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THE IMPACT OF INNOVATION ON ECONOMIC GROWTH IN ALGERIA: AN ECONOMETRIC ANALYSIS USING THE ARDL MODEL (1996–2021)

N. ABBES

Nawal Abbes
Faculty of Economics and Management, Abou Bekr Belkaid University of Tlemcen, Algeria
https://orcid.org/0009-0004-5104-5978, E-mail: abbesnawal4@gmail.com

Abstract: *The present study has been conducted for the purpose of analysing the relationship between innovation and economic growth in Algeria during the period 1996-2021. The study adopted a standard quantitative analytical approach using the augmented distributed lag regression (ARDL) model to estimate the relationships. The model was applied to a sample of 24 observations using EViews version 12. The study addressed four independent variables: high and medium technology exports, patent applications by residents, patent applications by non-residents, and scientific and technological articles. The findings indicated a negative correlation between high- and medium-technology exports and gross domestic product (GDP), with no discernible impact on the latter. Conversely, scientific and technological articles exhibited a positive correlation with GDP, albeit without exerting an effect on the immediate economic landscape. Furthermore, patent applications by residents demonstrated a negative correlation with GDP, affecting it in both the short and long term. In contrast, patent applications by non-residents exhibited a negative effect on GDP in the long term. In light of the findings, it is evident that innovation in Algeria is characterised by inefficiency and economic unproductivity within the prevailing structural framework. This necessitates a thorough re-evaluation of the policies and strategies associated with the national innovation system and Algerian economic growth by the state.*

Keywords*: innovation, Patent registration applications, residents, Patent registration applications,non- residents , Scientific and technical journal articles, Medium and high-tech exports, Economic Growth ,ARDL ,Algeria*

1.Introduction

Innovation has been identified as a fundamental catalyst for economic progress, playing a pivotal role in driving transformative change within industries and societies (Challoumis, 2024). It has been posited by certain economists that policies which embrace openness, competition and productivity improvement will promote sustainable growth. However, this assertion has been countered by others, who have argued that the strategy should instead emphasise domestic innovation activity, with a particular focus on high-tech manufacturing. (Siong Hook Law, 2020).In the pursuit of augmenting the conventional neo-classical growth model, an endeavour was made to enhance it through the utilisation of innovation (INV) in order to achieve enhanced productivity through the explicit modelling of total factor productivity. In the growth model, the acronym INV may be referred to as follows: Innovation and technology improvement, Research and development (R&D) spending, Patenting (Sardar Fawad Saleem, 2024).It is evident that innovation plays a pivotal role in catalysing economic growth on both a national and global scale. By cultivating a competitive environment, innovation fosters the creation of employment opportunities and facilitates the adaptation of economies to the evolving global landscape. In essence, it may be argued that, in the absence of innovation, economic growth would stagnate, and societies would be subject to decline. It is evident that there is a considerable challenge in addressing emerging issues. The ability to either confront challenges or to capitalise on new opportunities is of paramount importance (Challoumis, 2024) .The Spring 2025 World Bank Economic Update highlights Algeria's robust economic growth and decreasing inflation in 2024, while emphasizing the need to boost productivity in key sectors to achieve more sustainable

and diversified growth, thereby mitigating external risks (Bank, 2025).In light of the mounting interest in the role of innovation in achieving economic growth, a considerable number of previous studies have addressed this topic from a variety of theoretical and applied perspectives ,the study conducted by Siong Hook Law , Tamat Sarmidi, Lim Thye Goh(2020) titled : Impact of Innovation on Economic Growth: Evidence from Malaysia , The present study has been designed to analyse the relationship between innovation and economic growth in Malaysia. To this end, a neoclassical growth model that includes labour, physical capital and human capital has been employed. The study focuses on innovation as a key driver of strong growth.Time series methods (Time Series Techniques) have been used to analyse long-term economic and innovation data.The measurement of innovation was achieved through the utilisation of several indicators, including the number of patent applications (both domestic and foreign) and the number of patents granted (Patent Grants).The study results demonstrated that the number of patent applications (both local and foreign) exerted no significant impact on economic growth. In contrast, the number of patents granted has been shown to have a positive and moral impact on economic growth.This suggests that the quality of innovation is more important than its quantity (Siong Hook Law, 2020) .

as well as the research by Irsan Hardi, Samrat Ray, Muhammad Umer Quddoos Attari, Najabat Ali and Ghalieb Mutig Idroes (2024) titled : Innovation and Economic Growth in the Top Five Southeast Asian Economies: A Decomposition Analysis , The present study examines the dual impact of innovation on economic growth in five Southeast Asian countries (Indonesia, Thailand, Singapore, Malaysia, and Vietnam). The index was derived from 21 innovation indicators drawn from the Global Innovation Index (GII), which were then categorised into seven distinct groupings: institutions, human capital and research, infrastructure, market development, business development, knowledge and technology outputs, and creative outputs.The findings of Panel analysis and country-specific studies demonstrated that innovation exerts a substantial influence on economic growth. However, an examination of sub-indicators revealed that a considerable number of them impede growth rather than fostering it.The study indicates that innovation in these countries has not yet been optimally invested in, and recommends the need to adopt policies that stimulate innovation, such as removing barriers, directing investments towards vital sectors, and promoting education and skills development, in a way that creates an enabling environment to consolidate innovation as a major driver of economic growth (Irsan Hardi, 2024).

as well as the research by Vicente J. Coronel, Carmen Díaz-Roldán(2025) titled : Economic growth in the European Union: Exploring the role of innovation and gender, The present paper summarises the role of innovation and gender in the economic growth of EU countries. To this end, dynamic panel data analysis is employed to examine the relationships between human capital and employment in high-tech sectors. The findings indicated that employment in high-tech sectors is the primary contributing factor to growth, particularly in countries that are recognised as leaders in innovation. However, the study revealed a positive and moral impact of the gender gap in employment on growth in these innovative countries, highlighting the need for further analysis to understand how the current disparity in gender job roles affects the dynamics of economic growth in the European Union (Vicente J. Coronel, 2025).

