

MODELING THE EFFECT OF INTERNATIONAL OIL PRICES ON DOMESTIC PRICES IN RWANDA

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Abstract: Sharp increases in the prices of oil are generally unstable and this affects the economy of most countries results to the high domestic prices in developing countries especially in Rwanda. The aim of this research is to determine the effect of international oil prices on domestic prices in Rwanda using quarterly data covering the period of 2000Q1 to 2017: Q4, the study employs Vector Autoregressive model in order to test the interdependences between variables. Unit root test was conducted in order to test the stationarity of the data while Johansen co-integration approach was employed to investigate the long run relationship between consumer price index and variables mentioned above. Ordinary least square was adopted as estimation technique of the parameter to test their adequacy. Lastly Granger causality test was tested in order to emphasize the interdependence among variables. Eviews 7 software was used for data analysis. The results shows that all independent variables have positive impact on DOP, all coefficients of variables have positive sign, (5.265210) GDP, (4.012108) ER, (2.516107) CPI and (3.356115) M3. This shows that international oil prices contribute positively on the domestic prices in Rwanda from 2000-2017. $R(-1) = -1.085016$, this means that as far as time is concerned, the errors will be corrected at time t . All independent variable were positive correlated to the domestic price. R^2 (0.056016) show the goodness of fit the model. Durbin- Watson Stat is greater than R^2 which is (1.131954) $>$ (0.958128). Basing on those results, the researcher found that R-squared is significant at 95%. This means that GDP, exchange rate, M3 AND CPI contributed to the domestic Oil prices in Rwanda. It can be seen from the above results that the increase of the international oil price has a negative effect domestic price. Meanwhile it showed that facing the high oil price; authorities are more inclined to adopt tight monetary policy to curb inflation. The government should be prepared to make tax exemptions especially on the imported crude oil in order to reduce the adverse effect it has on the general public. The government needs to further look at the ways to make the price cap work by putting further stringent measures on the players who do not adhere to the rules and regulations set and this will prevent the exploitation of the citizen. The Monetary Policy Committee of the Central Bank (BNR), has had several measures to stabilize the Rwanda franc exchange rate and increase interest rates in order to reduce inflation levels in the economy.

1. INTRODUCTION

1.1 Background of the study

Since energy is essential to almost all economic sectors, oil has become one of the most strategic commodities for the global economy. Sharp increase in oil market has become one of the biggest economist's concerns since (Hamilton, 1983), who concluded the impact of oil price on the U.S economy after the 2nd World War. Moreover, crude oil has been playing a key role in all economic activities although the nature of this relationship may have changed over time(Arouri and Rault, 2011). So, changes in oil price can lead to a change in macroeconomic variables, policies as researcher. High increases in the price of oil are generally seen as a major contributor to business cycle asymmetries, a number of studies examined the relationship between oil prices and economic activity such as GDP, inflation rate, exchange rate, by using different econometric techniques (Oladosu, 2009; Cunado& de Gracia, 2005).

In the mid-1980s was established that the relationship between an oil prices and economic activity is not linear but is asymmetric, such that declining oil prices have a less significant positive impact on economic activity, whereas increasing

oil prices have a more adversely significant impact on economic activity, (Mork,1989) Popular myth is that high oil prices are generally associated with high consumer prices.

In general, the impact of oil price movements on consumer prices can be broken into two effects; first effects mainly reflect the impact of oil prices on the prices consumers pay directly for energy products, such as gasoline, kerosene and home heating oil. Supply and demand in the consumer market for energy are largely inelastic because there are few, if any, alternatives that consumers and producers can substitute for oil in the short run. Changes in crude oil prices are, therefore, almost immediately and completely passed on to retail consumer energy prices.

In addition to these direct first effects, oil prices indirectly affect the prices of consumer goods and services that use petroleum or petroleum products in their production. Assuming other input prices are slow to adjust, an increase in oil prices was cause the prices of goods and services that use petroleum or petroleum products as inputs (such as asphalt roof shingles or public transportation) to rise because production and operating costs was increased.

In contrast to effects, which typically imply a one-time change in consumer prices, second effects are more persistent and may cause prices to increase steadily, long after first effects diminish. Second effects come largely as a consequence of rising inflation expectations. If the public is not confident that a low and stable inflation rate was maintained over the medium to long run, the increase in prices associated with the first effects of an oil price increase could become imbedded in inflation expectations. If so, forward looking workers and employers may build higher inflation into future wages and prices, once an inflationary cycle begins, it can be difficult and costly to reverse.

