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Investigating the Link amongst the Main Macroeconomic Factors, Economic Growth and Crude Oil Price in Algeria

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Abstract.
We studied over the period of 1986 – 2016, the impact of crude oil price on economic growth and main macroeconomic factors in Algeria with vector autoregressive model and Granger causality. The variables were gross domestic product (GDP), gross fixed capital formation (GFCF), gross national expenditure (GNE), consumer price index (Inflation), real effective exchange rate (REER), oil production (OP), oil consumption (OC) and the realized volatility of crude oil price (Cop). We found unidirectional causality running from (Inflation) to (Cop), and this latest variable is affecting negatively the economic growth and the key macroeconomic factors.

Key words: *crude oil price, economic growth, main macroeconomic factors, vector autoregressive model, Granger causality*

JEL classification codes: *C32, O40, Q30*

Résumé.
On a étudié sur la période 1986-2016, l'effet du prix de pétrole brut sur la croissance économiques (CE) et les facteurs clés macroéconomique (FM) en Algérie avec le modèle de vecteur autorégressive et la causalité au sens de Granger. Les variables étaient le produit intérieur brut (GDP), la formation du capital fixe brut (GFCF), dépense national brut (GNE), l'indice de prix à la consommation (Inflation), le taux de change effectif réel (REER), production et consommation du pétrole (OP) et (OC), et la volatilité réalisé du prix de pétrole brut (COP). On a trouvé une relation bidirectionnelle entre (Inflation) et (Cop), cette dernière variable à un effet négatif sur (CE) et (FM).

Mots clés : *Le prix du pétrole brut, la croissance économique, les facteurs clés macroéconomique, le modèle de vecteur autorégressive, la causalité au sens Granger*

Codes de classification JEL: *C32, O40, Q30*

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1. Introduction.

Many natural resources-exporting countries, mostly oil-exporting ones are suffering from the resource. However, it has been perceived for many years that a huge number of oil- and mineral-exporting countries in the Middle East, Africa, and in Latin America recorded a poor social and economic development situation, more corruption, less equality, less political liberty, less education and health compared to other countries that are less dependent on such resources. This condition makes such countries cursed by their natural resources instead of being blessed. They were several clarifications for this harmful influence of natural resources such as Dutch disease, pro-cyclicality of fiscal policy, natural resource revenue volatility, and the poor quality of both political and economic institutions (**Chekouri et al., 2017**).

Global oil price are the most central external economic factor for the Algerian economy. Some modern theoretical literature has ignored the nature and the degree of the effect that oil price have on Algerian's economic growth and the correlation that exists between the GDP growth rate and oil price. The debate about the correlation between output growth in the Algerian economy and oil price should be founded on a formal economic and mathematical construct and built upon basic models of economic growth (econometric model). Otherwise, a purely qualitative and empirical analysis of recent topic will provide very short-term conclusions and may lead to the econometric dependencies that are unreliable with economic theory. (**Idrisov et al., 2015**). Therefore, we can answer the following problematic:

What is the effect of the crude oil price on the economic growth and the main macroeconomic factors in Algeria?

The goal of this paper is to analyse several papers that study the impact of crude oil price on the main macroeconomic factors. Also, define different correlations between the Algerian economy's output and global oil price from both short and long-term perspectives. Understanding this relationship and recognizing the basic procedure of the impacts that oil price have on economic development will allow for reconsideration of the reasons for the current slowdown in GDP growth and for a plan to accelerate it and to develop it. Also,

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this topic will be divided into 5 sections, introduction, literature review, data and methodology, empirical result, discussion and conclusion.

2. Litterature Review.

Rafiq et al. (2009) made a study about the impact of oil price volatility on key macroeconomic variables for the case of Thailand. They used Granger causality and the VAR model to examine the causal relationship between oil price volatility and other leading economic indicators during the period of 1993 Q1 to 2006 Q4. The variables were realized variance (oil price volatility), the growth rate of GDP, investment, interest rate, inflation, unemployment rates, trade balance and budget deficit. They found that GDP growth, investment, unemployment, and inflation are granger caused by oil price volatility. Also, the realized volatility of oil price has a significant and negative impact on the growth rate of GDP and unemployment, so the oil price volatility impacted negatively the economic activity growth and it also gives an increase in unemployment.