- as well as the research by Ayousha Fayyaz , · Zoltan Bartha(2025) titled : Research and development as a driver of innovation and economic growth; case of developing economies, The present study has been designed to analyse the channels of impact of research and development (R&D) on economic growth in developing countries. The analysis will be based on data from 32 countries from the lower middle-income bracket for 2019, according to the World Economic Forum database. The study adopted a theoretical model based on a research and development system that includes institutions, human capital, the financial market, and innovation. Structural Equation Modeling (SEM) method was employed to construct a path model, thereby illustrating the relationships between these components. The findings indicated that research and development, as well as financial institutions, exert a positive influence on innovation. However, the study concluded that there is no direct moral

impact on economic growth. Findings suggest that research, development and innovation (RD&I) endeavours in middle-income countries do not invariably result in sustainable growth, thereby reinforcing the concept of a middle-income trap. This notion posits that while innovation activities may foster entrepreneurship, they are often inadequate to catalyse genuine economic growth (Ayousha Fayyaz, 2025).

It is important to acknowledge that the majority of studies examining the impact of innovation on economic growth in Algeria have concentrated on the micro level, i.e. industrial firms and companies. However, there is a notable absence of studies that address this subject from a macroeconomic perspective. This research gap signifies a fruitful area that merits further analysis to ascertain the relationship between innovation and economic growth at the level of the national economy as a whole. The central research question guiding this study is as follows:**What is the extent to which innovation affects economic growth in Algeria?**

The following main hypothesis is hereby formulated:

H: Innovation affects economic growth positively and statistically significantly

H1: The positive and significant impact of Patent registration applications, residents on Algeria's gross domestic product (GDP)

H2: The positive and significant impact of Patent registration applications,non- residents on Algeria's gross domestic product (GDP)

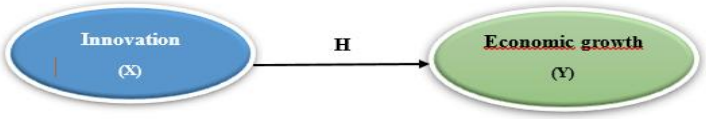
H3: The positive and significant impact of Scientific and technical journal articles on Algeria's gross domestic product (GDP)

H4: The positive and significant impact of Medium and high-tech exports (% manufactured exports) on Algeria's gross domestic product (GDP)

The primary objectives of this research are as follows:

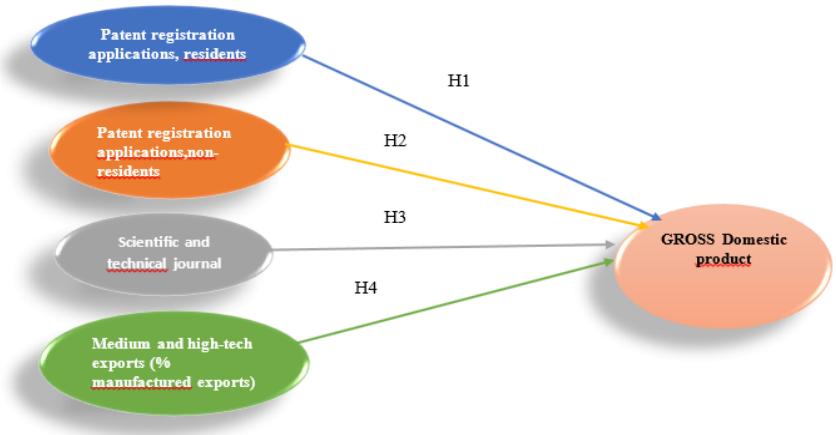
-Analysis of relationships: This study explores the impact of innovation on economic growth in Algeria during the period 1996-2020.

Figure01. The study model



Source: Author' estimations

Figure 02. The model is expressed as:



Source: Author' estimations

2.Literature Review

Innovation is the process of transforming new ideas and knowledge into new products and services (Gerguri, 2010).**Joseph Schumpeter** defines innovation as "the activity which leads to new production functions and new products". He divides this activity into several steps, as follows:

1)- The introduction of a new product: the entrepreneur should produce a new product that is easy to sell and that does not yet exist on the market.

2)- Introducing a new production method: innovation should offer a new scheme of production that can be achieved using existing inputs. This should lead to an increased output, a decrease in costs per unit product, the introduction of new inputs and the replacement of existing ones.

3)- Establishing new market presence: Innovations have the potential to expand sales into new regions and increase customer base.

4)- The identification of suitable raw material sources is a key priority. It is important to note that raw material suppliers may, on occasion, compromise the quality of their products or increase their prices. This can have a direct impact on the quality and selling price of the final product. Therefore, it is the responsibility of the entrepreneur to identify a suitable source of inputs for production of new products.

5) -The establishment of a new organisation in the industry. Schumpeter characterises this phase as the entry of the entrepreneur into a monopoly market, where there has been an absence of competition; or the establishment of conditions that enable the entrepreneur (McDaniel, 2002).

Innovations are defined as a process involving the creation of new products or services, new technological processes, new organisations, or enhancements to existing products or services, existing technological processes and existing organisations (Gerguri, 2010).

According to Tom Cannon, the distinction between these terms is as follows:

-Creativity represents an opportunity to generate new appearances, content or The process involves combining existing inputs or factors of production.

-**Inventiveness** is defined as the process of creating something new. This is a contribution to the overall knowledge of humankind.

