market, natural and man-made disasters can drive up crude oil prices if they are dramatic enough. Anyhow price instabilities in Brent oil can lead to decline in the economic goal attainments.

As Sri Lanka is a developing country, the country acts as a price taker from the international oil market. Hence the government of Sri Lanka has taken steps to revise the fuel formulae on a bimonthly basis. The volatility of the Brent oil prices of the international market can affect the Sri Lankan price of Brent oil either during a short period of time or within a long period of time.

Being a strategic input of economy, energy prices affect the whole economy such that both public and private policy makers in all countries consider energy price as a crucial economic factor. Infact, any increase in the prices of energy leads to a proportional increase in the price consumers pay for goods and services. The direct and indirect impacts of energy prices on economic variables are studied by numerous researchers (Stern, 2011). As such many researches have been done across decades to find out the relationship between crude oil prices and macro-economic variables. But in Sri Lankan context only little number of studies can be found. And also only limited number of studies has been conducted to find out the long term and short term impact on economy by the fluctuations in crude oil prices. Hence it is clear that more empirical work is needed to carry out regarding this topic. To fulfill that gap researcher conduct this research considering impact of crude oil prices on inflation. So this research will helpful to fulfill the research gap in the Sri Lankan context.

In other words, it can be clearly said that, this study will reveal the answer to the question that, whether there any long run or short run relationship between oil price and inflation in Sri Lanka

LITERATURE REVIEW

Scholar's special attention adverted towards to variety of models, analytical tools and methodology related to this studied area and key findings of the previous studies were summarized as follows.

When concern the situation of developed countries;Cologni and Manera (2008) investigated the impact of oil price on inflation and interest rate in G7 countries by using vector auto-regressive framework for the period of 1980 to 2003. The result of the study showed that except the Japan and UK, oil prices were significantly impact in inflation in other countries. As well as impulse response function analysis suggested that the existence of an instantaneous, temporary effect of oil price change on inflation.

In the case Greece, Filis (2010) examined the relationship between oil price and inflation for the period of 1996:1 to 2008:6. Unified statistical framework is used to study the data in levels and then VAR model was adopted to identify the relationship between variables. The empirical result suggested that the oil price positively effect on Consumer Price Index in the long run.

However in Kenya as an emerging country, Kiptui (2009) examined the impact of oil price pass-through to inflation in order to inform monetary policy decisions in Kenya and for the analytical purpose, scholar adopted a Philips curve approach. The empirical results were shown that 10 per cent increase in oil prices results in 0.5 per cent inflation in the short run and one per cent in the long run. Furthermore Olomola and Adejumo (2006) examined the nature of the oil price fluctuations and Nigerian economic activities for the period from 1970 to 2003. For this study scholar used VAR models and the results of this study was some extent contrary to previous empirical finding in other countries due to oil price fluctuations does not affect inflation and output of Nigeria. As well as Umar and Kilishi (2010) investigated the relationship among oil price shocks and Nigerian economy and the result of the study was almost same to the previous one.

When concern the overall nature of the impact of oil price shocks to inflation in Asian countries, there were some important findings and as a whole which agreed with the findings of other out of Asian countries.

Du, Yanan and Wei (2010) studied the relationship between world oil price and China macro-economy. Monthly time series macro related data from 1995 to 2008 and vector auto-regressive model (VAR) were employed for this study. The results showed that the world oil price affects

the economic growth and inflation of China significantly, and the impact is non-linear as well as China's economic activities fails to affect the world oil prices. In same context, Tang, Wu and Zhang (2010) investigated oil price shocks and their short-and long-term effects. The result of the vector auto-regressive model showed that an oil-price increase negatively affects output and investment, but positively affects inflation rate and interest rate. Furthermore, their decomposition results also showed that the short-term impact of oil-price on inflation in China context.

