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# Analyzing The impact of Human Capital Investment on Algeria's Economic Development (1990–2023)

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**Abstract:**
This study aims to analyze the impact of human capital investment on economic development in Algeria from 1990–2023, focusing on government spending on education (GE) and health (GH) as key indicators of such investment. A descriptive-analytical method was adopted, supported by advanced statistical tools, including correlation coefficients, multiple regression models, and time-series analysis. Python programming was used for data processing and graphical representation of the results. The variables examined include GDP per capita (GDPPC) as an indicator of economic development, in addition to education and health expenditures, labor force (L), capital stock (K), and annual inflation rate (IN). The results revealed a strong positive correlation between spending on education, health, and economic development, with correlation coefficients of 0.97 and 0.96, respectively. Regression models showed that each additional billion Algerian dinars spent on health and education increased GDPPC by 471 and 342 units, respectively. In contrast, inflation was found to hurt economic development. The study recommends enhancing investment in education and health while improving their quality and controlling inflation rates to ensure sustainable economic development.

**Keywords:** Human capital, economic development, education, health, Algeria.

## Introduction and context of the study

Investment in human capital is considered a fundamental pillar for achieving sustainable economic development, as human resources represent the primary driver of societal progress. Economic literature consistently highlights the significant positive effects of human capital investment on economic growth through enhanced productivity, improved workforce quality, and greater economic competitiveness. When well-educated and in good health, individuals are more capable of actively contributing to economic activity, which positively impacts comprehensive development indicators such as GDP and quality of life.

Moreover, investing in human capital supports innovation and technological advancement, as skilled individuals play a crucial role in developing creative solutions and improving production efficiency. Improved health and education also reduce the social and economic costs associated with disease and illiteracy, enhancing resource efficiency and accelerating development.
In this context, Algeria has made notable efforts to strengthen human capital through reforms in the education and health sectors, which are expected to contribute to long-term sustainable economic development.

### *Problem Statement:*

The central research problem of this study is summarized in the following question:
What is the impact of human capital investment on Algeria's economic development from 1990–2023?

***Sub-questions:***

1. To what extent does government expenditure on education (GE) influence GDP per capita (GDPPC) as an indicator of economic development?
2. To what extent does government expenditure on health (GH) affect GDPPC?
3. How do other variables, such as the labour force (L), capital stock (K), and inflation (IN), interact with human capital investment and its relationship with economic development?
4. During the study period, are there clear time trends in the relationship between human capital investment and economic development?

Hypotheses:

- H1: Government spending on education (GE) positively affects economic development (GDPPC).
- H2: Government spending on health (GH) positively affects economic development (GDPPC).
- H3: The labour force (L) and capital stock (K) positively affect economic development, while inflation (IN) has a negative effect.

Objectives of the Study:
This study seeks to:

1. Analyze the conceptual foundations of human capital investment and economic development.
2. Measure the impact of human capital investment on Algeria's economic development from 1990–2023.
3. Provide practical recommendations to optimize the use of human resources in support of economic restructuring policies in Algeria for comprehensive development

## Literature review

The provided research articles collectively highlight the multifaceted nature of human capital's impact on economic development, spanning micro-level household decisions to macroeconomic growth and resilience (de Pleijt & Frankema, 2025). A consistent theme is the positive association between human capital investment and economic outcomes (de Pleijt & Frankema, 2025) Studies focusing on education and health spending at the national level (e.g., the Algerian case study, research on Saudi Arabia) demonstrate this link, with some highlighting the outsized impact of health investments (Al-Anoud Yousef Al-Mutlaq (, 2022) This positive relationship also appears at the regional level, as seen in studies on ECOWAS (Dankyi et al., 2022) and BIMSTEC (Raihan Uddin et al., 2025) though these also emphasize the complex interplay with other factors like FDI and globalization (Raihan Uddin et al., 2025) Moving to the micro-level, research on Chinese households reveals the importance of financial inclusion in enabling human capital investments, (Ma et al., 2024) while another study links higher education levels of executives to corporate human capital investment (Wu & Fang, 2024) Interestingly, research also explores the influence of cultural factors like clan culture on investment choices (Zhang et al., 2025).

