The effect of oil price shocks on the Algerian economy

Dr. Yasmina Guechari
Université Biskra

Abstract :

The aim of this study is to investigate the impact of oil price shocks on the Algerian economy over the period 1980 to 2017, using a vector auto-regression model (VAR), macroeconomic variables and different oil price shocks measures. The results reveal: (i) the oil shocks has a limited impact on the Algerian economy, as, the oil price shocks explain only 0-10.7% of the change in the different macroeconomic indicators. (ii) The positive oil shocks have more explanatory power on the changes in macroeconomic variables than negative oil shocks; this means that the Algerian economy more affected by positive oil shocks than the negative shocks. (iii) Most of the macroeconomic variables respond in a volatile manner to oil price volatility, as, more than 8% and 6% of the variation in output and net export respectively attributed to the oil price volatility.

Keywords: oil price shocks, macroeconomic variables, vector auto-regression model, Granger causality test, Variance decomposition, Algeria

الملخّص:

الهدف من هذه الدراسة هو البحث في أثر الصدمات النفطية على الاقتصاد الجزائري خلال الفترة الممتدة من 1980 الى 2017 باستخدام نموذج الانحراف الذاتي (VAR)، متغيرات الاقتصاد الكلي ومؤشرات تقيس الصدمات النفطية. تشير النتائج القياسية لهذه الدراسة الى: (1) تأثير الصدمات النفطية على الاقتصاد الجزائري محدود جدا حيث ان الصدمات النفطية تفسر 0−10% فقط من التغير في مختلف مؤشرات الاقتصاد الكلي. (2) تتمتع الصدمات النفطية الموجبة بقدر أكبر من القوة التفسيرية للتغيرات في متغيرات الاقتصاد الكلي من الصدمات النفطية السالبة؛ وهذا يعني أن الاقتصاد الجزائري أكثر تأثرا بالصدمات النفطية الموجبة من الصدمات السالبة. (3) تستجيب معظم متغيرات الاقتصاد الكلي بصفة متقلبة لتذبذب أسعار النفط، وتنسب 8% و6% من التغير في الناتج المحلي الإجمالي وصافي الصادرات على التوالي الى تقلب أسعار النفط.

الكلمات المفتاحية: صدمات اسعار النفط، متغيرات الاقتصاد الكلي، نموذج الانحدار الذاتي، اختبار سببية قرانجر، تحليل التباين، الجزائر

Introduction :

Oil is a vital input in the production process of an economy, despite considerable increase in the use of alternative sources of energy, oil still one of the strategic commodities in modern economy. Oil price fluctuations affect the real economic activities on both demand and supply side, the supply side effects related to the firm's cost of production, and the demand side effect stems from consumption and investment. For instance, oil price increase mean higher input costs (higher production cost) this lead to a contraction in supply as the firms cut production in one hand. In the other hand, higher production cost lowers the rate of return on investment, which affect investment demand negatively.

In addition, oil price hikes increase the product prices, which in turn decrease the consumption demand; Fernald and Trehan (2005) indicate that higher oil prices like an increase in tax on consumption, as, the extra payement that consumers make cannot spent for the demand of other consumption goods. All these factors have the combined impact of slowing economic growth. While, lower oil prices means lower production cost, this stimulate firms production and the household consumption. However, the reallocation effect and the adjustment costs of the labor market (which is the result of downward rigidity of nominal wages) muddled the first effect. The opposite effect of these factors lead to the fact that lower oil price do not lead to rise in the output.

Since the 1970s, a considerable number of studies have attempted to investigate the relationship between oil price and economic activities. The first research in this issue was the pioneering work by Hamilton (1983), in this study Hamilton looked how oil prices affected U.S. economy over the period 1948-1981, the results indicated that every US recession in this period except the (1960-1961 recession) has been preceded, typically with a lag of three-four months of dramatic increase of oil prices. Since then, a number of researches have supported and extended Hamilton's results. Mork (1989) extended the data set to1988 and examined the effect of both upward and downward movement of oil price on GNP growth in US, author found an asymmetric effect of oil prices on economic activities: oil price increases are associated with lower output but oil price decreases do not lead to higher growth of output. The reasons for such asymmetry attributed to the reallocation effect and the adjustment costs. In another work on US economy, Gisser and Goodwin (1986) found a significant impact of crude oil prices on US output, this impact exceeded even the impact of monetary and fiscal policies.

Using the OECD data, Burbridge and Harrison (1984) found that an increase in oil price have a high negative effect on the industrial production of UK and USA, but small negative impact on the other OECD countries (Canada, Germany, Japan). The results also show a negative relationship between oil price shock and the selected macroeconomic indicators. Mork and Olsen (1994) used the data of seven OECD countries over the period 1967Q3 to 1992Q4 to examine the macroeconomic response to oil price increases and decreases. To do so, they estimated the bi-variate and partial correlations within a reduced form macroeconomic model. The results indicate significant and negative correlation between oil price increases and GDP for Canada, Germany, France, Japan UK and USA, but positive for Norway. Authors found also a positive correlations between oil price decreases and GDP for all countries under study, but significant only in the case of Canada and USA.