Hanabusa (2012) studied the change of volatility after 107th OPEC Ordinary Meeting and investigated the relationship between oil price and economic activities over the period 1991 to 2008 (data was monthly) in the case of Japan. He employed structured break, Granger causality of the VAR model for the variables of oil price changes with AR-EGARCH Model, the economic growth rate and the inflation rate. He concluded that the premium gasoline and regular gasoline were positive and significant, but the diesel was negative and statistically not accepted. Consequently, the volatilities of premium gasoline and regular gasoline increases from April 1999. The regular gasoline price was considered as the highest volatility series in this model. He said also that the high volatility of oil price may be related to the Iraq War, the economic growth of emerging countries and the increase in the investment in oils. Furthermore, he established in the short-run that there's relationship between oil price changes, economic activities and macroeconomic variable after the meeting.

Pradhan et al. (2015) did a research about the link amongst economic growth, oil price, depth in the stock market, real effective exchange rate, inflation rate and the real rate of interest for G20

countries over the period of 1961-2012. They used the Granger causality, panel VAR model (unbalanced panel) and panel VECM model to test the short and long-run relationship between variables. They made 3 VECM panel models (long-run causality) and they found in the both three models that the vector error correction of GDP rate was negative and significant and the crude oil price variable was negative and significant. They found also several bidirectional and unidirectional causalities between variables.

Vásconez et al. (2015) investigated the impact of oil shocks with a new-Keynesian framework for the case of the USA. The data were composed of real GDP, the real private fixed investment, the hours worked inflation, the oil used in production and the federal funds rate during the period 1984Q1 to 2007Q1. They employed prior and posterior distribution of structural parameters, and they found that the effect of the oil shock with impulse response generate an upsurge of the oil price, which will cause a direct diminution of oil consumption, but with a limited reaction to domestic price.

Chekouri et al. (2017) examined the relationship between oil export's incomes and economic growth in Algeria over the period of 1979Q1 to 2013Q4. The endogenous variables were log real output created from natural Logarithm (ln) of (GDP/CPI) and log real exchange rate (ln) of (ET/CPI), GDP was nominal gross domestic product, CPI was the consumer price index, and ET was the nominal exchange rate. They used the exogenous variables as foreign output (represent the total of trade share * number of trades) and the oil income represented by (ln) of (nominal price of oil* oil production) for this study and they employed the procedure of cointegration for the vector autoregressive model with weakly exogenous variables (VARX) and they confirmed their results with impulse response. They found that there's a strong positive relationship between oil revenue and long-run growth. Also, they studied the relationship amongst volatility of oil income and economic growth performance with squared oil revenue series (realized volatility), they observed a high income volatility between the first positive oil shock of 1973, the crash of 1986 and during the second gulf war (1990-1991), as they confirmed the existence of the resource curse hypothesis.

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Shi and Sun (2017) investigated the influence of oil price on economic development with giving consideration to local price alteration due to rules. The variables were the output (industrial sales and industrial production index), labour (number of employees in industrial enterprises), the capital (constructed from fixed asset investment), the oil dependency (the share of oil imports in domestic oil consumption), the crude oil import price and fuel price distortion. They employed the ARDL procedure to estimate the short and long-run coefficient over the period (monthly) of 2005- 2012. They concluded the significant estimate suggests that for both oil import price and price distortion can play an important role in the economy. In the long-run, all variables, except oil dependency were significant and maintain the same sign as in the short run.