Several studies delve into the mechanisms through which human capital affects economic outcomes. Government health investment is linked to enhanced economic resilience through improved health human capital and optimized industrial structure (Guo et al., 2025) .Another study finds that automation can stimulate household human capital investment via increased

public spending on education (Yang et al., 2024) The role of institutional quality is also explored, with one study finding that poor governance can hinder the positive effects of human capital and FDI on macroeconomic performance.

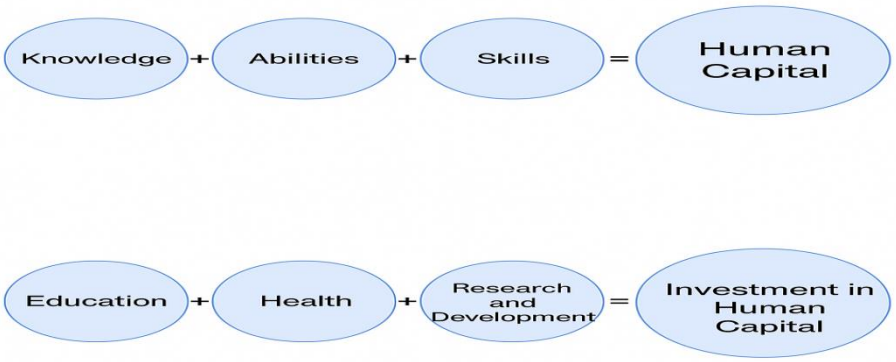
Finally, the research touches upon the importance of human capital in addressing broader societal challenges. Studies on natural disasters highlight the role of human capital in mitigating economic losses (Khan et al., 2023) while others examine the connection between human capital and the transition to renewable energy (Nawaz et al., 2024.) and achieving sustainable development goals (Jie & Lan, 2024) The research on early childhood investments in Sub-Saharan Africa underscores the long-term economic benefits of investing in nurturing care, nutrition, and pre-primary programs Overall (Behrman & Vazquez, 2025), the literature emphasizes the crucial role of human capital in fostering economic development, resilience, and societal progress across various levels and contexts.

***Human Capital Investment: An Overview***

Human capital refers to the skills, knowledge, experience, and abilities individuals gain or inherit, allowing them to participate in economic life and earn income. These qualities can be enhanced through investments in education, healthcare, training, and other forms of personal development. Economist Alfred Marshall emphasized the importance of investing in people, viewing human capital as a key national investment. He believed that most of a nation's capital value lies in its people, as the economy cannot grow without human resources capable of transforming raw materials into productive and technological power. Therefore, true investment is in human capital due to its long-term benefit (Hamid Toumi et al.,2020.)

The areas of human capital investment differ based on national priorities. From an economic standpoint, education, healthcare, and research and development are essential. However, a broader approach includes housing, transportation, social services, and social security. This research concentrates on education, healthcare, and research and development as the main fields of human capital investment. Below is an illustration differentiating human capital from investment in human capital:

**Figure 1.** ***The Distinction Between Human Capital and Human Capital Investment***




**Source**: Nagham Hameed Abdul-Khader, Khaled Rokan Awad, Rabab Nazem Khazem, (2023).Analyzing the Relationship between Human Capital Investment and Economic Growth in Iraq for the Period (2004–2020), Journal of Business Economics, Vol. 5, No. 3, p. 429.

Investing in human capital is a cornerstone of sustainable economic growth, with education, health, and research and development (R&D) being the most influential domains. Education

improves the quality of the labor force by equipping individuals with essential knowledge, skills, and competencies that increase productivity and the ability to adopt new technologies. Human capital theory, as developed by (Becker, 1994)and Schultz (Theodore W. Schultz, 1961), views education as a form of capital that yields long-term economic returns. Schultz emphasized that education is not merely a social service but a strategic investment embedded in individuals, enhancing their capacity to contribute to the economy. Health is equally critical, as a healthy population forms the backbone of a productive workforce. According to the World Health Organization (Who, 2010), improved health increases labor participation, lowers absenteeism, and increases economic output. (Bloom & Canning, 2000)also show that better health outcomes are closely linked to economic growth through their positive effect on human productivity and demographic dividends.

