Determinants of Demand for Algerian Products Outside the Hydrocarbon Sector During the Period 2000-2022

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Abstract:

This study aims to identify the primary determinants of demand for Algerian products outside the hydrocarbon sector in international markets between 2000-2022. This is achieved through a quantitative analysis of annual data, elucidating the directional relationships between various variables by formulating them into mathematical models. Through performing all tests concerning the nature of the relationship existing between the variables, and employing the Johanson cointegration test, the study concludes that there are three cointegrating vectors. This implies a long-term equilibrium relationship between Algeria's non-hydrocarbon exports and their determinants, permitting the use of the Vector Error Correction Model (VECM). Upon estimating the VECM, it was found that the error correction coefficient, representing the strength of returning to the long-term equilibrium, is statistically significant and negative, estimated at (-0.3932). This means that when the variable of non-hydrocarbon exports in Algeria deviates from its equilibrium value in period (t-1), it gets adjusted by 39.32% of this deviation in period (t). This adjustment span is approximately two and a half years, reflecting the sluggishness in returning to the equilibrium in the long run.

Keywords: Economic diversification, non-oil exports, local product, vector Error Correction Model.

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1. Introduction

The export sector constitutes an important part of the country's economy because it is considered its primary financier of hard currency and its biggest contributor to the economic growth process. It opens up avenues for production and marketing abroad, and introduces the local products. Additionally, it's an indicator that reflects the productive, competitive, and marketing capacity of the country in foreign markets. However, a distinguishing feature of Algeria is its heavy reliance on the hydrocarbon sector for exports, leading to economic dependence on this single sector. This always exposes it to numerous risks in light of the fluctuations in global oil prices.

The issue of economic diversification and the search for sources to enhance exports outside the hydrocarbon sector has become imperative for Algeria, not just a choice. This is because the national economy's dependence on the hydrocarbon sector has, and continues to, expose the Algerian economy to numerous shocks. The policy of economic diversification is a constantly evolving topic because it reflects the resilience of the national economy in the face of crises and enhances the country's competitive capacity on the global level. This is achieved by promoting the state's exports outside the hydrocarbon sector and transitioning from a rentier economy to a production-based economy.

a. Research Problem

Investigating the prerequisites to enhance exports from Algeria outside the hydrocarbon sector is critically significant. This is due to its relevance to an intensely competitive and swiftly advancing domain internationally. Based on this, the subsequent question arises: What have been the primary factors influencing the demand for Algerian goods outside the hydrocarbon sector between 2000 and 2022?

b. Study Hypotheses

Through the aforementioned primary problem, the following hypotheses were identified:

An increase in economic growth in other countries leads to an increased demand for Algerian products.

The exchange rate plays a significant role in determining the competitiveness of Algerian products in the global market.

There is a long-term cointegration between the demand for Algerian products outside the fuel sector and its determinants.

c. Previous Studies

Among the studies conducted on this topic, we find:

Study by Boukhatem and Ben Meriem (2022): This study aims to estimate the impact of diversification on economic growth outside the hydrocarbons sector using the ARDL model in Algeria for the period 1980-2018. The study relied on the Herfindahl-Hirschman Index and concluded that there is a positive significant effect of the diversification index and oil prices on long-term economic growth. The impact of diversification on growth was more pronounced than oil prices in the long run, with a short-term positive effect of diversification on growth, while growth outside hydrocarbons remained unaffected by short-term oil price changes.

Study by Menaqer, Ben Taresh, Jumai, and Shkib (2017): This study aims to understand the extent to which the decline in oil prices contributes to diversifying exports outside the

hydrocarbons sector in Algeria by analyzing the dependence of Algerian exports on hydrocarbons and the development of Algerian non-oil exports. The study found that the composition of Algerian exports heavily relies on the hydrocarbons sector, and non-hydrocarbon exports remain marginal in Algerian foreign trade, given its primary rentier status.

Study by Ben Taresh (2016/2017): This research attempts to shed light on the competitiveness of exports outside the hydrocarbons sector for small and medium Algerian enterprises in foreign markets. It emphasizes the role these enterprises can play in energizing the export sector in Algeria by addressing the concept of Relative Comparative Advantage (RCA) and examining a set of exports from SMEs during the period 2011-2015 across various sectors. The study concluded that exporting SMEs benefit from the relative advantages of the national economy in the case of 4 out of 28 exported products, i.e., 14,28 % during the studied period 2011-2015. These products include dates, carob and its seeds, couscous, and shrimp.