Millard et al. (2017) examined the effect of the fall in the oil incomes and oil price reductions (the land royalty payments in the oil and gas sector). They constructed several scenarios for the model price-growth, which is based on neoclassical economic theory. The variables were GDP, household income, household consumption, investments, labour expenditures, royalties, percentage of GDP and domestic production. They made scenarios for 2040, which was based on the baseline of 2014-2015 with dynamic computable general equilibrium model, as a conclusion, they made a sensitivity analysis accounts for the magnitude of the shock and timing of recovery and they concluded for a significant influence of shock in the price of oil on GDP in the first years, then on the first five years, they found a decrease in GDP by 2.1% in their most representative shock scenarios. However, in another scenario, they established severe falls in GDP over the first five years, which will be mitigated somewhat in the long run as the oil price rises. In the long-term (until the scenarios of 2040) the negative effect on GDP will continue due to the oil price shock that was in 2014-2015 and will worsen if there is a prolonged shock.

Mohammed et al. (2017) studied the interaction amongst natural resource rents and institutional quality for the Algerian economy over the period of 1984 to 2013. They employed the cointegration procedure over the variables of corruption index, oil rents as percentage of GDP, interaction (oil rents with democratic accountability) and the manufacture exports as percentage of total

exports. They established from the correlation matrix and cointegration analysis that there is a negative association between corruption and oil rents, so an increase by 1% in oil rents will upsurge the level of corruption in Algeria by 0.16% (because according the International Country Risk Guide governance indicators corruption scores range from 1 to 6 so with higher values indicating less corruption and low score means higher corruption).

Mohaddes and Pesaran (2017) investigated the influence of lower oil price in the global macroeconomic factors in the case of 27 countries over the period from February 1946 to March 2016. They also examined the effects of low oil price on the US economy, especially over the post period of 2008, and they employed the global VAR or global quarterly econometric model (developed by **Mohaddes and Peasaran, 2016**) for the variables of GDP, inflation, real exchange rate, short and long-term interest rates, oil production and oil price. They established with the generalized impulse response formulated from GVAR that there's a negative short-term oil price shock (oil price changes), which will allow an increase on the global real equity price and a reduction in the interest rates. Besides, they showed that the fall in long-term interest rates across the major economies in the world following an oil price decline is due to a strong disinflation pressure in all major net oil importers. In the case of the USA economy, they concluded that the relationship between oil price and real equity price was stable over the period 1946 to 2016, but it was not statistically accepted. However, since the global financial crisis in 2008, a positive relationship has been appeared between oil and equity price. Consequently, these results suggest that the link amongst real oil and stock price was not stable over time, but this change should not be taken as evidence that lower oil price are bad for the real economy. They concluded with the ARDL regression, that the estimated coefficient of the oil price variable on the real dividend variable was negative and significant in all sub samples, even in the post-2008 period, so this result suggests that the lower oil price have been good for the US economy, even if we only consider the period after the Great Recession.

Cross and Nguyen (2017) examined the link between the global oil market (price) variations (shock) and GDP in the case of

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China over the period of 1992Q1 to 2015Q3. They used the Bayesian VAR for the variables of real GDP, real oil price, oil demand and oil supply and they found that the model of vector autoregressive with stochastic volatility delivers a better fit as compared to its constant counterparts. Besides, the structural analysis showed that the influences of different global oil price shocks on China' output are often small and not persistent, while the oil supply and specific oil demand shocks tend to have negative actions in China's GDP growth. Also, they found that the Chinese output shocks have not a statistical effect on price or quantity movements within the global oil market.

Raza et al. (2017) studied the relationship between oil shocks, U.S inflation and major commodity price indices during the period of January 1970 to December 2016 and they employed the non-linear autoregressive distributed lag (ARDL) developed by **Shin et al. (2014)** for the variables of crude oil, inflation rate on major commodity price and major commodity indices specifically energy, beverages, vegetable oil and meals, grains, food items, raw material, fertilizer, industrial metals and precious metals. They established the existence of nonlinear long-run relationship between commodity price indices, oil price and inflation shocks, and they found that the oil price shocks had a positive impact on all commodity price indices. However, they showed that all the commodities react weakly to a negative oil price shock, but in the long-run, a positive oil price shock has a positive influence and statistically accepted coefficient on energy, beverages, vegetable oil and meals, fertilizer and precious metals indices. This suggested that these supplies can deliver significant protection against losses occurring due to oil price changes, but the oil price shocks have a weak and statistically insignificant effect in the case of grains, food items and industrial metals, which implied that these supplies will react weakly to a positive oil price shock and this latest has a negative impact on the raw material only.