Furthermore, R&D serves as the innovative engine of human capital investment. It involves systematically expanding knowledge and developing new applications that fuel industrial advancement and societal well-being (Frascati Manual ,2015). (Romer, 1990)endogenous growth theory identifies technological innovation, often driven by R&D, as a key factor in sustaining long-term economic progress. In today's knowledge-based economy, countries prioritizing investment in R&D are more likely to maintain a competitive edge, adapt to global changes, and climb the technological value chain. Therefore, a balanced and strategic investment in education, health, and R&D is essential to fully harness the potential of human capital and foster inclusive, innovation-driven growth.

***Economic Development*: *An Overview***

Economic development is a foundational concept in economics, representing a nation's overall progress in improving the quality of life for its population. It extends beyond economic growth, which refers primarily to increases in income or GDP, to include broad improvements in living standards, health, education, institutional capacity, and political stability (Economic Development, 2022). In this broader view, development is a comprehensive transformation process to reduce inequality, eradicate poverty, and expand human freedoms (The Globalization and Development Reader, 2014). The **material dimension** of development focuses on overcoming underdevelopment by modernizing productive structures. This includes capital accumulation, industrialization, and the transition from traditional modes of production to mechanized, technology-based industries, which help build strong domestic markets and enhance national productivity (*World Investment Report 2018*, 2018). The **political dimension** emerged prominently after World War II, especially among countries that gained independence and sought to assert economic sovereignty. Development in this sense involves resisting external domination and reducing dependency on global powers or institutions, although many developing nations face challenges (Rodrik, 2007).

The **social dimension** of development emphasizes inclusive growth that enhances individual capacities and ensures equitable access to resources, education, healthcare, and opportunities. It also involves targeted public policies to eliminate poverty and support social integration based on human rights, justice, and dignity (UNDP, 2022). This approach aligns with the concept of human development, which places people at the center of the development process. The **international dimension** reflects the increasing role of global cooperation in supporting development efforts. After WWII, institutions such as the World Bank and the International Monetary Fund (IMF) were established to aid reconstruction and promote economic stability. The United Nations launched the "First Development Decade" in 1961, aiming to achieve a 5%

annual growth rate in developing countries. Initiatives like the General Agreement on Tariffs and Trade (GATT) and the United Nations Conference on Trade and Development (UNCTAD) were also introduced to foster fairer global trade and reduce economic disparities between nations (World Development Report 2022: FINANCE for an Equitable Recovery,2022). Together, these dimensions show that economic development is a multidimensional process requiring integrated efforts at national and international levels to achieve sustainable and inclusive progress

***The Relationship Between Human Capital Investment and Economic Development***

Human capital is a key driver of economic development. It represents the knowledge and expertise accumulated over time, which fuels progress in any society. Human resources remain the primary force behind national growth and prosperity(Nora Gueddouche & Esma Zedouri, 2023).

Investing in human capital through education and training leads to the formation of skilled personnel capable of advancing economic development. This requires a favorable investment environment, including clearly defined goals and effective strategic planning—highlighting the complementary relationship between human capital development and economic growth(Forichon, 2020).

Abandoning the human aspect has been one of the main reasons behind the failure of development policies in many developing countries. These policies focused excessively on physical capital (financial and industrial) while overlooking the crucial role of investing in people. Thus, comprehensive economic development requires consideration of several additional factors, most importantly human capital as a foundation for sustainable development(Cruz et al., 1996.).

**Methodology and Tools**

**Methodology:**

This study adopts the descriptive-analytical approach to examine the relationships between various variables, focusing on measuring the impact of human capital investment on economic development. It utilizes statistical analysis tools such as correlation coefficients to determine the strength of the relationship between variables and multiple regression models to understand the quantitative impact of each variable on economic development. Time series analysis was also applied by dividing the data into periods to track changes and trends over the years.

***Tools:***

**Data:** The dataset covers the period from 1990 to 2023 and includes the following variables:

- **GDPPC**: GDP per capita (as an indicator of economic development).
- **GE**: Government expenditure on education (as an indicator of investment in human capital).
- **GH**: Government expenditure on healthcare (another indicator of human capital investment).
- **L**: Labor force.
- **K**: Capital stock (as a percentage of GDP).
- **IN**: Annual inflation rate (as a percentage).

