

The Impact of Higher Education on Economic Development in Algeria: A Regression Analysis Study

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Abstract: In the contemporary global knowledge economy, higher education has assumed an increasingly significant role in terms of both quantity and quality. This growing importance can be attributed to its perceived role as a driver of economic development through the development of human capital and the promotion of innovation. Nevertheless, the efficacy of this approach in developing countries remains a subject of debate. The present study employs a multiple linear regression model to analyse the relationship between higher education and economic growth in Algeria during the period 2001–2020. The following indicators are taken into account: gross domestic product, higher education teachers, resident patent applications, and non-resident patent applications. The findings of the study indicate a positive effect of higher education on economic development according to the F-test. The findings indicate that the impact of higher education on economic development is not unidirectional; rather, it is contingent on the indicator employed.

Keywords: higher education; economic development ; Linear Regression; Algeria

JEL Classification Codes : O10, A23,c22 ,I25

1. INTRODUCTION

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It is evident that higher education constitutes a pivotal catalyst for the enhancement of economic growth, performance, prosperity, and competitiveness at both the national and global levels. Adam Smith's philosophy of education was predicated on the principle of universal access, a concept that finds resonance in contemporary educational policy discourse. The seminal contributions of Milton Friedman, Gary Becker and Jacob Mincer have led to the development of the "human capital" theory, a conceptual framework that explores the economic implications of education for individuals and society at large. The human factor is considered to be one of the most significant productive factors contributing to economic growth.

Economic development is denoted by: as economic growth plus an improvement in quality of life, The population, as observed in education, society, the economy and politics (Murray, 2015). (Feldman, 2015). A robust theoretical framework exists that elucidates the relationship between economic growth and education (Barro, 2004) (Greiner, 2005) (Mankiw, 1992) (Romer, 1989).

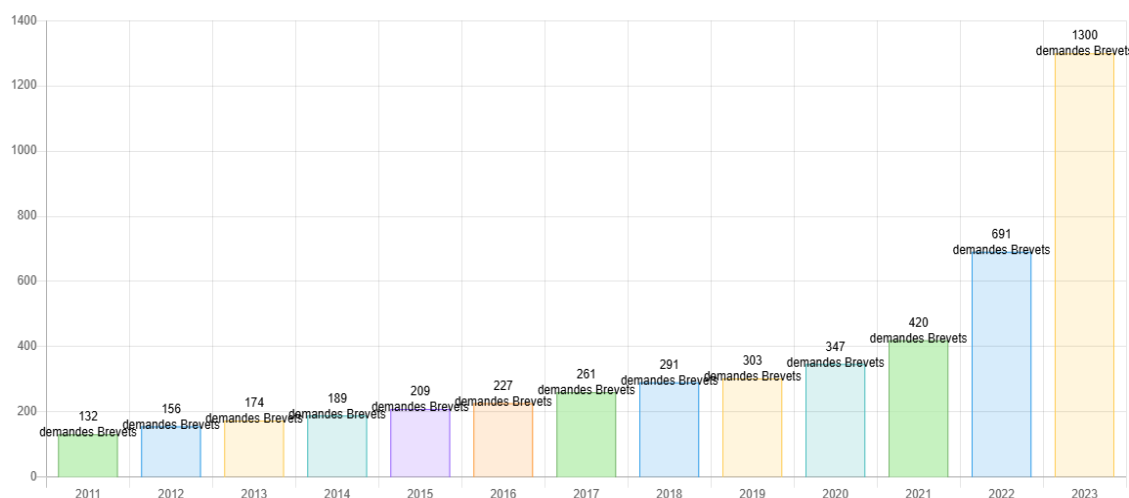
It is evident that investment in human capital and knowledge economics plays a pivotal role in the promotion of economic growth. The present study seeks to explore the significant relationship between human capital and gross domestic product(GDP per capita), It is evident that the internal rate of innovation is influenced by the aforementioned factor. (Romer, 1989). The functions of economic and university bodies are as follows: The organisation's primary objectives are threefold: firstly, to act as a mediator in social debates; secondly, to provide citizens with information and training on scientific and technical matters; and thirdly, to promote dialogue between different agents (politicians, businessmen, HEI managers and citizens) and contribute to socioeconomic progress (Corazza, 2019).

