Dynamic Relationship Between Energy Consumption and GDP in Algeria (1971-2017)

Abdellah KORI YAHIA[1].*
University of M'Hamed Bougara- Boumerdes, Algeria.

Received: 11/05/2021 ; **Revised:** 24/06/2021 ; **Accepted:** 19/07/2021

Summary: The objective of this study is to investigate the relationship between energy consumption and real GDP per capita (oil and non-oil) in Algeria over the 1971-2917 period by using SVECM methodology.

The empirical results of this study show that any energy conservation policy has asymmetric effects on oil and non-oil GDP in Algeria. A positive energy consumption shock had a negative impact on oil and non-oil GDP per capita. However, the GDP, oil GDP and non-oil GDP shocks positively affected energy consumption in Algeria.

Keyword; Energy Consumption, GDP, SVEC model, Algeria.
Jel Classification Codes : Q43, Q48, C22, E62.

I- Introduction :

Since the seminal study by (Kraft and Kraft, 1978), the causal relationship between energy consumption and economic growth has been the subject of many empirical studies in different developing and advanced countries. Previous studies have focused on cointegration and causality analysis to examine the relationship between energy use and economic growth. The results led to mixed conclusions in terms of the energy consumption-growth nexus. Accordingly, (Payne, 2010) states that: ‘’the ambiguous results on the issue are mainly due to the use of different econometric approaches, different data set, variable selection and the differences in countries characteristics’’

In the literature, the relationship between energy consumption and economic growth is categorized into four hypotheses (Alkhars et al. 2020):
- Growth hypothesis: in this category, the energy consumption causes economic growth. Therefore, any conservation policy will have a negative impact on the economic growth of the country.
- Conservation hypothesis: contrary to the growth hypothesis, the economic growth causes an increase in the energy consumption. Under this hypothesis, any energy conservation policy such as increasing the tariff will not have a negative impact on economic growth.
- Feedback hypothesis: the relationship between energy consumption and economic growth is bidirectional meaning that energy consumption leads to economic growth, and economic growth leads to an increase in energy consumption.
- Neutrality hypothesis: there is no causal relationship between energy consumption and economic growth. According to Belloumi (2009), the main reason for the neutral impact of energy on economic growth is that the cost of energy is negligible, so it is not likely to have a significant impact on economic growth.

The purpose of the current study is to investigate the impact of shocks on energy consumption and income in Algeria for 1971 2017. Specifically, we use a Structural Vector Error Correction

1 * Corresponding author, e-mail: koriiab@live.fr

Model (SVECM) and impulse response function (IRF) to capture the short-run and long-run dynamics binding energy consumption to GDP in Algeria. Another contribution is to explore the dynamics of the relationship between energy consumption, and real GDP in Algeria by breaking down GDP in oil GDP and non-oil GDP. The rationale behind is that the growth model for Algeria is dependent on oil exports and public-sector spending. Furthermore, activity in the oil sector is largely driven by conditions in international oil markets, and other exogenous shocks or structural changes. (Elkhdari et al. ,2018). Hence, our objective is to provide a comprehensive review of the energy oil GDP dynamics on the one hand, and the energy non-oil GDP dynamics on the other hand.

It is very important for policymakers to understand the relationship between energy consumption and economic growth. This is not only because energy consumption affects various aspects of economic activity, but also because it has an influential impact on a country's efforts to achieve long-run economic growth and improve the quality of life.

I.1.Literature Review on Energy Consumption And Economic Growth Nexus For Algeria:

Previous studies addressing the relationship between energy consumption and economic growth for Algeria. Four studies specifically refer to Algeria (See table.1):

- (Cherfi and Kourbali, 2012) examined the relationship between energy consumption and economic growth in the 1965–2008 period, finding unidirectional causality running from GDP to energy consumption.

- (Bélaïd and Abderrahmani, 2013) examined the causal relationship between electricity consumption, oil price and economic growth for Algeria over the period of 1971–2010. The authors found bidirectional causal relationship between electricity use and economic growth.

- (Bouznit et al. 2018) examined the causal relationship between residential electricity consumption and income for Algeria in the period 1970–2013, by estimating a residential electricity consumption per capita demand function which depends on GDP per capita, its squared and cubed terms, the electricity prices, and the goods and services imports. The estimate results show that the relationships between electricity use and GDP (in per capita terms) present an inverted N-shap.

- (Chekouri et al. 2020) examined the relationship between energy consumption and economic growth in the 1971–2016 period, finding unidirectional causality running from GDP to energy consumption.

I.2.Overview Of The Energy In Algeria:

I.2.1. Energy Supply:

In 2017, Algeria produced a total amount of 55 485 ktoe of energy. The main energy sources in Algeria are natural gas (65%) and crude oil (35%). Other energy sources energies are much smaller and close to zero. The primary energy supply was 40 740 ktoe in 2010 and 26 955 ktoe in 2000 (See figure.1).

3.2.1. Energy Consumption:

Algeria's total final energy consumption has been steadily increasing in recent years. While in 2010, the energy consumption added up to around 15 343 ktoe, in 2017 it had increased to 38 354 ktoe with an increase of 149 %. The figure 2 shows that the transport sector is the one which consumes the most energy (39% of the total energy consumption in 2017), followed by the residential sector (28% of the total energy consumption in 2017), and the industry sector (17% of the total energy consumption in 2017). Thus, between 2010 and 2017 the energy consumption of the residential sector, transport sector and industry sector increased by 70%, 41% and 25% respectively.

The main energy sources of energy consumption in Algeria are crude oil (46% in 2017) and natural gas (41% in 2017). (See Figure.3).

II– Methods and Materials:

II.1 .Variables and Data:

To examine the relationship between energy consumption and GDP in Algeria, three different SVEC models are used :

- the baseline model defined on the baseline vector $Z_t \equiv$ (EC,GDP) in which EC is the logarithms of energy consumption (kg oil equivalent) and GDP is the logarithms of GDP per capita (constant LCU) in Algeria.
- the GDP-OIL model defined on the vector $Z_t^{GDP-OIL} \equiv$ (EC,GDPOIL) in which GDPOIL is the logarithms of oil GDP per capita (constant LCU) in Algeria.
- the GDP-NON-OIL model defined on the vector $Z_t^{GDP-NON-OIL} \equiv$ (EC,GDPNONOIL) in which GDPNONOIL is the logarithms of non-oil GDP per capita (constant LCU) in Algeria.