Bhattacharya and Bhattacharyya (2001) investigated the impact of increase in oil prices on inflation and output in India using monthly data from April 1994 to December 2000. VAR models were employed for this study and results attempted to identify the lag structure in which a rise in the prices of petroleum begins to affect the prices of other commodities and output. Furthermore, the VAR model discovered that a 20 percentage point increase in oil prices course to a 1.3 percentage point increase in inflation in other commodities and which usually occurred after five to seven months after the shock. As well as above impact on prices persists for about two years.

Cunado and Gracia (2005) examined the impact of oil price shocks on economic activities and inflation in six Asian countries such as Japan, Singapore, Malaysia, Thailand, South Korea and Philippine using the data from 1975 to 2002. The empirical findings of this study is that the oil price is significantly impact on both economic activities and inflation as well as the impact is limited to the short run and more significant when oil price shocks are defined in local currencies. Furthermore Chang and Wong (2003) found a strong positive impact from oil price to inflation in Singapore context.

IMF study indicates that for the industrial countries as a whole, a US $ 5.0 per barrel increase in oil price reduces GDP by 0.3 percentage points and leads to an increase in inflation in the short run. The same study also reveals that among developing countries, the impact of a sustained oil price increase widely varies across countries (IMF 2000).

These findings paw the way to conduct a research to identify the relationship between inflation and crude oil prices for Sri Lankan context.

METHODOLOGY

Data

This study has employed the deductive approach using the secondary data over the period from January 2008 to April 2018 on a monthly basis.Monthly frequency data on Colombo Consumer Price Index (CCPI) and Brent oil prices has obtained from Data Library of Central Bank of Sri Lanka.

Data Analysis and presentation

Statistical analysis are used to describe an account for the observed validity of the data. The researcher has used inferential statistics for this study. Inferential statistics are used to draw conclusions about the reliability and generalizability of the findings. In this study, the researcher has used ADF (Augmented Dickey Fuller Test), JJ test (Johansen-Juselius test), Impulse Response Analysis and Variation De Composition Analysis.

Augmented Dickey Fuller Test

An important initial step of the research is to conduct unit root tests on the variables used. Thus, the unit root analysis, using the Augmented Dickey Fuller Test is also an important part of this research. The order of integration was established using the Augmented Dickey Fuller (ADF) test which consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms, and optionally, a constant and a time trend.

Johansen-JuseliusCointegration Test

The Johansen-Juselius (1990) cointegration test is a statistical method for testing for cointegration. The Johansen-Juselius approach is based on a VAR model of order p to examine the long run relationships that may exist among representative variables.The Johansen-Juselius approach can be expressed mathematically in the following general form:

$$Yt = \mu + A1Yt{-}1 + A2Yt{-}2 + A3Yt{-}3 + \cdots + ApYt{-}p + \varepsilon t \quad (1)$$

Where Yt is a vector containing p variables, all of which are integrated of order one and the subscript t denotes the time period. μ is an $(nx1)$ vector of constants, Ap is an $(n{\times}n)$ matrix of coefficients where ρ is the maximum lag included in the model, and εt is an $(nx1)$ vector of error terms.

Impulse Response Analysis

The concepts and tools were developed to interpret VAR models. The most important are the causality concepts, forecast error variance decomposition and the impulse response analysis. For this research, impulse response analysis and Variation De Composition Analysis test has been used.

The impulse response analysis quantifies the reaction of every single variable in the model on an exogenous shock to the model. Two special cases of shocks can be identified: The single equation shock and the joint equation shock where the shock mirrors the residual covariance structure. In the first case we investigate forecast error impulse responses, in the latter orthogonalized impulse responses. The reaction is measured for every variable a certain time after shocking the system. The impulse response analysis is therefore a tool for inspecting the inter-relation of the model variables.

Variation De-Composition Analysis

For any variable, short run variations are due to its own shocks, but over time other shocks contribute to these changes as well. Forecast error variance decomposition (FEVD) is a method available to examine this interesting phenomenon. In fact, while the IRFs analyze the dynamic behavior of the target variables due to unanticipated shocks within a VAR model, variance decompositions determine the relative importance of each innovation to the variables in the system.