As mentioned above the oil is an important material in production process, it can have an effect on inflation, investment employment and output. An oil price shock can cause inflation rise and lower investment demand by rising the production cost. It also affect employment as the increased inflation lead to fall in the demand and this, in turn, lead to cut production, which can create unemployment (Loungani 1986). The impact of oil price on inflation and economic growth was studied by Cunado and Gracia (2005), using quarterly data over the period 1975Q1-2000Q2 of the six Asian countries (namely Japan, Malaysia, Singapore, South Korea, Philippine and Thailand). The results of this study show evidence of the significant impact of oil price on inflation and economic growth; the results also indicate the existence of the asymmetry effect of oil price on economic activities. Using US macroeconomic indicators and oil price volatility Guo and Kliesen (2005) examine the impact of oil price volatility on the US economy over the period 1984-2004. Authors found evidence of significant effect of oil price volatility on the selected macroeconomic variable such us fixed investment, consumption, employment and unemployment rate. The result also confirm that the explanatory variables do not forecast realized oil price volatility, which indicate that the variance of future oil prices reflect stochastic disturbances. Cologni and Manera (2008) used quarterly data of the G-7 countries over the period 1980Q1-2003Q4 to examine the impact of oil prices on inflation and interest rates. Authors found significant impact of oil prices on inflation, which can transmitted to the real economy by increasing interest rates.

Other research focused on the effect of oil prices on the exchange rates, as the oil price fluctuation not only affect the output and the prices in an economy, but also affect the currency exchange rate as shown by Cebula and Mechael (1980) and Hamilton (1996). Zhou (1995), Chaudhuri and Daniel (1998), Amano and Norden (1998) used panel predictive regression estimate to assess the role of real oil price in predicting real exchange rates over long horizons. Their results show that the real oil prices have significant power of forecasting real exchange rate. Lizardo and Mollick (2010) suggested that oil prices significantly explain movements in the value of US dollar (USD) against other currencies. Using G-7 countries data over the period 1972M1-2005M10, Chen and Chen (2007) investigate the existence of the long run equilibrium relationship between real exchange rates and real oil price. The result show evidence of the co-integration relationship between real oil price and real exchange rates. The oil price also affect the terms of trade, (Dohner, 1981) showed that an increase in oil price deteriorates the terms of trade for oil-importing countries, implying a wealth transfer from net oil importing countries to net-oil exporting countries.

Most of the studies mentioned above based on the data from oil-importing countries or the industrialized nations. Recently, Farzanegan and Markwardt (2009) use Iranian data (net oil-exporting country) to examine the impact of oil price shock on Iranian major macroeconomic variables. The result show evidence of positive relationship between oil price increase and output growth, the results also show an inflationary effect because of the appreciation of the domestic currency. Mehrara and Oskoui (2007), El Anshasy and Bradley (2012) indicate that the oil price shocks are the major cause behind the macroeconomic fluctuation in oil-exporting countries. In contrast, the finding of Iwayemi and Fowowe (2011) show that the oil price shocks did not have a major impact on most Nigerian (oil-exporting country)

macroeconomic variables. This means that the impact of oil price shocks on oil-exporting countries' economies appears to be ambiguous.

Few studies have focused on the economic implications of oil prices shocks on the Algerian economy, so this study conducts an empirical analysis of the effect of oil price shocks on the economic activities of one developing oil-exporting country (Algeria). The aim of this study is first, to shed light on how oil price fluctuations affect Algerian economy; second, to improve and extend the existence literature on this issue, and help to clarify this effect in the oil-exporting countries. Finally, investigate to what extent the recent decline in oil price affect the economic activities in Algeria. Based on the previous studies on oil exporting countries, and given the state of the Algerian economy, which depends mainly on oil exports, we expect to find a significant effect of oil price shocks on the Algerian economy, and the extent of this effect expected to vary depending on the nature and the trend of the oil price shock.

The organization of the rest sections is as follow: the next section provides the method of the study including the data and the econometric model used, section three presents the empirical results and discussion. Finally, the section four reports the conclusion and some recommendations.

II-Methods

II-1-Data

This paper uses the data from 1980-2017 for Algeria, the reason behind choosing of this period is the availability of the data, as well as the important changes in Algerian economy, and most of the oil shocks were happened within this period. The variables used in our model are real gross domestic product (y_t), government expenditure (G), Investment (INV), inflation (INF), real effective exchange rate ($REER$), net export (NX), and the unemployment (U). The data of these variables obtained from the International Financial Statistics (IFS) CD-ROM of July 2008, and from the socio-economics-database "Economic-Algeria Data Portal"; the table below give the description of the selected variables.

Table 1: data description

Variable	Description
y_t	Real Gross Domestic Product, is an inflation-adjusted measure of GDP[1]
G	The government expenditure that is the sum of government's recurrent and capital expenditure.
INV	Investment is calculated by the gross fixed capital formation as a percentage of GDP
INF	Inflation is computed as a percentage change in the consumer price index (CPI)
REER	Real effective exchange rate: is an average of the bilateral RERs between the country and each of its trading partners, weighted by the respective trade shares of each partner.
NX	Net export measure the difference between total exports and total imports.
U	The unemployment rate, gives the number of unemployed persons as a percentage of the labor force (the total number of people employed plus unemployed).