The data are annual and spread over the period 1971-2017 from the World Bank and Ministry of Finance (Algeria). (See table.2).

Ii.2 .Methodology:

Sims (1980) introduced Vector Auto-Regression (VAR) modelling which has become a popular tool in empirical macroeconomics and finance. Sims (1980) assumed a causal chain structure in order to identify structural parameters since when a structural VAR approach (SVAR) has developed in which more flexible approaches to identification replace the assumption of a causal chain. According to Dungey and Pagan (2008, p.1): ‘’ SVAR are still regarded as the best way to discover what dynamic relations exist between multivariate series .’’

In parallel, Vector Error Correction Models (VECM) were developed by Granger (1981) and Engle & Granger (1987) to be superior to VAR and SVAR in the presence of cointegration in the model’s variables. VECM estimation is called for when the variables included in the system are non-stationary, with stochastic trends, but cointegrated. Cointegration is defined as stationarity for some linear combination(s) of the variables and this implies restrictions on the VAR parameters that can be expressed by rewriting the VAR in levels as a VAR in differences with an added error-correction term. Identification restrictions can be applied to VEC models, such models are called Structural Vector Error Correction Models (SVECM); see for example: Vlaar (2004), Lutkepohl and Velinov .(2014)

Structural Vector Error Correction Models (SVECMs) have some important advantages in systems with stochastic trends and cointegration. It is well known that the use of non-stationary data can lead to spurious regressions. This danger can be avoided by modelling in first differences but then the long run relationships in the levels of the variables cannot be investigated. VEC and SVEC models allow for testing of whether or not non-spurious (cointegrated) long-run relationships exist and for their estimation when they do exist.

Because VEC and SVEC models incorporate parameter constraints, estimation precision is improved when these constraints are valid. In particular, estimated impulse responses become more precise. For example: according Jang and Ogaki (2001, p.2): “levels VAR can lead to exploding impulse response estimates even when the true impulse response is not exploding. This possibility is practically eliminated in a SVECM”. In addition, Phillips (1998) shows that the SVECM specification with consistently estimated cointegration rank significantly improves estimated impulse responses even for short horizons compared to the unrestricted VAR specification.

Suppose that the economy is described by a $VAR(p)$ model of the form:

$$A(L)Z_t = \nu_t \qquad (1)$$

Where Z_t is $(k \times 1)$ vector of time series, $A(L)$ is a $(k \times k)$ matrix whose individual elements are lag polynomials of order p and ν_t is a $(k \times 1)$ vector of unobservable independent and identically distributed stochastic disturbances with a multivariate normal distribution, mean zero and non-singular covariance matrix Σ_ν, $(\nu_t \sim N(0,\Sigma_\nu))$.

The model can be written as a VECM in the form:

$$B_0 \Delta Z_t = \Pi^* Z_{t-1} + B(L)\Delta Z_{t-1} + \varepsilon_t \qquad (2)$$

Where B_0 is a $(k \times k)$ matrix of coefficients for contemporaneous interactions; $B(L)$ is a $(k \times k)$ matrix of lag polynomials of order p-1; Π^* is the long-run impact matrix and ε_t is a $(k \times 1)$ structural form error with zero mean and identity covariance matrix $\Sigma_\varepsilon = I_k$ contains the structural shocks $(\varepsilon_t \sim N(0,I_k))$. Assuming that B_0 is invertible, equation (2) can be written in reduced form as:

$$\Delta Z_t = \Pi Z_{t-1} + \Gamma(L)\Delta Z_{t-1} + u_t \qquad (3)$$

Where:

$\Pi = B_0^{-1}\Pi^*$, Π has a reduced rank such that $rank(\Pi) = r < k$, and: $\Pi = \alpha\beta'$, where β is a $(k \times r)$ matrix of long-run “cointegrating” relationships, α is a $(k \times r)$ matrix of the "speed of adjustment" coefficients. More precisely, r is the cointegrating rank of the process and β is the cointegration matrix – each column contains the coefficients in one of the long run relationships. In addition: $\Gamma(L) = B_0^{-1}B(L)$.

We are interested in the effects of the fundamental shocks (ε_t) on the system variables Z_t . This relationship involves:

$$u_t = B_0^{-1}\varepsilon_t = B\varepsilon_t \qquad (4)$$

$(k \times 1)$ Vector u_t is a white noise process with zero mean and covariance matrix: Σ_u $(u_t \sim N(0,\Sigma_u))$ containing the unobservable structural disturbances. By using the assumption that structural shocks are uncorrelated and have unit variances $(\Sigma_\varepsilon = I_k)$, we get:

$$\Sigma_u = E[u_t u_t'] = BB' \qquad (5)$$

From Johansen’s (1995) formulation of the Granger’s representation theorem it follows that the VECM can be represented in the reduced form as a Vector Moving Average (VMA) process:

$$Z_t = \Xi \sum_{i=1}^{T} u_i + \Xi^*(L)u_t + Z_0 \qquad (6)$$

With:

$$\Xi = \beta_\perp \left[\alpha'_\perp \left(I_k - \sum_{i=1}^{p-1} \Gamma_i \right) \beta_\perp \right]^{-1} \alpha'_\perp, \quad \Xi^*(L) = \sum_{j=0}^{\infty} \Xi_j^* L^j, \quad \lim_{j \to \infty} \Xi_j^* = 0$$

$\perp$ indicates the orthogonal complement of a matrix ($\alpha'_\perp \alpha = 0$); Ξ^* : is a convergent matrix polynomial in the lag operator (L), and thus relates to the stationary part of the process; Ξ relates to the common stochastic trends; Z_0 represents the initial values.

Replacing u_t by their structural counterparts, as in (4), we obtain:

$$Z_t = \Xi B \sum_{i=1}^{T} \varepsilon_i + \Xi^*(L) B \varepsilon_t + Z_0 \tag{7}$$

Where the long-run effects can be captured by ΞB which has a rank $k-r$, and $\Xi^*(L)B$ expresses the short-run effects.