Gbatu et al. (2017) investigated the impact of oil price shocks on key macroeconomic variables in the case of Liberia over the period of 1980 to 2014. They employed the procedure of ARDL for the variable of employment, GDP, exchange rate, oil price changes, positive oil price changes, negative oil price changes,

scaled oil price increase, scaled oil price decrease. They concluded for the non-existence of cointegration term, so the oil price shocks didn't affect the level of economic activities in the long-run. However, in the short-run, they found in the 1st equation that the oil price and the exchange rate had an insignificant coefficient but the employment had a significant coefficient and positive effect on GDP. However, in the 2nd and 3rd equation the employment, the positive oil price changes and scaled oil price increase had a significant and positive impact on GDP, but the exchange rate was still insignificant. Also, they established with the Granger causality test with an unrestricted VAR that the positive oil shocks cause granger the real GDP and employment, but there's no causal relationship with the exchange rate.

Amarfio et al. (2017) determined the factors that may impact the crude oil price with multiple regression analysis. The authors focussed on the variables of crude oil price per day, crude oil production, crude oil consumption, OPEC production, natural gas consumption, refinery capacity and oil war with using the multiple OLS to test their six hypotheses, which was built on explanatory variables and they applied the goodness of fit statistics and model selection criteria during the period 1965-2015. They concluded that the presence of dummy variable (oil wars) was very significant and the global oil and OPEC production rates had a negative relationship with oil price, in this case, the OPEC's had a gradual plateau and the decrease in the oil production from 1972 to 1975 caused a sharp spike in oil price. However; the price became fairly stable when the oil production rates began to increase after 1975.

3. Data and methodology.

The variables are transformed into natural logarithm, and are mainly from the World Bank database. In this study, we used the capital (Gross fixed capital formation), the government expenditure (Gross national expenditure), the economic growth (gross domestic product), and the inflation rate (consumer price index per year %) and real effective exchange rate index. However, the crude oil price was from a database of West Texas Intermediate (WTI) - Cushing, Oklahoma, Dollars per Barrel and is from U.S Energy Information

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Administration. Also, the variables of oil production and consumption were from British petroleum database.

Table 01. **Definition of variables**

Variables	Names	Unit of measure
COP	Crude oil price	Dollars per barrel
GDP	Gross domestic product	Constant 2010 dollars
GFCF	Gross fixed capital formation	Constant 2010 dollars
GNE	Gross national expenditure	Constant 2010 dollars
Inflation	Consumer price	Annual percentage
OC	Oil consumption	Barrels per year
OC	Oil production	Barrels per year

Source: done by the researchers.

This study is done over the period of 1986-2016, and we can make the appropriate model as following:

$$Y_t = a_n + b_n * trend + \sum_{i=1}^{p} c_{ni}\, cop_{t-i} + \sum_{i=1}^{p} d_{ni}\, gdp_{t-i} + \sum_{i=1}^{p} e_{ni}\, gfcf_{t-i} + \sum_{i=1}^{p} f_{ni}\, gne_{t-i} + \sum_{i=1}^{p} g_{ni}\, inflation_{t-i} + \sum_{i=1}^{p} h_{ni}\, oc_{t-i} + \sum_{i=1}^{p} j_{ni}\, \mathrm{op}_{t-i} + \sum_{i=1}^{p} k_{ni}\, \mathrm{reer}_{t-i} + V_{nt}$$

n: number of variables (1…8); $\mathbf{Y_t}$: each variable will be as an endogenous variable; **P**: number of lags.

COP indicates the world crude oil price.

GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making

deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant local currency.
GFCF is the gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.
GNE is the gross national expenditure (formerly domestic absorption) is the sum of household final consumption expenditure (formerly private consumption), general government final consumption expenditure (formerly general government consumption), and gross capital formation (formerly gross domestic investment).
Inflation indicates the changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, like yearly. (**World Bank**).
OC is the oil consumption.
OP is the oil production
REER is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.
$a_{(1...8)}$ are the constant variable of each VAR equation that represents all variables, which are not included like interest in short and long-term, labour force, investment…etc.
The trend represents the level of technological progress.