ESTIMATION AND RESULTS

Unit Root Test

One of the underlying property in time series data is whether the variables that in our models are stationary or non-stationary. Thus, for test the stationary in our variables, Augmented Dickey-Fuller (ADF) unit root test was used. As well as macro-economic data behave normally in stochastic trend and that can be removed by differencing the variables.

Table 01 - Results of the Augmented Dickey Fuller Test

Augmented Dickey Fuller				
	Level Series		First Difference Series	
Variable	ADF Statistic	Pob. Value	ADF Statistic	Pob. Value
CCPI	-1.7384	0.4094	-8.4447	0.000*
OP	-2.4301	0.1357	-6.6872	0.000*

Note: * Indicates stationary at 5% level.

According to Table 01, the results suggested that the level series in CCPI and OP are not stationary due to ADF statistics for both variables are not less than the critical value of 05%. However regarding the first difference series, the null hypothesis of "variable has a unit root" was rejected due to calculated ADF statistics for both variables are less than the critical P-value of 05%. Thus the results of stationary process can be concluded as whether the level series are not stationary, both variables in first difference series are stationary under 5% probability level.

Long Run Analysis

Selection of Optimal Lag Lengths;

Determine the optimal lag length for VAR system is necessity for identify the cointegration between variables. For that scholars used five criteria which are sequential modified (LR) test, final prediction error criteria (FPE),Akaike information criteria (AIC), Schwarz criteria (SC), and Hannan-Quinn information criterion (HQ). The results as follows;

Table 02 - Optimal Lag Length for VAR System

Lag	LogLikelihood	LR	FPE	AIC	SC	HQ
0	-1080.41	NA	1011628.0	19.50282	19.55164	19.52263
1	-1070.89	18.52541	915876.6	19.40336	**9.54983***	19.46278
2	-1064.67	11.86596	880162.3	19.36349	19.60760	19.46252
3	-1055.15	**17.84845***	**796934.0***	**19.26395***	19.60569	**19.40258***
4	-1052.72	4.463268	820131.5	19.29226	19.73164	19.47051
5	-1052.17	0.986400	873287.3	19.35447	19.89149	19.57232
6	-1048.02	7.332219	871636.5	19.35172	19.98639	19.60919
7	-1047.19	1.430769	923996.1	19.40889	20.14120	19.70597
8	-1047.13	0.100855	993504.4	19.47989	20.30984	19.81657
9	-1042.42	7.810731	982755.2	19.46706	20.39465	19.84336
10	-1041.92	0.820673	1049149.0	19.53002	20.55524	19.94592
11	-1038.11	6.032177	1055963.0	19.53354	20.65641	19.98905
12	-1036.22	2.935045	1100686.0	19.57148	20.79199	20.06661

Note: * indicates the lag order selected under 5% probability level.

According to the results of Table 02, except to the SC criterion, all other four criteria suggested that the optimal lag length for VAR system is three due to each test's calculated statistics are less than the critical value of 05%. Whether the SC criterion suggested as optimal lag length is one, four criteria out of five suggested it as lag length three. Thus scholars selected lag length three as optimal lag length for the further proceedings.

Optimal lag length implies that the time period which are taken by the CCPI for react to the OP change. On the other words, change of the oil price in world market may affect to the Sri Lankan economy after three months of that variation. This can be happened due to Sri Lanka imports crude oil under some hedging contracts and usually Sri Lankan government not take quick actions against to the world oil price variations. Thus, we cannot expect an immediate reaction on CCPI when change of the word crude oil drum price. Hence the optimal lag length of three months is justifiable.

Results of the Johansen-JuseliusCointegration Test

For identify the long run and short run relationship between CCPI and OP in the system assuming as there exists a liner trend in VAR and the cointegrating relationship only has an intercept. The approach of maximal eigenvalue and trace statistic of Johansen and Juseliuswas used to determine the number of cointegating vectors and the following table 03 and 04 presents the results of above tests at the 05% significant level.