According to Juselius, the empirical shocks of the structural VMA model are defined by basic assumptions, (2006, chapter 15.2). First: structural shocks can be separated into $k-r$ permanent and r transitory shocks. Second: a transitory shock has no long-run impact on any variable in the system. Third: a permanent shock must have a long-run effect on at least one of the variables in the system. We can impose long run restrictions as implied by the economic theory by setting certain elements of ΞB and $\Xi^*(L)B$ to zero.

II.3. Structural VEC Model's Construction

II.3.1 .Stationarity

Time series univariate properties were examined using two-unit root tests: Augmented Dickey and Fuller (ADF), and Phillips and Perron (PP). Table 3 shows that neither of these tests in level at 5 percent significance level. However, the results show that the series are stationary in first differences.

II.3.2. Testing for Cointegration for The Baseline Model

Using an unrestricted VAR with three lags, we performed the Johansen cointegration tests to determine the number of cointegrating vectors. The number of lags has been selected according to the Akaike information criterion and the LM test. The results of the cointegration tests are presented in Table 4. They suggest the existence of at most one cointegrating vector present in the three systems (baseline model, OIL-GDP model and (NON-OIL-GDP model). Thus, a VECM with one cointegration relation is estimated for each system.

II.3.3. Structural Identification:

The VMA form of VECM in the case of baseline vector $Z_t \equiv (\mathrm{EN}, \mathrm{GDP})$ can be written as follows:

$$\begin{pmatrix} EC_t \\ GDP_t \end{pmatrix} = \underbrace{\begin{pmatrix} 0 & * \\ 0 & * \end{pmatrix}}_{\Xi B} \begin{pmatrix} \sum_{i=1}^{t} e_{si} \\ \sum_{i=1}^{t} e_{li} \end{pmatrix} + \underbrace{\begin{pmatrix} * & * \\ * & * \end{pmatrix}}_{\Xi_0^* B} \begin{pmatrix} e_{st} \\ e_{lt} \end{pmatrix} + \Xi_1^* \mathrm{A}^{-1} \begin{pmatrix} e_{st} \\ e_{lt} \end{pmatrix} + ...$$

$$\Xi_0 B = \begin{pmatrix} 0 & * \\ 0 & * \end{pmatrix}, \quad \Xi_0^* B = \begin{pmatrix} * & * \\ * & * \end{pmatrix}$$

''$\Xi_0 B$'' is long run matrix, ''$\Xi_0^* B$'' is a short-run matrix. Transitory shocks cannot have a long-run effect on any variable in the system, and this can be seen from the zeros in the first column of the matrix $\Xi_0 B$. The unrestricted elements in the second column mean that the GDP can have a long-run effect on CE and GDP, according to the neoclassical theory that energy is neutral to growth on the long-term. (Talel et al. 2013).
''ε_{sECi}'' is an energy consumption transitory shock; 'and ''ε_{lGDPi}'' is a total tax permanent shock.

Estimates of the structural form of the baseline model is therefore as follows:

$$\Xi_0 B = \begin{pmatrix} 0 & 0.0962 \\ 0 & 0.0500 \end{pmatrix}, \quad B = \begin{pmatrix} 0.0438 & 0.0050 \\ 0.0035 & 0.0206 \end{pmatrix}$$

Using the same methodology, we can make the structural identification of the GDP-OIL and GDP-NONOIL models with one cointegrating relation ($r = 1$). Estimates results are respectively:

$$GDP-OIL \rightarrow \Xi_0 B = \begin{pmatrix} 0 & 0.1191 \\ 0 & 0.1802 \end{pmatrix}, \quad B = \begin{pmatrix} 0.0468 & 0.0080 \\ -0.0476 & 0.1864 \end{pmatrix}$$

$$GDP-NON-OIL \rightarrow \Xi_0 B = \begin{pmatrix} 0 & 0.0397 \\ 0 & 0.0557 \end{pmatrix}, \quad B = \begin{pmatrix} 0.0432 & 0.0321 \\ -0.0163 & 0.0707 \end{pmatrix}$$

III- Results and discussion :

III.1. The Effects of Energy Consumption and GDP Shocks:

To evaluate the relationship between energy consumption and GDP in Algeria, we investigate the Impulse Response Functions (IRF) of the three models SVECM estimated .

Figures from 4 to 9 display the impulse responses of energy consumption and the production of both types of shocks generated by SVEC modelling, namely short-term and long-term shocks. Dashed lines represent the intervals of two standard deviations, while the solid lines represent the impulse function. Bootstraps from percentile method proposed by Hall (1992) are used to construct the 95% confidence intervals. It should be noted that none of the confidence intervals associated with the impulse response functions does contain zero. It follows then that the long-term effect of the permanent shock on both variables will be significant.

III.1.1. The Effects of EC Shock:

A positive shock of EC contemporaneously had a positive effect on GDP with a magnitude of 0.004. Then, the effect is decline in the medium and long term which confirms the long- term identification. (See Figure.4). Conversely, a positive energy consumption shock had a negative impact on oil-GDP and non-oil GDP in the short term (-0.015 and -0.05 respectively) and long term (Figure 5 and Figure 6). The absolute value of these effects shows an overall downward trend after the chock.

III.1.2. The Effects of GDP Per Capita Shock:

The effect of the GDP per capita shock on consumption energy is positive in the short term with about 0.01. (See figure 7). Furthermore, this effect is increased in the medium and long term and reaching a maximum of 0.08 in the at the 20th period following the shock.

III.1.3. The Effects of Oil GDP Per Capita:

As can be seen in Figure 8, a positive shock to oil GDP per capita leads to a significant increase in consumption energy with about 0.03 in the short term. This effect remains stable, low and significant in the medium and long term.

III.1.4. The Effects of Non-Oil GDP Per Capita:

Figure 9 chows that an increase in non-oil GDP per capita leads to a significant increase in consumption energy by with about 0.035. This effect is constant and significant in the medium and long term.

