

Health Status as an Engine for Economic Takeoff in Algeria: An Econometric Study Using the ARDL Method.

الحالة الصحية كمحرك للإقلاع الاقتصادي في الجزائر: دراسة قياسية باستخدام طريقة ARDL

L'état de santé comme moteur de décollage économique en Algérie : une étude économétrique utilisant la méthode ARDL

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ملخص:

تهدف الدراسة إلى تحديد عوامل الإقلاع الاقتصادي في الجزائر خلال الفترة الزمنية (2000-2021) باستخدام نموذج الانحدار الذاتي للإبطاء الموزع (ARDL). يكشف التحليل أن متوسط العمر المتوقع له تأثير إيجابي ذو دلالة إحصائية على الناتج المحلي الإجمالي الحقيقي، مما يعني أن تحسين الصحة يقوي الاقتصاد. ومع ذلك، لا يظهر معدل إتمام التعليم الابتدائي، والاستقرار السياسي، وإمكانية الوصول إلى الكهرباء، وإجمالي الاستثمار علاقات ذات دلالة إحصائية مع الناتج المحلي الإجمالي في هذا النموذج. تشير هذه النتائج إلى إعطاء الأولوية لتحسين الصحة إلى جانب استكشاف تأثير المتغيرات الأخرى على النمو الاقتصادي في الجزائر.

الكلمات المفتاحية: إقلاع اقتصادي؛ حالة صحية؛ تكامل مشترك؛ ARDL؛ نمو اقتصادي؛ الجزائر

Abstract:

This study explores the determinants of economic take off in Algeria (2000-2021) using The Autoregressive distributed lagged model. The analysis reveals that life expectancy has a statistically significant positive impact on Real GDP, implying improved health strengthens the economy. However, primary school completion rate, political stability, access to electricity, and total investment don't exhibit statistically significant relationships with GDP in this model. These findings suggest prioritizing health improvements alongside exploring the influence of other variables on Algeria's economic growth.

Keywords: Economic takeoff; health status; cointegration; ARDL; Economic growth; Algeria.

Résumé :

Cette étude explore les déterminants du décollage économique en Algérie (2000-2021) en utilisant le modèle ARDL (Le modèle à retards échelonnés autorégressifs). L'analyse révèle que l'espérance de vie a un impact positif statistiquement significatif sur le PIB réel, ce qui implique que l'amélioration de la santé renforce l'économie. Cependant, le taux de scolarisation au niveau primaire, la stabilité politique, l'accès à l'électricité et l'investissement total n'affichent pas de relations statistiquement significatives avec le PIB dans ce modèle. Ces résultats suggèrent de prioriser les améliorations de la santé tout en explorant l'influence d'autres variables sur la croissance économique de l'Algérie.

Mots clés : Décollage économique ; Etat de santé ; cointégration ; ARDL ; croissance économique, Algérie

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Introduction:

The Algerian economy has endured protracted periods of volatility and structural problems, owing to its reliance on hydrocarbon exports and the resulting swings in global oil prices. In response, Algeria has undertaken a number of ambitious reforms aimed at broadening its economic basis. The New Industrial Strategy (NSI), introduced in 2007, aimed to modernise the country's industrial infrastructure, attract investment, and boost growth. However, the anticipated results were not achieved due to persisting structural impediments such as antiquated industrial equipment, limited access to financing, governance flaws, and the challenges of privatising state firms. These factors have greatly hampered the performance of SMEs and SMIs and their contribution to national growth. (Radhia, 2019).

Despite these ongoing obstacles, recent developments indicate a cautious confidence about Algeria's economic future. Official rhetoric now promotes a narrative of rejuvenation, backed up by higher GDP figures, a stronger agriculture sector, and legislative initiatives such as investment code reform. Positive developments such as rising foreign exchange reserves, reduced import dependency, and increased support for domestic production point to a slow but noticeable shift towards economic diversification. Similarly, policy actions aimed at increasing national and foreign investment and stimulating innovation through start-up development reflect a changing, business-friendly environment. Socially, the government has prioritised justice and inclusive growth through salary hikes, tax breaks for low-income earners, and pledges to overhaul public services in education and health. These measurements reflect an increasing emphasis on social justice and the equitable distribution of income (BENSLIMANE, 2024; BOUFATAH, 2024).