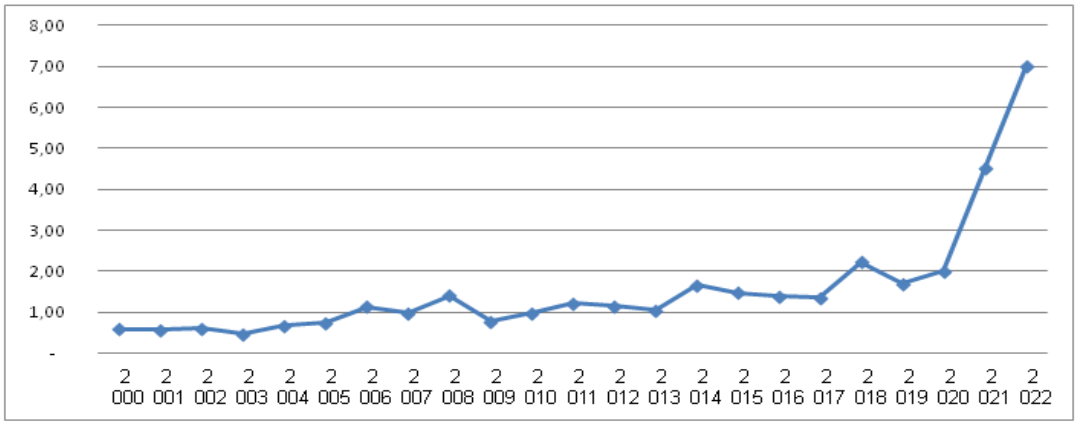
Study by Abdous (2018): The study aims to understand the competitive position of Algerian dates in the global market compared to major date-exporting countries using several indicators that measure the competitive ability of dates. It also seeks to identify the main determinants of foreign demand for Algerian dates, focusing primarily on the French market. The study revealed that the main export markets for dates are France and Russia, followed by Canada and Germany, based on a high market share index. Algeria's competitive price in date exports has the potential to increase date exports, and the volume of Algerian date exports to the French market is primarily determined by the Algerian export price of dates, as well as the French export quantity to other countries and the income per capita in France.

Study by Bouazza (2022): This research identifies the competitive situation of Algerian olive oil in the global market compared to major olive oil-exporting countries. The main goal is to understand the determinants of foreign demand for Algerian olive oil, focusing primarily on the Canadian market. The study noted that Algerian olive oil export prices to the Canadian market are lower than its competitors, but this advantage hasn't significantly affected gaining a considerable market share in Canada, mainly because, despite its high quality, Algerian olive oil does not meet the demands of importing countries in terms of quantity, timing of arrival, and packaging.

Analysis of Algerian Exports Outside the Hydrocarbons Sector During the Period 2000-2022:

Figure No. (01): Value of Algerian Exports Outside the Hydrocarbons Sector

for the Period 2000-2022 (in billion dollars)



Source: Prepared by the researchers based on data from the Bank of Algeria.

From the table above, we observe that the total Algerian exports outside the hydrocarbons sector during the period 2000-2019 experienced fluctuations. Their value did not exceed a maximum of 2 billion dollars during that period. This is primarily because the majority of Algerian exports are represented by oil and its derivatives. Consequently, products outside the hydrocarbons sector during this period represented an almost marginal percentage of Algerian exports.

However, for the period from 2020 to 2022, non-oil Algerian exports surged significantly. This increase can be attributed to several reasons, most notably the adoption by the Algerian state of an economic diversification policy and a focus on other sectors, such as agriculture and manufacturing industries. For the first time, we notice that the value of non-oil exports rose from 1.7 billion dollars in 2019 to 5 billion dollars in 2021, and then to 7 billion dollars in 2022, with an annual increase of approximately 30 percent. Forecasts predict this value will reach 13 billion dollars by 2023, thanks to the efforts Algeria has made to diversify its economy and adapt its economic governance to a new context, allowing it to take advantage of a better strategic position.

2. Methodology

In this section, we aim to devise a quantitative model for the factors affecting and determining the value of Algerian exports outside the hydrocarbon sector during the period 2000-2022. We should first note that the model is based on annual data for the model's variables for the period 2000-2022. One advantage of choosing annual data is the focus on the main factors affecting the value of exports outside the hydrocarbon sector and neglecting seasonal fluctuations and other secondary or incidental factors. Additionally, using annual data allows us to bypass the possibility of a time lag between changes in one of the variables. Thus, using annual data allows us to assume that a year's duration is sufficient for all the aforementioned partial adjustments.

a. Determining the Model's Variables:

The process of selecting economic variables that influence any economic phenomenon primarily relies on economic theories and, secondarily, on previous studies. By analyzing the trend of such phenomena, each quantitative model consists of a set of endogenous (dependent) variables, whose values are determined within the model, i.e., through the model's relationships, and exogenous (independent) variables, whose values are determined outside the model and influence the studied phenomenon. Alongside these, parameters dictate the nature of the relationship between the model's internal and external components, plus an error term, also known as the disturbance term (residuals).

These are the error variables that connect the main variables through ratios in a function, formulating each model as a linear function. Through our theoretical study of factors influencing exports, we have identified a set of explanatory economic variables for the period extending from 2000 to 2022, which include:

b. **Dependent Variable:**

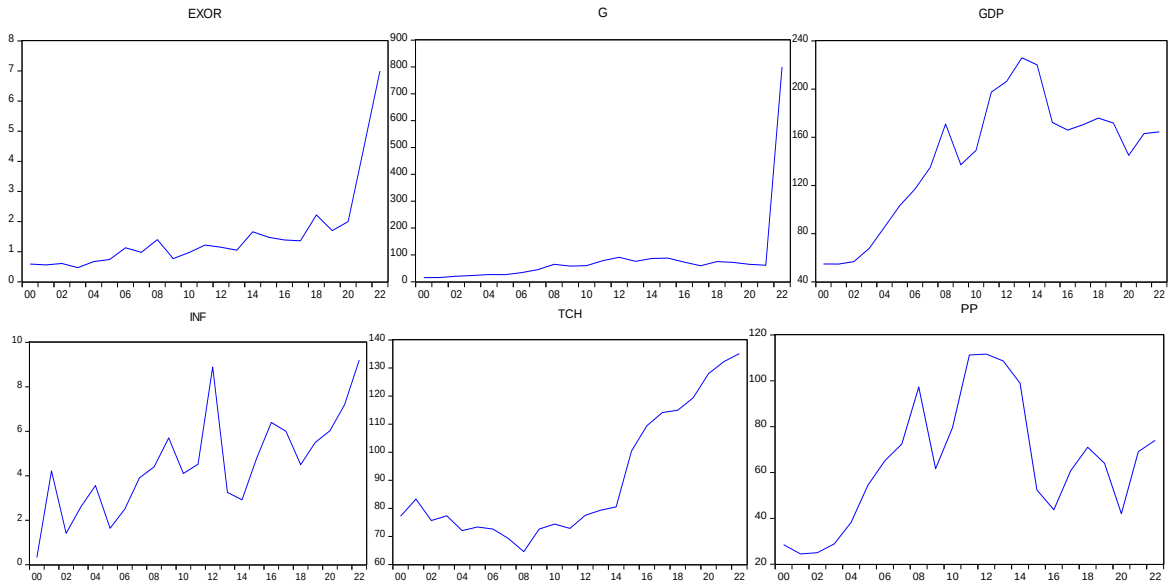
Exports outside the fuel sector, measured in current billion dollars. Denoted as EXOR.

c. **Definition of Explanatory Variables:**

The econometric model includes explanatory or independent variables, which are: global economic fluctuations represented by global economic growth, as well as a second independent variable which is the US dollar exchange rate. The third independent variable is the US oil stockpile, while the fourth independent variable represents the global demand for oil.

- **Gross Domestic Product (GDP):** "Is the sum total of the 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 deducting the value of the depreciation of manufactured assets or making any deductions due to the depletion and deterioration of natural resources **(Al-Haqbani, L. A. R. & Mohamed).** The data is expressed in current US dollar values," and it's symbolized by the acronym GDP.
- **US Dollar Exchange Rate:** The exchange rate of the US dollar against the Chinese Yuan (Renminbi) was taken into consideration, given that China has become one of the important countries in global trade and economy. It's symbolized by TCH.
- **Trade Balance:** ....., measured in billion dollars. Denoted as BC.
- **Government Spending:** ....., measured in billion dollars. Denoted as G.
- **Oil Price:** ……..., measured in current US dollars per barrel. Denoted as PP.
- **Random Error Margin:** Represents some variables that might affect the global oil price but weren't included in the model due to measurement challenges, such as: geopolitical factors, climatic conditions, psychological factors, technical factors... etc. Denoted as Ui.

Figure No. (02): Description of the study variables for the period 2000-2022



Source: Prepared by the researchers based on the Eviews 10 software..

Having identified the variables contained in the econometric model and after collating the data associated with each variable, our general model for determinants of global oil prices, based on both theoretical and empirical considerations previously discussed, is formulated as:

Poil t = f (ECWt, EXCHDO t STPUS t, DEP t)

The multiple linear regression method will be used to estimate the econometric model related to global oil prices. The linear formulation of the model is:

Poilt=b0+b1ECWt+b2EXCHDOt+b3STPUSt+b4DEPt+Ui

It should be noted that our econometric model is probabilistic in nature; therefore, we incorporated the error term Ui which represents certain variables that can influence global oil prices but were not included in the model due to measurement difficulties, such as: geopolitical factors, climatic conditions, psychological factors, technical aspects, etc.

Where:

- b0: is the intercept.
- b1,b2,b3,b4: are model parameters and represent the slope of the function or the change in global oil price resulting from a unitary change in the independent variables.

3. Results Discussion

a. Stationarity Test of Time Series Data

Time series data often exhibit non-constant mean and variance due to changes over time. The stationarity test is utilized to study the properties of the time series and ensure its stability, determining its order of integration, before its use in statistical analysis. This avoids potentially misleading results that don't reflect the actual nature of the relationship under investigation. The stationarity test is conducted in several ways, and relying on the Augmented Dickey-Fuller (ADF) test, using the Eviews 10 software, we arrived at the results as delineated in the following table:

Table No. (1): Time Series Stability Study Using the ADF Test.

Variable	Sample	Level			1st difference		
		ADF	t-Statistic .5%	Prob	ADF	t-Statistic. 5%	Prob
EXOR	III/None	-0.228198	-1.953381	0.5950	-4.513997	-1.953858	0.0001
	II/trend and intercept	-1.939993	-3.580623	0.6073	-4.393409	-3.587527	0.0089
	I/ intercept	-1.262326	-2.971853	0.6325	-4.485590	-2.976263	0.0015
TCH	III/None	-1.303025	-1.953381	0.1732	-5.767376	-1.954414	0.0000
	II/trend and intercept	-4.386601	-3.580623	0.0087	-5.567375	-3.595026	0.0006
	I/ intercept	-4.322939	-2.971853	0.0021	-5.682933	-2.981038	0.0001
GDP	III/None	0.066102	-1.953381	0.6956	-4.173276	-1.953858	0.0002
	II/trend and intercept	-2.207937	-3.587527	0.4666	-3.995444	-3.587527	0.0213
	I/ intercept	-2.206419	-2.976263	0.2087	-4.079792	-2.976263	0.0040
BC	III/None	0.766126	-1.953858	0.8734	-3.056874	-1.953858	0.0036

	II/trend and intercept	-2.252281	-3.587527	0.4439	-3.449456	-3.307527	0.0458
	I/ intercept	-2.576117	-2.976263	0.1101	-3.165775	-2.976263	0.0335
G	III/None	2.407329	-1.953381	0.9948	-4.413351	-1.953858	0.0001
	II/trend and intercept	-2.945449	-3.580623	0.1645	-5.440743	-3.587527	0.0008
	I/ intercept	-1.139359	-2.971853	0.6856	-5.452276	-2.976263	0.0001
PP	III/None	2.407329	-1.953381	0.9948	-4.413351	-1.953858	0.0001
	II/trend and intercept	-2.945449	-3.580623	0.1645	-5.440743	-3.587527	0.0008
	I/ intercept	-1.139359	-2.971853	0.6856	-5.452276	-2.976263	0.0001

Source : Prepared by the researchers based on EViews.10.