First, we will perform the unit root test with Augmented Dickey-Fuller and Phillips-Perron to show if the variables are integrated in the same order or not. Next, we will select the optimal VAR model by using the Akaike, Schwarz and Hannan-Quinn criterion, which will give us an optimal VAR model with its number of lags included, then, we shall estimate the fitted model with all variables. After that, we shall analyse several tests of residual and autoregressive root to see if the VAR model is stable or not. Afterward, we will make a conclusion and discussion about the result.

4. Empirical results.

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Our findings showed that all variables are stationary into first difference except GDP, which was stationary with second difference and Cop was stationary on the level (because it's estimated with realized volatility). Consequently, we cannot apply the procedure of the cointegration or the bound test of Fisher because the variables have not the same number of integration.

Therefore, we found with the criterion that the optimal VAR model is with two lags.

4.1. The model residual and diagnostics analysis.

First, we initiated the investigations with the graph of the inverse roots of the characteristic AR polynomial (**Lütkepohl, 1991**). The autoregressive root graph shows that the model VAR is stationary and stable, because we have all roots lie inside the unit circle, so this result is good and it may give us consistent estimators.

Then, we tested with multivariate normality, if the residuals are normally distributed or not. Our outcomes showed that the VAR residuals are normally distributed and we concluded for the acceptation of the null hypothesis (normality distribution) and the rejection of the alternative hypothesis.

4.2. The coefficient diagnostic.

The R^2 (R-squared) or the determination coefficient was high, so we can say that the exogenous variables explained almost more than 91% of the endogenous variables (in almost all equation). These statistics showed that there's a strong and positive relationship between variables.

The F coefficient (Fisher statistics) showed that we cannot accept the null hypothesis and we could say that almost all the models are well specified, so the VAR model can be generally stable.

4.3. The pairwise Granger causality tests.

We established with the Granger causality at the lag 2 that not only they were several bidirectional causalities at the level of 10%, but they were numerous unidirectional causalities at the level of 5% as well. Therefore, these findings are on lines with the main literature reviews that investigate the relationship between the crude oil price, economic growth and the main macroeconomic variables.

4.4. The model.

From the Granger causality test, we showed that the variable of realized volatility of crude oil price can only affect the variable of inflation, so there's a unidirectional relationship running from (COP) to (Inflation). However, in the model, the coefficient was negative, so an increase by 1 unit in COP can decrease the elasticity of Inflation by 0.11 (COP_{t-1}) and by 0.04 (COP_{t-2}), indicating that the level of price consumer will decrease with the increase of crude oil price. However, almost all variables used in this model were not statistically accepted due to their low coefficient, but we can say that the Cop has a negative effect on almost all variables, so an increase by 1 unit in COP_{t-1} can decrease the elasticity of GDP, GNE and Inflation by 0.005, 0.008 and 0.11, respectively, and a rise by 1 unit in COP_{t-2} can reduce the elasticity of GDP, GNE and Inflation by 0.0005, 0.004, 0.04 respectively, indicating a lower crude oil price can have a serious damage on Algerian economic as it can lead to industrial and socio-economic instability and it may create financial crisis. This result is in line with **Rafiq et al. (2008), Mohaddes et al. (2017) and Millard et al. (2017)**.

5. Discussion and conclusion.

This paper presents an empirical investigation of the impact of oil price volatility on key macroeconomic variables in Algeria by using vector autoregressive systems. We find that the whole model was not statistically accepted, but we provided some explanation for this. We did also the pairwise Granger causality and we found that there's several bidirectional and unidirectional causality between variables as it's described before. Then, we built the system of vector autoregressive composed of two lag variables and we found that the model is well specified from the several tests of the coefficient and residual diagnostic.

