

Impact of FDI on Export Diversification in Algeria: A Study via the ARDL Model

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Abstract:

This article aims to analyze the relationship between foreign direct investment and export diversification in Algeria. To this end, the work has relied on the ARDL model to highlight the factors that influence the relationship between FDI and exports in Algeria during the period from 1995 to 2023. The results obtained have shown that foreign direct investment indeed had a positive effect on the diversification of exports in Algeria in the long run.

Key Words: FDI, Export diversification, Impact, ARDL, Algeria.

JEL Classification : F41, F14, C51

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1. Introduction

The debate on the role of diversification as a lever for economic development has been marked in recent years by a strong comeback. Several reasons explain this resurgence. The high volatility of raw material prices (Oualet, 2025), associated with the crises of recent years, has slowed economic growth and shown the strong vulnerability of North African economies to shocks, despite their low level of integration into world markets, underlining the need for their structural transformation (Moussir & Tabit, 2016).

Foreign direct investment (FDI) has become a vital component of economic globalization, playing a significant role in the economic advancement and diversification of many nations worldwide. The connection between export diversification and foreign direct investment is compelling, as FDI functions as a catalyst for growth and therefore for the progress of emerging and developing economies.

Although extensive literature is available on the link between FDI and its effects on economic growth, studies that directly connect FDI and export diversification are relatively few, in both developed and developing nations.

In the Algerian context, it is important to recall that, on an empirical level, few studies have examined the effect of FDI on export diversification. Among the studies carried out, we find the one conducted by (Touati, Keddari, & Azib, 2023), using a general autoregressive distributed lag (ARDL) model to assess the relationship between FDI and export diversification growth. They showed that FDI has a positive effect on diversification.

The objective of this study is precisely to fill the gap in research on the relationship between FDI and export diversification. It will be a matter of answering the following question: Does FDI contribute to diversifying Algerian exports? To answer this question, we use the ARDL model proposed in particular by Pesaran et al. (2001) over the period 1995 to 2023.

2. Brief Review of the Empirical Literature

It is generally accepted that FDI can play a positive role in the diversification of a country's exports. Few studies have analyzed the relationship between FDI and export diversification in both developed and developing countries.

(Kutan & Vuksic, 2007) examined the impact of inward FDI flows on export performance in 12 Central and Eastern European countries (CEECs) for the period between 1996 and 2004. The authors concluded that specific effects of FDI on exports are only observed in the new member states of the European Union.

(Jayaweera, 2009), in turn, investigated the impact of FDI on export diversification in the nations of the Central African Economic and Monetary Community (CEMAC), utilizing a panel model for the 1995-2019 period. The econometric findings indicate that private investment has a positive influence on economic diversification, whereas public investment obstructs it.

In a similar vein, (Tadesse & Shukralla, 2011) demonstrated that an increase in the volume of FDI promotes export diversification. Furthermore, the magnitude of this effect varies considerably between countries, depending on the stage of diversification they are in. To reach these conclusions, parametric and semi-parametric methods were applied to a sample of 131 countries, covering the period from 1984 to 2004.

(Iwamoto & Nabeshima, 2012) focused on analyzing the effect of inward FDI flows and stock on the diversification and sophistication of host countries' export baskets over the period from 1980 to 2007, using a dynamic panel data model. The authors show that an inflow of FDI with a five-year lag is positively correlated with export diversification and sophistication as well as with sustainable economic growth. They also find that these positive impacts of FDI only manifest in developing countries.

In the same line, (Moussir & Tabit, 2016) attempted to verify the link between FDI and diversification over the period 1980-2014 in Morocco using the Generalized Method of Moments (GMM). The authors agreed on a significant and positive relationship existing between FDI, gross fixed capital formation (GFCF), and export diversification in this country. On the other hand, the variables of per capita income, real effective exchange rate, inflation rate, and governance do not impact export diversification in any way.