-Innovation is inextricably linked to the effective marketing of new products and services. This is a technological process, the result of inventiveness (Cannon, 1991).

Innovation is widely regarded as a primary catalyst for economic growth and development. The term refers to the generation and execution of novel concepts, methodologies, commodities, and technologies (Grii Nihal, 2023)**.**

As illustrated in **Figure No. 3**, the indicators of inputs (resources) and outputs (performance) are represented.The Input Indicators (Resources) are divided into two main categories.

-The following section will address the subject of Human Resources.

The data is represented by the number of science and technology graduates (i.e. engineers), the number of researchers in research and development (R&D), and the number of scientists.

It is widely acknowledged that this resource is of paramount importance in terms of facilitating economic growth and social development.

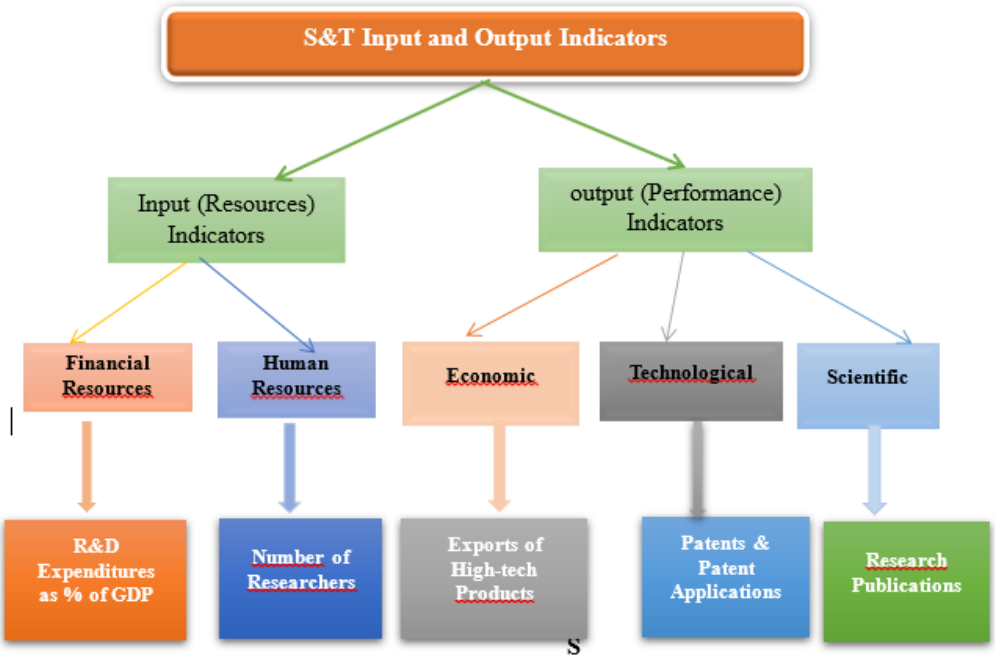
-The financial resources available are as follows:

The representation is by expenditure on research and development (R&D) as a percentage of Gross Domestic Product (GDP). This indicator is the most widely used for the evaluation and comparison of creativity and scientific and technological development across different countries. The Outputs (Performance) are divided into three sections: Economy, Science, and Technology, with the following specific indicators:

Economic Indicator: The export of high-technology products as a percentage of the country's total exports is indicative of economic benefit. The following technological indicator is hereby presented for consideration:The number of patent applications and their implementation serve as the primary indicators.

Scientific Indicator:The number of published scientific articles is used as a metric for this purpose. (Seyma Caliskan Cavdar, 2015)

Figure 03.S&T Input and Output Indicator



Source : Seyma Caliskan Cavdar, Alev Dilek Aydinb, An Empirical Analysis about Technological Development,2015,page 1488. (Seyma Caliskan Cavdar, 2015)

Economic growth is defined as a sustained, long-term increase in real national income, preferably measured in terms of per capita income because it reflects improvements in living standards. It is imperative to ascertain that this increase is not merely nominal, but rather an indication of an actual rise in the volume of goods and services produced. This necessitates a foundation in a permanent increase in the productive capacity of the economy, such as the introduction of modern technology or the strengthening of infrastructure. This ensures that the improvement is sustained and does not merely represent a short-term fluctuation (Avinash Mishra, 2024)

The seminal work in economics, entitled Endogenous Growth Theory, was authored by Aghion and Howitt.This offers a novel interpretation of the phenomenon of economic growth. The authors posit that economic growth. The phenomenon of accumulation is influenced by a number of factors, including the level of innovation and human capital. Within the context of an economy. The theory accentuates the significance of economic policies that are conducive to the promotion of the following factors have been identified as key drivers of economic growth: innovation, investment in human capital, and competition (Aghion P, 1998).

The measurement of economic growth is most commonly achieved through the analysis of fluctuations in the aggregate value of goods and services that are produced within a nation's economy. This measurement is commonly referred to as Gross Domestic Product (GDP).

Innovation and Economic Growth

Innovation is not a recent phenomenon; it is an innate human tendency to seek new and better ways of accomplishing tasks. Innovation is a key and decisive factor for economic growth and performance in a globalised economy. The introduction of new technologies and products, and the provision of improved methods for producing goods and delivering services, are key factors in innovation. These measures have been shown to boost productivity, create jobs and improve citizens' quality of life. As the driving force of the 21st-century economy, innovation constantly injects new vitality into the economic system. Conversely, commoditisation rapidly transforms distinctive and profitable entities into commonplace and marginal ones, resulting in the loss of vitality and profits (Gerguri, 2010).

