Forum For Economic Studies and Research Journal Volume: 09/ N°: 01 (2025), p 697 - 711

The causal relationship between investment in human capital and economic growth in Algeria 2001-2022

ABID MOHAMED NADIR [1], SAYEH HAMZA [2]

[1] Laboratory for Sustainable Development in the High Plateaus and Desert Areas, University center Nour Bachir El Bayadh, Algeria, m.abid@cu-elbayadh.dz .

[2] Laboratory for Sustainable Development in the High Plateaus and Desert Areas, University center Nour Bachir El Bayadh, Algeria, hamzasayah98@yahoo.com.

Received: 09/02/2025 **Accepted: 26/05/2025**

Abstract:

The study aimed to understand the nature of the relationship between investment in human capital, represented by the percentage of expenditure on education from total government expenditure, and economic growth, represented by Gross Domestic Product (GDP), in Algeria, this investigation covered the period from 2001 to 2022, To achieve this objective, previous studies and relevant research were reviewed, and an empirical study was conducted with data analyzed using Eviews10 software employing the Yoda and Yamamoto Causality methods, as well as Granger causality, The study concluded that investment in human capital and economic growth are independent variables in the Algerian economy, with no causal relationship between them observed in either the short or long term.

Key Words: *Human capital, Investment in human capital, Economic growth, Gross Domestic Product (GDP).*

JEL Classification : *O15, O34, M12, J24*

1. *Introduction*

In a rapidly changing world where economic and technological developments are accelerating, investment in human capital stands as one of the fundamental pillars for achieving sustainable economic growth. Skilled and well-trained human resources play a crucial role in enhancing productivity, improving the quality of goods and services, and driving innovation. Accordingly, these transformations necessitate comprehensive strategies based on continuous education and training, improving the work environment, and ensuring employee well-being.

Algeria, a country endowed with abundant natural resources, faces unique challenges in diversifying its economy beyond excessive reliance on the energy sector. Since the beginning of the 21st century, Algeria has taken steps to strengthen investment in human capital to achieve more diversified and sustainable economic growth. These efforts span multiple domains, including education and vocational training, aiming to build a solid base of human resources capable of addressing future economic and social challenges.

This study aims to explore and analyze the causal relationship between investment in human capital and economic growth in Algeria during the period from 2001 to 2022. It will examine data related to investment in education and training, linking them to economic growth rates to determine the extent of their impact on Algeria's economic development. Additionally, the study will review economic literature and theories that have addressed this topic, utilizing statistical data and economic indicators to provide a comprehensive and integrated analysis that may contribute to formulating practical recommendations for policymakers in Algeria. Through this analysis, we seek to present recommendations that enhance human capital investment policies, contributing to an integrated and sustainable economic vision for the country.

Main Research Question:

Is there a relationship between investment in human capital and economic growth in Algeria from 2001 to 2022?

Sub-Questions :

1. Is there a causal relationship between investment in human capital and economic growth in the short run?
2. Is there a causal relationship between investment in human capital and economic growth in the long run?

Research Hypotheses:

1. There is a causal relationship between investment in human capital and economic growth in the short run.
2. There is a causal relationship between investment in human capital and economic growth in the long run.

Methodology and Research Tools:

The study adopts a descriptive approach, utilizing theoretical literature and previous studies related to the current research topic, including books and academic journals. For the empirical analysis, the study employs the EViews software to examine causality relationships using the Granger causality test and the Toda and Yamamoto causality approach.

2. *Theoretical Framework*

2.*1 Investment in Human Capital*

Human capital is a central concept in modern economic analysis, referring to individuals' stock of knowledge, skills, and abilities that enable them to contribute to economic production and drive growth and development.

2.1.1 Human Capital

The concept of human capital was established by economists Theodore Schultz and Gary Becker in the 1960s. They linked investment in education and training to improved living standards, leading to the formal integration of human capital into economic models.

Schultz defines human capital as the accumulated stock of skills and acquired knowledge among individuals, distinguishing them from unskilled labor. This stock represents the total skilled workforce that can be utilized to exploit economic resources and achieve growth. Human capital consists of :

- A qualitative aspect, representing cognitive abilities and educational levels, determined by education, experience, and knowledge.
- A quantitative aspect, representing the total population size (Michael Armstrong, 2009, p. 68).