III.2. Economic Implications

Overall, findings of this study imply that an expansive energy consumption policy may have an adverse effect on oil and non-oil GDP. In Algeria, energy and electricity production is based essentially on natural gas. This may decrease the quantity of fossil fuels available for export while decreasing oil revenues. Furthermore, the Algerian government fixed and subsidized the energy prices. According to the IMF country report « these subsidies cost an estimated 2 293 billion DA (22.8 billion US$) in 2015, equal to 13.6% of GDP. Energy subsidies accounted for over half this amount …». (IMF Country Report No. 13/47). On the other hand, the minister of energy of Algeria stated that: « the amount of the energy subsidies is 1500 billion dinars in 2016». (Alilat Y., Le Quotidien d'Oran, 30 août 2017) (about 8.5% of GDP, and 65% of the budget deficit). These subsidies have important drawbacks. For instance, low energy prices have led to a rapid rise in domestic energy consumption, leaving less oil and gas for Algeria to export, reducing revenues for the budget, and aggravating pollution and local traffic congestion. Also, create incentives for smuggling to neighbouring countries. Hence, energy prices are subsidized and the overuse of energy may compromise oil and non-oil GDP in Algeria.

As part of the result of the Impulse Response Functions, it also shows that the oil and non-oil GDP shocks positively affected energy consumption. In fact, the increase in per capita GDP improved life quality of citizens and increased demand for energy, particularly in the transport and residential sectors through increased demand of personal transport (fuel and energy transportation) and the use of electronic tools and communications technologies. On the other hand, rapid development in the industrial, cement industries and infrastructure sectors in the country also account for the overuse of energy. Furthermore, the positive effect of GDP chock may be explained by the increasing urbanization and the lifestyle changes. Along this line, (Gupta, 2018) states that the lifestyles in cities of the developing countries are becoming energy intensive. Likewise, (Karanfil and Li, 2015) found that urbanization is a relevant factor of electricity use in all income levels, except for the high-income level, with it also being the most important driver of electricity use in upper-middle income countries, such as Algeria. According to the World Bank database, about 72% of the Algerian population lived in urban regions in 2017, while the urbanized segment of the population was at 67.5% in 2010.

IV- Conclusion:

The objective of this study is to investigate the relationship between energy consumption and GDP (oil and non-oil) in Algeria over the 1971-2017 period by using SVECM methodology. The empirical results show that any energy conservation policy has asymmetric effects on oil and non-oil GDP in Algeria, a positive energy consumption shock had a negative impact on oil and non-oil GDP per capita. These findings imply that an expansive energy consumption policy may have an adverse effect on oil and non-oil GDP. In that sense, energy and electricity production is based essentially on natural gas in Algeria. This may decrease the quantity of fossil fuels available for export while decreasing oil revenues. Furthermore, energy prices are subsidized and the overuse of energy may compromise oil and non-oil GDP in Algeria .

On the other hand, the oil and non-oil GDP shocks positively affected energy consumption in Algeria. This can be explained by the fact that, an increase in per capita GDP improved life quality of citizens and increased demand for energy, particularly in the transport and residential sectors. Therefore, the total final energy consumption has increased 149% from 2010 to 2017, the main energy increases being related to the transport and residential sectors have been raised respectively 41% and 70% over the same period.

The study is of great importance to policy-makers as they suggest that Algeria should explore new sources of energy to achieve the diversification of its economy by encouraging the non-oil sector to adopt energy efficient technology. Hence, to simultaneously attain sustainable economic growth and long-run environmental quality, Algeria is recommended to invest heavily in renewable energies. Promoting renewable energies may be adequate to increase the energy production in order to cover the increasing demand. The other hand, the results show that the effect of energy conception shock is negative and significant, which may be related to low energy prices because they are subsidized by the Algerian Government. Therefore, the Algerian Government may control the rapid growth of energy consumption by adjusting energy tariffs to rationalize its consumption .

- Appendices:

Include data and information not necessary for inclusion within the text, which provide important explanatory information to understand the article, and information that can be included in the annexes, for example: raw data; questionnaires; graphs, tables, and diagrams (New Times Roman12; The interlines spacing lines 0.88).

Table (1): Summary of some empirical studies on energy consumption – economic growth nexus for Algeria

Authors	Period	Methodology	Variables	Conclusion
Cherfi S.; Kourbali B. (2012)	1965-2008	Cointegration and Granger causality tests	Energy consumption (EC), GDP per capita.	GDP → EC
Belaid, Abderrahmani (2013)	1971-2010	Vector Error Correction Models (VECM) Gregory–Hansen cointegration test	Residential electricity consumption (EC), GDP per capita.	GDP ↔ EC
Shahateet (2014)	1980-2011	Panel ARDL model and Granger Causality Test	Energy consumption (EC), GDP per capita.	GDP - - EC
Ozturk (2017)	1971-2011	Bivariate Vector Autoregression model and Granger causality approach	Energy consumption (EC), GDP per capita.	GDP → EC
Bouznit, Sánchez-Braza (2018)	1970-2013	Autoregressive Distributed Lag model (ARDL) and Granger Causality Test	residential electricity consumption (EC), GDP per capita.	GDP → EC
Chekouri et al.(2020)	1971-2016	Toda-Yamamoto causality test	Energy consumption (EC), GDP per capita.	GDP → EC

Note: EC → GDP means that the causality runs from energy consumption to (GDP).
GDP → EC means that the causality runs from growth to energy consumption.
GDP ↔ EC means that bi-directional causality exists between energy consumption and GDP.
GDP - - EC means that no causality exists between energy consumption and growth.

Table (2): Data description

Acronyme	Description	Source
EC	logarithms of Energy Consumption (kg oil equivalent per capita)	World Bank
GDP	Logarithms of GDP per capita (constant LCU).	
GDPOIL	Logarithms of Oil GDP per capita (constant LCU).	Ministry of Finance-Algeria
GDPNONOIL	Logarithms of Non-Oil GDP per capita (constant LCU).	