***Note**: real gross domestic product, government expenditure and net export expressed on billions of national currency.*

Where rop_t is the real oil price at time *t*, ROP_t^+ the real oil price increase, and ROP_t^- is real oil price decrease.

Used GARCH (1, 1) model we calculate oil price volatility, which we use as measure of the oil shock. This measure reflect both the time varying conditional variance of oil price changes forecasts as well as the unanticipated component of real oil price movement. The GARCH (1,1) model is as follow:

$$\sigma_t = \sum_{i=1}^{k} X_i \sigma_{t-1} + \varepsilon_t$$

$$\varepsilon_t = v_t\sqrt{h_t}, v_t \sim N(0,1)$$

$$h_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 h_{t-1}$$

We refer to the estimated volatility as *VOP*, which indicates the third measure of oil price shocks.

II-2-Methodology [2]

In this study, we use unrestricted vector autoregressive model, as the VAR gives a framework to evaluate the impact of particular variable on the other variables; and since all the variable we take are considered to be endogenous so no need to make any restrictions. First, we examine the stationarity of the selected variables, there are number of tests to examine the presence of unit roots, in this study we use the most popular Augmented Dickey-Fuller (ADF) test and the Philips Perron (PP) test. If the time series are non-stationary, so, there is no stability condition for VAR, in this case the cointegration tests and vector error correction model (VECM) are recommended to examine the relationship between the non-stationary variables.

After checking the stationary condition, we proceed to examine the causal relationship between oil price shocks and other leading macroeconomic variables. The causality imply when the variable X_t has explanatory power in the regression of Y_t; the variable X_t said to be granger-cause the variable Y_t if the inclusion of past value of X_t helps in better prediction the variableY_t. Given multi-variables VAR such equations (1) and (2) then, X_t does not granger-cause Y_t if $\tilde{a}_i = 0$.

$$Y_t = \acute{a}_0 + \sum_{i=1}^{n} \hat{a}_i Y_{t-i} + \sum_{i=1}^{n} \tilde{a}_i X_{t-i} + \grave{\imath}_t$$

(1)

$$X_t = \ddot{o}_0 + \sum_{i=1}^{n} \grave{u}_i Y_{t-i} + \sum_{i=1}^{n} \grave{e}_i X_{t-i} + v_t$$

(2)

Then, to examine the dynamic response of macroeconomic variables to different oil price shocks, we use the impulse response function (IRF). Finally, to investigate the contribution of oil price shock on the variation in the macroeconomic variables, we use the variance decomposition analysis.

III-Empirical results and discussion

III-1-Unit Root test [3]

Prior to estimating the model, we have to check the stationarity of our variables by testing for unit root hypothesis against stationarity alternative, using the augmented Dickey-Fuller (ADF) and Phillips-Peron (PP). The table 2 report the results the stationary test.

According to ADF test, PP test the inflation (*INF*), net export (*NX*) and all the oil price shock variables *(NOP, ROP$^-$, ROP$^+$ and VOP*) are stationary at level *I(0)*, so, the null hypothesis of a unit root in the level series is rejected for these variables. Both tests also suggest that output variable (*Y*), real effective exchange rate (*REER*), investment (*INV*), unemployment (*U*) are stationary in first difference *I(1),* while the government expenditure (*G*) only the PP tests supports stationary in first difference. The results indicate that the multiple individual time-series variables integrated of different orders, so, we do not conducted the cointegration tests. In addition to this, most of the variables are *I (0)* and differencing would be inappropriate (Hamilton, 1984). We therefore use the unrestricted VAR in levels.

Table 2: Stationary test for the fundamentals: ADF [4] and PP [5] tests

Variables	**ADF Levels**		**ADF First difference**		**PP Level**		**PP First difference**		**Decision**
	Intercept	Intercept + trend	Intercept	Intercept + trend	Intercept	Intercept + trend	Intercept	Intercept + trend	
Y	2.76	-1.35	-3.89*	-4.47*	2.56	-0.58	-3.82*	-4.51*	I(1)
G	0.98	1.79	0.33	2.07	3.09	0.02	-4.94*	-6.09*	I(1)
INV	-0.78	-0.89	-4.94*	-5.52*	-0.88	-0.39	-4.86*	-8.61*	I(1)
REER	-1.79	-1.69	-3.55**	-5.21*	-1.17	-1.59	-3.43**	-3.38**	I(1)
NX	-3.82*	-3.8**	-3.06**	-3.68**	-3.43**	-3.44**	-4.12*	-3.73**	I(0)
INF	-2.65***	-3.45***	-6.01*	-5.92*	-2.71***	-3.43**	-6.02*	-5.93*	I(0)
U	-1.15	-2.18	-3.78*	-3.9**	-1.09	-1.43	-3.8*	-3.92**	I(1)
NOP	-6.18*	-6.1*	-7.82*	-7.71*	-6.2*	-6.11*	-21.61*	-18.46*	I(0)
ROP	-5.29*	-5.38*	-7.54*	-7.42*	-5.32*	-5.38*	-26.01*	-25.85*	I(0)
ROP$^+$	-5.98*	-5.9*	-7.69*	-7.56*	-5.97*	-5.9*	-17.79*	-16.58*	I(0)
VOP$^-$	-5.34*	-5.29*	-8.69*	-8.58*	-5.3*	-5.22*	-22.94*	-28.51*	I(0)