Investments in education are among the key investments in human capital, as they enhance workers' skills and abilities, leading to increased productivity and profitability.

Becker defines human capital as a set of productive capabilities acquired through knowledge accumulation and skill development. He argues that investing in knowledge, skills, and health is the most significant factor in modern economies. The more individuals invest in themselves, the higher their skills and productive abilities, ultimately driving economic success at both the individual and societal levels (E, 2017, p. 13).

Human capital is a collection of assets that individuals possess, such as educational qualifications, work experience, personal skills, health, and technological knowledge. These assets enhance employment opportunities and increase an individual's value to an organization. A workforce with high human capital contributes to achieving organizational goals and improving productivity and efficiency (Saleh, 2015, p. 28).

Based on the previous definitions, an operational definition of human capital emerges, encapsulating a unique mix of capabilities:

- ✓ **Intellectual abilities**, such as intelligence, innovation, and problem-solving skills, acting as a compass guiding individuals toward new horizons.
- ✓ **Cognitive abilities**, including memory, concentration, and perception, serving as tools for absorbing knowledge and transforming it into applicable skills.
- ✓ **Accumulated knowledge**, spanning sciences, arts, and technology, which fuels creativity and unlocks hidden potential.
- ✓ **Practical experience**, gained through work, study, and life, enriching skills with realism.
- ✓ **Good health conditions**, including physical and psychological well-being, forming the foundation for productivity and achievement.

All these elements merge into a single entity, forming human capital, an invaluable wealth that generates substantial economic benefits and contributes to societal well-being. The greater the investment in human capital development, the more societies flourish, nations advance, and individuals prosper.

2.1.2 Investment in Human Capital

Todaro defines investment in human capital as productive investments that enhance an individual's capabilities, including skills, abilities, and values derived from education expenditures. These investments are essential for boosting individuals' productive capacity, thereby driving sustainable economic development (Abdulbasit, 2019, p. 4).

Investing in human capital is a strategic step toward strengthening human resources through well-planned financial allocations aimed at skill development, experience refinement, and intellectual expansion. This investment is not a mere expenditure but a proactive process that yields long-term added value for businesses by enhancing production excellence and providing distinguished services. Investing in human capital is not a luxury but a necessity for companies' survival and prosperity (Al-Quraishi, 2012, p. 476).

Therefore, companies that recognize the importance of human capital investment will dominate the future economy and contribute to building a prosperous society.

Investing in human capital is a smart strategy for enhancing individuals' abilities and developing their skills, ultimately improving productivity and fostering innovation. As such, this investment is a fundamental pillar of sustainable economic growth, promoting excellence, advancing workforce skills, and improving organizational performance. It is a shared responsibility between individuals, society, and the state (Wasif, 2003, p. 4).

Definition of Human Capital Investment

Based on the aforementioned perspectives, human capital investment can be defined as a set of organized measures and policies aimed at allocating a portion of societal and individual savings toward skill development, behavioral refinement, and capacity enhancement. This is a sustainable investment that yields substantial long-term economic and social returns.

The primary goal of this investment is to increase productivity and efficiency, leading to higher output levels and greater societal well-being.

2.1.3Objectives of Human Capital Investment

Investing in human capital is a strategic imperative for enhancing human resources through planned financial allocations aimed at skill development, experience enrichment, and intellectual expansion. This process yields long-term added value for businesses in the following ways (Madfouni, 2017, pp. 44-45):

a) Enhancing Productivity:

- ✓ Developing workers' skills improves production efficiency, enhances product quality, and reduces costs.
- ✓ Encourages innovation and the creation of new solutions to meet evolving market demands and customer needs.

b) Improving Organizational Performance:

- ✓ Enhancing employee skills leads to better customer service and increased customer satisfaction.
- ✓ Helps build **sustainable relationships** with customers, fostering long-term loyalty and trust.

c) Promoting Excellence and Innovation:

- ✓ Investing in skill development creates a positive work environment that encourages creativity and innovation.