Within this evolving economic and social landscape, it becomes necessary to examine less conventional yet equally impactful drivers of long-term growth. Among these, population health emerges as a central element. Theoretical and empirical research has underscored the bidirectional relationship between health and income: healthier populations tend to be more productive, invest more in education, and accumulate more human capital over time, while higher income levels generally promote better health through improved living standards and access to public services (David N., 2014; Aghion, Howitt, & Murtin, 2010). Nevertheless, the strength and nature of this relationship are often mediated by other macroeconomic and institutional factors, such as governance quality and educational attainment.

In Algeria, knowing how population health may help with economic change is critical. Despite the country's persistent reliance on petroleum earnings, achieving economic diversification necessitates developing sustainable development drivers. This study, therefore, tries to analyse the role of health in aiding Algeria's economic takeoff, which is characterised by rapid and sustained structural growth. The key goal is to determine whether there is a dynamic relationship between health and economic performance in Algeria, both in the short and long term. The analysis will also take into account the complementary effects of variables like investment and education on this relationship.

The importance of this study lies in its potential to enrich economic policy design by integrating health as a fundamental determinant of growth. In doing so, it aligns with current national goals of inclusive development, resilience building, and social welfare enhancement. The problematic that this research addresses can be summarized as follows: **What role does population health play in fostering economic takeoff in Algeria?** By investigating this question, the study contributes not

only to academic debate but also to practical policymaking in a country seeking to move beyond its rentier economic model.

Our study is organized into six sections. Section 2 provides a literature review, examining prior research on the topic. Section 3 outlines the different phases of the Algerian economy. In Section 4, we detail the methodology, including the econometric models and data sources used. Section 5 presents the empirical results, discussing the ARDL model estimates and their implications for the relationship between health and economic take-off in Algeria. Lastly, Section 6 offers a discussion of the results, situating the findings within the broader literature and suggesting policy recommendations and future research directions.

1- Literature Review

The relationship between health and economic takeoff is a topic of crucial importance in the field of development economics. As emerging economies seek to stimulate their growth and improve the well-being of their populations, it has become increasingly evident that health plays a fundamental role in this process. This literature review aims to explore the complex links between health and economic takeoff, shedding light on research findings in this area.

To begin with, Cheng-Feng Wu et al. examine the impact of healthcare expenditure on economic growth in Asian regions using a quantile-on-quantile approach. Their objective is to determine whether an increase in healthcare spending systematically leads to economic growth. Analyzing data from forty Asian countries, they find that the impact of healthcare expenditure on economic growth is not linear. Positive and negative effects are observed at different levels of healthcare expenditure and economic growth. These results underscore the importance of considering factors such as corruption, bureaucracy, and inefficiency in healthcare resource utilization to ensure optimal economic outcomes. (Cheng-Feng, Tsangyao, Chien-Ming, & Tsung-Pao, 2021)

Building upon this regional perspective, Ayfer Ozyilmaz et al. shift the focus to the European context by examining the impact of healthcare expenditure on economic growth in 27 European Union countries over the period 2000–2019. Using the Toda-Yamamoto causality test on panel data, they identify a bidirectional causality relationship between healthcare expenditure and economic growth at the panel level. This relationship is further analyzed through the random forest method, applied to both the panel and individual countries. The findings suggest a positive impact of healthcare expenditure on growth, though the magnitude of the effect varies across countries. Furthermore, the study disaggregates healthcare spending into public, private, and out-of-pocket categories, ranking them in terms of their influence on growth. Advanced predictive models—support vector regression, Gaussian process regression, and decision tree regression—are then applied to simulate the data, and their performances are evaluated (Ozyilmaz et al., 2022).