Oil prices change day to day, this results to the instability of the economy and leads to high prices of goods and services hence the high inflation, for instance with regard to commodity prices in 2011 oil prices continued their strong rebound during the first half of the year due to the unrest in oil producing countries but also following the high demand in emerging economies. According to IMF estimates in January 2012, crude oil average price rose by 31.9% to USD 104.23 in 2011 after 27.9 percent increase in the previous year. In the medium term, oil prices are expected to slow down with futures contracts for December 2013 trading at USD 103.6 per barrel, During the last quarter of 2011, non-energy prices recorded strong declines on improved supply conditions but also commodity prices researcher re affected by concerns about the debt crisis and their impact on the global demand. In aggregate terms, the price index for non-energy commodities denominated in US dollars was 14.8 percent at the end December 2011 than at the beginning of the year (ECB bulletin, January 2012).

By looking to price developments, oil prices are estimated to decline by 4.7% in 2013 as result of researcher global demand after an increase of 1.0% in 2012 and 31.6% in 2011. Non-fuel commodity prices are projected to drop again by 1.8% after a sharp decline of 9.9% mainly due to ample supply conditions and researcher demand. During the first six months of 2013 from December 2012 to June 2013, commodity prices dropped by 2.0% on the back of higher supply amid researcher ak global demand particularly for industrial commodities. While energy prices lost by 2.0%, food and metal prices dropped by 3.0% and 12% respectively. Compared to July 2012- June 2012, all commodity price indices lost by 3.3% in July 2012- June 2013, of which energy prices fell by 3.7% and non-energy prices by 2.4%. Similarly, beverages, agricultural raw materials and metal prices declined by 13.7%, 4.7% and 10.7% respectively between researcher en the two periods(BNR, 2013).

Domestic inflation also increased but remained benign, standing at 3.0% in 2015 on average, compared to 1.9% in 2014, while imported inflation slid to 1.1% in 2015 from 1.5% recorded the previous year. The rise in domestic inflation reflects the increase in domestic food prices, while imported inflation varied following the trend in international oil prices(BNR, 2016)

Rwandan inflation is more affected by food and fuel prices, as in 2015Q3, inflation continues to be influenced by prices for food especially for vegetables and transports costs such as fuel and public transport fares. Since June 2015 vegetables prices have been more volatile than expected. Though vegetables inflation slightly varied in October standing at 12.4% from 11.9% in September, it almost doubled in November 2015 peaking to 22.5%. During the same period, transport inflation fell from 0.4% to -1.4% on the back of the reduction in local pump prices from 920FRW/liter to 888FRW/liter on 5th October 2015. It bounced back to 2.0% in November as a result of the uptick in domestic bus fares towards the end of October 2015. The increase in bus fares offset another downwards revision of the local pump prices from 888FRW/liter to 874FRW/liter in November.

After decreasing to 1.3% in October, core inflation bounced back to 2.3% in November in line with the ongoing BNR accommodative monetary policy and the seasonal increase in spending towards the end of the year. The inflation is

generally low as the aggregate demand is still low but progressively recovering, while domestic inflation continues to follow the changes in housing and domestic food prices, imported inflation continues to follow the trend in international oil prices but with some lags. It fell from 1.8% in September to 0.1% in October due to declining international oil prices in August- September period but rose again to 1% in November following a lag effect of the increase in international oil prices from 46.29\$ per barrel in September to 46.96\$ per barrel in October 2015.

At the short-term horizon, most factors point to inflationary pressures. These include: increase in government spending in the second half of 2015/2016 financial year following the back-loading of government expenditure to the first half of 2016. IMF projects the international oil prices to start increasing in 2016Q2 which was increased the local pump prices. The level shifts resulting from the increases in water and electricity tariffs since September and the increase in bus fares since November 2015 was continue to have upward effects on inflation until the base effect dies out or bus fares are revised downwards.

Indeed, the evolution of food prices was significantly increased on the direction and magnitude of inflation in the coming months. All in all, due to mounting pressures, headline inflation in December 2015 and March 2016 is likely to be 3.5% and 5.5%(Economic & Developments, 2015)

Generally, in 2016Q1 commodity prices reached the lowest level in the last ten years with the price of the barrel selling at 29.9 USD in January 2016. Despite high uncertainty around oil prices, IMF still project that oil prices are likely to gradually and slightly increase since 2016Q2. Food prices fell between 2015Q4 and 2017Q4 and are expected to remain below but gradually increasing. For beverages price; coffee prices also dropped in 2016Q1 and are projected to remain around the same level during 2016(Bank, 2016).