- ✓ Facilitates the development of new products and services that meet market needs and enhance organizational competitiveness.

d) Achieving Sustainable Development:

- ✓ Investment in human capital raises living standards and generates new employment opportunities.
- ✓ Promotes social stability and reduces poverty rates. By prioritizing human capital investment, societies can unlock economic potential, drive sustainable development, and secure long-term prosperity.

2.1.4 Characteristics of Investment in Human Capital

The characteristics of investment in human capital manifest as vital factors that influence individuals' productivity and positively reflect on the economic and social performance of society as a whole. Among these characteristics are:

- ➢ **Continuity:** Investment in human capital is a long-term process that requires continuous commitment from individuals, society, and the state.
- ➢ **Accumulation:** The skills and abilities acquired contribute to improved performance over time.
- ➢ **Intangibility:** Human capital cannot be measured in tangible units, making its assessment challenging.
- ➢ **Diversity:** Human capital varies from one individual to another, necessitating specialized training programs tailored to the needs of each person.

Education as a Key Driver of Investment in Human Capital

Education serves as an effective tool and a fundamental means for enabling individuals to participate actively in professional life and achieve sustainable human development. It is one of the most significant indicators of human development due to its crucial role in acquiring knowledge, skills, and cultural experiences. Education is a fundamental and legitimate right for every individual, providing opportunities to improve both material and social conditions while enhancing one's ability to contribute effectively to society.

Human development theory emphasizes education as the central pillar of progress. The success of development efforts in any society primarily depends on the strength and effectiveness of its educational system. Education is the foundation of societal advancement and a critical mechanism for achieving economic, social, and cultural progress. Therefore, investing in education is the most valuable investment a society can make to ensure a prosperous future for its coming generations.

Technological advancements have significantly reshaped the role of education, making knowledge the most influential factor in the production equation. As the importance of natural and material resources diminishes, knowledge increasingly drives progress. Thus, developing human capital—producers of knowledge and innovation—becomes the decisive factor in societal advancement. Investment in education is among the most rewarding economic investments, particularly in the knowledge era, where the knowledge industry has emerged as one of the most dominant industries due to its immense potential to create new opportunities for growth and prosperity. *(Mahza, 2019, p. 135)*

2.2 Economic Growth

2.2.1 Concept of Economic Growth

Throughout history, economic growth has been a fundamental goal pursued by nations, as it leads to improved living standards and enhances a country's position on the global stage. Therefore, significant efforts are devoted to identifying various strategies to increase growth rates. Economic growth is one of the most critical macroeconomic indicators, reflecting a country's economic performance and activity. Higher growth rates are associated with greater prosperity and well-being, positively impacting individuals' income levels and their ability to meet both essential and non-essential needs. Consequently, sustaining and accelerating economic growth is a fundamental priority in national development strategies.

Economic growth is a continuous and dynamic process that enhances an economy's productive capacity over time through increased productivity, investment expansion, and higher exports. As an economy's production capacity grows, its Gross National Product (GNP) increases, reflecting the total value of goods and services produced within a specific period. Therefore, achieving economic growth remains a primary objective for all nations. *(Mahmoud, 2006, p. 31)*

Achieving economic growth depends on three interrelated pillars: increasing investment, advancing technological progress, and improving workforce skills and efficiency. These factors collectively contribute to enhancing a society's productive capacity, thereby ensuring sustained increases in national output, improving living standards, and fostering overall societal well-being. Attaining such growth necessitates comprehensive economic policies and continuous governmental support to stimulate investments, encourage innovation, and enhance education and vocational training systems. *(Al-Khatib, 2015, p. 327)*

Based on these definitions, economic growth can be understood as:

A continuous process aimed at expanding an economy's productive capacity over time, leading to higher Gross National Product levels. Economic growth is driven by investment expansion, technological progress, and workforce development. This growth contributes to improved living standards and enhanced societal well-being. Achieving sustainable economic growth requires integrated economic policies and ongoing governmental support to stimulate investments, encourage innovation, and strengthen education and vocational training programs.