From the table above, we note that the estimated value of Φ is less than the tabulated value for all study variables at a significance level of 5%. This implies the acceptance of the null hypothesis H0, indicating the presence of a unit root, and thus the time series are non-stationary at the level. Therefore, it's necessary to take first differences. After differentiation, the time series of the variables became stationary of order one. We note that the estimated value of Φ is greater than the tabulated value for all study variables at a significance level of 5%, which means rejecting the null hypothesis H0, i.e., no unit root. Consequently, the time series of the explanatory variables are stationary at the first difference I(1). This allows us to proceed to the cointegration test to examine the existence of a long-term relationship between the global oil price and its determinants.

b. **Johansen Cointegration Test:**

Given that the time series of the study variables are integrated of order one, and the residuals series is integrated of order zero, it's possible to test for the existence of a long-term relationship among the variables using Johansen's cointegration test. This test is broader than the Engle-Granger methodology, as it allows determining the number of long-term equilibrium

relationships among several variables integrated of the same order. Johansen's approach is based on the eigenvalues of the matrix. This method **follows two stages (Sheikh Mohammed, 2011):**

This test outperforms the Engle-Granger cointegration test, especially suitable for small samples and when there's more than two variables. More importantly, this test reveals if there's a unique cointegration. Meaning, cointegration is only verified if the dependent variable regresses on the independent variables. This is significant in the cointegration theory, as the absence of unique cointegration implies that the equilibrium relationship among the variables remains questionable **(Al-Abdali Al-Sharif, A. B. A. R. 2007).**

To test for a long-term equilibrium between the two stable series of the same order, despite short-term disturbances, a cointegration test is conducted using the Johansen and Johansen & Juselius methodologies. These are considered superior even when there are only two variables because they allow for reciprocal effects between the study variables, an assumption not present in the two-step Engle-Granger methodology.

Johansen and Johansen & Juselius' approach tests for the rank of matrix Π. For cointegration to exist among the time series, the matrix Π should not be of full rank ($0 < r(\Pi) = r < \eta$). To determine the number of cointegration vectors, two statistical tests based on the Maximum Likelihood Ratio Test (LR) are used: the Trace Test and the Maximum Eigenvalues Test.

The impact test is known as:

$$\lambda_{trace} = -T \sum_{i=r+1}^{n} \log(\hat{\lambda}_i)$$

The null hypothesis tests the premise that the number of cointegrating vectors is ≤ r against the alternative hypothesis that the number of cointegrating vectors is r (where r = 0, 1, 2). The maximum eigenvalue test is defined by:

$$\lambda_{max} = -T \log(1-\hat{\lambda}_i)$$

where the null hypothesis tests the number of cointegrating vectors as r against the alternative hypothesis that there's a cointegrating vector of r + 1. 7. **(Al-Qadeer, K. B. H. B. A., 2004)**

The Error Correction Model (ECM): It stands out from the Engel-Granger model in that it separates the long-term relationship from the short-term one. Additionally, it's more suited to small sample sizes, and the estimated parameter in the model is more consistent than other methods, such as the Engel-Granger (Engel Granger 1987) method and Johansen (Johansen 1988). To test the cointegration amongst variables under ECM, Persaran (2001) offers a modern approach to examine the equilibrium relationship (both short and long-term) amongst variables

under the error correction model. This approach is notable for its applicability, whether the explanatory variables are integrated of order zero I(0) or first order I(1), or if there's co-integration of the same degree between them. It's feasible for small sample sizes, unlike traditional methods. This model is only applied after the successful Johansen cointegration test. The results of the study are presented in the following table:

Table (2): Results of the Johansen Cointegration Test,

Results of the Trace Test

Date: 05/26/23 Time: 23:14

Sample (adjusted): 2002 2022

Included observations: 21 after adjustments

Trend assumption: Linear deterministic trend

Series: EXOR G GDP PP TCH BC

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.978254	185.1796	95.75366	0.0000
At most 1 *	0.863187	104.7847	69.81889	0.0000
At most 2 *	0.791201	63.01278	47.85613	0.0010
At most 3 *	0.552275	30.11879	29.79707	0.0459
At most 4	0.434227	13.24367	15.49471	0.1062
At most 5	0.059260	1.282855	3.841466	0.2574

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Prepared by the researchers based on EViews 10.

We note that the calculated value of the Trace Statistic, which equals 185.17, is greater than the tabulated value estimated at 95.75 at the 5% significance level regarding the first hypothesis (None). Thus, we reject the null hypothesis H0 indicating no cointegration at (None) and accept H1, indicating the existence of a cointegrated relationship.

