

An Econometric Study of the Impact of Trade Openness and Foreign Direct Investment Flows on Economic Growth during the Period 1990-2020

PhD student: Abdessamed Saadi ^{(1)*}. Pr: Boualem Moulay ⁽²⁾

⁽¹⁾⁽²⁾Laboratory of development policies and prospective studies,
Faculty of Economics, Business and Management Sciences University
of Bouira, 10000 bouira (Algeria).

⁽¹⁾ a.saadi@univ-bouira.dz ⁽²⁾ b.moulay@univ-bouira.dz

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Abstract:

This research paper examines the impact of trade openness and foreign direct investment flows on economic growth in Algeria from 1990 to 2020, using an econometric analysis conducted with EViews 10.

First, the paper reviews the theoretical background by defining each variable separately. It then analyzes the real-world application of these concepts in the Algerian context.

The study employs a simultaneous integration methodology to assess the impact of trade openness and foreign direct investment on economic growth, grounded in economic theory. The results reveal a long-term integrated relationship between the independent and dependent variables, aligning with core economic principles.

Keywords: trade openness; FDI; economic growth.

Introduction:

Since the beginning of the nineties, Algeria has sought to liberalize foreign trade, as it has deliberately enacted many laws, adopted a huge amount of reforms and established many institutions

* Corresponding author

framing this openness in order to maximize its benefits in order to reach acceptable growth rates, enabling it to reduce its dependence on the fuel sector (Petroleum Rent), which has become threatening its economy due to fluctuating, Economic development is a goal that all individuals strive for, as is the quest for variables that will enhance the individual and societal quality of life. This is why many economists are interested in researching and analyzing various economic models to determine the link between economic growth and other factors. Foreign trade plays a vital role in the economic growth function, serving as a crucial component that drives economic expansion. can economize productive expenditures and expand consumption time by increasing consumer benefits, which necessarily leads to increased economic growth rates. Today, commercial openness is no longer presented as an alternative choice for Algeria, but as a factual asset to be adopted. From what has been addressed, the following problem must be answered:

What is the effect of trade openness and foreign direct investment flows on economic development in Algeria?

The sub-questions:

- Is Algeria's economy an open or closed economy?
- What is the relationship between trade openness and economic growth?
- What is the relationship between foreign direct investment and economic growth?

Study hypotheses: In light of the discussion and in order to address the earlier queries, we have developed the following theories:

- Since the Algerian economy depends on oil revenues for its revenues, it is an open economy
- Trade openness positively affects economic growth
- Foreign direct investment has a negative influence on economic growth rates.

The importance of research

The research is significant since it attempts to analyze trade openness, one of the key phases of the Algerian economy. Additionally, this research may effectively highlight and provide a picture while evaluating experience and highlighting strengths and faults.

Objectives of the study:

The aim of this study is to achieve several outcomes:

-This study examines the relationship between trade liberalization and economic growth performance..

-To identify the nature of the relationship between economic growth and foreign direct investment.

- The study develops an economic model grounded in theory to illustrate the relationship between the independent and dependent variables. The course of study:

The study employed a descriptive analytical approach, which provided conceptual insights into the variables under investigation and their relationships. Additionally, a standard quantitative analytical method was used to determine the connection between economic growth and openness.

First: The Concepts of Foreign Direct Investment, Trade Openness, and Economic Development .

1-The Concept of Economic Growth: Some individuals contend that economic growth and development both point to an increase in the economy's capacity for production. Some prefer to group them based on economic characteristics; industrialized countries are often called "growth" and rising countries "economic development. "Because they believe that both development and economic growth relate to an increase in the economy's capacity to generate goods and services, some people often use the words interchangeably. Developed countries are often called "growth" and rising countries "economic development" due to the differences between their economies.

The term "growth" has a range of accepted meanings, including:

- When a country's GDP or RNP rises over a period of time, we say that the economy is growing⁽¹⁾.

- Any nation that wants to build its economy and provide better living conditions for its citizens has economic growth as one of its primary economic objectives⁽²⁾.

(1) Abdul Muttalib, A. H. *Economic Theory: Partial and Total Analysis*. Egypt: University Press, 2006, p. 466

(2) al-Habsi, N. S.-D. *Macroeconomics: Principles and Applications*. Jordan: Al-Hamid Publishing and Distribution, 2006, p. 43

- According to Kuznets, a nation's progress may be characterized as a gain in both population and per capita income, since economic growth is a quantitative phenomenon.⁽³⁾

There are three factors that contribute to economic growth:

- Raising national income per capita on average
- Reaching a real rise in the average real income per person, or increasing people's buying power for goods and services;
- For real GDP growth that is both steady and persistent, a rise in the amount of economic activity must be the driving force behind rising real GDP per capita. The World Bank ⁽⁴⁾

Economic development refers to the process by which a country's average per capita real income rises over time. This rise is the product of various changes, including improvements in production and service quality, changes in income distribution to help the poor, and so on⁽⁵⁾.