The possession of a university education is a prerequisite for those seeking to enter the workforce in the field of labour, and it is an essential component of economic development (Carnoy, 2007).The extant literature suggests that investment in education can increase the potential talent pool, improve innovation and abilities, and significantly contribute to economic growth. (Gu, 2024).

A study undertaken by the World Bank in 2020 indicates that the attainment of an additional year of education by a nation's population is associated with a 0.5 percent increase in that nation's average annual GDP growth rate (Al-Samarrai, 2020).

The following figure illustrates the evolution of patent applications in Algeria between 2011 and 2023. It is observed that the beginning of the examined period is characterised by slow growth, which is followed by a gradual improvement and then a quantum leap in 2022 and 2023, with an unprecedented doubling of the number of applications.

Figure 1. Evolution of patent applications in Algeria during the period 2011–2023



Source: scientific research and technological development, directorate of technological development and innovation

The present study makes a contribution to the extant literature by adopting an integrated approach to examine the relationship between higher education and economic development. This is based on the premise that innovation and economic growth are mutually causative in the development process (Holtz-Eakin, 1988).

We aim to examine the case of Algeria based on the previous study conducted by **Rana P. Maradana, Rudra P. Pradhan, Saurav Dash, Kunal Gaurav, Manju Jayakumar, and Debaleena Chatterjee (2017)**, titled "Does innovation promote economic growth? Evidence from European countries", The present study examines the long-term relationship between innovation and per capita economic growth in 19 European countries during the period 1989–2014, using six innovation indicators, including: patents for residents and non-residents, spending on research and development, number of researchers, high-tech exports, and scientific and technical articles..

as well as the research by **Xiaoqi Deng (2024)**, titled "The Crucial Link Between Education and Economic Growth". The study examines the relationship between education and economic growth. The results confirm that education has a positive impact on economic growth. The study also examines the reverse effect, i.e., how economic conditions affect government spending on education.

It also analyzes different types of education (such as primary, secondary, and higher education) and their relationship to economic development.

Despite the numerous studies conducted in European and Asian contexts, the Algerian context still suffers from a clear lack of studies that adopt a comprehensive approach integrating higher education indicators (e.g. the teachers in tertiary education) and innovation indicators (e.g. patents for residents and non-residents) in analysing their impact on economic growth.

This study uses higher education indicators teachers in tertiary education, patent applications by residents, and patent applications by non-residents during the period **2001–2020**. Accordingly, the main research question posed in this study is as follows:

- How did higher education affect economic development in Algeria during the period 2001–2020?

The formulation of research hypotheses is an essential preliminary step in any scientific investigation.

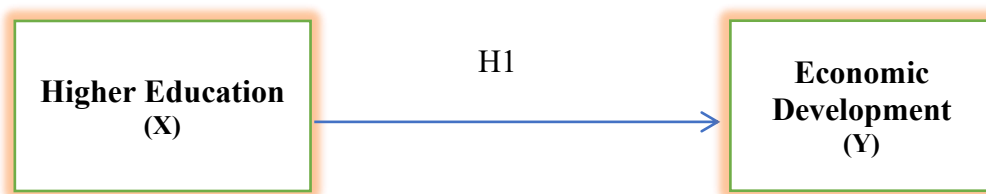
H1: Higher education has a positive and significant impact on economic development in Algeria.

H11: The positive and significant impact of teachers in tertiary education on Algeria's gross domestic product (GDP)

H12: The positive and significant impact of Patent registration applications, residents on Algeria's gross domestic product (GDP)