2.2.2 Elements of Economic Growth

Economic growth is a complex process that requires the integration of multiple elements to be achieved effectively and sustainably. It is a key objective for nations seeking to improve citizens' living standards and bolster their international standing. To realize this goal, several interdependent factors must be considered, as they play a crucial role in enhancing productivity and increasing national output. Among these essential elements are : *(Al-Sharqawi, 2015, pp. 47-48)*

- **Labor Force:** Efficiency and expertise serve as fundamental pillars for a capable workforce to navigate modern challenges. In the face of rapid advancements, particularly technological ones, it has become essential for the labor force to acquire the necessary skills to adapt to and leverage these changes. However, many countries still struggle with a surplus of unskilled and untrained workers, unable to operate advanced technologies or sophisticated machinery. This lack of skill presents a significant barrier to sustainable economic development in these nations.

- High unemployment rates in many developing countries highlight this issue, often leading to a reliance on foreign labor that may not effectively contribute to national economic development.
- Addressing this challenge requires strategic measures such as increasing investments in education and vocational training, modernizing curricula, fostering an entrepreneurial culture, and providing incentives to attract investments.

- **Capital:** Capital is the backbone of any thriving economy, encompassing all means of production necessary for generating goods and services—including machinery, infrastructure, and raw materials. The availability of capital is directly linked to national savings levels; the higher the savings rate, the greater the capital available for investment.
- **Natural Resources:** Natural resources are a double-edged sword, representing significant wealth for nations that possess them. They include resources such as oil, gas, minerals, and arable land, which, when effectively utilized, can drive economic growth and improve citizens' quality of life.
- **Technology:** Technology entails the knowledge of efficient methods to transform raw materials into goods and services. Its role extends beyond creating new products to improving existing ones. Essentially, the three primary factors of production—land, labor, and capital—require various forms of technology to enable the production of a diverse range of goods and services.

2.2.3 Justifications for the Relationship Between Education and Economic Growth

Individuals spend several years in formal education under the belief that it enhances their chances of securing better employment opportunities. Education serves as a vehicle for social mobility, prompting nations to increase educational attainment among their populations to improve productivity and job quality, ultimately leading to higher economic growth rates. In the early literature on the economics of education, a prevailing hypothesis suggested that education plays a substantial role in economic sectors by supplying a skilled workforce capable of increasing productivity. However, there remains no definitive answer regarding how education precisely affects productivity and economic growth, or which levels and types of education contribute most significantly to this growth. Studies indicate that countries experiencing high economic growth tend to have a workforce with high levels of formal education and strong competencies. *(Taha, 2009, p. 95)*

Modern growth theory asserts that developing countries can bridge the gap with advanced economies if they possess an adequate stock of skilled labor capable of utilizing and developing modern technologies. Training and educating the workforce enhance productivity by equipping workers with additional skills that boost innovation and efficiency. The first aspect of this theory links human capital to education levels, demonstrating that higher education enhances labor productivity and facilitates the absorption and advancement of technology. The second aspect positions human capital at the core of economic growth, arguing that the external benefits generated by human capital serve as the primary driver of endogenous economic growth. In this context, a more educated and skilled workforce directly and indirectly contributes to higher economic output. *(Bouchna, 2021, p. 45)*

3. Descriptive Analysis

3.1 Investment in Education in Algeria

Table 1: Percentage of Education Expenditure Relative to Total Government Spending

Percentage of Education Expenditure from Total Government Spending (%)	Total Education Expenditure (DZD)	Total Public Expenditure (DZD)	Year
22.74	190,137,286,000	836,294,176,000	2001
21.83	229,284,158,000	1,050,166,167,000	2002
22.58	247,834,777,000	1,097,385,900,000	2003
22.33	267,921,516,000	1,200,000,000,000	2004
25.77	309,186,355,000	1,200,000,000,000	2005
25.27	324,341,686,000	1,283,446,977,000	2006
22.14	348,631,785,000	1,574,943,361,000	2007
20.75	418,723,920,000	2,017,969,196,000	2008
21.39	554,847,322,000	2,593,741,485,000	2009
20.88	592,548,005,000	2,837,999,823,000	2010
23.89	820,477,072,000	3,434,306,634,000	2011
18.89	870,689,751,000	4,608,250,475,000	2012
21.70	940,881,624,000	4,335,614,484,000	2013
21.57	1,017,043,611,000	4,714,452,366,000	2014
22.08	1,097,781,473,000	4,972,278,494,000	2015
23.43	1,126,577,657,000	4,807,332,000,000	2016
24.07	1,105,357,372,000	4,591,841,961,000	2017
23.33	1,069,735,418,000	4,584,462,233,000	2018
21.69	1,074,735,918,000	4,954,476,536,000	2019
23.27	1,138,901,241,000	4,893,439,095,000	2020
22.46	1,193,514,445,000	5,314,506,529,000	2021
20.37	1,285,619,370,000	6,311,532,437,000	2022

Source: Prepared by the researchers based on Finance Laws and World Bank data.