1- the concept of business openness:

In an effort to attain world peace and security, post-WWI economic thought focuses on implementing new international trade law norms, mostly centered around trade identification and freedom of competition. In their pursuit of free trade, states have also worked to open up international markets using standardized criteria and principles.

- The trade partners of the National Planning Institute focused on trade, regulatory, macroeconomic management, and exchange rate policy. Policies that result in the adoption of import-export neutral policies and the abandonment of anti-export biased policies are referred to as trade openness. The trade liberalization program's content is comprehensive, encompassing various activities related to import and export policies, such as lowering high tariff values and converting quantitative restrictions into tariffs⁽⁶⁾.

(3) Bounoua, S., & Ben Yakhlef, Z. *Introduction to Macroeconomic Analysis*. Algeria: University Publications Bureau, 2010, p 60

(4) Nasif, H. A. *Macroeconomic Theory*. Egypt: Wael Publishing and Distribution, pp. 333-335

(5) Ajima, M. A., & others. *Economic Development: Theoretical and Applied Studies*. Egypt: University Press, 2006, p. 77

(6) Abdous Abdel Aziz. *Trade Liberalization Policy and Its Role in the Competitiveness of Countries*, PhD Thesis in Economic Sciences. Tlemcen: Faculty

– One definition of trade openness by international institutions is policies that lead to neutral or devaluation of high tariffs, the trend towards a unified tariff regime, the conversion of quantitative restrictions into tariffs, the abandonment of pro-export policies, and the control of high tariffs⁽⁷⁾.

2- the concept of foreign direct investment:

– The International Monetary Fund (IMF) and the Organization for Economic Cooperation and Development (OECD) define foreign direct investment (FDI) (DECD) as a kind of investment in which a company with headquarters in an economy (the direct investor) seeks to acquire a long-term stake. This interest implies a long-term partnership between the two parties as well as the direct investor's significant management impact.⁽⁸⁾.

Foreign direct investment (FDI) is also meant for enterprises that are either entirely owned by foreign investors or in which foreign investors share valuable local investors or control the management. These projects tend to be very stable and supplied by multinational corporations that help transmit technology, knowledge, and managerial skills⁽⁹⁾.

Analysis of indicators

Table 1: Development of domestic output and foreign trade during the period 1990-2020

years	Domestic product	Exports	Imports	Balance of trade
1990	472805,7	122279	87018	35261
1991	752592,3	233589	139241	94348
1992	918623,8	249010	188547	60463

= _____
of Economic Sciences, Commercial Sciences, and Management Sciences, Abou Bakr Belkaid University, 2011, p 44

(7) Barik, M. *Trade Liberalization and the Real Exchange Rate: A Case Study of Algeria*, Thesis Submitted for a Master's Degree in Economic Sciences. University of Tlemcen, 2013, p. 37

(8) *OECD*. Paris: Third Edition of the Detailed Benchmark of Foreign Direct Investment, 1999, p. 07

(9) Zghdar, A. Foreign Direct Investment as a Form of Support for Strategic Alliances to Face Competition, *Al-Bahith Journal* (Issue 3) 2004, p. 159

1993	1005031,4	239552	205035	34517
1994	1274944	324338	340142	-15804
1995	1743631,8	498451	513193	-14742
1996	2256712,6	740811	498326	242485
1997	2423613,7	791767,5	501579,9	290187,6
1998	2444370,2	588875,6	552358,6	36517
1999	2825227,6	840516,5	610673	229843,5
2000	3698683,7	1657215,6	690425,7	966789,9
2001	3754870,8	1480335,8	764862,4	715473,4
2002	4023413,8	1501191,9	957039,8	544152,1
2003	4700040,4	1902053,5	1047441,4	854612,1
2004	5545851,5	2337447,8	1314399,8	1023048
2005	6930153,3	3421548,3	1493644,8	1927903,5
2006	7823794,6	3979000,9	1558540,8	2420460,1
2007	8554266	4214163,1	1916829,1	2297334
2008	9968908,7	5095019,7	2572033,4	2522986,3
2009	8770806,4	2572033,4	2854805,3	-282771,9
2010	10404470,8	4333587,4	3011807,6	1321779,8
2011	12211018,1	5374131,3	3442501,6	1931629,7
2012	13561457,2	5687369,4	3907071,9	1780297,5
2013	14096723,5	5217099,8	4368548,4	848551,4
2014	14490178,8	4917598,2	4719708,3	197889,9
2015	13812762,8	3537186,7	5193459,7	-1656273
2016	14455022,3	3277716,4	5154776,8	-1877060,4
2017	15804189,4	3928295,6	5111297,6	-1183002
2018	17390711,2	4889278,6	5403233	-513954,4
2019	15321321,3	4271648,8	5016837	-745188,2
2020	15024828,9	2846371,4	4363653,1	-1517281,7