***Note**: The asterisks *,**, ***, denote statistical significance at 1%, 5% and 10% level respectively.*

III-2-Granger causality tests results

We perform the Granger-Causality test in order to examine the causal relationship between the different measures of oil price shock with the selected macroeconomic variables; the table 3 report the results of the causality test. The empirical results show that the null hypothesis that oil shocks do not granger cause government expenditure, inflation and real exchange rate cannot be rejected when the oil shock measures are the net oil price change (*NOP*), real oil (*ROP*), oil volatility (*VOP*). The plausible explanation of the absence of the explanatory power between these variables is:

First, the volume of government expenditure cannot easily changed according to the oil export earnings, as for example, Algeria has a public health care system, which is accessible and free of charge to all citizens of Algeria. In addition, the education system in Algeria is also free for Algerians; and the most important factor is Algeria cannot lower its military expenditure as all of its borders are threatened; all these factors lead to the insignificant effect of the oil price changes on the volume of government expenditures. Second, the oil prices changes have no a direct effect on inflation rates, as inflation rate is mainly determined by the demand and supply, the monetary policy, as well as the intervention of central bank via the devaluation of the national currency. For instance is that what happened in two last years (the value of the dinar declined from 20% to 22% in 2015, then "around 3%" in 2016). Finally, the oil price change does not help in predicting and in the determination of the Algerian exchange rate as the Algerian dinar is a non-oil currency; in addition, the Algeria has control over the dinar exchange rate.

The finding also indicate that oil shocks granger cause net export, this can be explained by the fact that the oil account about 95% of Algeria's export revenues and because country is a member of OPEC, oil export quotas are stipulated based oil prices. The null hypothesis that oil shocks do not granger cause output cannot be rejected when the oil shock measures are net oil price change, positive real oil change. This is because Algeria is not an industrialized country, so the effect of the increase in oil prices on economic growth is insignificant. All oil price shock measures do granger cause the investment, this means that oil shock have a direct effect on Algeria investment, this because the lion's share of Algerian investments are the investment in hydrocarbons so negative or positive oil shock can have a significant effect on investment. The real oil prices increase and net oil prices is found to be granger cause the unemployment, this can be explained by the fact that increase in oil price in contrast to the oil importing countries, in oil exporting country it stimulates investment which lead to affect the unemployment in negative sense (lower the unemployment). Interestingly, we find evidence of asymmetric effect of oil shocks on some selected variables, as the negative oil shocks presented by negative real oil price changes (ROP^-) granger cause output and investment. This in contrast with the result indicated by some previous studies on developed economies, which indicate little or no significant impact of negative oil shocks on the macroeconomy (see for example Mork 1989).

Table 3: Granger causality tests

Null hypothesis: oil price shocks do not granger cause the different variables

Variables	*Oil price shock measures*			
	NOP	*ROP+*	*ROP-*	*VOP*
Output (Y)	1.07 (0.3536)	1.82 (0.1784)	2.49*** (0.1)	3.18** (0.0553)

Government (G) expenditure	1.38 (0.2654)	1.18 (0.3208)	2.16 (0.1332)	2.34 (0.1131)
Investment (INV)	3.74** (0.0355)	3.17** (0.0565)	7.74* (0.0019)	2.78*** (0.0771)
Net export (NX)	3.11*** (0.0591)	2.79*** (0.0831)	1.57 (0.2231)	2.99** (0.0644)
Real exchange rate (REER)	1.82 (0.1774)	1.37 (0.2696)	2.37 (0.1104)	1.16 (0.3261)
Inflation (INF)	0.87 (0.4252)	1.91 (0.1653)	1.49 (0.2424)	1.51 (0.2382)
Unemployment (U)	2.56*** (0.0934)	2.72*** (0.0785)	2.064 (0.1439)	1.57 (0.2226)

***Notes**: We give the F-statistic values of overall significance in the table; and the P-value is in parenthesis. * ** and *** indicate the rejection of the null hypothesis that vertical variable does not cause the respective horizontal variable to change, at 1%, 5% and 10% level of significance respectively.*

III-3-Impulse response functions

The figure 1 show the response of macroeconomic variables to shocks to net oil price change; from the figure we see the output has a sharp positive increase after the shock to the NOP measure, then it experiencing a small increase and decrease in the following years. Inflation and government expenditure also have a positive response to an oil shock results, which remains for ten periods, but the response of inflation is small. These results indicates that the output, government expenditure and inflation have a sustained positive reaction.

For the exchange rate, the oil shock initially worsened Algeria's real exchange rate, this deterioration lasts for 3 year, then it starts experiencing an increase until the response become zero. A more volatile response obtained for the net export and investment as we see they have a series of positive and negative response to the shock in oil price.