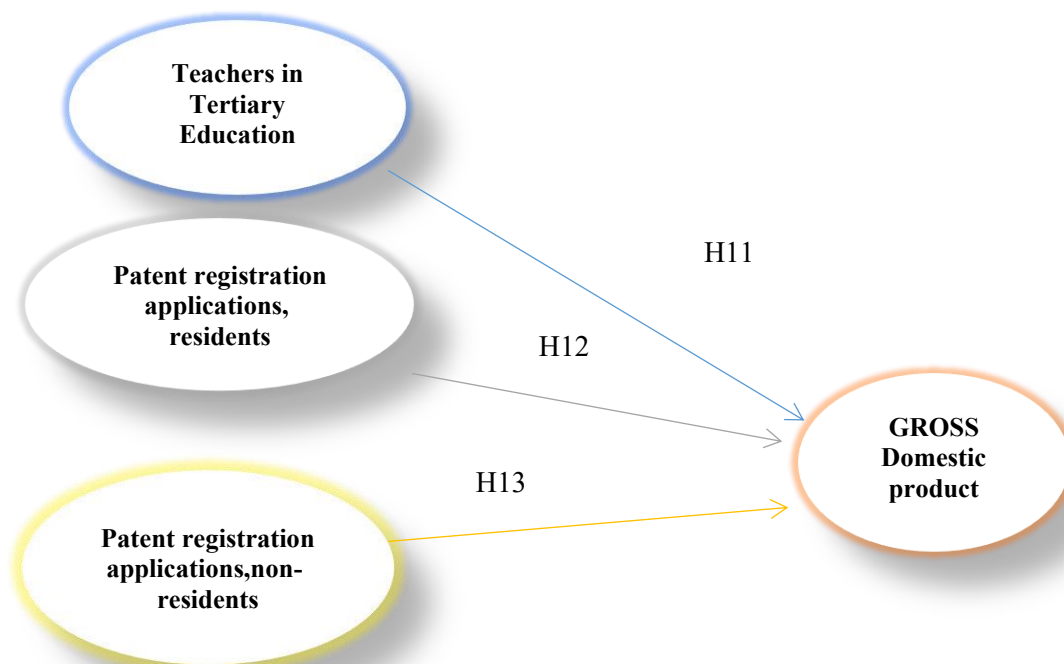
H13: The positive and significant impact of Patent registration applications, non-residents on Algeria's gross domestic product (GDP)

Figure 2. The study model



Source: Author' estimations

Figure 3. The model is expressed as:



Source: Author' estimations

2. Literature Review

It is evident that higher education plays a pivotal role in the socialisation of individuals, facilitating the modernisation and transformation of societies. Moreover, it is imperative to recognise the significant contribution of teaching and scientific research to the creation, absorption and dissemination of knowledge (Pillay, 2010). This constitutes a form of investment in human capital development, which has been demonstrated to make a significant contribution to the economic growth of countries. The institution has been demonstrated to facilitate the development of a workforce that is both educated and equipped to navigate the demands of the contemporary knowledge economy (Allam Hamdan, 2020).

2.1 Higher education

Higher education is defined as all post-secondary education, training and research guidance at educational institutions such as universities that have been authorised as institutions of higher education by state authorities. In the World Declaration on Higher Education, as adopted by the World Conference on Higher Education in 1998, the following definition of higher education was established: This term refers to all types of studies, training or training for research at the post-secondary level. These are provided by universities or other educational establishments that are approved as institutions of higher education by the competent state authorities. In order to analyse the link between higher education and development, it is necessary to employ a dynamic definition of higher education. (Kimenyi, 2013).

It is imperative that the roles of higher education be given due consideration. The development of human resources is an essential component for the economic and social advancement of any given society. The fundamental purpose of higher education has been the cultivation of human resources that are endowed with the requisite knowledge and competencies for economic and social advancement..

The generation and dissemination of knowledge, in addition to the capacity to utilise knowledge and technical expertise, is of paramount importance for the economic development of any given society. For instance, Asian countries that have adopted the technological advancements of more developed nations have experienced substantial economic growth as a result of their own technological implementation. The development of a healthy civil society and the cultivation of social cohesion are of paramount importance in contemporary society. It is imperative that higher education institutions recognise their role in the reform of the social system and the cultivation of social cohesion. It is suggested that this objective may be realised through the generation of new knowledge, encompassing the dissemination of democratic principles and respect for multiculturalism, the promotion of political participation, the fortification of civil society and the encouragement of democratic governance. Furthermore, higher education institutions are expected to play a pivotal role in the reform of the social system and the cultivation of social cohesion. It is suggested that this objective may be

realised through the generation of new knowledge, encompassing the dissemination of democratic principles and the promotion of multiculturalism, the facilitation of political engagement, the fortification of civil society and the advancement of democratic governance.