Table (3): Summary of unit root tests

Variable	**ADF test**		**PP test**	
	Level	**First difference**	**Level**	**First difference**
GDP	**-1.11**	**-8.25**	**-3.10**	**-7.43**
EC	**-3.03**	**-5.75**	**-3.00**	**-5.74**
GDPOIL	**-2.56**	**-4.42**	**-3.59**	**-6.46**
GDPNONOIL	**-1.67**	**-7.12**	**-1.62**	**-7.13**

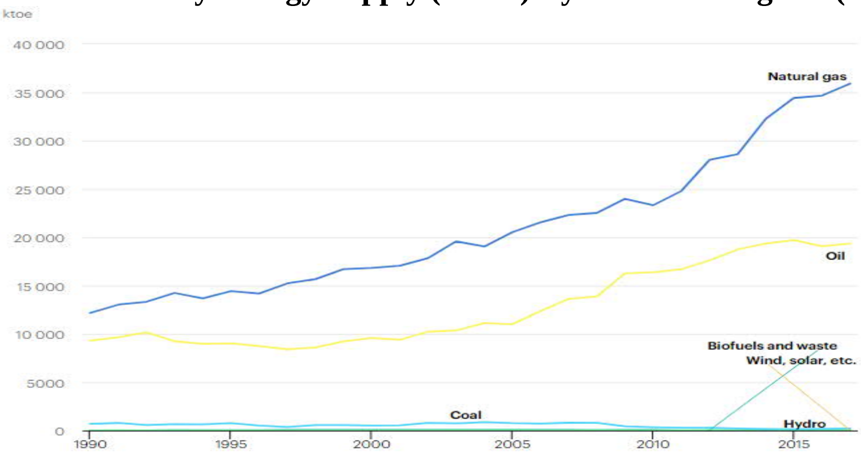
Notes: The critical values for the ADF and PP tests at the 1%, 5% and 10% significance level are −4.17, −3.51 and −3.18 respectively.

Table (4): Determining the cointegration rank: for the baseline model

Baseline model (EC, GDP)			
Null hypothesis	Trace statistic	Critical value 5%	P-value
r=0	**26.02***	**15.49**	0.00
$r \leq 1$	**1.28**	**3.84**	0.25
GDP-OIL model (EC, GDPOIL)			
Null hypothesis	Trace statistic	Critical value 5%	P-value
r=0	**16.00***	**15.49**	0.00
$r \leq 1$	**2.61**	**3.84**	0.20
GDP-NON-OIL model (EC, GDPNONOIL)			
Null hypothesis	Trace statistic	Critical value 5%	P-value
r=0	**16.14****	**15.49**	0.03
$r \leq 1$	**2.05**	**3.84**	0.15

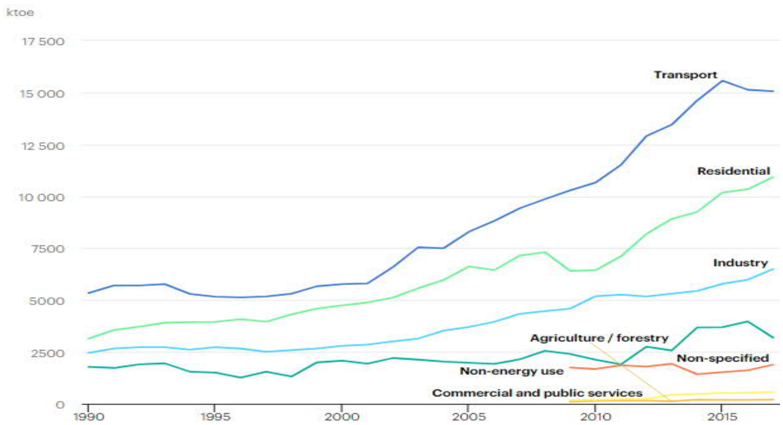
Notes: Critical values are taken from Osterwald-Lenum (1992).
* indicate rejection of the null hypothesis at 1%.
** indicate rejection of the null hypothesis at 5% levels.

Figure (1): Total Primary Energy Supply (TPES) By Source In Algeria (1990-2017) .



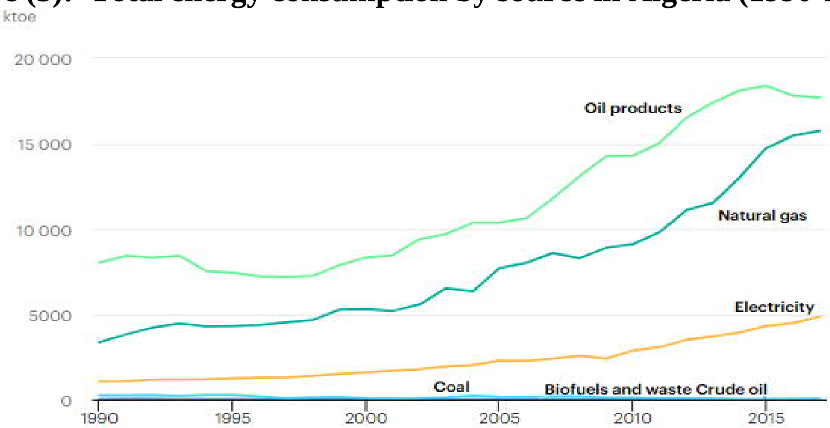
The Source: Energy International Agency

Figure (2): Total energy consumption by sector in Algeria (1990-2017) .



The Source: Energy International Agency

Figure (3): Total energy consumption by source in Algeria (1990-2017).



The Source: Energy International Agency.

Figure (4): Responses of EC and GDP to EC shock.