We note that the calculated value of the Trace Statistic, which equals 104.78, is greater than the tabulated value estimated at 69.81 at the 5% significance level regarding the second hypothesis (At most 1). Hence, we reject the null hypothesis H0 and accept H1, indicating the existence of a cointegrated relationship.

We note that the calculated value for the Trace Statistic, which equals 63.01, is greater than the tabulated value estimated at 47.85 at the 5% significance level regarding the third hypothesis (At most 2). Hence, we reject the null hypothesis H0 and accept H1, indicating the existence of a cointegrated relationship.

We note that the calculated value of the Trace Statistic, which equals 30.11, is greater than the tabulated value estimated at 29.79 at the 5% significance level regarding the fourth hypothesis (At most 3). Hence, we reject the null hypothesis H0 and accept H1, indicating the existence of a cointegrated relationship.

Based on the above, we conclude that there are four cointegrating relationships between the value of exports outside the hydrocarbon sector and its determinants at the 5% significance level. This implies the existence of four vectors for cointegration, meaning that the value of non-hydrocarbon exports in Algeria is simultaneously integrated with the other variables. This confirms the existence of a long-term equilibrium relationship between the variables included in the model. These variables do not deviate much from one another in the long run and exhibit similar behavior in the long term, according to the Trace test. As for the results of the Maximum Eigenvalue Test, they are presented in the table below.

Table (3): Results of the Johnson Cointegration Test,

Results of the Maximum Eigenvalue Test.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)		
Hypothesized	Max-Eigen	0.05

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.978254	80.39490	40.07757	0.0000
At most 1 *	0.863187	41.77190	33.87687	0.0047
At most 2 *	0.791201	32.89400	27.58434	0.0094
At most 3	0.552275	16.87512	21.13162	0.1780
At most 4	0.434227	11.96081	14.26460	0.1121
At most 5	0.059260	1.282855	3.841466	0.2574

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Prepared by the researchers based on EViews 10 software.

We note that the computed value for Maximum Eigenvalue, which equals 80.39, is greater than the tabulated value estimated at 40.07 at a 5% significance level for the first hypothesis (None). Thus, we reject the null hypothesis H0 which indicates "no cointegration at None", and we accept H1 indicating the presence of a cointegrating relationship.

We note that the computed value for Maximum Eigenvalue, which equals 41.77, is greater than the tabulated value estimated at 33.87 at a 5% significance level for the second hypothesis (At most 1). Hence, we reject the null hypothesis H0 and accept H1 indicating the presence of a cointegrating relationship.

We observe that the computed value for Maximum Eigenvalue, which equals 32.89, is greater than the tabulated value estimated at 27.58 at a 5% significance level for the third hypothesis (At most 2). Therefore, we reject the null hypothesis H0 and accept H1 indicating the presence of a cointegrating relationship. From this, the Maximum Eigenvalue test indicates the presence of three long-term cointegration relationships among the study variables. As the results from the two tests differ, we will decide based on the test that has fewer relationships, i.e., there exist three cointegrating relationships among the study variables. After confirming the presence of a long-term relationship among the study's variables, it's possible to apply a causality test to determine the direction of influence among the variables in this long-term relationship.

C. The number of lags in the model :

The time lag is gauged by the period during which the impact of one variable on another is evident. This period is determined by answering the following question: How long does the influence of one variable on another take to appear? The phase of selecting the number of lag periods is of utmost importance as it directly impacts the results of the estimation. On one side, in cases of small samples such as our study **(Allawi, K., Al-Fatlawi, K., & Al-Zubaidi, H. L., 2014),** it's best to keep the number of lags minimal. On the other side, to determine the lag periods, we will rely on criteria like the Akaike information criterion (AIC), Schwarz information criterion (SC), and the Hannan-Quinn information criterion (HQ). These indicators select the period where they have the lowest values. The results of the lag selection test are shown in the subsequent table:

Table (4): Test to Determine the Number of Time Lags Periods.

VAR Lag Order Selection Criteria

Endogenous variables: BC EXOR G GDP PP TCH

Exogenous variables: C

Date: 05/27/23 Time: 00:09

Sample: 2000 2022

Included observations: 21

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-504.3989	NA	5.20e+13	48.60942	48.90785	48.67418
1	-393.0351	148.4850	4.65e+10	41.43191	43.52096	41.88529
2	-325.9579	51.10645 *	7.20e+09*	38.47218*	42.35183 *	39.31416 *

* indicates 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 information criterion

Source: Prepared by the researchers based on EViews 10.

Where: indicates the number of lags chosen by the criteria and (0.1.2) are the number of lags. The test results indicate that the optimal lag order that should be included in the model is 2.

Fourth, Granger Causality Test Results: This test is used to investigate the existence of a causal relationship between two variables and primarily relies on the F-test. It is said that the variable X affects the variable Y if the lag of variable X has a predictive power higher than the predictive power of the lag for variable Y. Accepting the null hypothesis implies that X does not affect Y, if the p-value of the F-statistic is greater than 0.05. Rejecting the null hypothesis means that X affects Y if the p-value of the F-statistic is less than 0.05.