Net export show a sharp negative drop after the shock to the NOP measure and after the 2nd year there is a sharp increase in the response until the response become positive; then since the 5th year the net export witnesses a sharp decline until the response become negative again. Investment on the other hand has a sharp positive increase after the shock to NOP and from the 2rd year begin experiencing a decline until the response become negative, then since the 5th year, the investment show a sharp increase in response to the shock in NOP until the response become positive again. Finally, the unemployment has a negative response to oil shock, as we see a sharp negative decline in unemployment in response to oil shock.

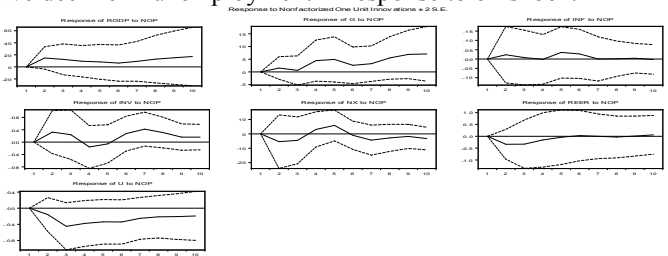

***Figure 1:** Response from RGDP, G, INV, NX, REER, INF and U to one unit Innovation +2S.E. in NOP.*

In the figure 2 we have the impulse response functions for the ROP^+ measure, the output has a sharp positive increase after the shock to the ROP^+ measure which lasts

for two years, then it experiencing a small decrease in the following two other years, after that the response become stable. A more volatile response obtained for the government expenditure, this variables witness series of positive increase and decline response to the shock ROP^+ until the 7th years the reaction become stable. This indicate that the response of real GDP and government expenditure is positive to the positive real oil price shock. The unemployment initially has an increase positive response to oil shock which is lasts for 2 year, then, it starts experiencing a decline until the response become negative so we can say that the positive oil shock decrease the unemployment rate. For the other selected variables, an oil shock results a negative response, which remains for different periods ranging from first to ten periods for exchange rate, while for the investment the negative response last for the sixth period after which the investment show a sustained positive reaction to oil positive shock. Inflation initially show a negative response to positive oil shock, this deterioration in inflation remain for three period, since then it starts increase until the reaction become positive. The oil shock initially worsened Algeria's net export this deterioration lasts for one period, then it stats experiencing an increase until the response become positive and stable. The negative reaction of net export to positive oil shock in the first period is mainly due to the fact that, Algeria import most it need on different good and the oil-export earnings cover only 85% of imports, only after the accumulation of oil earning the trade balance can record a surplus.

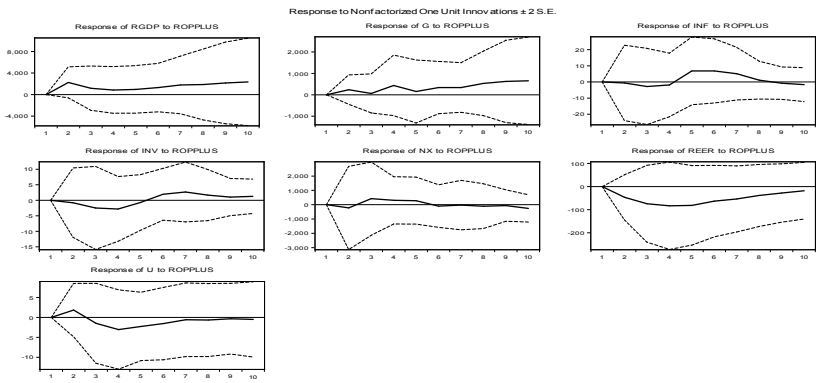

Figure 2: *Response from RGDP, G, INV, NX, REER, INF and U to one unit Innovation +2S.E. in ROP+.*

The figure 3 show the impulse response functions for the ROP^- measure, first, the Algeria's real GDP initially has a positive response to the oil shock, this positive effect of the oil shock on output remain for 3 period which follow the chock , then it experiencing a continuous decrease until the reaction become negative. The unemployment has a sustained negative response to oil shock, as we see a negative decline in employment in response to oil shock. While, the real exchange and investment has sustained positive reaction to the negative oil shock. A more volatile response obtained for the government expenditure, net exports and inflation, these variables witness series of positive and negative response to the shock ROP^-. The government expenditure initially has negatively reacted to the negative real oil price shock, this negative reaction remain only for three period since then the reaction becomes negative. For the net export, the negative oil shock initially worsen the

Algeria trade balance, this deterioration lasts for 3periods, then the reaction becomes positive, but not for long time as we see it lasts for two period then it starts to decrease until the response become negative again. Finally, the positive reaction of inflation to a negative oil shock is dominant as we see the negative response is too small and appeared in the fourth period and lasts for a short time before it becomes positive again