Extending the analysis to a national level, Idowu Opeoluwa Isreal Akingba, Shivee Ranjanee Kaliappan, and Hanny Zurina Hamzah investigate the case of Singapore. Their study analyzes the impact of health capital on economic growth from 1980 to 2013 using the ARDL-ECM methodology. The results indicate a positive and significant influence of health capital on long-term economic growth, with a rapid correction towards equilibrium following short-term shocks. Importantly, they find a one-way causality from healthcare expenditure per capita to GDP per capita, emphasizing that increasing healthcare spending can substantially enhance growth. Their findings provide robust evidence on the relationship between health capital and economic development in Singapore, covering more than three decades (Akingba, Kaliappan, & Hamzah, 2018).

Focusing on the Algerian context, Messaili and Tlilane assess the contribution of health to economic growth over the period 1974–2013. Their study examines public health expenditures, life expectancy at birth, infant mortality rate, and crude death rate as determinants of real GDP, using the ARDL cointegration approach. The results show that public health expenditures, life expectancy, and the crude death rate exert a positive and significant impact on real GDP. In contrast, the infant mortality rate is not statistically significant. The analysis also highlights the positive and significant long-term effect of education, though it is not significant in the short run. Moreover, variables such as gross fixed capital formation and hydrocarbon export revenues are found to significantly influence real GDP both in the short and long term (MESSAÏLI & Nouara, 2020).

To provide a broader theoretical foundation, Aghion, Howitt, and Martin (2010) approach the health-growth nexus through the lens of modern endogenous growth theory. They present a unified theoretical framework combining capital accumulation and health level as key growth drivers. By using cross-country regressions with instrumented variables, the authors reveal a positive and significant effect of both the initial level and increase in life expectancy on per capita GDP growth. Their contribution underscores the role of health as a catalyst for economic performance in the broader development context (Aghion, Howitt, & Martin, 2010).

Distinction of Our Study

While existing studies offer valuable insights into the relationship between health and economic growth, they often focus on developed nations or abstract theoretical models. Moreover, they typically analyse the impact of healthcare expenditure on growth without considering the broader socio-economic, political, and infrastructural context. Our study differentiates itself by applying Rostow's economic development model to Algeria, an emerging economy in North Africa, and by considering a range of variables that affect health and economic growth. This holistic approach provides a more comprehensive understanding of how health impacts various stages of economic takeoff, particularly in Algeria's unique socio-political and economic environment.

Research gap

Our research not only builds on the existing body of literature but also fills critical gaps by providing an updated, context-specific analysis that takes into account the dynamic interplay of health, infrastructure, political stability, and economic policy in Algeria. This distinctive approach offers new policy insights and directions for future research.

2- The main phases of the Algerian economy

After independence, Algeria experienced ups and downs in laying the foundations for building an economy and minimizing the negative effects of policies during the colonial period. These policies had deeply affected human capital, as well as many other sectors. For instance, the under education of the Muslim population and disparities in access to education persisted after independence.

In response to these challenges, Algeria adopted a planned economy to address the aforementioned problems. Despite a difficult post-war context marked by high rates of unemployment, illiteracy, and migration the government launched an emergency plan (1962–1966) and implemented measures such as the recovery of vacant property and the nationalization of certain industries.

However, state-controlled self-management failed due to the lack of qualified personnel and widespread bureaucracy. As a result, the government shifted its focus toward industrialization as a driver of economic development, targeting key sectors such as the chemical industry and hydrocarbons. This strategy was supported by oil revenues, which allowed for massive investments in the years following independence.

Nevertheless, these high investments failed to build a strong and resilient economic base. In the 1980s, a new strategy was adopted to improve economic performance, but the fall in oil prices soon led to an economic crisis. By 1989, Algeria sought IMF assistance, resulting in a structural adjustment plan in the 1990s. This ushered in a series of programs and economic reforms aimed at stabilizing the economy, reducing the budget deficit, and stimulating growth.