Using dynamic panel cointegration techniques and the SGMM method, (Fayou, 2018) examined the relationship between foreign direct investment (FDI) and export performance in 23 developing countries. The author found that an increase in the volume of FDI improves export diversification.

Further evidence of the positive correlation between FDI and export diversification is provided in Algeria by (Touati, Keddari, & Azib, 2023), who show from an ARDL model, over the period 1995-2019, that FDI inflows promote export diversification.

(Swathi & Sridharan, 2022) examined the determinants of export diversification using a panel regression covering 101 countries ranging from high-income to middle- and low-income economies over the period 1995 to 2019. The results show that foreign direct investment (FDI) has a positive and significant effect on export diversification in many countries, primarily linked to industrial development and trade openness.

In their study, (Zhang, Chen, & Li, 2024) used data from Chinese firms to investigate whether exporting companies that engage in outward foreign direct investment (OFDI) succeed in diversifying their export baskets in terms of both products and destinations. The authors find that OFDI enhances both product and destination diversification of exports.

Finally, (Djermoun, Djermoun, & Bouchoul, 2025) studied the impact of FDI on export diversification in Saudi Arabia over the period 2005–2022 using the ARDL model. The explanatory variables used include FDI, the Productive Capacity Index (PCI), and total natural resources (TNR). The results indicate that FDI does not have a significant impact on diversification, as it remains concentrated in oil-related sectors. Natural resources have a negative effect, confirming the presence of the "resource curse," while the PCI shows only a weak positive effect.

3. Methodology and Choice of Econometric Model

The objective of our research is to investigate the exact effect of foreign direct investment on export diversification using an ARDL model over the period 1995-2023.

3.1 Study Methodology

In order to verify whether foreign direct investments have a positive impact on export diversification, we will apply the ARDL model.

Before introducing the econometric model, it is essential to identify the variables that compose it. Thus, to answer our research problem, two categories of variables have been selected: the dependent variable and the explanatory variables. The data used for the econometric estimations come mainly from the World Bank database and are annual time series (covering the period from 1995 to 2023, for a total of 29 observations).

3.1.1 The Dependent Variable

We select the dependent variable "Concentration Index (CI)": also known as the Herfindahl-Hirschmann Index (HHI of products), it measures the degree of a country's export concentration based on the exported products. The closer this index is to 1, the higher the concentration.

3.1.2 The Explanatory Variables

We select the following variables:

- **GDP per capita (GDR):** Gross domestic product (GDP) is a widely used indicator that measures the wealth created in a given country for a given year.
- **Foreign direct investment as a percentage of GDP (FDI):** is an economic indicator that measures the amount of foreign direct investment (FDI) in a country as a proportion of its gross domestic product (GDP).
- **Trade Openness (TO):** The degree of openness of the economy reflects the degree of exposure or participation of the host country in international trade and can also be a factor among others that is widely used in the economic literature.

3.2 Justification for the Choice of the ARDL Model

The choice of the ARDL model for this study is based on several methodological considerations. First of all, it is particularly suitable for time series involving variables with mixed orders of integration, whether they are stationary at level (I(0)) or in first difference (I(1)). This flexibility represents a major advantage over classical cointegration models, which require all variables to be integrated of the same order. Another reason motivating the choice of ARDL is its ability to simultaneously analyze short-run and long-run relationships (Kibala Kuma, 2018).

3.3. Model Specification

Drawing upon the empirical literature that investigates the impact of foreign direct investment (FDI) on export diversification, we specify our regression model in alignment with established empirical approaches:

$$\text{LogCI} = \beta_0 + \beta_1 \text{LogGDP} + \beta_2 \text{LogFDI} + \beta_3 \text{LogTO} + \varepsilon_t$$

In the equation above, C denotes the constant term, while β_1 , β_2 , and β_3 represent the coefficients associated with the explanatory variables. The term ε_t corresponds to the regression's residual error. All estimations were performed using the econometric software EViews 09, supplemented by standard statistical computations.