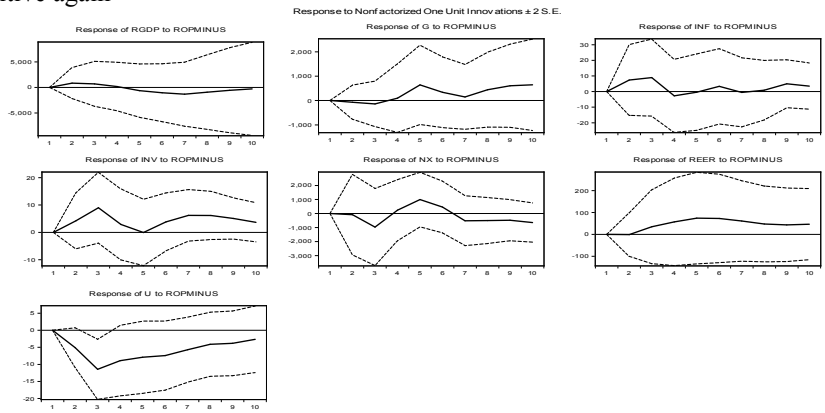

Figure 3: *Response from RGDP, G, INV, NX, REER, INF and U to one unit Innovation +2S.E. in ROP*˙.

According to the figure 4 the impulse responses show that, the Algeria's real GDP has two different response to the oil price volatility, negative response in the fifth first period and positive reaction in the other five periods. The unemployment has a sustained and stable positive response to oil volatility, while, the real exchange has sustained negative reaction to the negative oil price volatility. A more volatile response obtained for the government expenditure, net exports, investment and inflation, these variables witness series of positive and negative response to the oil price volatility. The highest response is that of investment, as we see in the graph a sharp negative decline in the first three period, then the response becomes positive for a short time horizon before it becomes negative again. The government expenditure initially has a small response to the oil price volatility, then since the 4th period this variable have an important positive and negative response to the shock, before it become stable in the three last periods. For the net export, it respond in a volatile manner to shock in oil price as there are sharp rises and decline in the response function. Finally, the inflation show small negative responses, which lasts until the 3rd period after which the inflation experience a large positive response for a long time horizon.

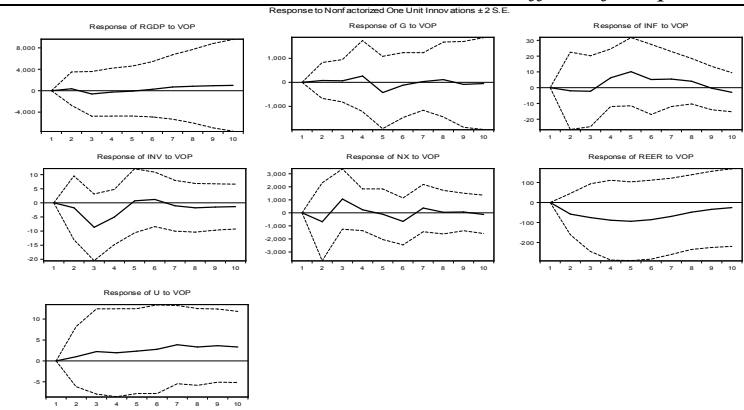

Figure 4: *Response from RGDP, G, INV, NX, REER, INF and U to one unit Innovation +2S.E. in VOP.*

III-4-Variance decompositions

The variance decomposition gives the proportion of the movement in the dependent variables that are due to their "own" shock and the shocks to other variables. Since we are interested on the impact of oil price shocks on the macroeconomic variables, so in the table we report only the result of variance decomposition for different variables attributable to oil shock.

The result in table 4 show the proportion of movement in the dependent variables that is due to the oil shocks, the result reveal that oil price shocks contributed to 0% to variation in all variables in the first period; this result is same for all oil price shock measures. Then, for the NOP measure, this proportion increased over time as we see the oil shock contributed to 3.97% to variation in output, and between 4.40-4.66% to variation in government expenditure, inflation and net export. The result also show that small proportion (less than 2.8%) of the innovation in investment, real exchange rate and unemployment is due to the oil shock. The variance decomposition for the second measure (ROP^{+}) presented in the column 4, the results reveal that oil price shock explain a significant proportion of variation in macroeconomic variables, with oil shock account for 4.48-10.7% of the variation of macroeconomic variables. With exception of the output and real exchange rate where only 2.40% and 3.40% of the variation in output and real exchange rate respectively are attributed to oil shock. The negative oil shock as measured by (ROP^{-}) have the smaller effect on macroeconomic variables as it is seen that oil shock contribute to less than 2.8% for all variables; except for the real exchange rate where oil shock account for 3.49 and 3.90% of the variation REER after the 5^{th} and 10^{th} period respectively. The sixth column contains the variance decomposition when oil shock measure is oil volatility (VOP). The results reveal that oil shock account for 5.45-8.62% of variation in most variables except real exchange rate and investment, where less than 2.3% of the innovation in these two variables attributed to oil shocks.