Table 03 -Johansen-JuseliusCointegration Test (Trace Statistic)

Hypothesized No. of CE(s)	Trace Criterion			
	Eigen value	Trace. Stat	0.05 Critical Value	Probability
None*	0.4396	101.894	15.49471	0.0001
At Most One*	0.2365	32.3826	3.841466	0.0000

Table 04 -Johansen-JuseliusCointegration Test (Maximum Eigen Statistics)

Hypothesized No. of CE(s)	Maximal Eigen Criterion			
	Eigen value	Max.Eig.Stat	0.05 Critical Value	Probability
None*	0.43969	69.51177	14.2646	0.0000
At Most One*	0.23651	32.38261	3.841466	0.0000

According to the results of Table 03 and 04, both of max-eigenvalue statistic and the trace statistics suggest a same answer which is two cointegrating vectors are significant at 5% level. Thus the key finding of those two test is there exist a long run relationship between OP and

CCPI in the system. Further this finding can be present as a mathematical equation and it as follows;

$$CCPI = \underset{(0.00017)}{-0.00075\ OP} \qquad (01)$$

The equation 01 indicate that there is a significant negative long run relationship between Colombo consumer price index and oil price in world market.

Actually this finding is some extent contrary with the previous scholars' findings. Whether the sign of the coefficient of OP is negative, its absolute magnitude is very small. On the one hand, most of the time Sri Lankan government bear or act in assailable way to the changers of the oil price in world market. Due to this, when the changers of the world oil price impact to the Sri Lankan economy through the CCPI, there may some modification possibility of that change. Thus this negative coefficient may possible.

Short Run Analysis

For identify the short run dynamic behavior of the variables, impulse response analysis and forecast error variance decomposition were used.

Impulse Response Function (IRF) Analysis

Impulse response function tries to capture the time period of the dependent variable which spend to come to the equilibrium after the shock of independent variable in the VAR system. Further IRF helps to understand the magnitude, direction and length of the time period that the CCPI affected by a shock of the OP in the system.

According to the figure 01, the dotted lines show the 95% confidence bands in the impulse response function. The middle line indicates the responding time period which are taken by the CCPI to come to the equilibrium after the shock of OP in world market. As well as the IRFs indicates that there is a statistically significant short run relationship between CCPI and OP. Furthermore, the figure 01 indicates that the response comes to the maximum stage in third month and after that approximately five months are taken for come to the neutral. Thus the results of IRF often implies that there is a contemporaneous effects of world oil price changes on Colombo consumer price index.