1.2 Problem statement

The increase in volatility of oil price can cause a great challenge on the economy of any country specially those which are developing and oil importing countries. The high oil price lead to the deterioration of currencies this results to the high domestic price for different good and services, an oil price increase as an inflationary shock. As a consequence, an oil price increase leads to a rise in the consumer price index, depending upon the share of oil products in the consumption basket (Lescarou,2008).

According to (P.C. Abbott, 2008) , a rise in oil prices leads to exchange rate effects by increasing current account deficit which depreciates the local currency; changes in oil prices, can also reduce investment, to the extent that the return from an irreversible physical investment project depends on the price of oil, increased uncertainty about the future price of oil could cause firms to delay investment and reduce capital expenditures. Similarly, uncertainty generated by sharp movements in oil prices can also hinder the consumption of durable goods (Kilian 2014). In addition, rising uncertainty of future oil price can also lead to more precautionary demand of crude oil, with second-order impacts on activity (Anzuini, Patrizio and Pisani 2014). There is different negative impact of high oil price on importing oil countries because it leads to high cost of transport services and the raw materials imported outside the country are more expensive even goods and services inside the country become expensive compared with the period of oil price.

On other hand falling oil prices reduce overall energy costs as prices of competing energy products are forced down and oil fired electrical. Researcher becomes cheaper to produce. In oil-importing countries where declining oil prices may reduce medium-term inflation expectations below target and reduce external financing pressures, central banks may respond with additional monetary policy loosening, which in turn, can support growth; due to oil prices inflation rate even poverty continue to have effect on youth employment all over the country and on food and transport prices. Recently energy price shocks have increased food insecurity and poverty levels in Rwanda. Evidence from household surveys (NISR, 2013) shows that oil price shocks tend to have a stronger effect on poorer households, as a higher proportion of their expenditure goes towards oil products.

It is in this sense that the researcher decided to seek the model that can be applied to manage these shocks of oil prices on domestic prices in Rwanda, this study intent to show which amount high international oil price affect Rwandan economy especially on domestic prices measured as CPI inflation by using vector autoregressive model so that the policymakers know how to control and fight against shocks on inflation.

1.3 General objective

The general objective of this research examined the effect of international oil price on the domestic prices in Rwanda using vector autoregressive model.

1.4 Specific objectives

1. To measure the long run and dependence of domestic prices on oil.
2. To measure the short run and dependence of domestic prices on oil.
3. To test the Granger causality between domestic prices and international oil prices.

1.5 Stationarity of time series data

The first step in time series analysis is to check if the data are stationary because when non stationary data are used the results lead to spurious results; it gives a false relationship between the variables.

2. GRANGER CAUSALITY TEST

A variable X is said to Granger cause another variable Y, if Y can be better predicted from the past of X and Y together than the past of Y alone, other relevant information being used in the prediction (Granger, 2001). The concept of Granger causality starts with the premise that the future cannot cause the past. If event A occurs after event B, then A cannot cause B. Granger (1969) applies this concept to economic time series to determine whether one-time series 'causes' in the sense of precedes another.

Granger argues that co-integration between two prices implies an inefficient market as the error correction model indicates that at least one of the prices is predictable. Therefore, the Granger-type causality procedure was applied to determine the direction of causation among the Y and X series. A general specification of the Granger causality test in a bivariate (X, Y) context can be expressed as:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_i Y_{t-i} + \beta_1 X_{t-1} + \dots + \beta_i X_{t-i} + \mu \quad (3.8.1)$$

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \dots + \alpha_i X_{t-i} + \beta_1 Y_{t-1} + \dots + \beta_i Y_{t-i} + \mu \quad (3.8.2)$$

In the model, the subscripts denote time periods and μ is a white noise error. The constant parameter α_0 represents the constant growth rate of Y in the equation (3.8.1) and X in the equation (3.8.2) and thus the trend in these variables can be interpreted as general movements of co-integration between X and Y that follows the unit root process. Researcher can obtain two tests from this analysis: the first examines the null hypothesis that the X does not Granger-cause Y and the second test examines the null hypothesis that the Y does not Granger-cause X.

If researcher fail to reject the former null hypothesis and reject the latter, then researcher conclude that X changes are Granger-caused by a change in Y. Unidirectional causality was occur between two variables if either null hypothesis of equation (3.8.1) or (3.8.2) is rejected. Bidirectional causality exists if both null hypotheses are rejected and no causality exists if neither null hypothesis of equation (3.8.1) nor (3.8.2) is rejected (Asari *et al.*, 2011)

3. TEST OF RESIDUALS

By using the ADT Unit Root test on the residuals estimated from the co-integrating regression, the Econometric package E-views.