4. Empirical Results and Discussions

To ensure the reliability of the results, we used Eviews 9 software to perform various tests, including stationarity, cointegration, error autocorrelation, and heteroscedasticity tests.

4.1 Stationarity Analysis

To assess the stationarity of the variables in the model, we employed the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The results of the stationarity tests applied to the model's variables using both ADF and PP methods are summarized in Table 01,

indicating the integration order of each variable as well as the conclusion regarding its stationarity. The ARDL model is therefore appropriate in this context, as the variables exhibit integration either at level I (0) or at first difference I(1).

Table 1. Results of the stationarity of variables

Variables	ADF Test		Phillips-Perron Test		Integration order
	AtLevel	First difference	AtLevel	First difference	
LCI	-1.762866 (0.6954)	-4.826224 (0.0033) *	-1.797424 (0.6789)	-4.829017 (0.0033) *	I(1)
FDI	-3.799535 (0.0317)	-	-3.777840 (0.0332)	-	I(0)
LGDP	-0.722715 (0.9612)	-4.249305 (0.0122)	-0.799496 (0.9537)	-4.249305 (0.0122) **	I(1)
LTO	-1.693965 (0.7271)	-6.207083 (0.0001) *	-1.751245 (0.7395)	-6.207070 (0.0001) *	I(1)

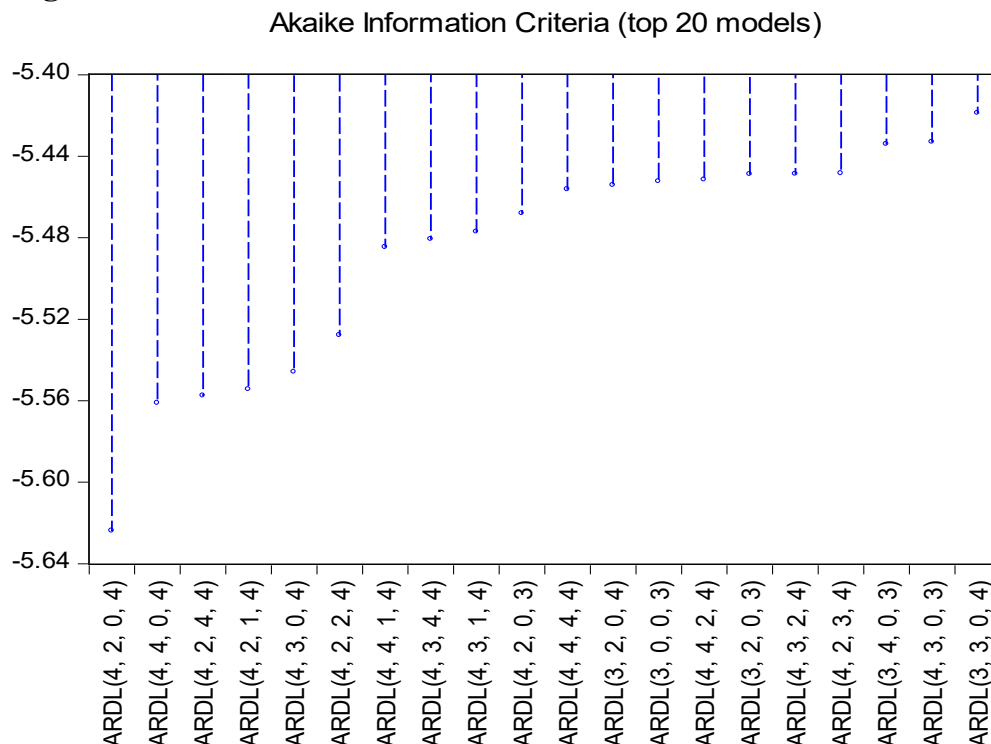
*Significant at 1%, ** Significant at 5%, *** significant at 10%.