Source: prepared by researchers based on the General Directorate of Customs, CNIs National Center for information and statistics of Customs

A-the development of gross domestic product during the period 1990-2020:

The figure shows that the worst known period for economic GDP occurred between 1990 and 1995, with an increase from 1990 to 1995 from 472,805.7 to 1743,631. 8. Progress was hindered by the drop in oil prices and the start of the economic crisis, which had an impact on all sectors of the economy. In 2000, the gross domestic product was expected to reach 3,698,683 at the start of the new century. The relative decline in oil prices caused Algeria's GDP to fall in 2006, 2007, 2009, 2010, and 2011.

Evolution of FDI flows for the period 1990-2020:

Table No. 02: Evolution of FDI flows during the period "1990-2020"

year	1990	1991	1992	1993	1994	1995	1996	1997	1998
value	0.3	11.6	30	0.001	0.001	0.001	270	260	606.6
year	1999	2000	2001	2002	2003	2004	2005	2006	2007
value	291.6	280.1	1113.1	1065	637.8	881.8	1156	1841	1686.7
year	2008	2009	2010	2011	2012	2013	2014	2015	2016
value	2638	2746	2300	2571	1500	1691	1503	537-	1546
year	2017	2018	2019	2020					
value	1236	1475	1384	1146					

Source: Prepared by researchers based on the World Bank

Several changes have been discovered by FDI flows, as can be seen from the table. The situation with the inflow improved somewhat in 1996, when it reached \$270 billion, after being practically nonexistent during the preceding three years. The understanding and acceptance of the government's financial incapacity to shoulder the load of debt is the root cause of this. Two factors—oil prices and government changes to the investment law—have contributed to a marginal uptick in the next years.

an econometric study on the impact of trade openness and FDI on Algeria's economic growth during the period 1990-2020

First: analysis and econometric estimation of the study model

1. Data and study methodology:

This research looks at the Algerian economy every year from 1990 until 2020. The choice of the commencement of the period was based on developments in this phase. We used databases maintained by the World Bank and the National Statistical Office to compile our data.

In terms of the approach, we will analyze the effects of programmatic adjustments and developments to variables by employing the ARDL self-regression model for dispersed time gaps. 10. (EViews) Regarding the study's methodology, we will employ the ARDL self-regression model to analyze the effects of changes and developments in variables using a computer, which is in line with current trends in time series analysis that make economic relations quantifiable. (EViews.10)

2. Study model variables:

In this study, we use a linear regression model to look at the growth function we're interested in and see how the independent and dependent variables are related. To represent growth, we use GDP and trade openness, which we represent as $Popo$ FDI, which is represented by FID, because it has this general mathematical form:

$$GDP = f(X, M) \dots \dots \dots (01)$$

The following is the model's econometric representation:

$$X_t + \beta_2.M_t + \varepsilon_t \dots \dots \dots (02) = c + \beta_1 GDP_t$$

GDP economic growth is the dependent variable;

Free trade (OP) and FDI (foreign direct investment) stand as the independent variables.

Research model estimation data was obtained from a database maintained by the World Bank and the National Bureau of Statistics in 2023. In order to eliminate the problem of variable variability, the data was transformed into its natural logarithm using the program. 10. Views expressed in the analysis, supposing that the subjects of the inquiry would be:

$$\ln X_t + \beta_2.LnM_t + \varepsilon_t \dots \dots \dots (03) = c + \beta_1 \ln GDP_t$$

C : Efficiency coefficient.

ϵ : The remaining indicators from the model's non-variables that affect economic growth can be represented by the degree of error.

β_2, β_1 . Model parameters.

3. To prevent the false regression problem from ever cropping up, it is important to evaluate the stability of the time series in question before moving on to model estimation Spurious.

Using the standard OLS micro-square method yields erroneous results when dealing with chain instability; this describes a fall that performs well in terms of the F, t) test and the R2 value.