Higher education is a means of developing the human resources necessary for economic development. Simultaneously, it functions as a conduit for personal edification. In concrete terms, individuals have the capacity to enhance both their income and quality of life by acquiring additional knowledge and skills. This, in turn, enables them to broaden their life choices, including those pertaining to their professional sphere (cooperationAgency, 2004).

2.2 .The relationship between higher education and economic development

Economic development is defined as the expansion of capacities that contribute to the advancement of society through the realization of individuals', firms', and communities' potential. The present study posits that effective institutions are predicated upon norms of openness, tolerance for risk, appreciation for diversity, and confidence in the realization of mutual gain for the public and private sectors (association, 2015).

Economists have long acknowledged the pivotal role of education in propelling development. For instance, it is evident that Adam Smith demonstrated a satisfactory understanding of the fundamental principles of what is now termed the theory of human capital. Smith's approach to investment in education was consistent with his perspective on investments in physical capital, regarding education as a potential source of returns.. The theory of human capital, incorporating estimates of returns to education, emerged subsequently, following the contributions of economists such as Schultz (1959), Schultz (1961), Becker (1960), Mincer (1962) and Weisbrod (1962), among others.

The Solow model is to be extended and a new model is to be specified in which education is shown to determine the capacity of nations to innovate, adopt and implement new technologies by facilitating the diffusion of ideas in the economy (Nelson, 1966) It is imperative to acknowledge the pivotal role of higher education in augmenting a nation's capacity to undertake research and generate novel knowledge. This, in turn, facilitates the development of innovative products and production technologies, thereby contributing to the advancement of society. (Hansen, 2006)

In the context of higher education, economic development is characterised by proactive institutional engagement with partners and stakeholders, with the objective of fostering sustainable growth in the competitive capacities that contribute to the advancement of society. This process entails the realisation of individual, firm, community, and regional-to-global economic and social potential. It is evident that tertiary education can also have less direct benefits for economies by producing well-trained teachers (David Bloom, 2006).

3. Methodology

The data set under consideration consists of 20 observations over the 2001–2020 periods, obtained from the database of world development indicators. (<http://data.worldbank.org/indicator>).

-The variable is per gross domestic product (GDP), which is a measure of economic development.

- The variables are: Teachers in Tertiary Education Patent registration applications, non-residents; Patent registration applications, residents), which is a way of measuring higher education.

In this study, the model was estimated using multiple linear regression data for 20 observations. The objective of this research is to conduct an explanatory study of the impact of higher education on economic development in Algeria.

3.1. The study employed the following model: the multiple linear regression

$$\text{GDP}_t = \alpha + \beta_1 \text{Teach}_t + \beta_2 \text{Patent, residents}_t + \beta_3 \text{Patent, non-residents}_t + \varepsilon_t$$

Where: GDP_t : gross domestic product (GDP) for the year of (t).

α : constant.

Teach_t : teachers in tertiary education in the year (t).

$\text{Patent, residents}_t$: Patent registration applications, residents in the year (t).

$\text{Patent, non-residents}_t$: Patent registration applications, non-residents in the year (t).

ε_t : the error term.

4. RESULTS AND DISCUSSION

4.1. 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 :

$$Y_t = pY_{t-1} + \varepsilon_t$$

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

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

ε_t is an error term.

The null hypothesis posits that Y_t 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 :

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \delta_2 \Delta y_{t-2} + \dots + \delta_p \Delta y_{t-p} + \varepsilon_t$$

Δy_t is the first difference of the time series y, α is a constant term,

βt is a linear trend term,

y_{t-1} is the lagged value of y, Δy_{t-1} , Δy_{t-2} ,.....

- ✚ $\Delta y_t - p$ are the lagged differences of y up to p lags,
- ✚ ε_t 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 $\Delta y_t - 1$, $\Delta y_t - 2$, and so forth, up to and including $\Delta y_t - p$ (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 (Glynn, 2007). The present study aims to utilise the EVIEWS 12 programme to conduct an ADF test, thereby seeking to ascertain the stability of the time series from 2001-2020. This will provide a valuable opportunity to investigate the impact of higher education on economic development in Algeria. The investigation revealed that the series demonstrated stability at the first level for all variables. As shown in the tables.