Table No. (5): Granger Causality Test

Pairwise Granger Causality Tests

Date: 05/27/23 Time: 00:24

Sample: 2000 2022

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
D(G) does not Granger Cause D(EXOR)	20	6.39668	0.0098
D(EXOR) does not Granger Cause D(G)		0.0397	0.9822
D(BC) does not Granger Cause D(PP)	20	4.91155	0.0229
D(PP) does not Granger Cause D(BC)		0.49840	0.6172
D(BC) does not Granger Cause D(TCH)	20	4.11404	0.0376
D(TCH) does not Granger Cause D(BC)		0.06503	0.9373

Source: Prepared by the researchers based on EViews 10.

From the table above, we notice that the probability value (prob) for the F-Statistic is less than 0.05 for the relationship directed from the variable D(G) to D(EXOR). This indicates that D(G) causes D(EXOR). As for the reverse relationship directed from D(EXOR) to D(G), the probability (prob) for the F-Statistic is greater than 0.05. This means that D(EXOR) does not cause D(G). We conclude that there is a unidirectional causality from D(G) to D(EXOR).

From the table, we also notice that the probability value (prob) for the F-Statistic is less than 0.05 for the relationship directed from the variable D(BC) to D(PP). This means that D(BC) causes D(PP). As for the reverse relationship directed from D(PP) to D(BC), the probability (prob) for the F-Statistic is greater than 0.05. This means that D(PP) does not cause D(BC). We conclude that there is a unidirectional causality from D(BC) to D(PP).

Observing the table, we can see that the probability value (prob) for the F-Statistic is less than 0.05 for the relationship directed from the variable D(BC) to D(TCH). This indicates that D(BC) causes D(TCH). As for the reverse relationship directed from D(TCH) to D(BC), the probability (prob) for the F-Statistic is greater than 0.05. This means that D(TCH) does not cause D(BC). We conclude that there is a unidirectional causality from D(BC) to D(TCH).

d. The Vector Error Correction Model (VECM):

The VECM is used as a means to adjust the behavior of a variable in the short term to its behavior in the long term. Differences (errors) between the estimated and actual values of the dependent variable in the integration model are extracted, then the model is re-estimated by introducing the first difference as a new independent variable according to the following equation:

$$\Delta \mathbf{Z}_t = \sum \boldsymbol{B}\Delta \mathbf{Z}_{t-i} + \boldsymbol{\lambda}\mathbf{u}_t + \boldsymbol{e}_t$$

"Where Z represents the vector of the variable to be tested, and the coefficients B represent the short-term components, while the difference coefficient λ represents the adjustment between the short term. This variable is stable if its absolute value is less than one and its sign is negative. The results of estimating the Vector Error Correction Model (VECM) are shown in the following table:

Table (6): Results of the Vector Error Correction Model (VECM) test.

Vector Error Correction Estimates
Date: 05/27/23 Time: 22:59
Sample (adjusted): 2003 2022
Included observations: 20 after adjustments

Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1				
D(EXOR(-1))	1.000000				
D(G(-1))	0.261005				
	(0.00317)				
	[-5.18293]				
D(BC(-1))	-0.010687				
	(0.00205)				
	[-5.20727]				
D(GDP(-1))	0.002810				
	(0.00194)				
	[1.44609]				
D(TCH(-1))	-0.016993				
	(0.00673)				
	[-2.52451]				
C	-0.140593				
Error Correction:	D(EXOR,2)	D(G,2)	D(BC,2)	D(GDP,2)	D(TCH,2)
CointEq1	-0.393229	323.4079	13.19105	-51.91051	5.825480

	(0.54141)	(65.2658)	(18.2654)	(16.5417)	(4.19186)
	[-4.72631]	[4.95524]	[0.72219]	[-3.13817]	[1.38971]
D(EXOR(-1),2)	0.608839	-62.29610	-7.637027	56.40666	-7.572215
	(0.50472)	(60.8435)	(17.0278)	(15.4208)	(3.90783)
	[1.20628]	[-1.02387]	[-0.44850]	[3.65782]	[-1.93770]
D(G(-1),2)	-0.037814	-2.398212	-0.487261	-1.021979	0.282420
	(0.01273)	(1.53479)	(0.42953)	(0.38899)	(0.09858)
	[-2.97008]	[-1.56257]	[-1.13441]	[-2.62724]	[2.86501]
D(BC(-1),2)	-0.012363	1.232883	-0.433962	-0.955184	0.149491
	(0.00738)	(0.88920)	(0.24885)	(0.22537)	(0.05711)
	[-1.67608]	[1.38650]	[-1.74384]	[-4.23831]	[2.61753]
D(GDP(-1),2)	-0.004694	0.000853	0.143279	-0.476240	-0.051982
	(0.00819)	(0.98714)	(0.27626)	(0.25019)	(0.06340)
	[-0.57317]	[0.00086]	[0.51863]	[-1.90350]	[-0.81989]
D(TCH(-1),2)	-0.000582	5.455118	-0.202219	-0.503339	-0.451122
	(0.02804)	(3.38030)	(0.94602)	(0.85674)	(0.21711)
	[-0.02077]	[1.61380]	[-0.21376]	[-0.58750]	[-2.07786]
C	0.049341	43.79454	0.769771	-6.398572	1.453542
	(0.15913)	(19.1823)	(5.36839)	(4.86176)	(1.23203)