It is interesting to note that the differential effects of asymmetric specification of oil shock, as shown in the column 4 and 5, which indicate that the positive oil shocks have a more pronounced effect on macroeconomic variables than the negative oil

shocks, this means that the positive oil shock dominate the negative oil shock effect. In addition, the results reveal that the output and net export more affected by oil price volatility as shown that more than 8% and 6% of the variation in output and net export respectively is due to the VOP. While, for the other variables, the positive oil shock (ROP+) has the major effect as it explain a significant proportion (7.08%, 10.7%, 6.99%, 7.84% and 3.38%) of the variation in government expenditure, investment, inflation unemployment and real exchange rate respectively.

Table 4: Variance decomposition analysis

Dependent Variable	Period	NOP	ROP+	ROP-	VOP
Output	1	0.000000	0.000000	0.000000	0.000000
	2	1.334900	0.008715	0.708791	0.712186
	5	3.145473	1.849968	2.084654	8.637047
	10	3.973587	2.408097	2.567902	8.627225
Government expenditure	1	0.000000	0.000000	0.000000	0.000000
	2	0.076678	0.255139	0.023790	2.353217
	5	4.482236	6.931058	1.532601	4.340789
	10	4.648176	7.081835	1.613526	5.450758
Investment	1	0.000000	0.000000	0.000000	0.000000
	2	0.159977	2.556125	1.314332	0.367020
	5	1.645744	8.403895	2.181848	0.712139
	10	2.569033	10.70375	2.475238	2.299775
Net export	1	0.000000	0.000000	0.000000	0.000000
	2	0.701966	1.070432	0.263481	3.999881
	5	4.115836	4.081515	0.474988	5.448184
	10	4.407427	4.478892	0.972214	6.377512
Real exchange rate	1	0.000000	0.000000	0.000000	0.000000
	2	2.955354	2.683918	2.194833	1.810452
	5	2.744833	3.402234	3.491615	2.276401
	10	2.829432	3.386255	3.903361	2.186762
Inflation	1	0.000000	0.000000	0.000000	0.000000
	2	1.669060	0.507288	2.319370	5.804280
	5	4.806723	7.520230	2.438882	6.274909
	10	4.664502	6.993061	2.838806	5.720934
Unemployment	1	0.000000	0.000000	0.000000	0.000000
	2	0.008867	7.507900	1.194178	0.655050
	5	0.476153	5.117900	1.375065	4.408554
	10	1.81439	7.840522	1.955233	7.555497

IV-Conclusion and Recommendation

This study empirically examines the impact of oil shocks on key macroeconomic variables in Algeria using vector auto-regression system (VAR) over the period 1980 to 2017. Studying this topic using the Algeria data provide fresh insight into the oil-macroeconomy relationship in the case of net oil-exporting countries. The main conclusions reached from this study is as follow:

The results of the granger causality show causality running from oil shock to output, investment, net export and unemployment. However, the lagged value of oil shocks

have no a direct effect on the government expenditure, real exchange rate and inflation.

The results from impulse response function and variance decomposition tests confirmed and clarified the results of granger causality as they showed that in the long period, the positive oil shock has a positive effect on real GDP, government expenditure, investment, net export and inflation. This can be explained by the fact that an increase in oil prices caused a higher cash income; which increased the aggregate demand in the economy (through marginal propensity to consumption), this in turn stimulate investment in the country; and will increase government spending and this will ultimately lead to real GDP improvement. The positive and significant impact of oil shock on the inflation level (7.52% of the inflation changes is explained by oil shock) is mainly due to the fact that an oil prices increase lead to higher production costs in developed countries; and since Algeria imports all these needs of finished products as well as raw materials from the developed countries. In addition, the persistence of high oil prices create more domestic demand for imports, the combined effect of these factors lead to higher inflation resulting from imported inflation. The positive oil shocks have a positive significant impact (4.47% of the NX changes is explained by oil shock) on net export, this because oil exports account for over 90% of Algeria's total export and thus positive shocks in oil prices affect positively net export. The positive oil shocks have a negative and significant effect on the unemployment, this can be explained by the fact that the high oil prices lead to increase the government expenditure and stimulate investment (create a new projects), which was contribute significantly over time to the absorption of unemployment. Another important result is the negative effect of oil prices on real exchange rate; the plausible explanation of this is rising oil prices lead directly to higher inflation in the major trading partners of Algeria via higher import prices; and most of its imports are in euro. In addition to that; the exchange rate regime applied in Algeria; is the floating exchange rate orbit; which also characterized by a lesser degree of flexibility; these factors together lead the mild negative impact of oil shock on real exchange. It is interesting to note that the contribution of negative oil prices shock on different macroeconomic variables is not very significant this indicate that negative oil price shocks are not sufficient to explain the changes happen in the Algerian macroeconomic indicators, compared to the effect of positive shocks. This results confirm that Algerian economy is more affected by positive oil shock than the negative one, this can be explained by the different policies applied by Algerian government such as the government spending policy (see subsidy, education system and health care system are free....), investment policy and monetary policies which cannot be easily changed following oil prices collapse.

Another important conclusion of this study is, most of the macroeconomic variables respond in a volatile manner to volatility in oil price as they show series of rise and decline in the response functions; except for the real exchange rate, which is negative and unemployment that has a sustained positive reaction to oil price volatility. In addition, the results reveal that the oil price volatility explain quite important proportion in the change of real GDP (8.62%), net export (6.38%). This explain these result by the fact that the Algerian output is mainly the crude oil production so as the oil prices become volatile the value of output becomes also volatile. In addition, as more than 90% of Algerian export is oil export, so the volatility in oil price inevitably affect the trade balance and the oil-export earnings.