Table1: Residuals test

Null Hypothesis: R has a unit root Exogenous: None Lag Length: 0 (Automatic - based on SIC, maxlag=6)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-4.822523	0.0000
Test critical values:		
1% level	-2.699769	
5% level	-1.541412	
10% level	-1.526110	

*MacKinnon (1996) one-sided p-values.
 Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(R)
 Method: Least Squares

Date: 24/05/18 Time: 15:02
 Sample (adjusted): 2000Q1 2017Q4
 Included observations: 66 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R(-1)	-0.883624	0.472104	-1.871843	0.0001
R-squared	0.958128	Mean dependent var		338.3694
Adjusted R-squared	0.095128	S.D. dependent var		2307.612
S.E. of regression	2195.110	Akaike info criterion		16.56091
Sum squared resid	1.30E+08	Schwarz criterion		16.54849
Log likelihood	-254.6528	Hannan-Quinn criter.		16.23546
Durbin-Watson stat	1.131954			

Source: Computed by Researcher using E-views.

Referring to the above Table1 the residual is stationary, t-statistic (-4.827723) is less than critical value (-1.561412) and the probability (0.0000) is less than 5% and this Table shows that the Durbin- Watson Stat is greater than R^2 which is (1.131954) > (0.958128). Basing on those results, the researcher found that R-squared is significant at 95%. This means that GDP, exchange rate, M3 and CPI contributed to the Oil prices in Rwanda.

4. ESTIMATION OF MODEL

To estimate the long run relation between variables

$$\text{Model: } Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_i Y_{t-i} + \beta_1 X_{t-1} + \dots + \beta_i X_{t-i} + \mu_t$$

After analyzing the stationarity by using the ADF Unit Root test, let's estimate this model by taking into the consideration the model of the variables that are stationary.

Table 2: Co-integration (Long run relationship)

Dependent Variable: DOP
 Method: Least Squares
 Date: 24/05/18 Time: 17:58
 Sample: 2000Q1 2017Q4
 Included observations: 66

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	5.265210	1.712110	3.418454	0.0015
ER	4.012108	2.911208	1.274603	0.0024
CPI	2.516107	2.082507	1.351976	0.0042
M3	3.356115	1.352524	1.341924	0.0021
C	0.022778	624.2051	0.455424	0.5223
R-squared	0.055132	Mean dependent var		1467.438
Adjusted R-squared	0.219610	S.D. dependent var		2282.372
S.E. of regression	2016.240	Akaike info criterion		18.17232
Sum squared resid	1.142408	Schwarz criterion		18.35554
Log likelihood	-286.7572	Hannan-Quinn criter.		18.23306
F-statistic	3.907913	Durbin-Watson stat		1.691052
Prob(F-statistic)	0.018909			

Source: Computed by Researcher using E-views

Estimation Equation:

$$\text{DOP} = \text{C}(1)*\text{GDP} + \text{C}(2)*\text{ER} + \text{C}(3)*\text{CPI} + \text{C}(4)*\text{M3}$$

Substituted Coefficients:

$$DOP = 5.265210 *GDP + 4.012108*ER + 2.516107*CPI + 3.356115*M3$$

$$\beta_0 = 0.022778$$

$$DOP = 0.022778 + 5.265210 GDP + 4.012108ER + 2.516107CPI + 3.356115M3$$

Co-integration is an econometric property of time series variables. If two or more variables are themselves non-stationary, but a linear combination of them is stationary, the theory of time series are said; to be co integrated it is often said that co integration is a means for correctly testing hypothesis concerning the relationship between two variables having unit roots. Testing co integration, there are two most popular approaches, the Engle Granger (EG) two steps method and Johansen procedure. The first is analysis of stationarity for the residuals from the levels regression. The variables were co-integrated; all variables have a long run relationship between them. Therefore, the researcher confirms that all variables are co-integrated and there is long run relationship between variables.

5. DISCUSSION AND INTERPRETATION

The results of the relationship of international oil prices and domestic prices presented in Table 2. It is clearly visible from the results that international oil prices influences the domestic prices in Rwanda.

$$DOP = 0.022778 + 5.265210 GDP + 4.012108ER + 2.516107CPI + 3.356115M3$$

The results shows that all independent variables have positive impact on DOP, all coefficients of variables have positive sign, (5.265210) GDP, (4.012108) ER, (2.516107) CPI and (3.356115) M3. This shows that international oil prices contribute positively on the domestic prices in Rwanda from 2000-2017. When GDP increased 1 unit, holding ER, CPI and M3 constants, DOP expected to increase (5.265210). This shows that all variables were contributed positively on the domestic oil price. R^2 (0.055132) this show the goodness of fit the model.