The Philips Perron Test's degrees of deceleration:

Since it is critical to determine the optimal time delays for the Philips Peron test by utilizing the lowest value of the AIC and SC criterion before running the unit root test, we calculated these values for each model in the test and chose the lowest one. The results are summarized in the table below:

Table No. (1): determination of the degrees of time dilation of the Phillips PERONPP test

Number of slowdowns variables		0	1	2	Optimal lag period
LGDP	Akaike	2.688	-1.880	-1.811	01
	Schwarz	2.735	-1.786	-1.670	
LOP	Akaike	-0.368	-1.444	-1.394	01
	Schwarz	-0.321	-1.349	-1.252	
LFID	Akaike	5.821	5.059	5.120	01
	Schwarz	5.868	5.153	5.261	

Source: created with Eviews10 by the researcher

The results displayed in the above table demonstrate that the akaikes lowest value is obtained at the degrees of deceleration and Schwarz criteria are degree one, i.e. (p=1) at the logarithm series of economic growth and trade openness, as well as at the logarithm series of FDI flows.

- Philips PERUNPP test: In the table that follows, you can see the statistical results of the unit root test for time series stability.

Table No. (2): Philips Perron PP test results

Time series	Decision	Phillips Perron	
		level	The first difference
LOGGDP	I(0)	-3.522	/
LOGOP	I(1)	1.702	-0.526
LOGFID	I(1)	1.322	-0.136
Critical Values	1%	-4.29	-4.30
	5%	-3.56	-3.57
	10%	-3.21	-3.22

Source: created with Eviews10 by the researcher

Results from the unit root table for time series stability show that variables (trade openness "LOGOP" and FDI "LOGFID") do not have a unit root, so it cannot be denied.

The computed results failed to meet the crucial values obtained at the 1%, 5%, and 10% significance levels due to instability in the data. The theory may be disproved for these variables when examining the initial differences, as the series (economic growth/logdp) only became stationary after taking the first differences I(1), indicating it was not stable at the level I(0).

We conclude from this that the time series under study is not integrated to the same degree, as it is a combination of the two degrees, namely: (1) $CI_{\sim}$ and (0) $CI_{\sim}$, and this allows the possibility of utilizing contemporary boundary test methodology to determine the degree of a long-term equilibrium link between the variables under study

Second: model estimation

Despite the fact that the boundary testing approach is applicable regardless of whether the basic variables are zero-order integral i.e. or first-order integral i.e. (1 $CI_{\sim}$), or jointly integrated, it remains necessary to ensure that there is no second-order integral variable (2 $CI_{\sim}$) and it was found that the variables are complementary of degree 1 $CI_{\sim}$ and 0 $CI_{\sim}$. this allows the possibility of applying 0) $CI_{\sim}$ (the use of contemporary boundary tests.

1. Testing the number of time lag periods in the model:

- Akaik Criterion (AIC) : $AIC(P) = \ln|\sum_e| + \frac{2k^2 p}{n}$
- Shwartz Criterion(SC): $SC(P) = \ln|\sum_e| + \frac{k^2 p \cdot \ln(n)}{n}$
- Hanna - Quinn Criterion(HQ): $HQ(P) = \ln|\sum_e| + \frac{2p \cdot \ln[\ln(n)]}{n} \cdot k^2 p$

The selection of P)) that minimizes the aforementioned values determines all these criteria in cases where:

k the number of system variables: n the number of observations: p the lags; form E: the covariance matrix of the remainders.

By taking the minimum value for AIC)) and SC)), we can get the ideal number of time lag periods that will allow us to do the estimation while still ensuring that the random variables are not linked.

The results are shown in the table below after these two criteria have been applied:

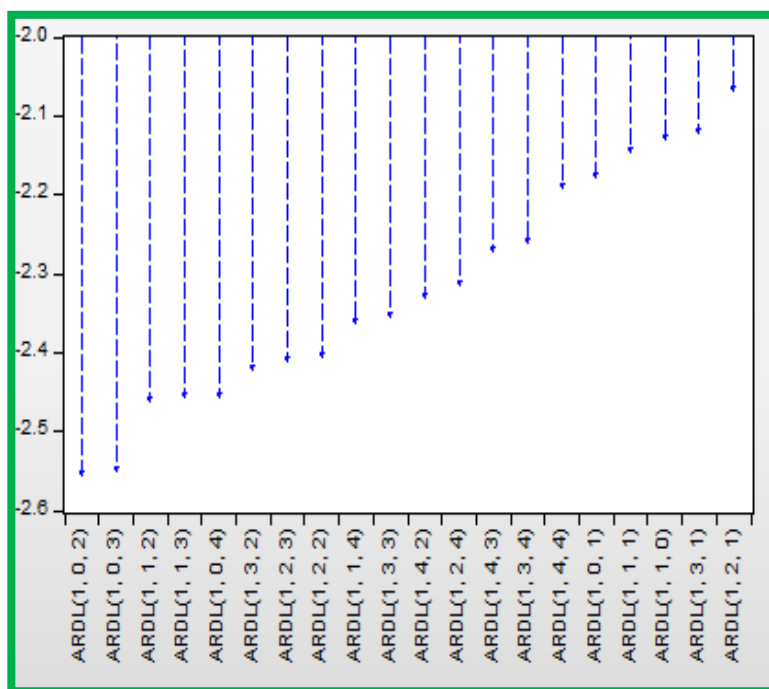
Table No. (3): testing the number of time lag periods of the model