Source: Prepared by the authors using Eviews 9

4.2 Selection and estimation of the Optimal ARDL Model

An important step in the framework of dynamic models is the determination of the optimal number of lags to include (Farjallah & Abdelhamid, 2017). To achieve this, various selection criteria are commonly used, the most widely applied being the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) (Kibala Kuma, 2018, p. 7). Among the top twenty models identified based on the AIC, the ARDL (4,2,0,4) model is considered the optimal specification, as it corresponds to the lowest AIC value. The results are presented in Figure 1.

Figure 1: Akaike Information Criteria



Source: Prepared by the authors using Eviews 9

Table 2. Estimation and Selection of the Optimal ARDL Model (4, 2, 0, 4)

Variables	Coefficient	Std.Error	t-statistic	Prob*
LCI(-1)	0.217026	0.170219	1.274983	0.2286
LCI(-2)	-0.045880	0.190539	-0.240790	0.8141
LCI(-3)	0.019620	0.177350	0.110630	0.9139
LCI(-4)	-0.922760	0.180413	-5.114717	0.0003
LGDP	-0.264141	0.256772	-1.028698	0.3257
LGDP(-1)	1.010898	0.394878	2.560029	0.0265
LGDP(-2)	-0.820273	0.267114	-3.070866	0.0106
FDI	-0.035525	0.009351	-3.799095	0.0029
LTO	0.484348	0.094650	5.117243	0.0003
LTO(-1)	-0.194811	0.082257	-2.368311	0.0373
LTO(-2)	0.143147	0.084159	1.700906	0.1170
LTO(-3)	0.083821	0.082064	1.021407	0.3290
LTO(-4)	0.150334	0.074486	2.018290	0.0686
C	-3.251648	0.805512	-4.036748	0.0020
R²= 0.97=):(Statistic= 29.40474 ;Prob=0.000001:DW=2.16				

Source: Prepared by the authors using Eviews 9

Overall, the model shows a good quality of fit, with a coefficient of determination (R^2) of 0.972029 and an adjusted R^2 of 0.938972, and a significant F-statistic (Prob(F-statistic)= 0.000001). The Durbin - Watson statistic (2.165706) indicates the notable absence of autocorrelation of residuals in our model, indicating that the model's errors are independent and that the latter is correctly specified in this framework.

4.3 Bounds Test for Cointegration

In order to analyze the long-run relationship and the short-run dynamic interactions of the variables of interest, which are export diversification, foreign direct investment, GDP per capita, and the degree of trade openness, we apply the ARDL Cointegration technique as developed by Pesaran et al (2001).

By analyzing Table3, the results of the bounds test for cointegration confirm the existence of a relationship, as the value of the F-statistic = 6.506551 is greater than that of the upper bound regardless of the critical threshold (10%, 5%, 2.5%, or 1%).

Table 3. Bounds Test for Cointegration

Signification	I0 Bound	I1 Bound
10%	2.72	3.77
5%	3.23	4.35
2.5%	3.69	4.89
1%	4.29	5.61
F-Statistique	6.506551	

Source: Prepared by the authors using Eviews 9

4.4 Short-Run Dynamics, Adjustment Coefficient, and Long-Run Coefficients

In what follows, we will present the results of the short-run and long-run ARDL modeling.

4.4.1 The Long-Run Relationship

To estimate the long-run relationship, we apply an ARDL model. The results of the estimations of the analysis model are presented as follows in Table 04.

Table 4. The Long-Run Relationship

Variables	Coefficients	Std.Error	T-Statistic	Prob
LGDP	-0.042446	0.036760	-1.154683	0.0427
FDI	-0.020511	0.006103	-3.361077	0.0064
LTO	0.385012	0.037905	10.157361	0.0000
C	-1.877402	0.330598	-5.678797	0.0001
Cointeq= LCI - (-0.0424*LGDP + 0.0205*FDI + 0.3850*LTO -1.8774)				

Source: Prepared by the authors using Eviews 9

Table 4 provides the estimation of the long -run dynamics coefficients. By analyzing these results, we can conclude that: The estimation results for most variables are consistent with empirical expectations. Economic openness was the only variable that defied expectations.