As Schumpeter (1939) originally identified, innovation plays a vital role in driving economic growth, and achieving an optimum level of innovation and R&D is crucial for this purpose. A substantial body of research among development economists indicates that innovation is a catalyst for productivity growth, thereby leading to the translation of a high level of innovation engagement into sustainable real GDP growth (Gill, 2007) (Pece, 2015) (Pradhan, 2018). One well-established theory that provides a valuable foundation for understanding the relationship between innovation and economic growth is the 'Schumpeterian Growth Theory'. This theory asserts that innovation is pivotal to economic growth, as it fosters the creation of new products, processes and technologies. This, in turn, results in increased productivity, higher profits and overall economic advancement (Alcouffe, 2004). The impact of innovation on economic growth is frequently gauged by means of a variety of indicators, including but not limited to gross domestic product (GDP) growth rate, employment, and per capita income (Ramadani, 2013).

The impact of innovation on economic growth is defined as the effect that innovation has on the overall economic performance of a country. The impact may be either positive or negative, with positive impacts resulting in increased economic growth and negative impacts resulting in decreased economic growth (Grii Nihal, 2023).

3. Data And Methodology

3.1. Variables Used in the Analysis

GDP	Per capita economic growth: expansion of a country's economy, expressed in per capita gross domestic product.
PAR	Patent registration applications, residents
PARN	Patent registration applications, non- residents
MHTE	Medium and high-tech exports (% manufactured exports)
STJ	Scientific & technical journal article

Source: Author' estimations

The data set under consideration consists of 24 observations over the 1996–2021 periods, obtained from the database of world development indicators. (http://data.worldbank.org/indicator). The approach adopted in the present study is quantitative and analytical in nature, with the EViews 12 programme being utilised for the purpose of analysis.

The following equation has been defined and employed for the purpose of testing the hypothesis:

$$GDP_t = \beta_0 + \beta_1 PAR_t + \beta_2 PARN_t + \beta_3 MHTE_t + \beta_4 STJ_t + \varepsilon_t$$

β_0: Constant (intercept)

$\beta_1, \beta_2, \beta_3, \beta_4$: Coefficients

ε : Error term

3.2. The study employed the following model: ARDL (Autoregressive Distributed Lag Model)

The ARDL cointegration technique was first developed by (Pesaran, 1999). and subsequently refined by (pesaran, 2001).The ARDL (Autoregressive Distributed Lag) method is an econometric approach that is frequently employed to examine dynamic relationships between variables over time, particularly when these variables are of different integration orders (I(0) or I(1)) and potential cointegration between them is under consideration. This methodological approach permits the concurrent evaluation of short- and long-term impacts within a malleable framework, obviating the necessity for all series to be integrated into the same sequence (Blancheton, 2020).The augmented-autoregressive-distributed-lag (ARDL) model is a hybrid model that integrates an autoregressive (AR) model with distributed lags.

The following variables are to be considered in order to provide an explanation. The aforementioned principle is expressed in the following formal statement:

$$Y_t = \phi + \sum_{i=1}^{p} a_i Y_{t-i} + \sum_{j=0}^{q} b_j X_{t-j} + \varepsilon_t$$

In this model, the dependent variable is denoted by Yt, the explanatory variables by Xt, and the parameters p and q. The respective lag orders are represented by phi, a constant, and εt, an error term assumed to be white noise (Seabold, 2010) (Kripfganz, 2023).

4. Results And Discussion

4.1. Descriptive statistics

The following presentation offers an exposition of the descriptive statistics of the variables over the 1996–2021 period. The summary statistics encompass the means, median, maximum and minimum of each series

Table 1.. Descriptive statistics of the variables for the period 1996–2021

	GPD	MHTE	PAR	PARN	STJ
Mean	2.960870	2.483646	93.56522	544.6087	2730.277
Median	3.100000	2.158900	84.00000	581.0000	2115.440
Maximum	6.500000	6.051154	268.0000	803.0000	6839.000
Minimum	-5.000000	0.458049	30.00000	94.00000	311.0000
Std. Dev.	2.234592	1.608828	53.74316	216.7496	2078.649
Skewness	-1.829528	0.312959	1.503742	-0.694812	0.511620
Kurtosis	8.200780	2.039852	5.852434	2.303661	1.966042
Jarque-Bera	38.75194	1.258921	16.46545	2.315280	2.027920

Source: Author's calculation using Eviews 12 application

4.2.Time Series Stability Test (ADF Test)

The Dickey-Fuller test (DF test) was originally developed by Dickey and Fuller to demonstrate the presence of a unit root (Guo, 2023) . The formula for the DF test as formula 1 :

$Yt = pYt - 1 + \varepsilon t$

Yt is the value of the time series at time t,

p is the coefficient on the lagged value of the time series, and

εt is an error term.

The null hypothesis posits that Yt is not stationary and that $p = 1$. In addition, it is assumed that the error term in the Dickey-Fuller test is identical and that it is distributed independently.. (de Carvalho, 2014). The null hypothesis for the DF test is that p = 1, which means the time series contains a unit root. Conversely, the alternative hypothesis does not contain a unit root, and p should be less than 1.

The formula for the ADF test as formula 2 :

$\Delta yt = \alpha + \beta t + \gamma yt - 1 + \delta 1 \Delta yt - 1 + \delta 2 \Delta yt - 2 + \cdots + \delta p \Delta yt - p + \varepsilon t$

- Δyt is the first difference of the time series y, α is a constant term,
- βt is a linear trend term,
- $yt - 1$ is the lagged value of y, $\Delta yt - 1$, $\Delta yt - 2$,.....
- $\Delta yt - p$ are the lagged differences of y up to p lags,
- εt is the error term

The ADF test is a statistical technique that has been developed to account for potential trends and serial correlations in time series data. It is evident that the constant term and linear trend term are instrumental in the capture of deterministic trends in the time series. Furthermore, the lagged value of y, denoted as $\Delta yt - 1$, $\Delta yt - 2$, and so forth, up to and including $\Delta yt - p$ (Guo, 2023).The null hypothesis posits that the time series contains a unit root, signifying that the series is non-stationary. The alternative hypothesis is that the time series is stationary. The presence of a unit root in the series is indicated by the non-stationary nature of the series, whilst the stationarity of the first difference is indicative of a unit root (Guo, 2023). The ADF test is a widely utilised tool for the identification of unit roots (Gllynn, 2007).