(HQ)	(SC)	(AIC)	(Lag)
5.876595	5.977763	5.833781	0
0.490316	0.894990	0.139063	1
0.767468	1.475647	0.467774	2
0.626324	1.638009	0.198191	3
-0.0865665	1.228626	0.643138*	4
*means the number of time periods chosen by the standrad			

Source: created with Eviews10 by the researcher

Table No. (03) shows that the study variable's optimal deceleration period is 4P= according to the indicated criteria. After implementing this deceleration, multiple model estimation attempts were conducted; the most successful model was obtained based on economic and statistical criteria; the figure below illustrates this:

Figure No. (01): results of the best model according to the criterion of infortiomation Criteria Akaike



Source: created with Eviews10 by the researcher

By figure No. (01) it is shown that the optimal deceleration intervals by the criterion of kaikainfortimation.(1,1,1,0,0,1) the Criteriaof the Gardl Model(p, q1, q2), are : (1.0.2) .

2. In order to determine if independent variables have a long-term equilibrium connection with economic growth, we conduct co-integration testing using the ARDL approach. The results are displayed in the following table:

Table No. (04): results of the joint integration test of statistical F for the ARDL approach)

Critical Values	minimum	The highest rate	Fisher calculated
At 1%significance level	4.13	5	18.44
At 5%significance level	3.1	3.87	
At 10%significance level	2.63	3.35	

Source: created with Eviews10 by the researcher

The calculated STATISTICF value is higher than the upper critical value for the 1%, 5%, and 10% levels (Table 04), indicating a co-integration link between independent variables and economic growth (See Appendix No. 02).

3. The ARDL model for long-term estimation Since the findings confirmed that the variables were integrated, it is necessary to estimate the long-term equilibrium connection. The ARDL model (p, q1, q2) estimates the long-term model, and both the long-term and short-term models are displayed in the following table.

Table no. (05): results of estimating a long-and short-term model using the ARDL model

$$EC = LOGGDP - (-5.7588 * DLOGOP - 0.3198 * DLOGFID + 17.1283)$$

$$CointEq(-1)^* = -0.069422 \quad prob = 0.0000$$

Source: created with Eviews10 by the researcher

3. Examining the model over the long run, we find the following in Table No. (05):

When the values of the independent variables are not present, the per capita economic growth is at the 17.12 limit, according to the parameter value computed for the constant limit (See Appendix No. 03) .

According to the estimated parameter value of the coefficient of foreign direct investment to economic growth, which came to (0.319), the effect of this coefficient is negative and not statistically significant. In other words, a 10% increase in the value of FDI to total economic growth will result in a 3.19% decrease in real GDP growth per capita.

As the value of the trade openness coefficient reached 5.7587, it indicates that a 10% increase in trade openness will lead to a 57.58% decrease in real GDP per capita. This goes against economic theory, which predicts a positive relationship between trade openness and GDP per capita.

4. Evaluating the statistical and standard quality of the short-term model (error correction model):

The error correction model determines the function in the short period while simultaneously considering the long-term equilibrium state.

We derive the following conclusions from the estimation of the estimated parameters' values.

CointEq (-1) negative statistical coefficient signal, statistically significant (at 5% level) This is because ($p = 0.000 < 0.05$) this underscores a common complementarity among the variables in question, where the estimated value of the error correction limit in the previous year was 0.069. This means that about 6.9% of the deviation in per capita economic growth, i.e. (Real GDP) in the previous year on long-term equilibrium value corrected in the current year, requiring approximately ($0.68 = 1.45/1$) That's about 0.7 years to reach long-term balanced value. (see Supplement No. 04)

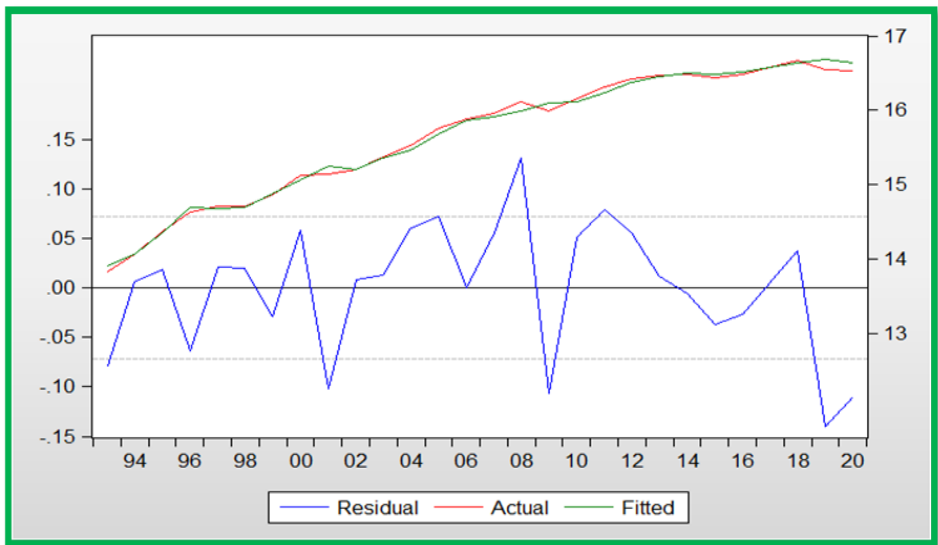
Confidence in these results is enhanced by:

- Corrected determination factor: 0.991 Adj. R²=, demonstrating the influence of independent variables and their role in identifying and interpreting shifts in per capita economic development, hence demonstrating the interpretative power of the model, i.e. (Real GDP), that is, this model has the ability to interpret 99% due to independent variables, and the remaining 1% is due to other factors or to other variables that are not included in the model and are due to the random variable (ui). (see Supplement No. 05)

Diagnosis of the model

1.1. Comparison of real values with estimated values: comparison of real values with estimated values using the model through the following diagram:

Figure No. (02): True values, estimated values and error correction form protectors



Source: created with Eviews10 by the researcher

You may use the estimated model to understand and evaluate the findings because, as shown in Figure No. (02), the estimated values converge with the true values.

2. Natural Distribution Requirement Test for Restricted Error Correction Model Protectors

The statistic Jarque-Bera will be used in this case because: $(J-B) = 0.928 < (\chi^2(3) (5\%)) = 7.81$. Therefore, we accept the null hypothesis (H_0), which states that the residuals follow a normal distribution. The fact that the test's approval probability ($\text{prob}=0.628$) is greater than 5% further confirms this. Consequently, this is viewed as evidence that the model's residuals follow a normal distribution, which is a desirable and positive aspect of the model (See Appendix No. 06).

3. Homogeneity (constancy) variance of residuals (errors)

One way to find out if the residual variance is homogenous is to apply the ARCH test, which is based on the LaGrange multiplier LM. Here are the steps to take during the test:

Find the squares of the residual after using the ordinary least squares approach to estimate the general form ($Y=XB+e$).

4. Calculate the following equation

$$\hat{\varepsilon}_t^2 = \theta_0 + \theta_1 \hat{\varepsilon}_{t-1}^2 + \dots + \theta_q \hat{\varepsilon}_{t-q}^2 + \mu_t$$

In this scenario, we deduct q-watch from the determination coefficient by plugging it into EQUATIONR2.

- The hypothesis of constancy of conditional variance for errors θ_h , which should be tested, is

$$H_0: \theta_0 = \theta_1 = \dots = \theta_q = 0$$

The Lagrangian multiplier statistic $LM = (n-q) \times R^2$ follows the distribution of χ^2 degree of freedom Q . If LM is greater than $X^2(q)$ the critical value of the distribution of X^2 is greater than (AF we reject H_0 , that is, if there is at least one of the coefficients of the ARCH equation)) that differs significantly from zero, then the conditional variance of the errors is inhomogeneous.

Where we have: $=3.84$ ($\chi^2(1)$ (%5)) ($LM=2.63 < \text{and from it we accept } H_0$) which states the homogeneity of the variation of the error limits, since the probability value $\text{prob} = 0.1043$ greater than 5% supports this. (See Appendix No. 07)

4. Verifying that error boundaries are independent (that is, that there is no sequential autocorrelation):

We use a test to investigate the hypothesis of the non-correlation of errors:

((Breusch-Godfrey Serial Correlation LM Test, for self-correlation, where:

$=5.99$) ($\chi^2(2)$ (%5)) ($LM=0.085 < \text{probability prob} = 0.95$ is greater than 5%, this indicates the rejection of the null hypothesis (H_0), which assumes an autocorrelation of the rest of the estimated model. (See Appendix No. 08)

5. Model stability test

The ARDL technique utilizes two key tests to assess model stability: the Cumulative Sum of Squares of the residuals (CUSUM of Squares) and the Cumulative Sum of the residuals (CUSUM). As illustrated in the diagram in Appendix No. 09, the model is stable

within a significant boundary. Specifically, the CUSUM, which represents the cumulative sum of the residuals, crosses the median line within the limits of the critical zone.

5. These two tests - CUSUM and CUSUM of Squares - demonstrate that the model is stable and produces results consistent with both the short-term and long-term periods. The CUSUM of Squares, which is the cumulative sum of the squares of the residuals, is positioned within the limits of the critical zone.