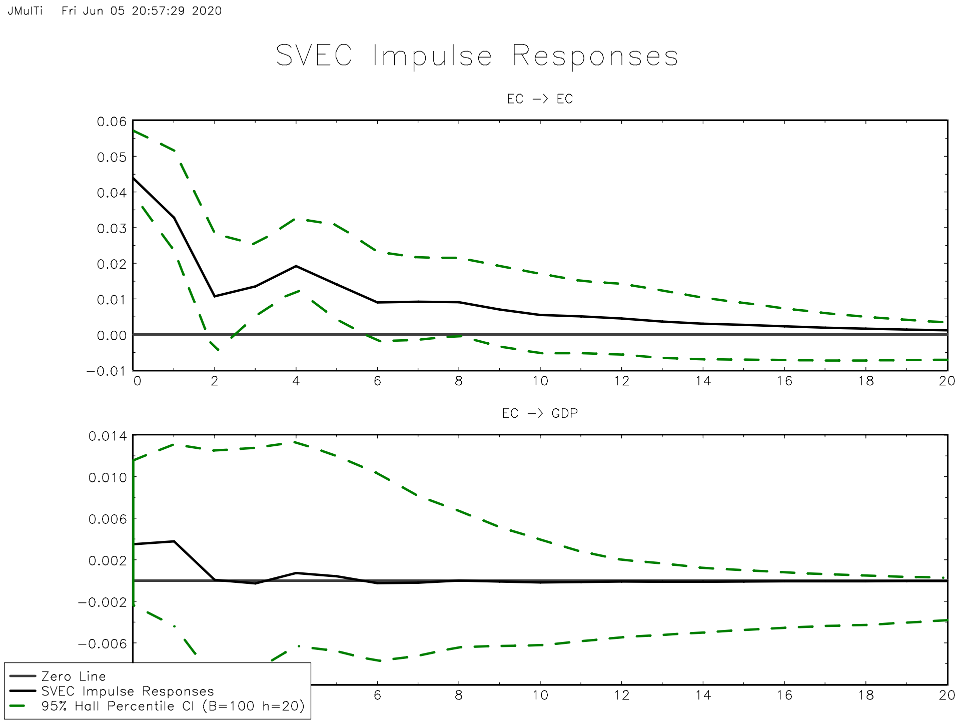


Figure (5): Responses of EC and GDPOIL to EC shock.

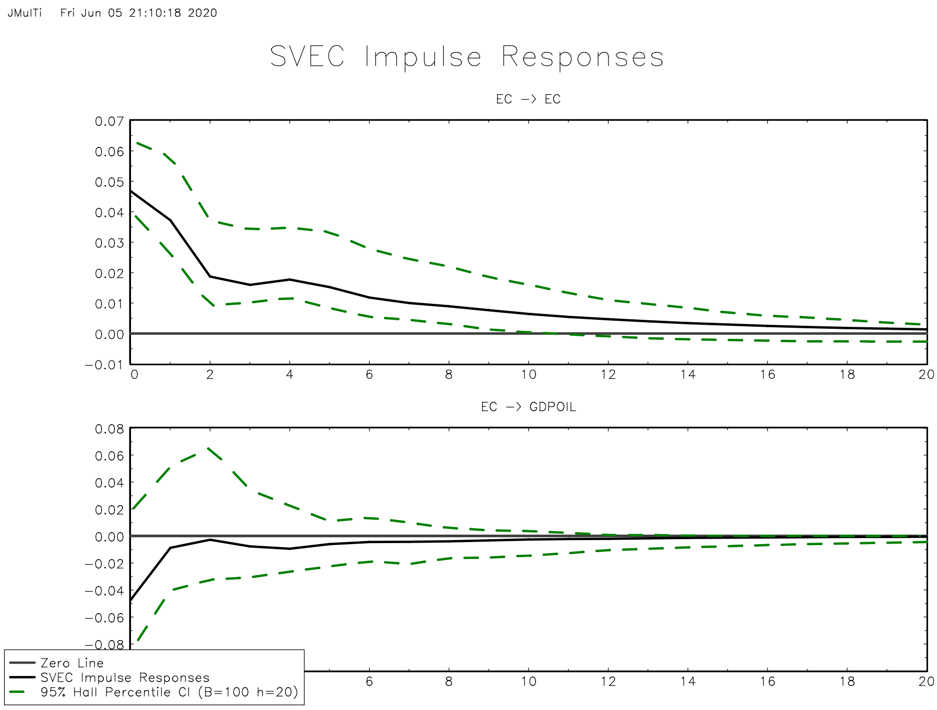


Figure (6): Responses of EC and GDPNONOIL to EC shock.

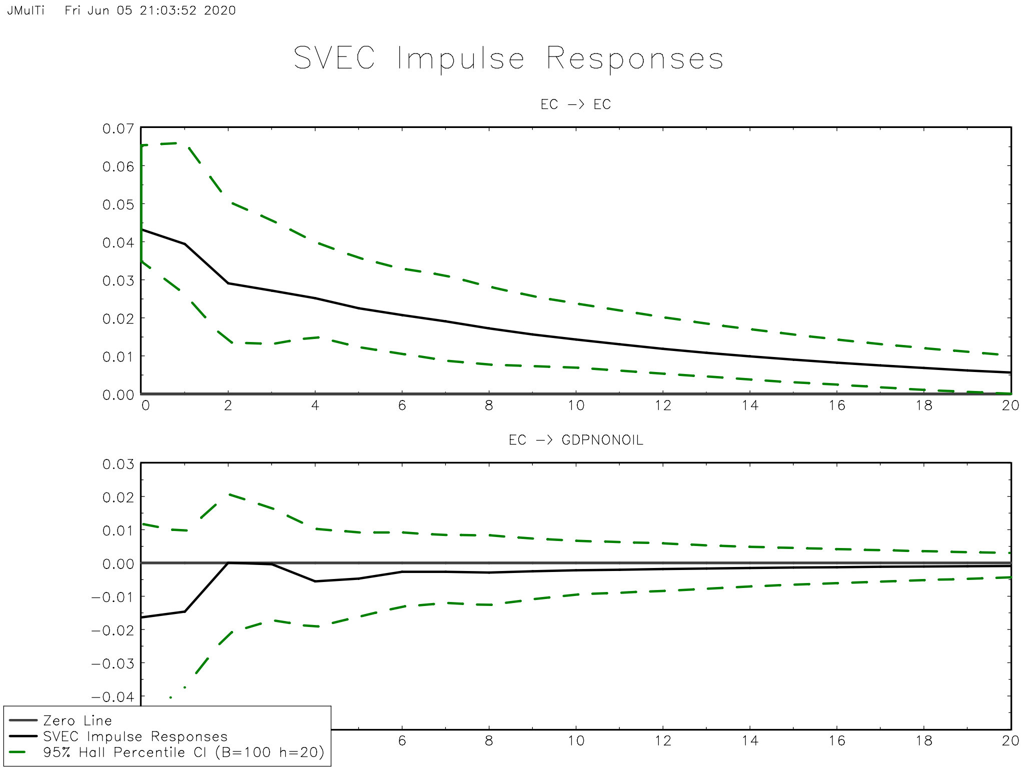


Figure (7): Responses of EC and GDP to GDP shock.