Regarding the FDI variable, we note that it is one of the determining factors of an economy's structural transformation since it contributes positively and significantly to export diversification. This also implies that a one - percentage - point increase in foreign direct investment would lead to a 0.02% decrease in export concentration and consequently an improvement in diversification. This finding is consistent with the conclusions of ((Tadesse & Shukralla, 2011), (Iwamoto & Nabeshima, 2012), (Moussir & Tabit, 2016) and (Touati, Keddari, & Azib, 2023)).

The results for export diversification are not directly interpreted. It should be noted that the Herfindahl-Hirschman Index (HHI), used as an indicator of export diversification, measures export concentration. Thus, a high concentration of exports (HHI index value close to 1) reflects low export diversification. Conversely, a low concentration of exports (HHI index value close to 0) indicates high export diversification. Therefore, since the index used is an inverse measure of diversification , a negative coefficient indicates a positive relationship between export diversification and the variables studied. Furthermore, the results in Table 04 also suggest that a 1% increase in GDP would lead to a 0.04% decrease in the concentration index. We can therefore affirm that in the long term, GDP has a positive effect on export diversification. This result is consistent with the work of (Touati, Keddari, & Azib, 2023), who demonstrated that a relationship exists between diversification and foreign direct investment.

Finally, trade openness has a positive and significant impact on export concentration , contrary to expectations. This implies that a 1% increase in trade openness would lead to a 0.38% increase in export concentration. This result strongly contrasts with previous studies. Contrary to theoretical expectations, trade openness in Algeria is associated with lower export diversification. This negative relationship is mainly explained by the country's strong dependence on hydrocarbons, which account for the majority of its external trade. Openness reinforces this specialization without encouraging the development of new export sectors, due to a lack of industrial competitiveness and structural reforms.

4.4.2 The Short-Run Relationship

After estimating the long-run relationship, we will now estimate the short-run relationship . The results of the short -run estimations are presented as follows in Table 5.

Table 5. Short-Run Dynamics

Variables	Coefficients	Std.Error	T-Statistic	Prob
D(LCI(-1))	0.949020	0.199869	4.748214	0.0006
D(LCI(-2))	0.903140	0.185933	4.857343	0.0005
D(LCI(-3))	0.922760	0.180413	5.114717	0.0003
D(LGDP)	-0.264141	0.256772	-1.028698	0.0257
D(LGDP(-1))	0.820273	0.267114	3.070866	0.0106
D(FDI)	-0.035525	0.009351	-3.799095	0.0029
D(LTO)	0.484348	0.094650	5.117243	0.0003
D(LTO(-1))	-0.143147	0.084159	-1.700906	0.1170
D(LTO(-2))	-0.083821	0.082064	-1.021407	0.3290
D(LTO(-3))	-0.150334	0.074486	-2.018290	0.0686
CointEq(-1)	-1.731994	0.252069	-6.871099	0.0000

Source: Prepared by the authors using Eviews 9

The results in Table 5 revealed that the overall performance of the model is satisfactory, with some of the independent variables having the expected short-term effect. The estimation results for most variables are consistent with empirical expectations. This shows that the variables included in the model, FDI and GDP, have a significant and positive short-term impact on export diversification. Trade openness was the only variable that revealed the opposite sign.

Finally, the results also indicate that the estimated coefficient of the error correction term (ECT) is negative and significant at the 1% level, which confirms the existence of cointegration relationships and therefore of convergence mechanisms towards the long-term equilibrium. The error correction model is therefore validated.