Despite these macroeconomic achievements, the reforms brought about significant social repercussions, including increased unemployment. During the 2000s, rising oil prices offered Algeria a period of relative economic stability. The government launched economic revitalization plans to modernize infrastructure and stimulate growth.

However, the economy remained largely dependent on hydrocarbons. Since 2014, the renewed fall in oil prices has triggered fresh financial turbulence. In response, reforms aimed at promoting investment, boosting domestic production, and streamlining administrative procedures have been implemented, reflecting an ongoing effort toward economic reorientation (KARA 2018).

3- Methodology

In this section, we will present the chosen model, the variables, and the data source.

3-1- Description of the Autoregressive Distributed Lag (ARDL) Model

The Auto-Regressive Distributed Lag (ARDL) model is a dynamic model. It has the particularity of taking into account the temporal dynamics (adjustment delay, expectations, etc.) in explaining a variable (time series), thereby improving forecasts and policy effectiveness (decisions, actions, etc.), unlike the simple (non-dynamic) model whose instantaneous explanation (immediate or non-extended effect over time) only captures part of the variation of the variable being explained. In the family of dynamic models, three types of models are distinguished. (Kuma, 2018)

- Autoregressive Models (AR): These are dynamic models where among the explanatory variables (X_t), the lagged dependent variable (its past values) is included. The term "autoregressive" reflects the regression of a variable on itself, either on its own lagged values.
- Distributed Lag Models (DL): These are dynamic models with explanatory variables including the dependent variable and its past or lagged values.
- Autoregressive Distributed Lag Models (ARDL): These models combine the characteristics of the two previous ones; among the explanatory variables (X_t), one finds the lagged dependent variable (Y_{t-q}) and the lagged values of the independent variable (X_{t-q}). (Kuma, 2018)

3-2- Selection Criteria and Advantages of the ARDL Model

In this study, we proceed with the cointegration analysis using the method of Pesaran et al. (2001) and Narayan (2005) for small samples. While the Johansen test is typically suitable when the series are integrated of the same order, the "bounds test to cointegration" is preferable when the series are integrated of different orders, $I(0)$ and $I(1)$. Despite the Johansen test being desirable in the case where series are integrated of the same order, we opted for the bounds test due to the small sample size.

The ARDL model is particularly effective in the presence of small samples, making it relevant for the data from Algeria from 2000 to 2021. Additionally, the ARDL model allows for distinguishing between short-term and long-term effects, providing a more complete analysis of the relationships between variables. (Rabhi, 2020)

3-3- Variables and Data Sources

The data used for this study covers the period from 2000 to 2021 and is sourced from reliable sources such as the World Bank. This dataset includes:

➤ **Dependent variable:**

- **Real GDP:** This is the Gross Domestic Product adjusted for inflation, meaning that the values are corrected to reflect constant prices over time. It is a measure of the total value of all goods and services produced in a country over a given period, usually a year, expressed in billions of constant national currencies.

➤ **Independent variables:**

- **Primary school completion rate:** This is the percentage of children who complete primary school in a given population. It can indicate the level of education of the population, which can impact economic development.
- **Life expectancy at birth:** This is the average number of years a person can expect to live at birth in a given population. It is a measure of the overall health and well-being of the population.
- **Political stability and absence of violence/terrorism:** This is an estimation of political stability and the absence of violence or terrorism in a country. It can influence investor confidence and have an impact on economic activity.
- **Access to electricity:** This is the percentage of the population that has access to electricity in a given country. It can be an indicator of infrastructure and economic development.
- **Total investment:** This is the total amount of investment, expressed as a percentage of GDP. It measures the share of investment in the economy relative to the size of the economy as a whole.