Conclusion:

All nations have welcomed foreign investment because of the benefits it brings to economic growth, which are highlighted in the study's discussion of standard and theoretical economic aspects, such as the fact that it helps reduce unemployment rates, recruits national labor, and eases the burdens of external financing. According to the standard study, trade openness also contributes to economic growth. The study found that export revenues, which are primarily made up of hydrocarbon revenues, directly affect GDP levels. This is because Algeria's industrial output base is not very diverse, so a smaller portion of the country's income comes from exports.

Results:

The effectiveness of the first strategy relies on the country's overall policy framework, which controls inflation, the black market, and government consumption.

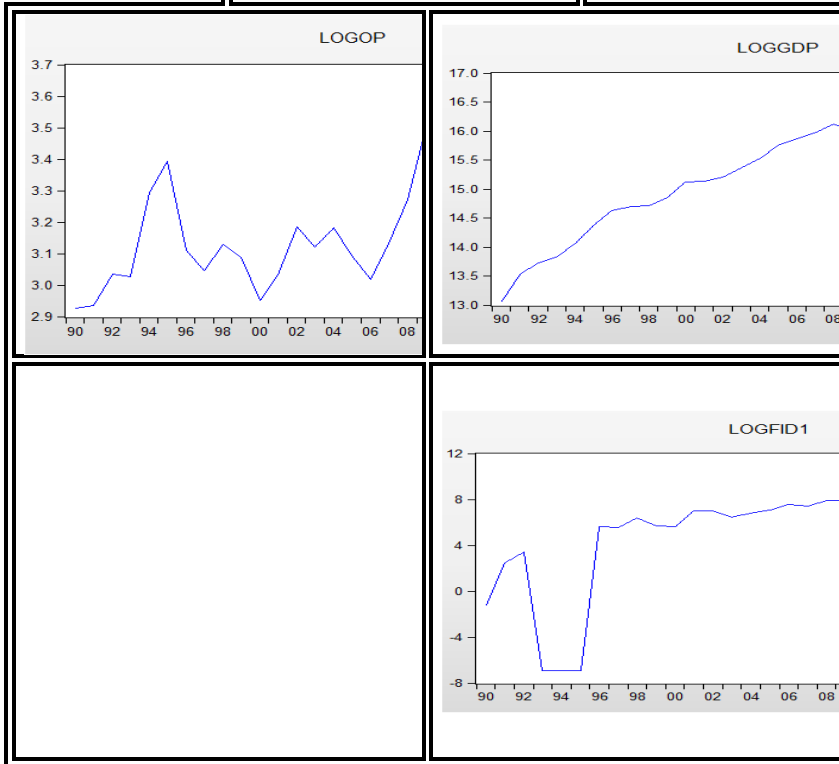
- When it comes to internal and international policy, emerging nations can't keep up with the times, so they invite foreign investors to help fund their infrastructure and economic growth.

Recommendations:

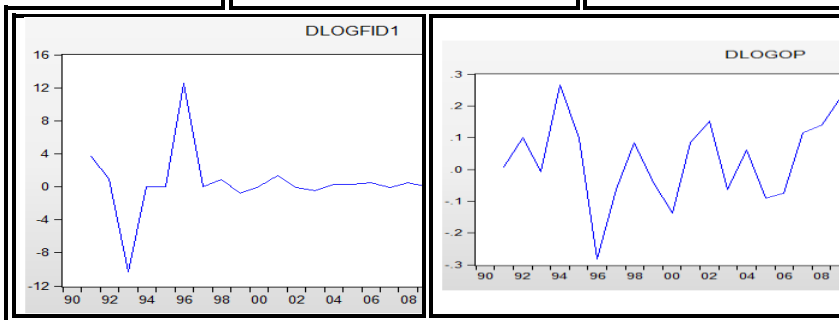
- The importance of maintaining a diverse revenue stream.
- To better compete in global markets, we must develop and promote exports that are not dependent on oil.
- Boosting private businesses and SMEs to fulfill local demand.
- To improve trade terms, Arab countries should work together economically.