We provided the results from the VAR (2) estimation which was verifying the relationship between the key macroeconomic factors and the oil sector. We concluded that the Algerian economy is mainly depending on the crude oil price, so a high volatility of this variable can impact positively the socio-economic development which can lead to improving the industrial, service and agricultural sectors. However, the crude oil price are now attaining a low level and it's starting to influence negatively the Algerian economy by

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increasing the level of inflation and consumer price such as the price of the car, food, and essential product price…etc. Also, this low level of crude oil price will decline the growth rate of gross domestic product and it will lead the Algerian economy to depression and high level of inflation.

Furthermore, if the Algerian government decided to continue to depend only on the oil sector, they must shift the current energy policy implication which will lead to stabilize the domestic oil price through several supports and it may help to boost the investment, employment, and growth.

On the other hand, the economy of Algeria cannot continue to rely on fossil fuel energy and its price to stabilize its socio-economic situation. Therefore, the country must diversify its government structure by focussing on other sectors such as agriculture, tourism, service or energy and maybe in the future, these sectors will have a key role to play in the development of economic growth and reduce the financial crisis in the country.

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Appendix.

Table 02. Unit root test of realized volatility of COP

Phillips-Perron			Augmented Dickey-Fuller			
Models	On level	1st difference	Models	On level	1st difference	Decision

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3	-3.88**	…	3	-4.05**	…	I(0)
2	-4.01***	…	2	-4.13***	…	I(0)
1	-3.23***	…	1	-3.23***	…	I(0)

Source: Done by the researchers on Eviews 9

Table 03. Unit root test of GDP

Phillips-Perron				Augmented Dickey-Fuller				
Models	On level	1st dif	2nd dif	Models	On level	1st dif	2nd dif	D
3	-2.49	-4.17**	-8.58***	3	-3.23	-4.09**	-8.24***	I(1)
2	1.43	-3.74***	-8.68***	2	1.05	-3.68***	-8.33***	I(1)
1	4.44	-1.61*	-8.42***	1	3.10	-3.96	-8.42***	I(2)

Source: Done by the researchers on Eviews 9

Table 04. Unit root test of GFCF

Phillips-Perron				Augmented Dickey-Fuller				
Models	On level	1st dif	Without trend	Models	On level	1st dif	Without trend	D
3	-5.28***	-4.85***	-4.85***	3	-2.57	1.54	1.54	I(1)
2	-2.74*	-4.40***	-4.99***	2	-2.97*	-2.97*	-4.99***	I(1)
1	-2.72***	-4.54***	-5.03***	1	2.52	2.52	-5.03***	I(1)

Source: Done by the researchers on Eviews 9

Table 5. Unit root test of GNE

Phillips-Perron				Augmented Dickey-Fuller				
Models	On level	1st dif	Without trend	Models	On level	1st dif	Without trend	D
3	-3.30*	-4.96***	-4.96***	3	-3.11	-4.96***	-4.96***	I(1)
2	1.55	-4.42***	-5.10***	2	-2.13	-1.46	-5.10***	I(1)
1	1.98	-3.25***	-5.15***	1	2.78	-0.76	-5.15***	I(1)

Source: Done by the researchers on Eviews 9

Table 06. Unit root test of Inflation

Phillips-Perron	Augmented Dickey-Fuller

Models	On level	1st dif	Models	On level	1st dif	D
3	-2.67	-7.55***	3	-1.79	-7.51***	I(1)
2	-2.43	-7.69***	2	-1.63	-7.65***	I(1)
1	-1.11	-7.83**	1	-0.85	-7.79***	I(1)

Source: Done by the researchers on Eviews 9

Table 07. Unit root test of OC

Phillips-Perron			Augmented Dickey-Fuller			
Models	On level	1st dif	Models	On level	1st dif	D
3	-1.19	-3.96**	3	-1.02	-3.97**	I(1)
2	0.66	-3.82***	2	1.02	-3.80***	I(1)
1	2.72	-3.00***	1	2.03	-1.89*	I(1)