Table 01: Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (Y) Gross Domestic Product (GDP) at First Difference

Null Hypothesis: D(Y) has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=4)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.480954	0.0028
Test critical values:				
	1% level		-3.857386	
	5% level		-3.040391	
	10% level		-2.660551	
*MacKinnon (1996) one-sided p-values. Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 18				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(Y,2) Method: Least Squares Date: 10/10/25 Time: 21:17 Sample (adjusted): 2003 2020 Included observations: 18 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(Y(-1))	-1.325406	0.295787	-4.480954	0.0004
C	-0.615742	0.474336	-1.298114	0.2126
R-squared	0.556528	Mean dependent var		-0.461111
Adjusted R-squared	0.528811	S.D. dependent var		2.923966
S.E. of regression	2.007104	Akaike info criterion		4.335702
Sum squared resid	64.45544	Schwarz criterion		4.434632
Log likelihood	-37.02131	Hannan-Quinn criter.		4.349343
F-statistic	20.07895	Durbin-Watson stat		1.699896
Prob(F-statistic)	0.000378			

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 first order of integration, I(1).

Table 02: Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_1) Teachers in Tertiary Education at First Difference

Null Hypothesis: D(X_1) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=4)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-2.991344	0.0548
Test critical values:				
	1% level		-3.857386	
	5% level		-3.040391	
	10% level		-2.660551	
*MacKinnon (1996) one-sided p-values.				
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 18				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D($X_{1,2}$)				
Method: Least Squares				
Date: 10/10/25 Time: 21:21				
Sample (adjusted): 2003 2020				
Included observations: 18 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D($X_1(-1)$)	-0.778666	0.260306	-2.991344	0.0086
C	1763.758	655.7042	2.689868	0.0161
R-squared	0.358670	Mean dependent var	-43.61111	
Adjusted R-squared	0.318586	S.D. dependent var	1309.249	
S.E. of regression	1080.756	Akaike info criterion	16.91315	
Sum squared resid	18688544	Schwarz criterion	17.01208	
Log likelihood	-150.2183	Hannan-Quinn criter.	16.92679	
F-statistic	8.948140	Durbin-Watson stat	1.803295	
Prob(F-statistic)	0.008634			

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) Teachers in Tertiary Education 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 03: Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X_2) Patent registration applications, residents at First Difference

Null Hypothesis: D(X_2) has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=4)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-5.994496	0.0002
Test critical values:				
	1% level		-3.886751	
	5% level		-3.052169	
	10% level		-2.666593	
*MacKinnon (1996) one-sided p-values.				
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 17				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D($X_{2,2}$)				
Method: Least Squares				
Date: 10/10/25 Time: 21:20				
Sample (adjusted): 2004 2020				
Included observations: 17 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D($X_2(-1)$)	-2.003419	0.334210	-5.994496	0.0000
D($X_2(-1),2$)	0.793688	0.264634	2.999187	0.0096
C	13.40257	4.776290	2.806063	0.0140
R-squared	0.742568	Mean dependent var	3.705882	
Adjusted R-squared	0.705792	S.D. dependent var	33.74421	
S.E. of regression	18.30319	Akaike info criterion	8.810813	
Sum squared resid	4690.096	Schwarz criterion	8.957851	
Log likelihood	-71.89191	Hannan-Quinn criter.	8.825429	
F-statistic	20.19160	Durbin-Watson stat	1.997066	
Prob(F-statistic)	0.000075			

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 (X₂) 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 04: Augmented Dickey-Fuller (ADF) Test Results for the Stationarity of the Dependent Variable (X₃) Patent registration applications, non-residents at First Difference

Null Hypothesis: D(X3) has a unit root Exogenous: Constant Lag Length: 0 (Automatic - based on SIC, maxlag=4)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.584850	0.0173
Test critical values:	1% level		-3.857386	
	5% level		-3.040391	
	10% level		-2.660551	
*MacKinnon (1996) one-sided p-values. Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 18				
Augmented Dickey-Fuller Test Equation Dependent Variable: D(X3,2) Method: Least Squares Date: 10/10/25 Time: 21:19 Sample (adjusted): 2003 2020 Included observations: 18 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(X3(-1))	-0.746083	0.208121	-3.584850	0.0025
C	8.142314	18.40824	0.442319	0.6642
R-squared	0.445429	Mean dependent var		-9.722222
Adjusted R-squared	0.410769	S.D. dependent var		97.94421
S.E. of regression	75.18335	Akaike info criterion		11.58218
Sum squared resid	90440.57	Schwarz criterion		11.68111
Log likelihood	-102.2396	Hannan-Quinn criter.		11.59582
F-statistic	12.85115	Durbin-Watson stat		1.869763
Prob(F-statistic)	0.002477			

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 (X₃) 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).