Table 2. Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (Y) Gross Domestic Product (GDP) at Level

Null Hypothesis: GPD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.911596	0.0065
Test critical values:	1% level	-3.724070	
	5% level	-2.986225	
	10% level	-2.632604	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GPD)
Method: Least Squares
Date: 07/11/25 Time: 19:42
Sample (adjusted): 1997 2021
Included observations: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GPD(-1)	-0.796505	0.203627	-3.911596	0.0007
C	2.364771	0.752130	3.144100	0.0045

R-squared	0.399487	Mean dependent var	-0.012000
Adjusted R-squared	0.373378	S.D. dependent var	2.799899
S.E. of regression	2.216386	Akaike info criterion	4.506251
Sum squared resid	112.9844	Schwarz criterion	4.603761
Log likelihood	-54.32814	Hannan-Quinn criter.	4.533296
F-statistic	15.30058	Durbin-Watson stat	1.946176
Prob(F-statistic)	0.000700		

Source: Author's calculation using Eviews 12 application

The results of the ADF test, following the implementation of the first difference, indicate that the variable It is evident that the GDP (Y) has become stable, as evidenced by the probability value (p-value) being less than 0.05. This indicates that the null hypothesis of the existence of a unit root is to be rejected. Therefore, it can be concluded that the variable Y is of the level order of integration, I(0).

Table 3. Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_1) Patent registration applications, residents at First Difference

Null Hypothesis: D(PAR) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.083009	0.0005
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PAR,2)
Method: Least Squares
Date: 07/11/25 Time: 19:45
Sample (adjusted): 1999 2021
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PAR(-1))	-1.984700	0.390458	-5.083009	0.0001
D(PAR(-1),2)	1.062317	0.262556	4.046054	0.0006
C	12.30058	4.908460	2.505996	0.0210

R-squared	0.563735	Mean dependent var	4.217391
Adjusted R-squared	0.520108	S.D. dependent var	32.01642
S.E. of regression	22.17913	Akaike info criterion	9.157288
Sum squared resid	9838.279	Schwarz criterion	9.305396
Log likelihood	-102.3088	Hannan-Quinn criter.	9.194537
F-statistic	12.92183	Durbin-Watson stat	1.424512
Prob(F-statistic)	0.000250		

Source: Author's calculation using Eviews 12 application

The results of the ADF test, following the implementation of the first difference, indicate that the variable It is evident that the (X_1) Patent registration applications, residents has become stable, as evidenced by the probability value (p-value) being less than 0.05. This indicates that the null hypothesis of the existence of a unit root is to be rejected. Therefore, it can be concluded that the variable Y is of the first order of integration, I(1).

Table 4. Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_2) Patent registration applications, non- residents at First Difference

Null Hypothesis: D(PARN) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.752279	0.0097
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PARN,2)
Method: Least Squares
Date: 07/11/25 Time: 19:46
Sample (adjusted): 1998 2021
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PARN(-1))	-0.776167	0.206852	-3.752279	0.0011
C	11.88076	17.13173	0.693494	0.4953

R-squared	0.390237	Mean dependent var	-0.958333
Adjusted R-squared	0.362521	S.D. dependent var	102.9993
S.E. of regression	82.23699	Akaike info criterion	11.73674
Sum squared resid	148784.3	Schwarz criterion	11.83491
Log likelihood	-138.8409	Hannan-Quinn criter.	11.76279
F-statistic	14.07960	Durbin-Watson stat	1.986127
Prob(F-statistic)	0.001101		

Source: Author's calculation using Eviews 12 application

The results of the ADF test, following the implementation of the first difference, indicate that the variable It is evident that the (X_2) Patent registration applications**,** non-residents has become stable, as evidenced by the probability value (p-value) being less than 0.05. This indicates that the null hypothesis of the existence of a unit root is to be rejected. Therefore, it can be concluded that the variable Y is of the first order of integration, I(1).

Table 5. Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_3) Medium and high-tech exports (% manufactured exports) at First Difference

Null Hypothesis: D(MHTE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.683050	0.0001
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(MHTE,2)
Method: Least Squares
Date: 07/11/25 Time: 19:44
Sample (adjusted): 1998 2021
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MHTE(-1))	-1.002849	0.176463	-5.683050	0.0000
C	0.069102	0.206442	0.334730	0.7410

R-squared	0.594821	Mean dependent var	0.133707
Adjusted R-squared	0.576404	S.D. dependent var	1.551558
S.E. of regression	1.009819	Akaike info criterion	2.937075
Sum squared resid	22.43418	Schwarz criterion	3.035247
Log likelihood	-33.24491	Hannan-Quinn criter.	2.963120
F-statistic	32.29705	Durbin-Watson stat	1.872460
Prob(F-statistic)	0.000010		

Source: Author's calculation using Eviews 12 application

The results of the ADF test, following the implementation of the first difference, indicate that the variable It is evident that the (X_3) Medium and high-tech exports (% manufactured exports) has become stable, as evidenced by the probability value (p-value) being less than 0.05. This indicates that the null hypothesis of the existence of a unit root is to be rejected. Therefore, it can be concluded that the variable Y is of the first order of integration, I(1).