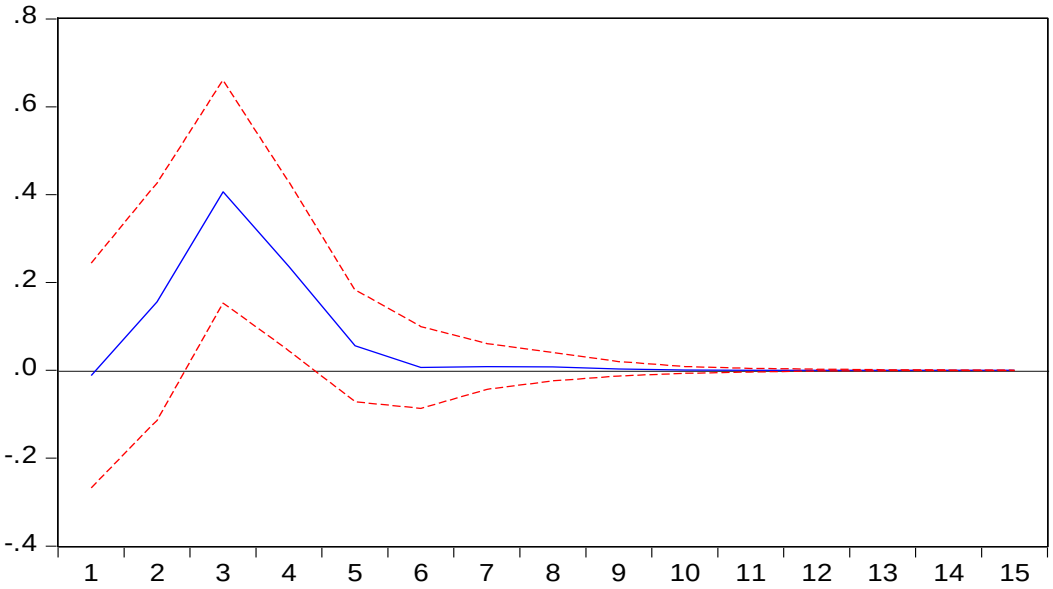

Figure 01 - Impulse Response Functions of the CCPI to Cholesky One S.D. Innovations

Forecast Error Variance Decompositions (FEVD)

The variance decomposition measures the proportion of forecast error variance in one variable explained by innovations in itself and the other variables in the system. In this study, FEVDs indicates the percentage of variation in the forecast error of the CCPI that is due to its own shocks versus shocks to OP in the system.

Table 05 - Variance Decomposition

Period	S.E	CCPI	OP
1	1.339702	99.99113	0.008866
2	1.369007	99.02273	0.977267
3	1.443950	89.50544	10.49456
4	1.530855	87.22393	12.77607
5	1.536505	87.15486	12.84514
6	1.547578	86.13171	13.86829
7	1.562328	85.38009	14.61991
8	1.564044	85.26100	14.73900
9	1.565093	85.21348	14.78652
10	1.567010	85.13124	14.86876
11	1.567237	85.11450	14.88550
12	1.567397	85.11235	14.88765

Table 05 indicates the FEVD for the CCPI over 12 months period and the degree of the influence of the CCPI in the OP change systematically become neutral approximately after

eight months. Hence the test of FEVD implies that the OP has a significant effect on the CCPI and the results of FEVD agree with the results of IRF.

Hypothesis Testing

According to the findings, Johansen-JuseliusCointegration test found that the long run relationship between CCPI and OP. The IRFs indicate that there is a statistically significant short run relationship between considered variables. Thus the fitted null hypothesis (H_{0B}) of "there is no any significant long run / short run relationship between CCPI and OP" was rejected and alternative one was accepted.

CONCLUSION

The impact of Brent oil prices on economic variables become more and more significant because of larger amount of oil consumption, higher dependence on the imported oil supply and due to the usage of market oriented oil pricing mechanisms. In this paper, we tried to investigate the impact of crude oil prices on inflation of Sri Lanka based on monthly data from 2008 to 2018.

Augmented Dickey Fuller test, Johansen cointegration test, Impulse response analysis and Variance Decomposition analysis has been employed as statistical tools. To test the stationary of the variables, ADF test has been used. The results of the test suggested that the level series is not stationary. Therefore, for the further proceedings, first difference series has been considered as it was stationary. Prior to deciding the long run relationship, it is needed to find out the optimal lag length. Out of the LR, FPE, AIC, SC and HQ criteria's, four tests suggest lag 3 while a one test suggest lag 1. Thus lag 3 has been selected as the optimal lag length for the further proceedings.

To find out the long run relationship, JJ test has been used at the 05% significant level and it suggests a significant negative long run relationship between the crude oil prices and CCPI. To identify the short run relationship, IRF and VDA tests has used. According to IRF test, it suggests that Sri Lanka will take eight months to become neutral after a price shock and also this outcome was proved by the results of the FEVD test also.

Findings of this study is contradictory with the findings of Filis (2010) and Tang, Wu and Zhang (2010) who found positive effect of oil price on inflation in the long run. Cologni and

Manera (2008) and Du, Yanan and Wei (2010), investigated a significantly impact of oil price to the inflation as we found.

The findings of this research suggest that there is a short run relationship as well as a long run relationship exists between Brent oil prices and inflation of the country. Hence the scholars suggest that policy makers have to pay more attention towards the oil pricing mechanisms and seem it need a huge revision.

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