4.5 Diagnostic Tests of the Estimated ARDL Model

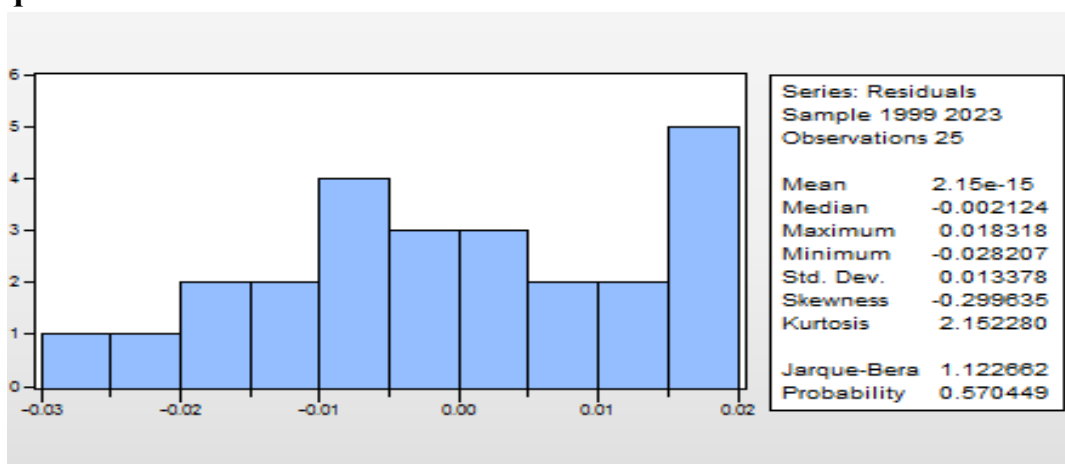
In order to ensure the reliability and robustness of our model, we applied a series of tests to evaluate its validity, namely the Normality test of the errors, the Heteroscedasticity test, and the Autocorrelation test of the errors. In addition, we evaluated the stability of the model to determine if the relationships between the variables remain consistent over time.

4.5.1 Normality Test of the Errors

The normality test of the errors is a statistical tool used to check if the residuals of a model follow a normal distribution. It is essential in econometrics, as the normality of errors is a key hypothesis to guarantee the validity of hypothesis tests and confidence intervals.

According to the results of the normality test, the errors follow a normal distribution, as the probability associated with the Jarque-Bera test is 0.5704, which is well above 5%. This confirms that the residuals are indeed white noise and respect the normality assumption.

Fig.2. Jarque-Bera Test



Source: Prepared by the authors using Eviews 9

4.5.2 Heteroscedasticity Test

In order to check for the presence of heteroscedasticity in our model, the Breusch-Pagan-Godfrey test was performed. The results of this test show that the Chi-Square probability is greater than 5%. Thus, we fail to reject the null hypothesis, which posits the absence of heteroscedasticity. We, therefore, accept the alternative hypothesis, hence our model is homoscedastic, which means that the variance of the error term in the model is constant for all levels of the independent variables.

Table 6. Breusch-Pagan-Godfrey Heteroscedasticity Test

F-statistic	1.236913	Prob. F(13,11)	0.3663
Obs*R-squared	14.84486	Prob. Chi-Square(13)	0.3171
Scaled explained SS	1.655805	Prob. Chi-Square(13)	0.9999

Source: Prepared by the authors using Eviews 9

4.5.3 Test of Residual Autocorrelation

To verify the absence of error autocorrelation, we opted for the Breusch-Godfrey test, which allows for statistically testing autocorrelation at any order. According to the results of the Breusch-Godfrey test, we observe that the probability value obtained is greater than 5%; consequently, we fail to reject the null hypothesis, meaning we accept that the residuals are not autocorrelated.