Table 6. Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_4) Scientific & technical journal article at First Difference

Null Hypothesis: D(STJ) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.63002	0.0000
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(STJ,2)
Method: Least Squares
Date: 07/11/25 Time: 19:49
Sample (adjusted): 1998 2021
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(STJ(-1))	-1.852828	0.159314	-11.63002	0.0000
C	-3.298102	91.49836	-0.036045	0.9716
@TREND("1996")	34.99144	6.492318	5.389668	0.0000

R-squared	0.866721	Mean dependent var	45.64417
Adjusted R-squared	0.854028	S.D. dependent var	534.8514
S.E. of regression	204.3471	Akaike info criterion	13.59399
Sum squared resid	876912.8	Schwarz criterion	13.74124
Log likelihood	-160.1278	Hannan-Quinn criter.	13.63305
F-statistic	68.28201	Durbin-Watson stat	1.992790
Prob(F-statistic)	0.000000		

Source: Author's calculation using Eviews 12 application

The results of the ADF test, following the implementation of the first difference, indicate that the variable It is evident that the (X_4) Scientific & technical journal article has become stable, as evidenced by the probability value (p-value) being less than 0.05. This indicates that the null hypothesis of the existence of a unit root is to be rejected. Therefore, it can be concluded that the variable Y is of the first order of integration, I(1).

4.3. The ARDL-Bounds Test approach was employed to examine the cointegration

4.3.1. Optimal Lag Length Selection

The objective of this study is to ascertain the optimal number of deceleration periods (p) that should be incorporated into the initial ARDL model.

As demonstrated in Table No. 7, it is evident that the optimal model for the study is 145, as evidenced by the smaller values of AIC, BIC and HQ. This finding is further substantiated by Figure No. 1, which illustrates the model's performance. The adjusted R^2 value of 0.7365 signifies that the ARDL model (3, 1 ,2, 3, 3) possesses the capacity to elucidate the phenomenon by 73.65 percent.

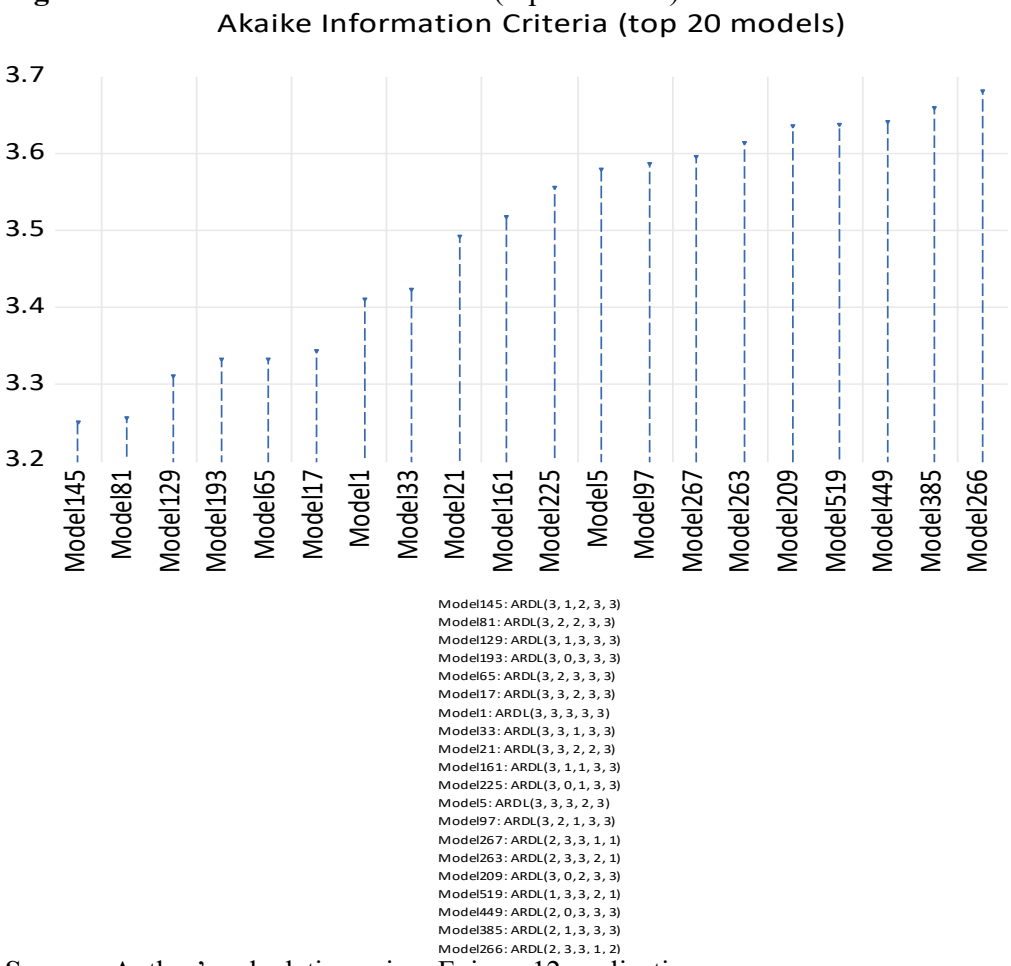
Table 7. Model Selection Criteria

Model Selection Criteria Table
Dependent Variable: GPD
Date: 07/11/25 Time: 20:17
Sample: 1996 2021
Included observations: 23