**Software:** Python was used to analyze the data and generate visual representations of the results.

***Descriptive Analysis***

**Descriptive Statistics:**

The variables (GDPPC, GE, GH, L, K, IN) were analyzed using Python scripts, and the results were summarized in Table 1 below:

***Table 1.*** *Descriptive Statistics of the Variables (1990–2023)*

| Variable | Mean | Min | Max | Standard Deviation |
|---|---|---|---|---|
| **GDPPC** | 297,630.38 | 21,902.75 | 728,665.29 | 209,269.07 |
| **GE (Billions)** | 381.76 | 30.03 | 1,170.07 | 313.00 |
| **GH (Billions)** | 187.53 | 0.38 | 711.34 | 187.32 |
| **L (Millions)** | 10.28 | 6.71 | 13.17 | 1.96 |
| **K (%)** | 31.07 | 20.68 | 43.39 | 6.49 |
| **IN (%)** | 8.60 | 0.34 | 31.67 | 8.90 |

**Source**: Prepared by the researchers based on Python outputs.

**Analysis of Descriptive Statistics:**

- **GDP per Capita (GDPPC)**:

The average GDP per capita during the study period is estimated at approximately 297,630.38 units, reflecting a moderate pattern of economic development. The lowest value was recorded in 1990 at 21,902.75 units, while the highest was reached in 2023 at 728,665.29 units—indicating a significant improvement in living standards. The standard deviation of 209,269.07 units highlights notable fluctuations in economic growth, which can be attributed to intermittent economic crises, most notably the sharp decline in oil prices in 2009 and the negative repercussions of the COVID-19 pandemic in 2020.

- **Government Expenditure on Education (GE) – in Billions**:

The average spending on education during the period under review was approximately 381.76 billion, reflecting growing interest in investing in this vital sector as a pillar of sustainable development strategies. The minimum expenditure was 30.03 billion in 1990, while the maximum reached 1170.07 billion in 2023—demonstrating a marked increase in resources allocated to the education system. The standard deviation of 313.00 billion indicates significant variation in educational spending over the years, attributable to several factors, including changes in national fiscal policies and educational reform waves that directly impacted budget allocations.

- **Government Expenditure on Health (GH) – in Billions**:

The average health expenditure stood at 187.53 billion—lower than education spending—yet still indicates the sector's priority. The minimum was 0.38 billion in 1990, and the maximum reached 711.34 billion in 2023, reflecting a gradual increase in spending. The standard deviation of 187.32 billion suggests consistent growth with relatively limited fluctuations, potentially indicating stable health policies during the study period.

- **Labor Force (L) – in Millions**:

The average labor force size during the study period was 10.28 million, steadily increasing from 6.71 million in 1990 to 13.17 million in 2023. The standard deviation of 1.96 million indicates relatively stable growth, indicating a notable improvement in employment rates and labor market participation.

- **Capital Stock (K) – as a Percentage of GDP**:

The average capital stock during the study period was 31.07%, with a minimum of 20.68% in 2000 and a maximum of 43.39% in 2016. The standard deviation of 6.49% reflects moderate variation in physical capital investment levels, possibly due to shifts in economic priorities or fluctuations in public investment over the years.

- **Annual Inflation (IN) – Percentage**:

The average annual inflation rate during the study period was 8.60%, with significant fluctuations ranging from a low of 0.34% in 2000 to a high of 31.67% in 1992. The standard deviation of 8.90% indicates considerable volatility in inflation rates, reflecting economic instability that could negatively impact economic development.

In brief, the data indicates a noticeable increase in government spending on education and healthcare over the years, accompanied by a clear rise in GDP per capita. This trend supports the core hypothesis that investment in human capital contributes to economic development. However, the substantial fluctuations in inflation and capital stock posed challenges to the sustainability of this development, especially during periods of economic crisis in Algeria, such as oil price collapses and political unrest.

## 5. Statistical Analysis

We conducted a statistical analysis using correlation coefficients and a multiple regression model to test the study's hypotheses. The results are summarized in the following tables and figures:

***Table 2.*** *Correlation Coefficients Between the Variables and GDPPC*

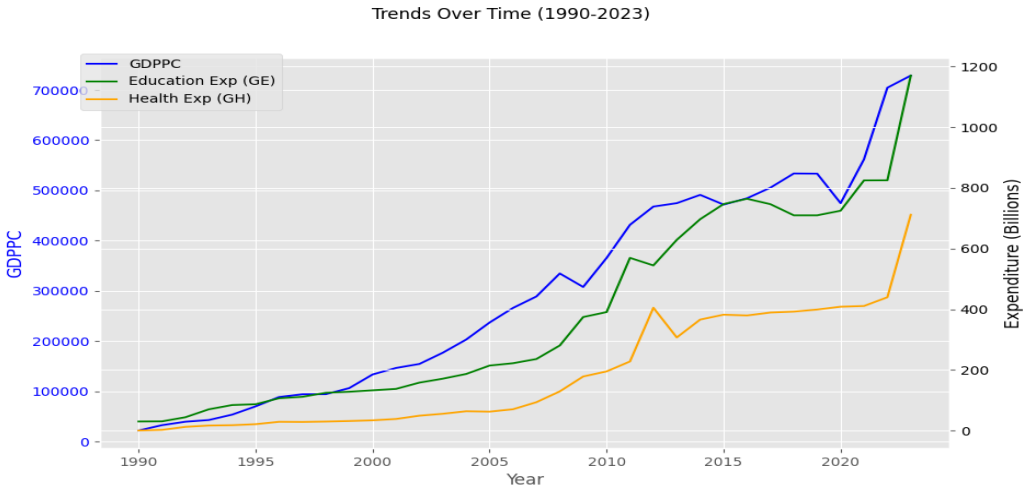
| Variable | Correlation with GDPPC |
|---|---|
| **GE** | 0.97 |
| **GH** | 0.96 |
| **L** | 0.97 |
| **K** | 0.73 |
| **IN** | -0.47 |

**Source**: Prepared by the researchers based on Python outputs.

**From Table 2, the following conclusions can be drawn:**

- The relationship between **education expenditure** and **GDP per capita (GDPPC)** shows a **very strong positive correlation (R = 0.97)**, indicating that investment in education is closely associated with economic development.
- The relationship between **health expenditure** and **GDPPC** also exhibits a **strong positive correlation (R = 0.96)**, reflecting the crucial role of the healthcare sector in supporting economic growth.
- The correlation between the **labor force** and **GDPPC** is **strong and positive (R = 0.97)**, suggesting that an increase in the labor force significantly enhances economic development.
- The relationship between **capital stock** and **GDPPC** shows a **moderate positive correlation (R = 0.73)**, indicating a supportive—though comparatively less influential—role in economic development relative to other variables.
- The correlation between **inflation** and **GDPPC** is **weak and negative (R = -0.47)**, implying a limited but potentially adverse effect on economic development, which will be clarified further in the subsequent analysis.

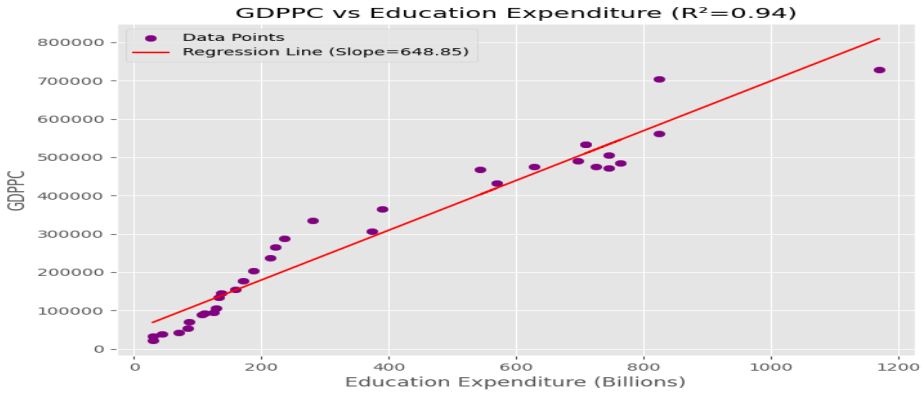
***Figure 2****. Temporal Trends of GDPPC, GE, and GH during the Period (1990–2023)*




**Source**: Prepared by the researchers based on Python outputs.

**Figure 2.** above confirms these findings by illustrating a **positive growth trend** in education expenditure, health expenditure, and GDP per capita (GDPPC) during the period 1990–2023, with **minor fluctuations** observed in 2009 (due to the global financial crisis) and 2020 (due to the COVID-19 pandemic).