Between 2001 and 2022, Algeria witnessed significant increases in education expenditures across various sectors, reflecting the state's commitment to enhancing human capital as a driver of economic growth. Higher education expenditures rose from DZD 43.6 billion to DZD 400 billion, while spending on primary and secondary education increased from DZD 137.4 billion to DZD 825 billion, demonstrating a strong focus on improving education quality and infrastructure. Although vocational education and training expenditures also grew—from DZD 9.1 billion to DZD 60.6 billion—the growth rate was relatively lower than in other sectors. This underscores the need for greater attention to vocational training to better align with labor market demands.

The period 2001–2010 saw a gradual increase in education spending, with a marked acceleration after 2008. A relative stabilization was observed between 2016 and 2020, before expenditures resumed their upward trend in 2021 and 2022, likely influenced by shifts in economic and social policies.

Despite fluctuations in the percentage of education expenditure relative to total government spending during this period, Algeria has demonstrated a consistent commitment to developing the education sector. The percentage ranged from a low of 18.89% in 2012 to a peak of 25.77% in 2005. Overall, total education expenditures increased from DZD 190.1 billion in 2001 to DZD 1,285.6 billion in 2022, alongside a parallel rise in GDP from DZD 4,227.1 billion to DZD 27,250.7 billion.

Despite economic challenges, the government has maintained a steady increase in education spending, reinforcing education as a national priority for achieving sustainable economic growth. Moving forward, it is recommended that Algeria continue this investment strategy while systematically evaluating the efficiency of education expenditures to enhance quality and ensure a balanced approach to economic policy for comprehensive development.

4. Econometric Analysis

4.1 Study Variables

This section of the research examines the causal relationship between investment in human capital and economic growth in Algeria during the period 2001–2022, based on the descriptive data presented earlier. To determine the linear relationship, it is essential to investigate the causality between these two variables over the specified period.

Table 2 : Definition of Study Variables

Symbol	Source	Data Series	Variable
IHC	Calculated using Finance Laws	Percentage of Education Expenditure from Total Government Spending	Investment in Human Capital
GDP	World Bank	Gross Domestic Product (GDP) in Algerian Dinars	Economic Growth

Source: Prepared by the researchers.

4.2 Conditions for Causality Testing

Several methods can be used to conduct causality testing, with **Granger causality** being the most widely recognized approach in the short run. However, the application of this methodology requires that both time series be stationary; otherwise, the method cannot be applied, making it impossible to detect causality between the two variables.

4.2.1 Testing the Stationarity of the Time Series for Investment in Human Capital and Economic Growth

To examine the stationarity of the model variables, we employ the Augmented Dickey-Fuller (ADF) test, as shown in the following table:

Table 3: Unit Root Test Based on the ADF Test

Stationarity Test at Level I(0)		Time Series	
	Test Statistic Prob.	IHC	GDP
With Constant	t-Statistic	-3.4179	-0.1365
	Prob.	0.0220 **	0.9316 n0
With Constant and Trend	t-Statistic	-3.3747	-3.9515
	Prob.	0.0820 *	0.0289 **
Without Constant and Trend	t-Statistic	-0.4425	3.2174
	Prob.	0.5105 n0	0.9991 n0
Stationarity Test at First Difference I(1)			
		d(IHC)	d(GDP)
With Constant	t-Statistic	-6.2218	-4.2106
	Prob.	0.0001 ***	0.0045 ***
With Constant and Trend	t-Statistic	-6.0847	-3.9001
	Prob.	0.0004 ***	0.0330 **
Without Constant and Trend	t-Statistic	-6.3854	-1.6587
	Prob.	0.0000 ***	0.0908 *

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

From the table above, we observe that the IHC series is non-stationary at level but becomes stationary at the first difference. Similarly, the GDP series is also non-stationary at level but attains stationarity at the first difference.