Table 7. Test of Error Autocorrelation

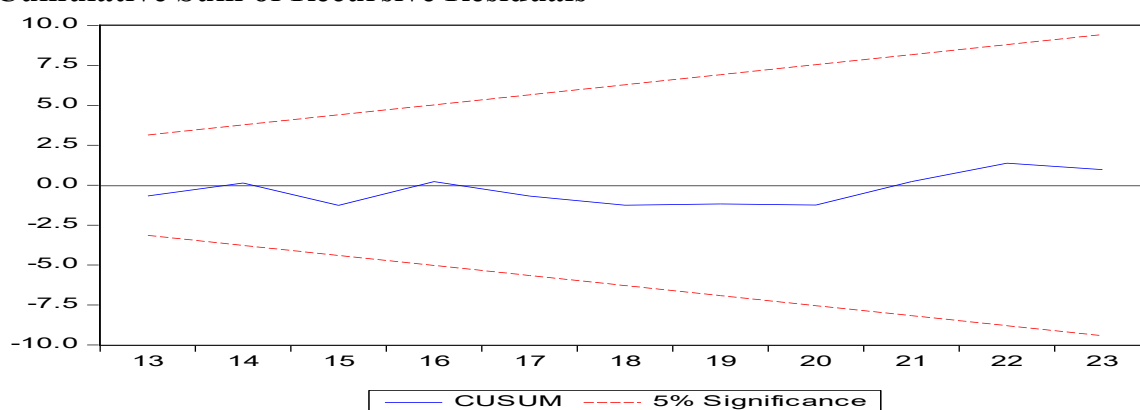
F-statistic	2.917230	Prob. F(2,9)	0.1055
Obs*R-squared	9.832613	Prob. Chi-Square(2)	0.5673

Source: Prepared by the authors using Eviews 9

4.5.4 Model Stability

The graph shows that the CUSUM curve constantly remains within the 5% critical bounds (the dotted lines). This indicates that the model is stable over the entire analyzed period, without evidence of structural changes in the coefficients.

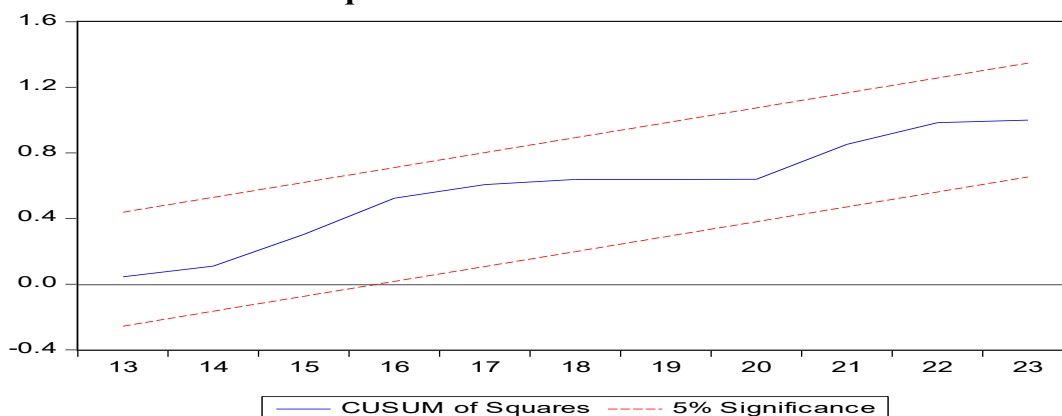
Fig.3. Cumulative Sum of Recursive Residuals



Source: Prepared by the authors using Eviews 9

The CUSUM of Squares graph shows that the curve also remains within the 5% critical bounds throughout the analyzed period. This confirms that the variance of the errors is stable, thus validating the stability of the model over the studied period.

Fig.4. The Cumulative Sum of Squares of Recursive Residuals



Source: Prepared by the authors using Eviews 9

5.CONCLUSION

Over the past two decades, the relationship between FDI and export diversification has captured the attention of a considerable number of economists, leading to empirical studies in this field. Most of these studies find that FDI plays an important role in export.

This study contributes to the literature on the relationship between FDI and export diversification in the Algerian context by mobilizing an ARDL model over the period 1995-2023. The results revealed that FDI did indeed have a positive effect on diversification in the long run.

In light of these results, it would be interesting for our economy to move towards an economic regime that favors FDI through organized and coordinated measures and choices. To achieve this, it is necessary to:

- Improve the business climate.
- Adopt a policy to attract foreign direct investment (FDI) targeting non-hydrocarbon sectors, such as manufacturing, in order to enhance export diversification in Algeria.
- Diversify the production structure by carrying out a profound structural transformation of the national economy.

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