4.2. Estimating the regression model using the OLS method

Ordinary least squares is a statistical method that is utilised for the estimation of the parameters of a linear regression model. The objective of OLS is to identify the most suitable line that best represents the data set under consideration. This is achieved by finding the minimum value of the sum of the squared differences between the observed values and the values predicted by the linear model. Mathematically, for a given set of observations (X_i, Y_i), where X_i represents the independent variable and Y_i the dependent variable, the OLS aims to determine the coefficients (β₀) and (β₁) in the linear equation (Majka, 2024).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_k + \varepsilon$$

Estimating the parameters $\beta_0, \beta_1, \beta_2, \beta_3, \dots, \beta_k$ using the Ordinary Least Squares (OLS) method, which aims to minimize the sum of squared errors between the actual values and the predicted values of the dependent variable.

Each coefficient signifies the extent to which Y will change when its corresponding variable is altered by one unit, whilst maintaining constant all other variables.

The study model can be elucidated by demonstrating the relationship between the independent variables, i.e. higher education (teachers in tertiary education,), and the dependent variable, i.e. economic development (gross domestic product).

-  Y: Gross Domestic Product (GDP)
-  X₁: Teachers in Tertiary Education
-  X₂: Patent registration applications, residents
-  X₃: Patent registration applications, non- residents
-  $\beta_0, \beta_1, \beta_2, \beta_3$: Coefficients
-  ε : Error term

Table 05: Linear regression results

Dependent Variable: Y				
Method: Least Squares				
Date: 10/10/25 Time: 19:10				
Sample: 2001 2020				
Included observations: 20				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X3	0.000804	0.002157	0.372715	0.7143
X2	-0.071860	0.022984	-3.126479	0.0065
X1	5.95E-05	6.12E-05	0.972701	0.3452
C	6.460736	1.302238	4.961254	0.0001
R-squared	0.611360	Mean dependent var		2.865000
Adjusted R-squared	0.538490	S.D. dependent var		2.386425
S.E. of regression	1.621207	Akaike info criterion		3.981075
Sum squared resid	42.05299	Schwarz criterion		4.180222
Log likelihood	-35.81075	Hannan-Quinn criter.		4.019951
F-statistic	8.389733	Durbin-Watson stat		1.264189
Prob(F-statistic)	0.001405			

Source: : Author's calculation using Eviews 12 application

- Equation of the model

Based on the analysis results, the final equation of the multiple linear regression model takes the following form:

$$\hat{y} = 5.95x_1 - 0.07x_2 + 0.0080x_3 + 6.46$$

4.2.1 Coefficients Interpretation

The findings of the study demonstrated that an increase of one unit in the number of teachers resulted in a(5.95)unit increase in GDP, under the assumption that all other

factors remained constant. Conversely, an increase in resident patent applications by one unit resulted in a decrease in GDP of (0.07)units, with all other factors remaining constant. Finally, an increase of one unit in non-resident patent applications resulted in an increase in GDP of 0.008.

4.2.2Statistical Significance

The concept of statistical significance is employed to ascertain whether the estimated parameter exerts a genuine effect on the dependent variable from a statistical standpoint.

We use hypothesis testing:

- Null hypothesis (H_0): $\beta = 0$
(i.e., the independent variable does not affect the dependent variable)
- Alternative hypothesis (H_1): $\beta \neq 0$
(i.e., the independent variable has a significant effect on the dependent variable)

-T-Statistic

The concept of statistical significance is employed to ascertain whether the estimated parameter exerts a genuine effect on the dependent variable from a statistical standpoint.