4.2.2 Determining the Optimal Lag Length for the VAR Model

Before conducting the causality test, it is necessary to determine the optimal lag length since the results are highly sensitive to the number of lag periods required to eliminate autocorrelation in the error term. The optimal lag length is selected based on the information criteria (HQ, SC, AIC), where:

- **HQ:** Hannan-Quinn Information Criterion
- **SC:** Schwarz Information Criterion
- **AIC**: Akaike Information Criterion

Table 4: Optimal Lag Length for the VAR Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-653.1240	NA	9.70e+25	65.51240	65.61198	65.53184
1	-625.5690	46.84352*	9.24e+24*	63.15690*	63.45562*	63.21522*
2	-624.8042	1.147173	1.30e+25	63.48042	63.97829	63.57761

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

From the table above, we observe that the optimal lag length for the VAR model for both series is one period, as indicated by the AIC, SC, and HQ criteria.

4.2.3 Causality Testing

Causality refers to identifying the variable that influences another variable. For instance, if we have two variables, X and Y, and we do not know which one affects the other—meaning we are uncertain about which is the dependent and which is the independent variable—then we conduct a causality test to determine the direction of the relationship between the two variables.

4.2.3.1 Granger Causality Test (Short-Run Analysis)

Several methods can be used to test the direction of the causal relationship, with Granger causality being the most well-known for short-run analysis. However, applying this method requires that both time series be stationary. If this condition is not met, the methodology cannot be applied, making it impossible to detect causality between the two variables.

The Granger causality test between X and Y is conducted using the VAR model on the first differences of both variables, as represented in the following equations:

$$d(Y_t) = c + \sum_{i=1}^{n} \beta_n \times d(Y_{t-i}) + \sum_{i=0}^{n} \alpha_n \times d(X_{t-i}) + \varepsilon_t \ldots\ldots\ldots\ldots (1)$$

$$d(X_t) = c + \sum_{i=0}^{m} \beta_{m,2} \times d(Y_{t-i}) + \sum_{i=1}^{m} \alpha_{m,2} \times d(X_{t-i}) + \varepsilon_t \ldots\ldots\ldots (2)$$

Where n represents the number of lags in the first equation and mmm represents the number of lags in the second equation.

We can consider that the variable X represents investment in human capital (IHC), while the variable Y represents economic growth (GDP), meaning:

$$\begin{cases} (X) = (IHC) \\ (Y) = (GDP) \end{cases}$$

From the previous equations (1) and (2), the relationship between investment in human capital (IHC) and economic growth (GDP) according to this methodology can be expressed as follows:

$$d(GDP_t) = c + \sum_{i=1}^{n} \beta_{n,1} \times d(GDP_{t-i}) + \sum_{i=0}^{n} \alpha_{n,1} \times d(IHC_{t-i}) + \varepsilon_t \ldots\ldots\ldots\ldots (3)$$

$$d(IHC_t) = c + \sum_{i=0}^{m} \beta_{m,2} \times d(GDP_{t-i}) + \sum_{i=1}^{m} \alpha_{m,2} \times d(IHC_{t-i}) + \varepsilon_t \ldots\ldots\ldots (4)$$

From the previous equations, the following null hypotheses can be derived:

From the first equation: The hypothesis that investment in human capital (IHC) does not cause economic growth (GDP) is tested. This can be achieved if the null hypothesis is accepted and the alternative hypothesis is rejected, as follows:

$$\begin{cases} H_0 : \sum_{i=0}^{n} \alpha_n = 0 \\ H_1 : \sum_{i=0}^{n} \alpha_n \neq 0 \end{cases}$$

From the second equation: the hypothesis stating that economic growth (GDP) does not cause investment in human capital (IHC) is as follows:

$$\begin{cases} H_0 : \sum_{i=0}^{m} \beta_m = 0 \\ H_1 : \sum_{i=0}^{m} \beta_m \neq 0 \end{cases}$$

Based on the previous explanation, the following table illustrates the Granger Causality Test in the short term, based on the data from the previous table for the series (GDP) and (IHC):

Table 5: Granger Causality Test

OBS	**Lag Length**	**Null Hypothesis (H_0)**	Calculated F Value	p-Value
20	1	(GDP) does not cause (IHC)	0.76281	0.4836
	1	(IHC) does not cause (GDP)	0.40572	0.6736

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

From the table, it is clear that both p-values are greater than the significance levels of 1%, 5%, and 10%, indicating that the calculated F value is smaller than the critical F value from the table. This leads us to accept the null hypothesis (H_0), which states that there is no causality between the two variables in the short term. Thus, neither (IHC) nor (GDP) causes the other, implying that they are independent of each other.