Model	LogL	AIC*	BIC	HQ	Adj. R-sq	Specification
145	-20.380880	3.250511	4.089790	3.461587	0.735525	ARDL(3, 1, 2, 3, 3)
81	-19.443149	3.255926	4.144574	3.479418	0.707482	ARDL(3, 2, 2, 3, 3)
129	-20.058793	3.309460	4.198108	3.532953	0.691396	ARDL(3, 1, 3, 3, 3)
193	-21.307529	3.331089	4.170368	3.542166	0.713332	ARDL(3, 0, 3, 3, 3)
65	-19.310126	3.331315	4.269332	3.567224	0.638558	ARDL(3, 2, 3, 3, 3)
17	-19.437823	3.342419	4.280436	3.578328	0.634522	ARDL(3, 3, 2, 3, 3)
1	-19.211061	3.409658	4.397044	3.657982	0.522210	ARDL(3, 3, 3, 3, 3)
33	-21.370279	3.423503	4.312150	3.646995	0.654116	ARDL(3, 3, 1, 3, 3)
21	-22.165657	3.492666	4.381313	3.716158	0.629347	ARDL(3, 3, 2, 2, 3)
161	-24.457770	3.518067	4.307976	3.716727	0.676853	ARDL(3, 1, 1, 3, 3)
225	-25.897858	3.556335	4.296875	3.742579	0.679526	ARDL(3, 0, 1, 3, 3)
5	-22.151727	3.578411	4.516428	3.814320	0.537245	ARDL(3, 3, 3, 2, 3)
97	-24.238012	3.585914	4.425192	3.796990	0.630131	ARDL(3, 2, 1, 3, 3)
267	-26.354229	3.596020	4.336560	3.782264	0.666552	ARDL(2, 3, 3, 1, 1)
263	-25.561909	3.614079	4.403988	3.812739	0.644288	ARDL(2, 3, 3, 2, 1)
209	-25.811963	3.635823	4.425732	3.834483	0.636469	ARDL(3, 0, 2, 3, 3)

Source: Author's calculation using Eviews 12 application

Figure 4. Akoike information criteria (top20models)



Source: Author's calculation using Eviews 12 application

4.3.2. ARDL Bounds Test

1. Testing the Hypotheses of the ARDL Bounds Test

H_0 : There is no cointegration relationship between variables (no long-term relationship).

H_1 : There is a cointegration relationship between the variables (there is a long-term relationship between the variables)

From the data presented in **Table 08**, we accept the alternative hypothesis (H1) and reject the null hypothesis (H0), due to the existence of a long-term cointegration relationship between the variables. This decision is based on a comparison of the calculated statistician value (F-statistic) with the two scheduled critical values: the minimum critical value I(0) and the maximum critical value I(1). The F-statistic of 3.80 is greater than I(0) of 2.2 and I(1) of 3.09.

F-statistic > I(0) and F-statistic > I(1)

Table 8. ARDL Long Run Form and Bounda Test

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GPD)
Selected Model: ARDL(3, 1, 2, 3, 3)
Case 2: Restricted Constant and No Trend
Date: 10/11/25 Time: 00:36
Sample: 1996 2021
Included observations: 23

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.47619	8.771310	2.448459	0.0499
GPD(-1)*	-2.567430	0.759674	-3.379648	0.0149
MHTE(-1)	-0.908428	0.791346	-1.147952	0.2947
PAR(-1)	-0.244906	0.122693	-1.996085	0.0929
PARN(-1)	-0.008897	0.004846	-1.835958	0.1160
STJ(-1)	0.000482	0.002101	0.229210	0.8263
D(GPD(-1))	1.158546	0.607661	1.906568	0.1052
D(GPD(-2))	1.007220	0.357255	2.819328	0.0304
D(MHTE)	0.233862	0.390313	0.599166	0.5710
D(PAR)	-0.018500	0.030446	-0.607641	0.5657
D(PAR(-1))	0.092239	0.057729	1.597783	0.1612
D(PARN)	-0.003240	0.004134	-0.783586	0.4631
D(PARN(-1))	0.018326	0.006557	2.794830	0.0314
D(PARN(-2))	-0.013359	0.004768	-2.801851	0.0311
D(STJ)	0.011418	0.004042	2.824861	0.0302
D(STJ(-1))	0.016157	0.005779	2.795849	0.0313
D(STJ(-2))	0.021042	0.005114	4.114795	0.0063

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
MHTE	-0.353828	0.258387	-1.369369	0.2199
PAR	-0.095389	0.031292	-3.048379	0.0226
PARN	-0.003465	0.001408	-2.461281	0.0490
STJ	0.000188	0.000790	0.237334	0.8203
C	8.364858	1.779160	4.701578	0.0033

EC = GPD - (-0.3538*MHTE -0.0954*PAR -0.0035*PARN + 0.0002*STJ + 8.3649)

F-Bounds Test — Null Hypothesis: No levels relationship

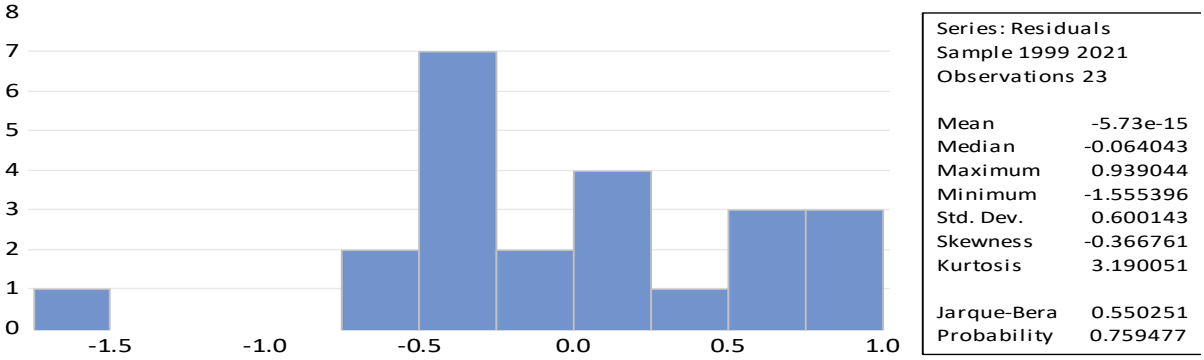
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	3.804531	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Actual Sample Size	23	Finite Sample: n=35		
		10%	2.46	3.46
		5%	2.947	4.088
		1%	4.093	5.532
		Finite Sample: n=30		
		10%	2.525	3.56
		5%	3.058	4.223
		1%	4.28	5.84