6. ERROR CORRECTION MODEL (ECM)

Error Correction Models (ECMs) is a category of multiple time series models that directly estimate the speed at which a dependent variable (Robin Best, 2008).

Y - Returns to equilibrium after a change in an independent variable - X. ECMs are useful for estimating both short term and long term effects of one time series on another.

ECMs are useful models when dealing with integrated data, but can also be used with stationary data.

The dynamic relation established by the model with correction of error ECM is deducted from relation of long term rising from the method of Engel and Granger, the characteristics of the models with correction of the error is to combine in the same specification of the effects of that short term with those of the long term, thus all the information of long term on the level of variables is stored in the model (Judith, 2011). Around the long run relationship, the error correction model permits to integrate the short run fluctuations, if the coefficient comes negative it would change model in the long run equilibrium so with E-views the long run model was done the short run model.

Table 3: Error correction model (ECM)

Dependent Variable: DOP
 Method: Least Squares
 Date: 24/05/18 Time: 18:04
 Sample (adjusted): 2000Q1 2017Q4
 Included observations: 66after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.082806	614.2038	1.622068	0.1239
GDP	3.432410	1.94E-10	0.994922	0.0029
CPI	0.212108	5.152408	1.790498	0.0050
ER	2.201208	2.061207	0.252162	0.0029
M3	0.152115	5.022404	1.560445	0.0012

R(-1)	-0.085066	0.439025	-0.330257	0.0026
R-squared	0.056016	Mean dependent var		1488.290
Adjusted R-squared	0.430018	S.D. dependent var		2316.999
S.E. of regression	1749.268	Akaike info criterion		17.91847
Sum squared resid	79558393	Schwarz criterion		18.14976
Log likelihood	-272.7363	Hannan-Quinn criter.		17.99387
F-statistic	6.658312	Durbin-Watson stat		2.064655
Prob(F-statistic)	0.000790			

Source: Computed by Researcher using E-views

Table 3 shows that R(-1)= -1.085016, this means that as far as time is concerned, the errors will be corrected at time t. All independents variable were positive correlated to the domestic price. R² (0.056016) show the goodness of fit the model. This means that from 2000-2017 international oil price contributed 5% to the local oil price

DOP=0.082806+3.432410GDP+2.201208ER +2.201208CPI+0.152115-1.085066 (R-1). The findings of the ECM, which incorporate the effect of international oil price and domestic oil price, estimated through ECM testing approach.

7. CONCLUSION

It can be seen from the above results that the increase of the international oil price has a negative effect domestic price.

It means higher oil price could slow down the economic growth in Rwanda, reduce the total import and push up prices. Meanwhile it showed that facing the high oil price; authorities are more inclined to adopt tight monetary policy to curb inflation. In addition, there exist lag-effect of the oil price on the macroeconomy, the current oil price fluctuation will affect the economic situation in the next few years. Therefore, when investigate the influence of the oil price and formulate corresponding measures, we should not only consider the current situations, but also take the past, the future possibility into consideration.

8. RECOMMENDATIONS

The government has put a lot of effort on keeping the inflation low since independence and this is justified because it encourages high economic growth rate in the economy. Looking at the factors that affect inflation in the economy is vital as in this study because it enables the economists and policy makers adopt relevant policy measures to help in curbing inflation. It further broadens the understanding on the effects of inflation and how to deal with inflationary pressures.

Rwanda is an oil importing nation and hence the country suffers a lot when the international crude oil prices sky rocket and hence these prices are immediately felt in the whole economy. Petroleum products are key in the manufacturing and domestic industries and when there is no stability the economy is hit with several disturbances including inflation. The government should be prepared to make tax exemptions especially on the imported crude oil in order to reduce the adverse effect it has on the general public.

Despite the government introducing the price capping mechanism of oil products in 2014, the consumers have not been able to feel the real difference because of the cartels that exist in the oil industry. The industry has several unscrupulous players who have tainted the efforts made by the government. The government needs to further look at the ways to make the price cap work by putting further stringent measures on the players who do not adhere to the rules and regulations set and this will prevent the exploitation of the citizen.

The efforts made by the Rwanda government. The government needs to further look at the ways to make the price cap work by putting further stringent measures on the players who do not adhere to the rules and regulations set and this will prevent the exploitation of the citizen. The Monetary Policy Committee of the Central Bank (BNR), has had several measures to stabilize the Rwanda franc exchange rate and increase interest rates in order to reduce inflation levels in the economy. While maintaining a stable exchange rate is important. This will make worse problem to the BOP of the country since Rwanda import more than it exports and the current account deficit is huge. The measures taken by the Rwanda government agencies and policy makers must take into account the long run effects of the measures on the economy and not just one sector.

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