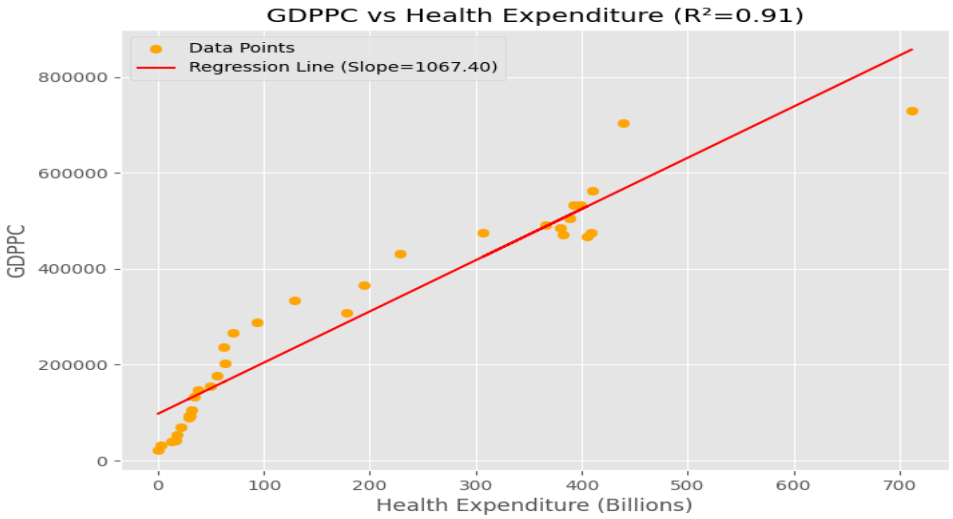
***Figure 3.*** *GDPPC versus Education Expenditure (1990–2023)*




**Source**: Prepared by the researchers based on Python outputs.

**Figure 3.** supports the **positive relationship** between education expenditure and GDP per capita (GDPPC), with a high coefficient of determination ($R^2 = 0.94$). The regression line (slope = 648.85) indicates that increased education spending is **strongly associated** with a significant rise in GDPPC.

***Figure 4.*** GDPPC versus Health Expenditure (1990–2023)




**Source**: Prepared by the researcher based on Python outputs.

**Figure 4.** further reinforces the **positive relationship** between health expenditure and GDP per capita (GDPPC), with a high coefficient of determination ($R^2 = 0.91$). The regression line (slope = 1067.40) indicates that increased health spending is **significantly associated** with a rise in GDPPC. Figure 4. also confirms the positive relationship between health expenditure and GDP per capita (GDPPC), with a high $R^2$ of 0.91. The regression line (coefficient = 1067.40) shows that higher health spending is significantly associated with increased GDPPC.

## 6. Multiple Regression Results

***Table 3.*** *Results of the Multiple Regression Model*

| Variable | Coefficient | P-value |
|---|---|---|
| **GE (billion DZD)** | 342.14 | 0.001 |
| **GH (billion DZD)** | 471.23 | 0.000 |
| **L (million people)** | 12,500 | 0.002 |
| **K (%)** | 2,100 | 0.015 |
| **IN (%)** | -1,500 | 0.030 |
| **$R^2$** | 0.95 | - |

**Source:** Prepared by the researchers using Python outputs.

The results in Table 3 can be interpreted as follows:

- **GE (Education Expenditure):** A 1 billion DZD increase in education spending leads to a 342.14-unit increase in GDPPC. This result is statistically significant (P-value = 0.001 < 0.05).
- **GH (Health Expenditure):** A 1 billion DZD increase in health spending results in a 471.23-unit increase in GDPPC. This effect is highly significant (P-value = 0.000 < 0.05).
- **L (Labor Force):** An increase of 1 million people in the labor force increases GDPPC by 12,500 units (P-value = 0.002 < 0.05).
- **K (Capital Stock):** A 1% increase in capital stock raises GDPPC by 2,100 units. This result is statistically significant (P-value = 0.015 < 0.05).
- **IN (Inflation):** A 1% increase in inflation leads to a 1,500-unit decrease in GDPPC. This is also statistically significant (P-value = 0.030 < 0.05).

- **$R^2$ = 0.95:** The model explains 95% of the variation in GDPPC, indicating that the independent variables strongly account for changes in economic development.