The choice of the period starting in the year 2000 and ending in 2021 is justified by the consistent availability of variables throughout this period. This timeframe provides continuity in the data, enabling robust and coherent analysis over a significant two-decade period. Additionally, a twenty-two-year period allows for capturing economic cycles and structural changes that may not be apparent over shorter periods.

The choice of the variable "Political stability" is justified both by its theoretical and empirical importance. Theoretically, economic growth and political stability are closely linked. On the one hand, the uncertainty associated with an unstable political environment can dampen investment and

the pace of economic development. On the other hand, poor economic performance can lead to the collapse of a government and political unrest. (Hussein, 2014) On an empirical level, several studies confirm this impact. In particular, a study covering 169 countries over the period 1960–2004 and using the System-GMM (authors, year) shows that a high level of political instability is associated with a significant decline in GDP per capita growth. (Aisen & Veiga, 2011)

However, some empirical results show contrasting effects of political stability on economic growth, depending on the specific context. For example, in a study on the Bangladesh (1984-2009), it is found that Political stability has a negative long-term effect and an effect Positive in the short term on economic performance. (Ahmed & Pulok, 2013)

In conclusion, the introduction of the political stability variable in this study would be particularly relevant in the Algerian context. Indeed, the period studied (2000-2021) directly follows a long phase of political instability that marked the 1990s in Algeria, particularly with the civil war. Analyzing the impact of this stability on Algeria's economic take-off during this period would test whether, in a country that has experienced prolonged instability, political stability promotes short-term growth while potentially presenting long-term challenges, particularly in terms of economic reforms and governance.

3-4- Data Analysis Steps

The following steps are followed for data analysis:

- **Descriptive Analysis:** Exploring trends and distributions of variables to understand how they behave over time.
- **ARDL Model Estimation:** Using econometric software (EViews) to estimate ARDL model parameters and test cointegration relationships between variables.
- **Interpretation of the Results:** Analysis of the estimated coefficients to understand the short- and long-term effects of health on economic takeoff.
- **Robustness Tests:** Carrying out additional tests to verify the robustness of the results obtained and to ensure their validity.

4- Results and discussion :

The estimation results section presents the outcomes of the analysis, starting with a detailed examination of the variables used in the study and the necessary preliminary tests. These preliminary tests are critical to ensuring the validity of the econometric model and the robustness of the findings. The section begins with descriptive statistics that summarize the main features of the data, followed by stationarity tests to assess the time series properties of the variables. To ensure the accuracy of the ARDL model, the optimal lag length is determined, followed by the bound test results that validate the cointegration relationship between the variables. Following these preliminary tests, the estimation of the short-term ARDL model is presented, alongside the long-term parameter estimates. Finally, robustness tests are conducted to confirm the reliability and consistency of the model's results across various specifications. Each of these steps contributes to a comprehensive understanding of the relationships between health and economic growth in Algeria, providing empirical evidence to support the hypotheses of the study.

4-1- Description of variables and preliminary tests:

➤ Descriptive statistics :

The table of descriptive statistics provides a summary of the key characteristics of the variables used in the analysis, including mean, standard deviation, minimum and maximum values, and quartiles.

Table -1-: Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
Real GDP	6574.636	6633.920	8202.860	4453.990	1225.848	-0.221297	1.796317
Primary school completion rate	93.32132	93.47349	96.26501	88.96552	1.791542	-0.586416	3.194538
Life expectancy at birth	73.702886	73.96550	76.474	70.47800	1.914471	-0.146158	1.742868
Political stability and absence of violence/terrorism	-1.199271	- 1.170560	- 0.842122	-1.754409	0.243899	-0.551955	2.747061
Access to electricity	99.06175	98.95678	99.78783	98.60853	0.416296	0.336346	1.597403
Total investments	40.78227	41.73000	54.20000	25.40000	8.466325	-0.136346	1.824371

Source: Data processed by the authors using Eviews

Algeria's macroeconomic data between 2000 and 2021 reveal several key aspects of its economic, social and political development. The average real GDP over this period stands at 6574,636, with a median slightly above 6633,920, indicating relative stability in economic growth. However, the high standard deviation of 1225.848 suggests significant variability in annual economic performance, which may result from factors such as dependence on commodity prices.