-The t-value for the teachers' coefficient was 0.972, which is less than the critical value (1.96). The associated probability value (p-value) is greater than 0.05, indicating that the teachers' coefficient is not significant at the 5% level. This suggests that teachers do not affect GDP. Therefore, the null hypothesis is accepted and the alternative hypothesis is rejected.

- The t-value for the coefficient of patent applications, residents is -3.126, which is greater than the critical value (1.96). The associated probability value (p-value) is less than 0.05, indicating that the coefficient of patent applications, residents is statistically significant at the 5% level. This finding suggests that patent applications have a substantial impact on GDP. Consequently, the null hypothesis is rejected and the alternative hypothesis is accepted.

- The t value of the non-resident patent application coefficient was 0.37, which is smaller than the critical value (1.96). The associated probability value (p-value) is greater than 0.05, indicating that the coefficient for non-resident patent applications is not significant at the 5% level. This finding suggests that non-resident patent applications do not significant influence on the gross domestic product. Consequently, we accept the null hypothesis and reject the alternative hypothesis.

-Coefficient of determination (R-squared or R^2)

The model showed that the value of the $R^2 = 0.613$, meaning that the model explains 61.3% of the changes in the dependent variable, which is GDP, and there are 38% unexplained due to other factors.

-F-statistic

The F test is a statistical procedure employed to ascertain the overall significance of a model. The findings of the model revealed that the F statistic value was 8.389, and the associated probability value (p-value) was less than 0.05. This finding indicates that the model as a whole is statistically significant at the 5% level of significance. This means that the independent variables included in the model explain a statistically significant portion of the change in the dependent variable. Therefore, the null hypothesis is rejected, thereby supporting the validity of the model in terms of interpretation and analysis.

-Durbin-Watson (DW) test

The Durbin-Watson statistic was found to be 1.26, which is lower than the reference value of 2. This indicates the presence of positive autocorrelation in the model's residuals, which represents a violation of one of the classical linear regression assumptions. This may have consequences for the accuracy of the statistical estimates, particularly the standard errors and the significance of the coefficients. Nevertheless, the model was maintained in its existing form, as the objective of the study was to analyse the relationship between the variables in an explanatory context, rather than to achieve precise prediction.

5. CONCLUSION

In the contemporary business environment, the pursuit of competitiveness necessitates a strategic emphasis on pivotal factors, including human capital, knowledge and innovation, and the knowledge economy. Education has been identified as the primary catalyst for propelling state economic development.

Investment in human capital has been demonstrated to engender innovation, stimulate production growth, and enhance profitability, which, in turn, has been shown to precipitate economic growth (Chen, 2024).

Education has been demonstrated to function as an agent for the promotion of innovation and technological advancement. Education has been proven to equip individuals with the ability to solve complex problems and think critically. Indeed, some forms of STEM education have been shown to significantly contribute to a country's capacity for innovation. It is evident that nations that accord a high priority to education tend to demonstrate superior innovative capabilities. This is indicative of their innovative prowess. The resulting innovations have the potential to drive higher productivity, thereby enabling greater output from similar inputs. This, in turn, has the capacity to lead to economic growth. The positive impact of education on economic growth has been demonstrated. (Deng, 2024).

The findings of the study demonstrated that higher education emerged as a significant factor contributing to the economic development of Algeria during the period spanning from 2001 to 2020. The regression coefficient estimates demonstrated that an

augmentation in the number of teachers within higher education institutions is associated with a concomitant increase in gross domestic product, thereby reflecting the positive impact of this factor on economic growth. Conversely, an increase in the number of patent applications filed by residents was found to be associated with a decline in GDP, which may indicate a weakness in translating these innovations into actual economic value within the national economy. Patent applications filed by non-residents showed a positive correlation with GDP, indicating the role of foreign innovation in supporting the Algerian economy.

It is evident from the findings that the impact of higher education on economic development is not unidirectional; rather, it varies depending on the indicator that is adopted. In order to achieve sustainable development, it is essential to adopt more effective educational and innovative policies that focus on quality, promote scientific research, and link its outcomes to the national economy.