**7. Hypothesis Testing and Justification**

Hypotheses were tested using the t-test for regression coefficients at a 95% confidence level ($\alpha = 0.05$):

- **H1 – Education Spending:** Accepted. The t-test shows that the coefficient for GE (342.14) is statistically significant (P-value = 0.001 < 0.05), confirming a positive and meaningful impact of education spending on economic development.
- **H2 – Health Spending:** Accepted. The coefficient for GH (471.23) is statistically significant (P-value = 0.000 < 0.05), indicating that health spending has a stronger and positive impact, even more than education.
- **H3 – Other Variables:** Partially accepted:
  - Labor force (L) and capital stock (K) both show positive and statistically significant effects on GDPPC (P-values of 0.002 and 0.015, respectively).
  - Inflation (IN) shows a negative and significant effect (P-value = 0.030 < 0.05), confirming that higher inflation decreases GDPPC.

**8. Interpretation of the Results**

**Priority of Health over Education:**

The greater impact of health spending (471 units vs. 342 units for education) suggests that better healthcare has immediate and tangible effects on productivity by reducing illness and improving efficiency. On the other hand, education needs more time to show its impact on productivity and development.

**Role of Labor Force and Capital Stock:**

The results show that the labor force (12,500 units) and capital stock (2,100 units) contribute positively to economic output. However, their influence is smaller than human capital investment, highlighting the critical role of education and health in driving growth.

**Explanation of the Negative Inflation Coefficient (-1,500):**

The negative and significant effect of inflation (P-value = 0.030 < 0.05) on GDPPC implies that each 1% increase in inflation reduces GDPPC by 1,500 units. This can be explained as follows:

1. **Purchasing Power Erosion:** Rising inflation increases prices and reduces purchasing power, limiting consumption, a key growth driver.
2. **Reduced Investment:** High inflation raises uncertainty and discourages long-term investments, negatively impacting economic development.
3. **Higher Production Costs:** Inflation drives the cost of inputs like raw materials and labor, reducing profit margins and firms' capacity to invest in growth.
4. **Dependence on Oil:** Algeria's economy relies heavily on oil revenues. Inflation often follows oil price volatility or poor monetary policies, resulting in instability and lower GDPPC.

These combined factors highlight inflation as a major barrier to development, explaining its negative coefficient in the model.

***Key Findings***

1. **Impact of Human Capital Investment:**

The study finds that spending on education and health strongly impacts economic development, with high correlation values (0.97 for education and 0.96 for health). Regression results show that health spending has a larger effect: 471 units per billion DZD compared to 342 educational units.

2. **Impact of Other Variables:**

The labour force contributes 12,500 units per million people, and capital stock adds 2,100 units per 1% increase, positively affecting growth. However, inflation negatively affects GDPPC by 1,500 units per 1% increase, showing that inflation is a serious obstacle to sustainable development.

3. **Time Trends:**

As shown in Figure 1, time-series analysis from 1990 to 2023 reveals steady growth in education and health spending and GDPPC. Minor declines were observed in 2009 and 2020 due to global economic crises.

## Conclusions

Investment in human capital is a key pillar for sustainable economic development in Algeria. Achieving this goal requires improving the quality of education and healthcare services and effective economic policies to control inflation. These steps will ensure balanced and long-term growth.

## Findings:

1. **Human Capital Investment:**

Spending on education and health significantly drives economic development in Algeria. These two factors explain 95% of the variation in GDPPC ($R^2 = 0.95$).

2. **Greater Impact of Health Spending:**

Health investments have a stronger and more immediate effect than education spending, emphasizing the importance of healthcare in enhancing productivity.

3. **Impact of Labor and Capital Stock:**

The labor force and capital stock positively influence development, while inflation remains a challenge that needs urgent economic policy intervention.

4. **Time Trends:**

Main development indicators have shown consistent growth, with some fluctuations caused by global crises.

## Recommendations:

1. **Increase Investment in Education and Health:**

The Algerian government should raise spending on these sectors and focus on improving service quality.

2. **Modernize Education:**

Update curricula to meet labor market needs, especially in productive and technological fields.

3. **Improve Healthcare Services:**

Develop healthcare infrastructure to ensure comprehensive services and boost workforce productivity.

4. **Control Inflation:**

Adopt effective monetary and fiscal policies to reduce inflation and its negative impact on growth.

5. **Train the Labor Force:**

Launch vocational training programs to enhance worker skills and support sustainable economic growth.

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