4.2.3.2 Toda and Yamamoto Granger Causality Test (Long Term):

The Toda and Yamamoto (1995) study used an advanced method (M. WALD) for testing the Wald test, employing a VAR (K) model, where K represents the number of lags. This method uses the Wald criterion based on the Fisher test (F) and chi square (χ^2)to assess the null hypothesis. (Nasour & Dahmani, 2015, p. 145)

To apply this test, which relies on the VAR model, the following steps must be followed:

1. Identify the stability order of the time series involved in the model.
2. Determine the appropriate number of lags (delays) for the VAR model.

3. Add all variables with a lag of (K+dmax), where K is the number of suggested lags and d max is the highest stability order of the time series used in the model, estimated through a unit root test.
4. Write the statistical model for this methodology for the two variables (IHC, GDP) as follows:

$$GDP_t = \alpha_0 + \sum_{i=1}^{K+d_{\max}} \alpha_{1,i} \times GDP_{t-1} + \sum_{i=1}^{K+d_{\max}} \alpha_{2,i} \times IHC_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots (5)$$

$$IHC_t = \beta_0 + \sum_{i=1}^{K+d_{\max}} \beta_{1,i} \times IHC_{t-1} + \sum_{i=1}^{K+d_{\max}} \beta_{2,i} \times GDP_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots (6)$$

Where:

- (α, β) represents fixed parameters that estimate the model.
- (ε) represents the error terms with a sum and mean equal to zero.

This methodology tests the null hypothesis (H_0) stating that there is no causal relationship between (GDP) and (IHC) in Equation (5), meaning that (IHC) does not cause (GDP).
On the other hand, the alternative hypothesis (H_1) suggests the existence of a causal relationship between the two variables, which can be formulated as follows:

$$\begin{cases} H_0 : \sum_{i=1}^{K+d_{\max}} \alpha_{2,i} = 0 \\ H_1 : \sum_{i=1}^{K+d_{\max}} \alpha_{2,i} \neq 0 \end{cases}$$

This methodology also tests the null hypothesis (H_0) stating that there is no causal relationship between (GDP) and (IHC) in Equation (6), meaning that (GDP) does not cause (IHC).
On the other hand, the alternative hypothesis (H_1) suggests the existence of a causal relationship between the two variables, which can be formulated as follows:

$$\begin{cases} H_0 : \sum_{i=1}^{K+d_{\max}} \beta_{2,i} = 0 \\ H_1 : \sum_{i=1}^{K+d_{\max}} \beta_{2,i} \neq 0 \end{cases}$$

Based on the data presented in the previous table, which demonstrates the stationarity of the time series, it is evident that both series became stationary at the first difference I(1). Consequently, we conclude that the maximum order of integration (dmax) is 1.

Furthermore, from the subsequent table, which determines the optimal lag length (K) based on the information criteria (AIC, SC, HQ), the optimal lag length was found to be 1.

Therefore, according to the modified Granger causality test (Toda and Yamamoto), the optimal lag length (K), which represents the order of the VAR model, is calculated as follows: K+dmax=1+1=2

Table 6: Results of the Causality Test in the Long Run (Toda and Yamamoto)

OBS	Lag length	Null hupothesis H0	χ^2	p-value
20	1	(IHC) does not cause (GDP)	0.811432	0.6665
	1	(GDP) does not cause (IHC)	1.525629	0.4664

Source: Prepared by the researchers based on Eviews10 output.

From the table above, we observe that both p-values are greater than the 1%, 5%, and 10% significance levels. This leads us to accept the null hypothesis (H0H_0H0), which states that there is no causal relationship between the two variables in the long run. That is, there is no causal link between human capital investment and economic growth in Algeria in the long run. This implies that human capital investment and economic growth do not influence each other and are independent variables within the Algerian economy.