Source: Done by the researchers on Eviews 9

Table 08. Unit root test of OP

Phillips-Perron			Augmented Dickey-Fuller			
Models	On level	1st dif	Models	On level	1st dif	D
3	-1.10	-3.27*	3	-3.36*	-3.22*	I(1)
2	-1.68	-3.15**	2	1.28	-2.42	I(1)
1	0.75	-3.12***	1	0.55	-3.10***	I(1)

Source: Done by the researchers on Eviews 9

Table 9. Unit root test of REER

Phillips-Perron			Augmented Dickey-Fuller			
Models	On level	1st dif	Models	On level	1st dif	D
3	-6.07***	-4.79***	3	-2.75	-2.16	I(1)
2	-11.87***	-4.18***	2	-2.73*	-2.07	I(1)
1	-2.29**	-3.88***	1	-1.06	-2.15**	I(1)

Source: Done by the researchers on Eviews 9

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(***), (**), (*) Show that the null hypothesis would be rejected respectively at the level of 1%, 5% or 10%, so there's no existence of unit root and the variables are stationary.

Table 10. The optimal VAR model

Lag	Log L	LR	FPE	AIC	SC	HQ
0	184.919	NA	$1.21*10^{-15}$	-11.649	-10.895	-11.413
1	352.478	219.559*	$1.21*10^{-18}$	-18.791	-15.019*	-17.610
2	**447.310**	**71.941**	$\mathbf{6.14*10^{-19}}$	**-20.917***	**-14.128**	**-18.791***

Source: Done by the researchers on Eviews 9

*, indicate lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level); **FPE**: Final Prediction error; **AIC**: Akaike information criterion; **SC**: Schwarz information criterion; **HQ**: Hannan-Quinn criterion

Table 11. The VAR (2) model estimation

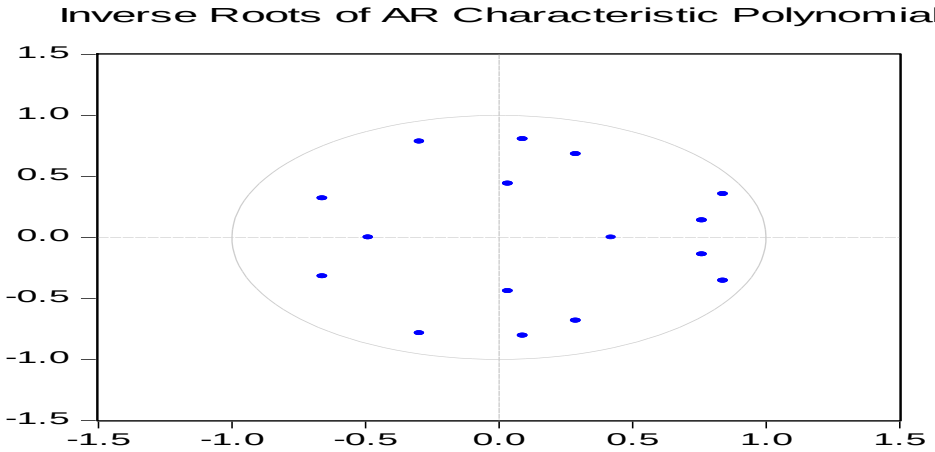
Var	Gdp	Gfcf	Gne	Infl	Oc	Op	Reer	Cop
Gdp_{t-1}	0.123	0.727	0.391	-6.897	-0.602	-0.425	3.743	29.098
t-stat	0.376	0.587	0.436	-0.386	-0.505	-0.404	1.098	0.273
Gdp_{t-2}	0.718***	0.833	1.106	-22.987*	1.511	1.141	-0.310	36.052
t-stat	2.925	0.898	1.645	-1.722	1.694	1.449	-0.121	0.453
$Gfcf_{t-1}$	-0.188	0.557	-0.071	-1.780	0.658	-0.642*	-0.473	-20.61
t-stat	-1.683	1.322	-0.232	-0.293	1.623	-1.793	-0.408	-0.570
$Gfcf_{t-2}$	0.066	0.206	0.100	-1.280	0.092	-0.261	1.529	49.399
t-stat	0.516	0.428	0.288	-0.184	0.198	-0.639	1.152	1.194
Gne_{t-1}	0.586	0.347*	0.456	-2.367	0.334	1.153	0.653	25.151
t-stat	-0.184	-1.765	-1.684	1.091	-1.358	0.527	-1.250	-1.627
Gne_{t-2}	-0.184	-0.929*	-0.643	8.270	-0.688	0.235	-1.811	-73.49
t-stat	-1.323	-1.765	-1.684	1.091	-1.358	0.527	-1.250	-1.627
$Infl_{t-1}$	0.004	0.010	-0.011	-0.607**	0.001	0.011	-0.017	1.667
t-stat	1.031	0.604	-0.881	-2.328	0.085	0.743	-0.359	1.073
$Infl_{t-2}$	0.009**	0.018	0.003	-0.316	-0.019	0.012	0.051	2.690*
t-stat	2.163	1.125	0.263	-1.347	-1.222	0.898	1.141	1.923
Oc_{t-1}	-0.230***	-0.767***	-0.208	13.65***	0.209	-0.217	-1.78**	-8.124
t-stat	-3.199	-2.825	-1.059	3.492	0.801	-0.940	-2.393	-0.348
Oc_{t-2}	-0.268**	0.713	0.600*	2.803	0.263	-0.96**	0.994	-13.96
t-stat	-2.096	1.477	1.717	0.403	0.568	-2.337	0.748	-0.337
Op_{t-1}	0.099	-0.172	-0.139	3.479	0.295	0.763**	-1.238	16.620
t-stat	1.032	-0.474	-0.528	0.663	0.843	2.466	-1.236	0.532