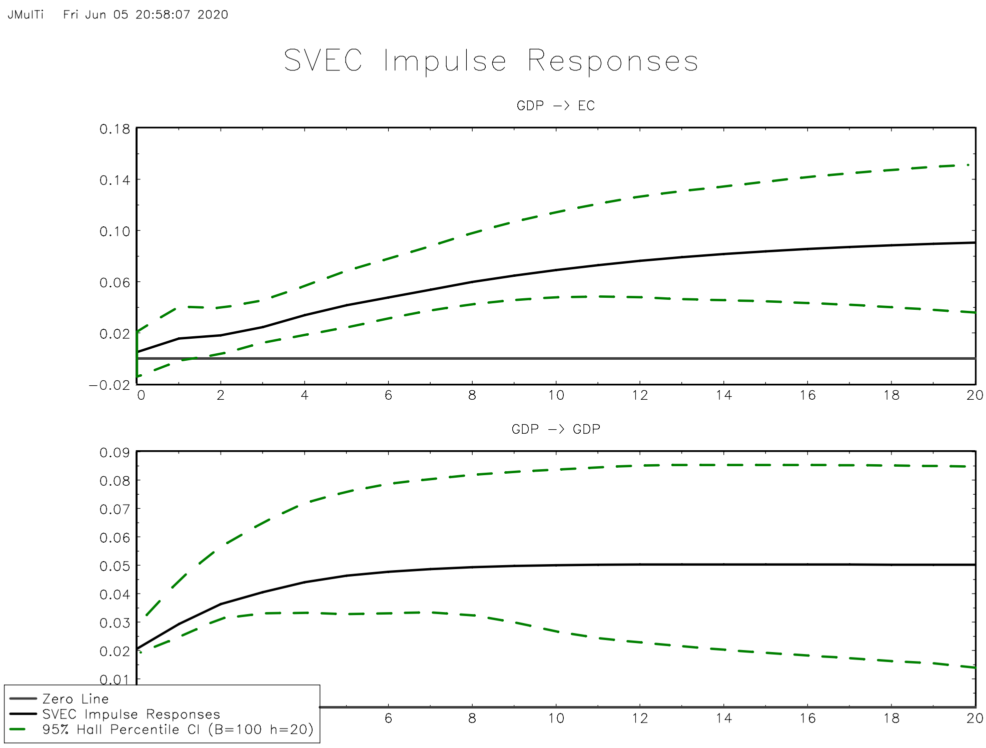


Figure (8): Responses of EC and GDPOIL to GDPOIL shock.

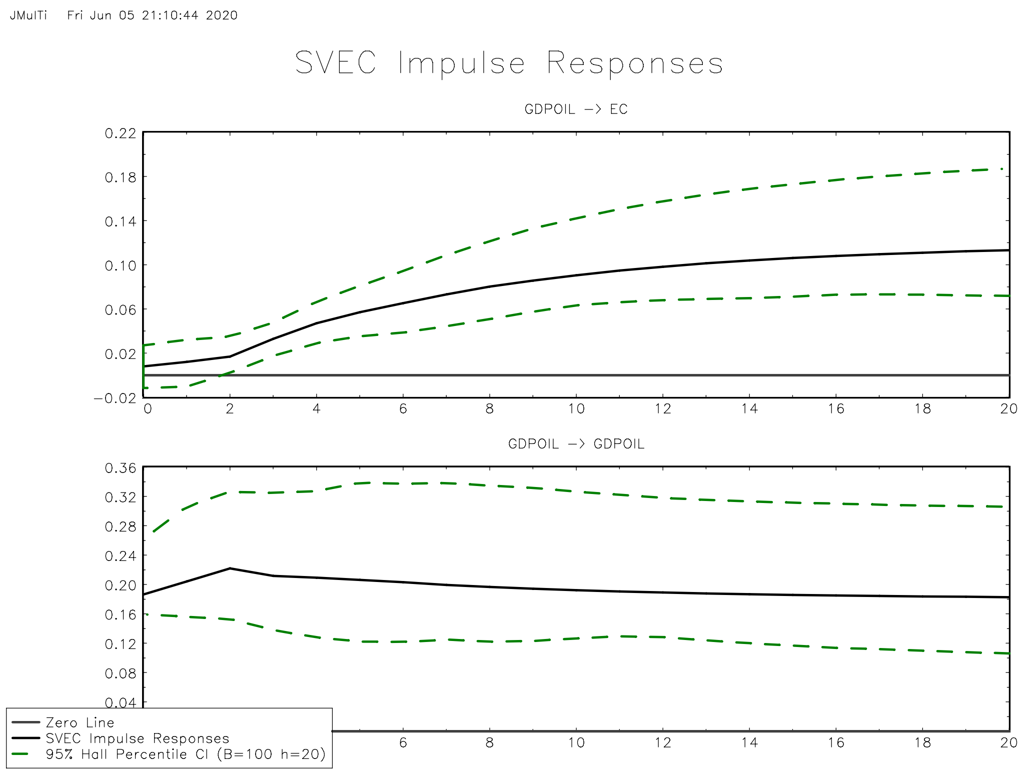
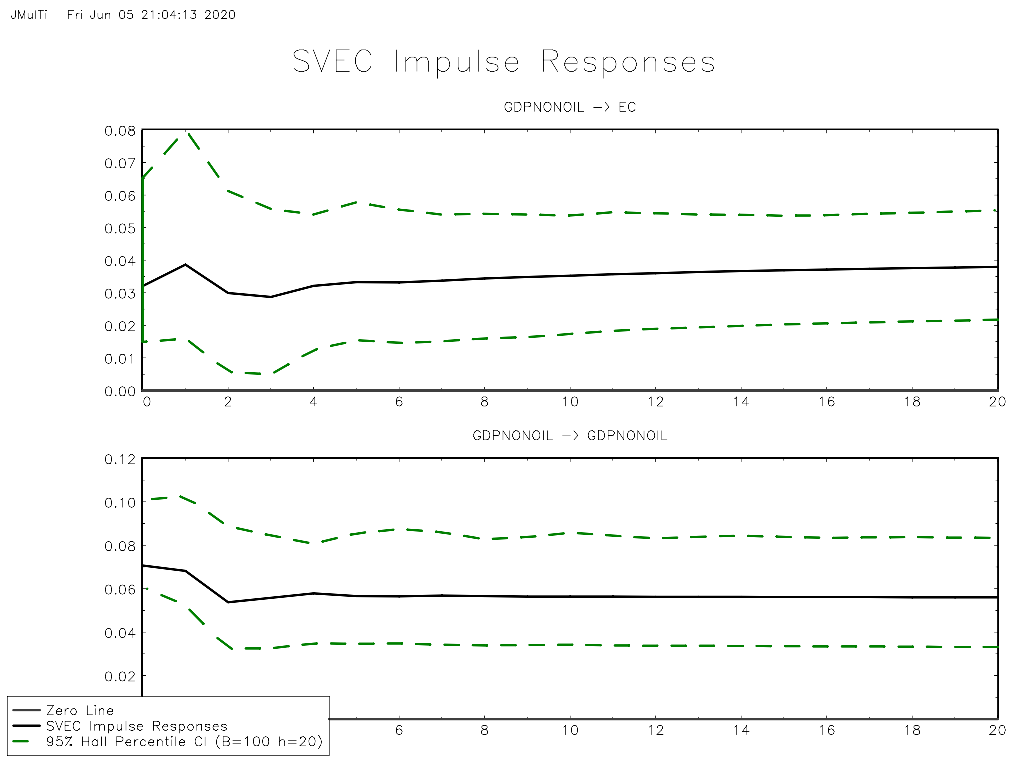