Source: Author's calculation using Eviews 12 application

-The (ARDL) model estimates that exports of high- and medium-tech products exhibit a negative and insignificant relationship, indicating that there is no discernible impact on GDP in the short and long term.
-Patent applications for residents have a detrimental effect on the gross domestic product in the short and long term.
-Patent applications for non-residents have a negative and insignificant relationship in the short term and a significant relationship in the long term, meaning there is a negative impact on the gross domestic product in the long term.
-- Scientific and technological journals have a positive and insignificant relationship, which means that there is no impact on GDP in the short and long term

4.3.3. Normality Test

Figure 5. Histogram – Normality Test



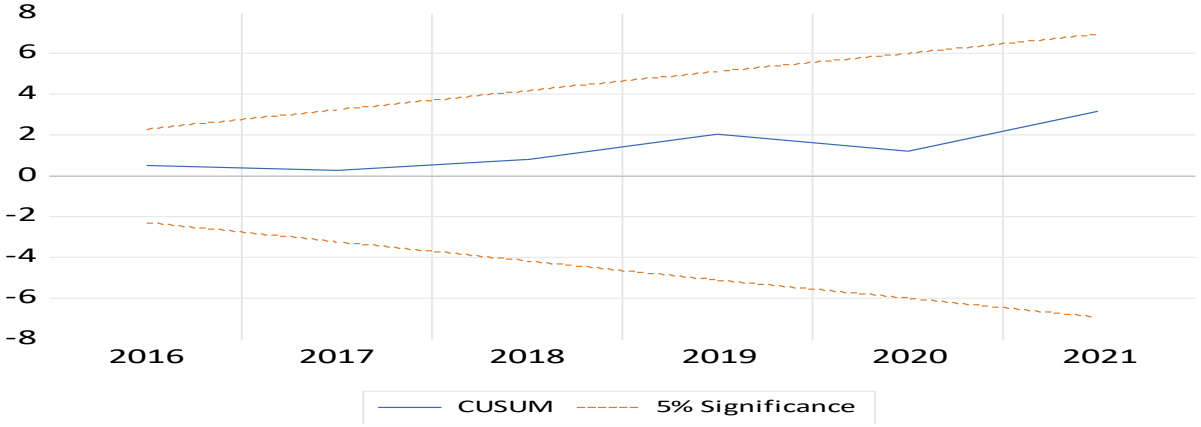
Source: Author's calculation using Eviews 12 application

The Jarque–Bera test was applied in order to verify the nature of the distribution of the ARDL model residue. The test value was found to be (JB = 0.55) with a probability value of (Prob = 0.76 > 0.05).This finding suggests that the residuals follow a normal distribution, thereby demonstrating that the model fulfils the normal distribution of error hypothesis.

4.3.4. Structural Stability Test (CUSUM)

The findings demonstrated that the blue line persisted within the confidence limits at a significance level of 5%, thereby signifying that the model coefficients exhibited structural stability over the course of the study period.

Figure 6. CUSUM



Source: Author's calculation using Eviews 12 application

6. Conclusions

Innovation is widely regarded as one of the fundamental pillars of sustainable economic growth, given its capacity to enhance productivity and develop and strengthen the competitiveness of the national economy. The findings of an applied study that examined the situation in Algeria during the period 1996-2021 demonstrated that exports of high- and medium-technology products exhibited a negative correlation and did not exert an impact on economic growth in either the short or long term. This suggests that these exports have not yet become a genuine and sustainable driving force for Algerian economic growth. This is attributable to the Algerian economic structure, which is heavily reliant on oil and gas, the limited development of technological industries, weak infrastructure, and a paucity of investment. While there is a demonstrable correlation between Gross Domestic Product (GDP) and the publication of scientific and technological articles, this correlation does not exert a direct influence on GDP. This is due to the fact that scientific research in Algeria is predominantly theoretical or academic, as opposed to being practical or economic in nature. The utilisation of scientific research findings to develop novel products or services that have commercial potential is a rarity. The correlation between patent applications submitted by residents and the subsequent impact on GDP, both in the short and long term, is indicative of a negative relationship. This suggests that local innovation may be either ineffective or more costly than its economic returns. It has been demonstrated that patents registered by residents may be economically unviable and lack the quality required to be transformed into successful, high-income commercial projects. The long-term implications of patent applications by non-residents on the GDP of the country in question are negative, with the result that the gains from innovation are retained by the country in which they are generated. Furthermore, the utilisation of this technology may necessitate the payment of licence fees, thereby conferring upon foreign companies a degree of control over the intellectual property (IP) rights of the technology employed in Algeria.

The present study seeks to explore the relationship between innovation and economic growth in Algeria. The findings of the study indicate that innovation exerts a negative and stimulatory effect on economic growth in Algeria. The study further finds that innovation indicators show a negative impact in both the long and short term. This finding suggests that innovation is not achieving its full potential in terms of economic productivity within the current structure of the Algerian economy. Consequently, decision-makers must prioritise the formulation of innovative policies that promote patents with substantial commercial viability. These policies should be oriented towards diversifying the economic structure and reducing reliance on hydrocarbons.

There is an imperative to establish mechanisms for technology transfer and to convert the findings of scientific journals into products and industries with high added value. The inflow of foreign investment that facilitates the transfer of technology without resulting in its complete monopolisation should be encouraged.

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