6. Bibliography List :

- Allam Hamdan, A. S. (2020). A causality analysis of the link between higher education and economic development: empirical evidence.
- Al-Samarrai, S. G. (2020). The Impact of the COVID-19 Pandemic on Education Financing. . <https://doi.org/10.1596/33739> .
- association, F. f. (2015). Higher Education Engagement in Economic Development. p06.
- Barro, R. a.-i.-M. (2004). "Economic Growth.". (Second Edition), The MIT Press: Cambridge,Massachusetts. London, England. .
- Carnoy, M. (2007). Higher Education and Economic Development. Journal o f Educational Planning and Administration, 205.
- Chen, E. (2024). The Impact of Education on Economic Growth. n.d. Accessed April 13.
- cooperationAgency, I. f. (2004). Approaches for Systematic Planning of Development Projects. p5-6.
- Corazza, L. D. (2019). Education of sustainable development goals through students' active engagement. Sustain. Account. Manag. Pol. J 10. Account. Manag. Pol. J 10(3), 521-544.
- David Bloom, D. C. (2006). Higher Education and Economic Development in Africa. HARVARD UNIVERSITY p16.
- de Carvalho, J. R. (2014). Annual maximum daily rainfall trends in the Midwest,

- southeast and southern Brazil in the last 71 years. *Weather and Climate Extremes*, 5,7-15.
- Deng, X. (2024). The Crucial Link Between Education and Economic Growth . *Proceedings of the 3rd International Conference on International Law and Legal Policy* DOI: 10.54254/2753-7048/57/20240123, 182-183.
- Feldman, M. H. (2015). The logic of economic development: a definition and model for investment. *Environ. Plann. C Govern Pol.* 34 (1), 5e21.
- Glynn, J. P. (2007). Unit root tests and structural breaks: A survey with applications.
- Greiner, A. S. (2005). “The Forces of Economic Growth: A Time Series Perspective?”. Princeton, NJ, USA University Press, 208.
- Gu, S. (2024). The Impact of Higher Education on Economic Growth: A Comparative Analysis of China, Germany, and the United States. *Proceedings of Finance in the Age of Environmental Risks and Sustainability - ICFTBA 2024 (ICFTBA 2024)* DOI: 10.54254/2754-1169/99/2024OX0191, 105-106.
- Gujarati, D. N. (2009). *Basic econometrics*. Tata McGraw-Hill Education. .
- Guo, Z. (2023). Research on the Augmented Dickey-Fuller Test for Predicting Stock Prices and Returns. *Proceedings of the 7th International Conference on Economic Management and Green Development* DOI: 10.54254/2754-1169/44/20232198, 100.
- Gylfason, T. 2. (2001). Natural resources, education, and economic development. *EUR Econ. Rev.* 45, 847e859.
- Hansen, J. a. (2006). ‘Agents of Change: Universities as Development Hubs’. *The Journal of Cleaner Production*, 14: 820–9.
- Holtz-Eakin, D. N. (1988). Estimating vector auto regressions with panel data. *Econometrica* ,56(6), 1371–1395.
- Kimenyi, M. S. (2013). Contribution of Higher Education to Economic Development: A Survey of International Evidence. *Journal of African Economies*, Vol. 20, AERC Supplement 3, pp. iii14–iii49,p 17.
- Majka, M. (2024). Ordinary Least Squares. 03.
- Mankiw, N. G. (1992). “A contribution to the empirics of economic growth.”. *Quarterly Journal of Economics*. vol 107, p. 407-437.
- Murray, A. S. (2015). The circular economy: an interdisciplinary exploration of the concept and application in a global context. . *J. Bus. Ethics* 140(3), 369e380.
- Nelson, R. a. (1966). ‘Investment in Humans, Technological Diffusion, and Economic Growth’. *American Economic Review*, 56 (1/2): 69–75.
- OECD. (2013). *The OECD Higher Education Programme (IMHE). ; Anna Glass , THE STATE OF HIGHER EDUCATION*,p03.
- Pillay, P. (2010). *Higher Education and Economic Development: A Literature Review*, Centre for Higher Education Transformation, Cape Town.
- Romer, P. M. (1989). “Human Capital and Growth: Theory and Evidence. (NBER

Working Paper 3137 NBER, Cambridge, MA.

Schmidt, P. R. (2015). Sustainability in higher education: a systematic review with focus on management education. *J. Clean. Prod.* 106, 22e33. *J. Clean. Prod.* 106, 22-33.