The retention rate to the end of primary education, with an average of 93.32132 and a median of 93.47349, shows a strong commitment to basic education. The average life expectancy at birth of 73.70 years reflects a continued improvement in social well-being, although variations in health conditions may be present, as evidenced by the standard deviation of 1.91. Access to electricity, with an average of 99.06, is a testament to a robust energy infrastructure. Finally, total investment, with an average of 40.78, indicates a commitment to economic development, although the standard deviation of 8.47 reveals potential fluctuations in investment levels from year to year. Overall, these data shed light on the trends and challenges that Algeria faced during this period. The political stability variable has negative values indicating a relatively low level of political stability, which may be associated with internal conflicts, social tensions, or terrorist activities. The proximity between the mean and the median suggests a relatively symmetrical distribution of the data, meaning that there is no strong trend towards extreme values of political stability. However, the moderate standard deviation (0.243899) indicates a moderate dispersion of values around the mean, implying some variability in the degree of political stability between years.

➤ Stationarity test :

“A time series is said to be stationary when all its marginal and joint distributions do not change over time. That is, it does not contain a unit root.

The null hypothesis and the alternative hypothesis for each of the series will therefore be:

H0: $\rho = 1$: the series contains a unit root.

Ha: $\rho < 1$: the series does not contain a unit root.

Several stationarity tests such as the Phillips-Perron (PP), the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) and the Dickey-Fuller Augmented (ADF) can allow us to respond to these hypotheses." (Khadidja, 2022) However, we will proceed with the one from Philips Perron (PP) on Eviews 12

Here are the Philips Perron test results for each variable with the different specifications (constant, trend and constant, none) and their first differences.

Table -2- : PP Stationarity Test Results at level

Variable	Constant	Trend and constant	None
Real GDP	0.3893	0.9351	0.9997
Life expectancy at birth	0.6958	0.0733*	1.0000
Access to electricity	0.9211	0.0206	0.9982
Political stability and absence of violence/terrorism	0.4445	0.2543	0.2318
Primary school completion rate	0.0651*	0.1887	0.5493
Total des investissements	0.3106	0.9418	0.8170

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table -3- : PP Stationarity Test Results at first difference

Variable	Constant	Trend and Constant	None
Real GDP	0.0061***	0.0058***	0.0367**
Life expectancy at birth	0.0000***	0.0000***	0.0000***
Access to electricity	0.0000***	0.0000***	0.0000***
Political stability and absence of violence/terrorism	0.0002***	0.0007***	0.0001***
Primary school completion rate	0.0003***	0.0010***	0.0000***
Total des investissements	0.0283**	0.627	0.0018***

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The values reported in Tables 2 and 3 correspond to the **probabilities (p-values)** associated with the Phillips-Perron stationarity tests.