Figure (12): Responses of EC and GDPNONOIL to GDPNONOIL shock.



Referrals and references:

1.**Kraft, J., Kraft, A., (1978).** On the relationship between energy and GNP. Journal of Energy and Development 3, 401-403.

2.**Payne, J. E. (2010).** A survey of the electricity consumption-growth literature. Applied Energy, 87(3), 723–731.

3. **AlKhars M., Miah F., Qudrat-Ullah H. and Kayal A.** (2020). A systematic review of the relationship between energy consumption and economic growth in GCC countries, Sustainability Review, 12(9), 3845.

4.**Belloumi M. (2009)**. Energy consumption and GDP in Tunisia: Cointegration and causality analysis. Energy Policy 37, 2745-2753.

5.**Elkhdari M., Souissi M., Jewell A. (2018)**. Empirical estimation of fiscal multipliers in MENA oil-exporting countries with an application to Algeria, IMF Working Paper.

6.**Cherfi S.; Kourbali B. (2012)**. Energy consumption and economic growth in Algeria: Cointegration and causality analysis. Int. J. Energy Econ. Policy 2012, 2, 238–249.

7.**Bélaïd F., Abderrahmani F. (2013)**. Electricity consumption and economic growth in Algeria: A multivariate causality analysis in the presence of structural change. Energy Policy 2013, 55, 286–295.

8.**Bouznit M., Pablo-Romero M., Antonio Sánchez-Braza A. (2018).** Residential electricity consumption and economic erowth in Algeria., Energies 2018, 11, 1656.

9.**Chekouri S.M., Chibi A., Benbouziane M. (2020)**, Causality between energy consumption and economic growth: evidence from Algeria, Review of Finance and Markets, VOL: 07 / N°: 01 (2020), p 01-19.

10.**Dungey M., Pagan A., (2008)**. Extending an SVAR model of the Australian economy. Working Paper, No. 21, National Centre for Econometric Research.

11.**Engle R.F. and C.W.J. Granger (1987)**, “Co-integration and error correction: Representation, estimation and testing”, Econometrica 55, 251-76.

12.**Sims, C. A. (1980),** Macroeconomics and Reality, Econometrica 48, 1–48.

13.**Granger C.W.J., (1981)**, “Some properties of time series data and their use in econometric model specification”, Journal of Econometrics 23, 121-130.

14.**Vlaar Peter J. G., (2004).** On the Asymptotic Distribution of Impulse Response Functions with Long-Run Restrictions”, Econometric Theory, 20(5), pp. 891-903.

15.**Lutkepohl H., Velinov A., (2014).** Structural Vector Autoregressions: Checking Identifying Long-run Restrictions vie Heteroskedasticity. Journal of Economic Surveys 2014.

16.**Jang K., Ogaki M., (2001)**. The Effects of Monetary Policy Shocks on Exchange Rates: A Structural Vector Error Correction Model Approach, Working Paper No. 01-02, Ohio State University.

17.**Phillips P. C. B. (1998).** Impulse response and forecast error variance asymptotics in nonstationary VARs, Journal of Econometrics 83: 21–56.

18.**Johansen S. (1995).** Likelihood-based Inference in Cointegrated Vector Autoregressive Models, Oxford University Press, Oxford.

19.**Juselius K. (2006).** The Cointegrated VAR model: Methodology and Applications. New York: Oxford University Press.

20.**Talel B., Ahdi Noomen A., Ghassen E., Fakhri I., (2013)**. Dynamic relationship between energy consumption and income in Tunisia: A SVECM approach. The Journal of Energy and Development Vol. 38, No. 1/2 (Autumn, 2012 and Spring, 2013), pp. 79-105.

21.**Hall P. (1992**). The bootstrap and Edgeworth expansion Springer Verlag, N.Y.

22.**IMF** Country Report No. 13/47.

23.**Gupta M.D. (2018)**. Impact of Lifestyle Pattern on Energy Consumption and Carbon Emissions—A View from India.

24.**Karanfil F., Li Y. (2015)**. Electricity consumption and economic growth: Exploring panel-specific differences. Energy Policy 2015, 82, 264–277.

25.**Energy International Agency**, www.iea.org/countries/Algeria.

26.**Ozturk, F. (2017).** Energy consumption–GDP causality in MENA countries. Energy Sources, Part B: Economics, Planning, and Policy, 12(3), 231-236.

27.**Shahateet M. I. (2014).** Modeling economic growth and energy consumption in Arab countries: Cointegration and causality analysis. International Journal of Energy Economics and Policy, 4, 349–359.

How to cite this article by the APA method:

Abdellah KORI YAHIA, (2021), **Dynamic Relationship Between Energy Consumption and GDP in Algeria (1971-2017)**, el-Bahith Review, Volume 21 (Number 01), Algeria: Kasdi Marbah University Ouargla, pp. 43-57.

How to cite this article by the APA method:
Abdellah KORI YAHIA, **Dynamic Relationship Between Energy Consumption and GDP in Algeria (1971-2017)**, el-Bahith Review, Volume 21 (Number 01), Algeria: Kasdi Marbah University Ouargla, pp. 01-16.