	[0.31008]	[2.28307]	[0.14339]	[-1.31610]	[1.17979]
R-squared	0.530825	0.847432	0.465865	0.705248	0.668099
Adj. R-squared	0.314282	0.777016	0.219341	0.569208	0.514913
Sum sq. resids	5.547335	80613.39	6313.857	5178.386	332.5443
S.E. equation	0.653237	78.74662	22.03818	19.95839	5.057700
F-statistic	2.451365	12.03462	1.889736	5.184140	4.361375
Log likelihood	-15.55462	-111.3956	-85.92647	-83.94393	-56.48918
Akaike AIC	2.255462	11.83956	9.292647	9.094393	6.348918
Schwarz SC	2.603969	12.18807	9.641153	9.442900	6.697424
Mean dependent	0.122500	36.70213	-0.216000	-0.027779	0.523000
S.D. dependent	0.788856	166.7611	24.94279	30.40828	7.261785

Determinant resid covariance (dof adj.)	5.83E+08
Determinant resid covariance	67661696
Log likelihood	-322.1942
Akaike information criterion	36.21942
Schwarz criterion	38.21088
Number of coefficients	40

Source: Prepared by the researchers based on EViews 10.

The table above indicates that the error correction coefficient CointEq1 is negative and significant at the 0.05 significance level. It represents the strength of the return towards equilibrium in the long term, estimated at (-0.3932). This implies that every year, 39.32% of the deviation from equilibrium is corrected. The adjustment speed is 1/0.3932=2.51/0.3932=2.5, i.e., approximately two and a half years. This is a relatively weak response to reaching its equilibrium value in the long term.

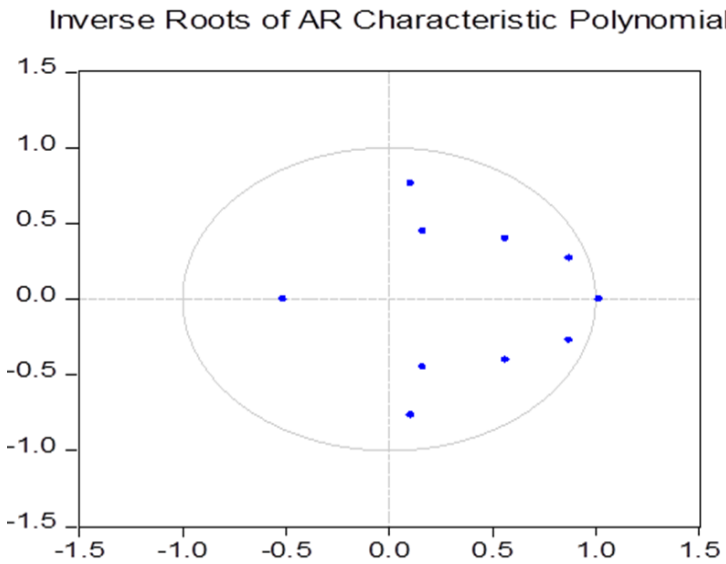
The determination coefficient is estimated at 0.5308, meaning that 53.08% of the changes in the dependent variable are explained by the explanatory variables. The remaining percentage is due to variables not included in the model.

The differential coefficient of the value of exports outside the hydrocarbon sector in Algeria with a one-period and two-period lag is positive, estimated at (+0.608839), and is statistically significant, indicating a trend towards an increase in the value of these exports during the study period. The differential coefficient of the Gross Domestic Product rate with a one-period lag is positive and estimated at (+ 0.002810). This indicates the positive impact of the GDP on the value of exports outside the hydrocarbon sector in the short term. This coefficient is significant in the first lag period and not significant in the second lag period. The differential coefficient of government spending on the value of exports outside the hydrocarbon sector with a one-period lag is positive, estimated at (+0.2610), and significant. This indicates the direct relationship between global oil demand and oil prices in the short term. As the demand for oil rises, the price of oil goes up. This coefficient is significant in the first lag period and not significant in the second lag period. The differential coefficient of the trade balance with a one-period lag is negative, estimated at (-0.010687). This indicates the negative impact of the trade balance on the value of exports outside the hydrocarbon sector in the short term and is statistically significant. However, this variable is not statistically significant in the second lag period. The constant coefficient is negative and equals 0.049341. This means that when all variables are null, the differential value of exports outside the hydrocarbon sector equals 0.049341, which is not statistically significant.

f. **Statistical Tests for the VECM Model**

- **Stability of the Error Correction Model:** We obtained the following results:

Figure 3 : Stability Test of the VECM Model.



Source: Prepared by the researchers based on EViews 10.

We observe from the figure above that the model meets the stability conditions, as all the coefficients are less than one and all the roots lie inside the unit circle, which means the model is stable.

- **Test for Autocorrelation among the Errors (Serial Correlation).**

Table No. (7): Results of the autocorrelation test among errors using the LM Test

VEC Residual Serial Correlation LM Tests Date: 05/21/23 Time: 23:11 Sample: 2000 2022 Included observations: 22						
Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
1	15.86296	25	0.9188	0.524097	(25, 20.1)	0.9367
2	19.08614	25	0.7930	0.666722	(25, 20.1)	0.8328
3	12.04918	25	0.9862	0.373105	(25, 20.1)	0.9896
4	18.60377	25	0.8157	0.644440	(25, 20.1)	0.8520
5	30.75015	25	0.1974	1.323497	(25, 20.1)	0.2630
6	17.99293	25	0.8427	0.616707	(25, 20.1)	0.8745
7	22.74086	25	0.5927	0.847073	(25, 20.1)	0.6568
8	27.93464	25	0.3109	1.142090	(25, 20.1)	0.384

9	28.65500	25	0.2786	1.186976	(25, 20.1)	0.3505
10	20.40272	25	0.7254	0.729300	(25, 20.1)	0.7748

Source: Prepared by the researchers based on EViews 10.