5. Conclusion

Based on the analysis of the results, the following conclusions can be drawn:

- ✓ There is no causal relationship between human capital investment (IHC) and economic growth (GDP) in the short run.
- ✓ There is no causal relationship between human capital investment and economic growth in the long run.

Discussion of the Results

These results are somewhat surprising, as previous studies suggest a positive relationship between human capital investment and economic growth.

Several potential factors may explain these findings:

- The quality of education in Algeria may not be high enough to have a significant impact on economic growth.
- University graduates may not be adequately absorbed into the labor market.
- Other factors unrelated to human capital investment may play a more dominant role in determining economic growth.

Based on these results, we infer that the relationship between human capital investment and economic growth in Algeria remains open for further interpretation, considering the influence of other variables that may affect this relationship over different periods. More research and analysis are needed to understand this relationship in greater depth and accuracy.

6. Recommendations

- ✓ Enhancing the quality of education in Algeria should be a priority.
- ✓ Efforts should be made to improve employment opportunities for university graduates.
- ✓ Further studies should be conducted to better understand the relationship between human capital investment and economic growth in Algeria.

Based on the econometric study, we conclude that human capital investment and economic growth are independent variables within the Algerian economy. There is no causal relationship between them in either the short or long run, meaning neither variable affects nor is affected by the other. These findings highlight the need for further research to understand the factors that shape the relationship between these two variables within the Algerian context.

7. Bibliography List :

1. Ahmed Ali Saleh, (2015), *Human Capital Management - Strategic Approaches for Investment Activation and Crisis Mitigation*, Al-Yazouri Scientific Publishing and Distribution, Amman, Jordan.
2. Michael Todaro, (2006), *Economic Development*, translated by Mahmoud Hassan Hussein and Mahmoud Hamed Mahmoud, Dar Al-Mareekh Publishing, Riyadh, Saudi Arabia.
3. Abdelsamad Boushneh, (2021), *An Econometric Study of the Relationship Between Public Expenditure on Human Capital and Economic Growth in Algeria (1970-2017)*, PhD Thesis, Faculty of Economic Sciences, Commercial Sciences, and Management Sciences, Kasdi Merbah University, Ouargla, Algeria.
4. Abdullah Ali Al-Quraishi, (2012), *Investment in Human Capital from a Financial Perspective*, Andalus Journal of Social and Applied Sciences, Issue 10, Volume 5.
5. Farouk Bin Saleh Al-Khatib, Abdulaziz Bin Ahmed Diyab, (2015), *Advanced Studies in Macroeconomic Theory*, King Abdulaziz University, Jeddah, Saudi Arabia.
6. Mohamed Amin Mokhaimer, Moussa Abu Taha, (2009), *Educational Reform in the Middle East and North Africa*, 1st Edition, University Book Publishing House, UAE.
7. Mahmoud Ali Al-Sharqawi, (2015), *Economic Growth and Reality Challenges*, 1st Edition, Ghidaa Publishing and Distribution, Amman, Jordan.
8. Hamza Merdassi, (2019), *Education and Economic Growth: A Comparative Study*, PhD Thesis, Faculty of Economic Sciences, Commercial Sciences, and Management Sciences, Batna 1 University, Algeria.
9. Munther Wasif Al-Masri, (2003), *Economics of Education and Vocational Training*, 1st Edition, Dar Al-Kutub Al-Ilmiyya, Benghazi, Libya.
10. Hinda Madfouni, (2017), *Investment in Human Capital as a Strategic Approach to Improve the Quality of Higher Education in Algeria in the Knowledge Economy – A Case Study of Some Algerian Universities*, PhD Thesis, Faculty of Management Sciences, Oum El Bouaghi University, Algeria.
11. Wael Fawzi Abdel Baset, (2019), *Estimating the Impact of Human Capital on Economic Growth in Egypt: An Econometric Study*, Arab Journal of Administration, Volume 39, Issue 3, Egypt, September.
12. Houghton, E. (2017), Human *Capital Theory: Assessing the Evidence for the Value and Importance of People to Organizational Success*, London, United Kingdom.
13. Michael Armstrong, (2009), *Human Resource Management Practice*, London, United Kingdom