Op_{t-2}	-0.135	0.105	0.035	3.086	-0.536	-0.268	0.381	-25.90
t-stat	-1.512	0.312	0.145	0.636	-1.652	-0.938	0.410	-0.895
$Reer_{t-1}$	-0.081**	0.068	0.121	-0.070	-0.189	-0.093	0.582	5.75
t-stat	-2.195	0.487	1.202	-0.035	-1.409	-0.790	1.514	0.480
$Reer_{t-2}$	0.070*	0.151	0.139	-0.560	-0.122	-0.010	-0.388	-4.137
t-stat	1.721	0.987	1.254	-0.253	-0.826	-0.083	-0.919	-0.313
Cop_{t-1}	-0.001	-0.005	-0.008***	-0.117**	-0.002	-0.0002	-0.009	-0.011
t-stat	-1.058	-1.489	-2.980	-2.067	-0.548	-0.083	-0.877	-0.035
Cop_{t-2}	$-8.27*10^{-5}$	-0.0005	-0.004	-0.046	0.0002	$-6*10^{-5}$	0.0002	0.089
t-stat	-0.059	-0.097	-1.294	-0.611	0.059	-0.014	0.015	0.197
C	-0.266	-19.715	-11.647	554.1***	-25.6*	-20.71*	-68.09*	-962.4
t-stat	-0.075	-1.471	-1.198	2.873	-1.987	-1.819	-1.846	-0.837
Trend	0.009**	0.003	0.006	0.102	-0.03**	-0.004	-0.08**	-0.170
t-stat	2.616	0.235	0.622	0.500	-2.760	-0.413	-2.247	-0.139

Source: Done by the researchers on Eviews 9.

(***), (**), (*) Show that the null hypothesis would be rejected respectively at 1%, 5% or 10%, so the coefficient is significant.

Graph 01. The VAR model stationarity



Source: Done by the researchers on Eviews 9

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Table 12. VAR residual normality test

Normality tests	**Chi-square (joint component)**	**Probability**
Skewness	10.462	0.234
Kurtosis	6.291	0.614
Jarque-Bera	16.753	0.401

Source: Done by the researchers on Eviews 9

Table 13. Pairwise Granger Causality test at lag 2

Null Hypothesis	F-Statistic	Prob
Inflation does not Granger Cause Cop	0.381	0.687
Cop does not Granger Cause Inflation	4.698**	0.019

Source: Eviews 9.