Based on the results obtained from this study and on the current state of the Algerian economy, we can provide some recommendations, which we consider very important for Algerian economy:

Firstly, diversifying the economy's productive base of Algeria in one hand. In other hand, it is more beneficial to the local economy, if Algeria develop an industry for oil derivatives, because export the oil derivatives generate more revenue to the economy than export the crude oil. Secondly, Algerian government should manage in good way the oil revenues and the financial surpluses to develop the other economic sectors and create a strong and diversified industrial base to absorb the unemployment and reduce the inflationary pressures. Thirdly, Algeria should cancel the rule of 49/51 to attract more foreign direct investment, and generate more capital flow in local economy, which can make progressively the Algerian dinar strong. In addition, Algeria must applied a more flexible exchange rate, to achieve a real independence and to help face external shocks.

Finally, Algeria should apply an efficient system of taxation through the declaration of actual turnover by the businessman and the billing of all commercial and financial transactions; the income from taxes could cover the budget deficit caused by the fall in oil prices.

Appendices

Table 5: Summary of the key factors and the related events of historical oil price shocks

Oil price shock	Key factors and related events
135% **Nov 73- Feb 74**	Oil OPEC embargo; Strong demand, supply constraint
139% **Apr 79- Jan 80**	Iranian revolution
45% **Nov 80- Feb 81**	Iran-Iraq War; controls lifted
93% **Aug 90-Oct 90**	Gulf war; supply shock and precautionary demand shock
-38% **Dec 97- Dec 98**	Asian financial crisis; Demand shock
92% **Jun 99- Nov 2000**	Strong global industrial growth, Supply cut and strong demand
28% **Nov 2002- Mar 2003**	Vensuelan crisis and Gulf war II; Supply shock
145% **Feb 2007- June 2008**	Commodities supercycle; Strong demand, stagnant supply and precautionary demand shock
-69% **Jul 2008- Dec 2008**	Global financial crisis; Demand shock
35% **Dec 2010- Apr 2011**	Arab uprising; Supply shock
-73% **Jul 2014- Jan 2016**	Excess capacity; Strong supply and stagnant demand

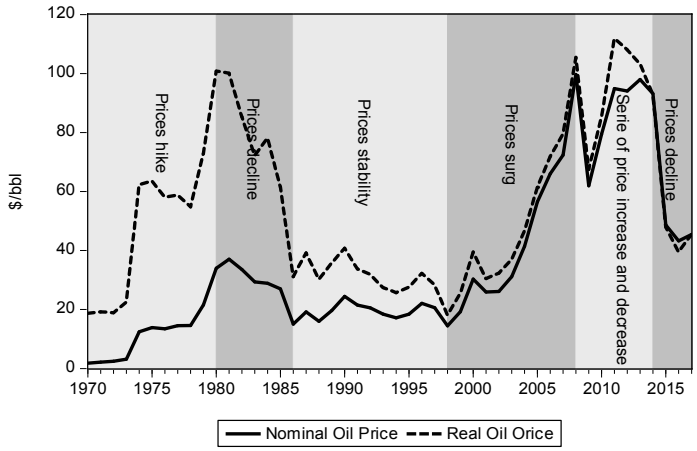

Figure 5: *Timeline of oil market episodes since 1970.*
Source: *Eviews 8 output.*

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[1] Real gross domestic product (GDP) is an inflation-adjusted measure that reflects the value of all goods and services produced by an economy in a given year, expressed in base-year prices, and is often referred to as "constant-price," "inflation-corrected" GDP or "constant dollar GDP." Unlike nominal GDP, real GDP can account for changes in price level and provide a more accurate figure of economic growth.

[2] The econometric analysis is conducted using Stata

[3] The null hypothesis for Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) is the series has a unit root (non-stationary). McKinnon (1996) critical values used for rejection of the null unit root.

[4] The critical values for ADF at level with intercept are -3.62 at 1%, -2.94 at 5% and -2.62; at level with intercept and trend are -4.22 at 1%, -3.53 at 5% and -3.2 at 10% level of significance. The critical value of ADF test at first difference with intercept -3.69 at 1%, -2.97 at 5% and -2.62 at 10%; first difference with intercept and trend are -4.24 at 1%, -3.54 at 5% and -3.2 at 10% level of significance, which have been tabulated from Mackinnon (1996) one-sided p-values

[5] The critical values for PP test at level are -3.62 (without trend),-4.24(with trend) at 1%, -2.94 (without trend) -3.53 (with trend) at 5% and -2.61 (without trend), -3.20 at 10% level of significance; while at first difference are -3.62 (without trend),-4.23(with trend) at 1%, -2.94 (without trend) -3.54 (with trend) at 5% and -2.61 (without trend), -3.20 at 10% level of significance, which have been tabulated from Mackinnon (1996) one-sided p-values

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