Appendix No. 01: study variables during the period (1990-2020)

Data at the level



Data at first level



Appendix no. (02): boundary test results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	18.44216	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Finite Sample: n=30				
Actual Sample Size	25	10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

Appendix No. 03: results of estimation of a long-and short-term model

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.189083	0.271729	4.375992	0.0003
LOGGDP(-1)*	-0.069422	0.017599	-3.944653	0.0009
DLOGOP**	-0.399786	0.144693	-2.762985	0.0124
DLOGFID1(-1)	-0.022202	0.009616	-2.308968	0.0324
D(DLOGFID1)	0.001414	0.005105	0.276989	0.7848
D(DLOGFID1(-1))	0.011851	0.004643	2.552216	0.0195
* p-value incompatible with t-Bounds distribution.				
* Variable interpreted as Z = Z(-1) + D(Z).				
Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOGOP	-5.758767	2.673468	-2.154043	0.0443
DLOGFID1	-0.319819	0.166381	-1.922205	0.0697
C	17.12830	0.491670	34.83696	0.0000
EC = LOGGDP - (-5.7588*DLOGOP -0.3198*DLOGFID1 + 17.1283)				

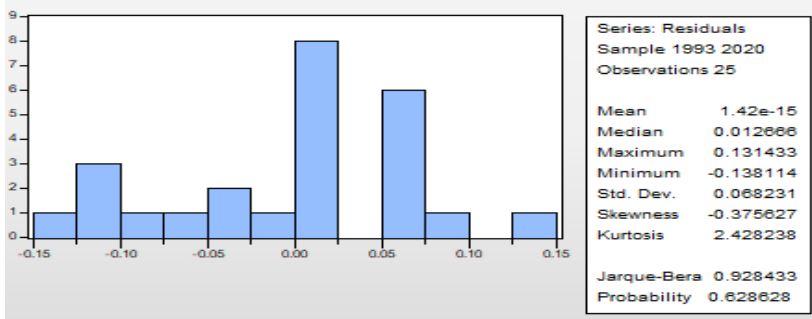
Appendix no. (04): error correction model estimation resultsECM)(

ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DLOGFID1)	0.001414	0.003504	0.403593	0.6910
D(DLOGFID1(-1))	0.011851	0.003454	3.430543	0.0028
CointEq(-1)*	-0.069422	0.007512	-9.242094	0.0000
R-squared	0.651258	Mean dependent var		0.102570
Adjusted R-squared	0.619554	S.D. dependent var		0.115540
S.E. of regression	0.071265	Akaike info criterion		-2.332648
Sum squared resid	0.111732	Schwarz criterion		-2.186383
Log likelihood	32.15810	Hannan-Quinn criter.		-2.292081
Durbin-Watson stat	1.600036			
* p-value incompatible with t-Bounds distribution.				

Appendix no. (05): The results of the assessment according to the ARDL method

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOGGDP(-1)	0.930578	0.017599	52.87662	0.0000
DLOGOP	-0.399786	0.144693	-2.762985	0.0124
DLOGFID1	0.001414	0.005105	0.276989	0.7848
DLOGFID1(-1)	-0.011766	0.005099	-2.307661	0.0324
DLOGFID1(-2)	-0.011851	0.004643	-2.552216	0.0195
C	1.189083	0.271729	4.375992	0.0003
R-squared	0.993373	Mean dependent var	15.54213	
Adjusted R-squared	0.991628	S.D. dependent var	0.838127	
S.E. of regression	0.076685	Akaike Info criterion	-2.092648	
Sum squared resid	0.111732	Schwarz criterion	-1.800118	
Log likelihood	32.15810	Hannan-Quinn criter.	-2.011513	

Appendix no. (06): testing the normal distribution of spores



Appendix No. 07: homogeneity (constancy) of heterogeneity of residuals (errors) ARCH

Heteroskedasticity Test: ARCH

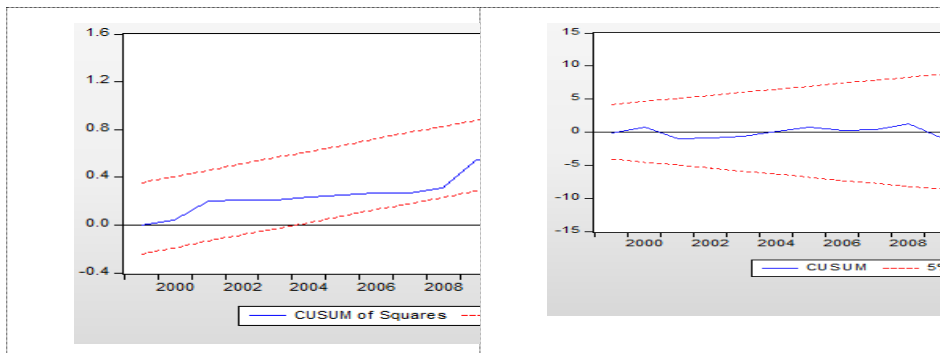
F-statistic	2.708195	Prob. F(1,25)	0.1124
Obs*R-squared	2.638976	Prob. Chi-Square(1)	0.1043

Appendix No. 08: testing the condition of independence of error limits

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.030467	Prob. F(2,20)	0.9700
Obs*R-squared	0.085048	Prob. Chi-Square(2)	0.9584

Appendix No. 09: model stability test



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