From the table, it is clear that the model does not suffer from the problem of serial correlation since the LM test statistic is less than the critical values. This is indicated by the probability values (Prob) as all of them are greater than the 5% significance level, which leads us to accept the null hypothesis and reject the alternative hypothesis, which means there is no autocorrelation problem in the errors.

- **Test for the presence of homogeneity in variance Breusch-Pagan-Godfrey Test.**

Table No. (8): Results of the variance stability test estimation.

VEC Residual Heteroskedasticity Tests (Levels and Squares)

Date: 05/21/20 Time: 23:13

Sample: 200 2022

Included observations: 22

Joint test:

Chi-sq	Df	Prob.
339.3753	330	0.3492

Source: Prepared by the researchers based on EViews 10.

We note from the table that the probability value (Prob) is greater than the significance level of 0.05, which leads us to reject the alternative hypothesis H1 and accept the null hypothesis H0. This indicates that the model does not suffer from the problem of variance instability, meaning the variance of the model is stable.

g. Dynamics of the VECM model:

The relationship between the study variables in the short term is studied using both the variance decomposition and the impulse response functions. Variance Decomposition: It is used to identify the amount of variation in the forecast that is due to the prediction in the variable itself and the amount that is due to the forecast error in other variables. Meaning, the variance decomposition analysis measures the amount of change in a certain variable that is due to changes in the same variable, and the amount of change that is due to other variables in the model. The variance components for the model were as follows:

Table No. (9): Results of Variance Decomposition Analysis.

Variance Decomposition of EXOR:						
Period	S.E.	EXOR	GDP	BC	G	TCH
1	11.33416	100.0000	0.000000	0.000000	0.000000	0.000000
2	17.28094	69.02579	1.289928	4.034871	19.50299	6.146422
3	20.44292	50.35364	3.947643	2.904586	38.26768	4.526450
4	26.44632	30.59110	12.51941	2.100221	51.76598	3.023298
5	33.90731	18.61061	16.88321	7.444211	53.30540	3.756573
6	39.70595	13.67132	16.69369	11.73443	54.01120	3.889362
7	44.50063	11.73557	15.43368	12.69256	55.84038	4.297801
8	48.73710	10.39984	15.15181	11.76889	58.24215	4.437319
9	53.14874	8.882835	16.13506	10.86621	59.74368	4.372218
10	57.87793	7.500065	17.11024	11.02872	60.00127	4.359706

Source: Prepared by the researchers based on EViews 10.

The results from the variance components analysis revealed the following:

When analyzing the variance components, the value of exports outside the fuel sector in the second period showed that approximately 69.02% of the forecasting error in its variance is attributable to the change itself. This percentage gradually decreases across the study's periods,

reaching 7.50% by the end. It is notable that exports made the most significant contribution in the second period.

Regarding government spending, it accounts for 19.50% of the fluctuations in the forecasting error of global oil prices in the second period. This percentage progressively increases, reaching 60%in the last period. This variable ranked first in terms of explaining the forecasting error in the value of non-fuel sector exports in the final period.

As for the Gross Domestic Product (GDP), its explanatory strength for the value of non-fuel sector exports was 1.28% in the second period. This ratio then increased to 16.88% in the fifth period. However, it started declining from the sixth period, reaching 15.15%in the eighth period, then rose again to 17.11% in the last period. This variable secured the second rank in explanatory strength during the final period.

This is followed by the trade balance, whose explanatory strength was measured at 4.03%4.03% in the second period. This percentage then decreased to 2.10%in the fourth period and increased again in the fifth stage to 7.44%, eventually continuing its ascent to reach 11.02% in the final stage. Thus, it ranked third in terms of explaining the forecasting error in the value of non-fuel sector exports.

Regarding the exchange rate variable's effect on the value of non-fuel sector exports, it explained 6.14% of the forecasting error fluctuations in the second period. This percentage consecutively started to decline from the third period, dropping to 3.02% in the fourth period, then increased again to 4.35% in the final stage. This modest percentage makes this variable hold the fourth rank in explaining the forecasting error in the value of non-fuel sector exports.

4. Conclusions

This study aimed to understand the relationship between non-energy exports in Algeria and various economic variables from 2000 to 2022. Relying on previous studies and economic theory, a set of variables was identified. The Johansen cointegration test revealed the presence of three cointegrated vectors, indicating a long-term equilibrium relationship between Algeria's non-energy exports and its determinants. This led to the utilization of the Vector Error Correction Model (VECM) to reconcile short-term behaviors of the variable with its long-term dynamics.

In the VECM, differences (errors) between estimated and actual values of the dependent variable in the cointegrated model are taken into account. The model is then re-estimated by introducing the first differences of the errors as a new independent variable. After estimating the VECM, it was observed that the error correction coefficient, which signifies the speed at which the system returns to long-term equilibrium, is statistically significant, negative, and estimated at -0.3932. This implies that deviations from equilibrium are adjusted by 39.32% annually. Therefore, when

non-energy exports in Algeria deviate from their equilibrium value in period (t-1), around 39.32% of this deviation is adjusted in period (t), which equates to an adjustment speed of approximately 2.5 years (0.3923/1=2.5). This reflects a rather slow adjustment back to the long-term equilibrium.

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