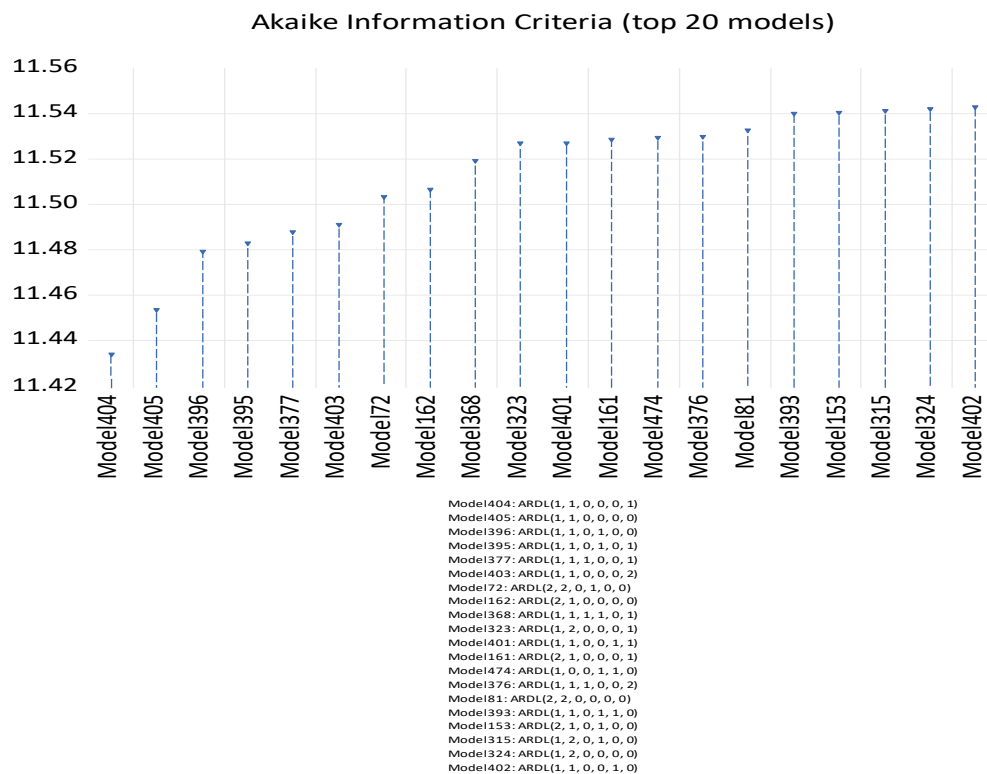
These results indicate that all the variables are not stationary at the level with any of the specifications (constant, trend and constant, none). However, after taking the first difference, all variables become stationary under all specifications.

These stationarity tests are essential to determine the properties of time series and to ensure that the econometric models used (such as ARDL in this case) are appropriate to avoid false results due to non-stationary series.

➤ **Determining Optimal Lag :**

Several selection criteria such as Akaike Information Criterion (AIC), the Schwarz Criterion (BIC), or the Hannan-Quinn (HQ) criterion are available to choose our optimal delays. For our study, we chose AIC to determine the optimal delay (Khadidja, 2022)

Figure -1- : Model slection using AIC



Source: Data processed by the authors using Eviews

The model selected for analysis is ARDL (1,1,0,0,0,1), chosen according to the Akaike Information Criterion (AIC). This selection is based on the optimization of the AIC criterion, which minimizes prediction errors while avoiding overfitting the model

➤ **Bound test Results for the ARDL model:**

The Bound Test is used to check for the presence of a co-integration relationship between the variables of the ARDL model. It compares the calculated F statistic to critical values to determine whether a long-term relationship exists.

Table -4- : Result of Bound Test

Level of Significance	Lower Bound I(0)	Upper Bound I(1)	Calculated statistic F
1%	3.06	4.15	32.816
5%	2.39	3.38	32.816
10%	2.08	3	32.816

Source: Data processed by the authors using Eviews

The results of the Bound Test indicate a long-term relationship between the variables of the ARDL model. The calculated F statistic is higher than critical values above all levels of significance tested (1%, 5%, and 10%), which means that the null hypothesis of non-cointegration can be rejected. Therefore, there is a co-integral relationship between life expectancy, female labor force and the added value of agriculture in the economy studied.

4-2- Short-term ARDL model estimation:

Table -5- : Estimation of Short-Term Parameters

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	-5480.733	10761.27	0.509302	0.6198
Real GDP	-0.411134	0.068469	-6.004696	0.0001***
Total investments	1.309952	5.255386	0.249259	0.8074
Primary school completion rate	9.859479	11.71843	0.841365	0.4259
Political stability	69.16680	101.6253	0.680272	0.5087
Life expectancy at birth	255.1525	35.62635	7.161903	0.0000***
Access to electricity	-115.1321	111.5531	-1.032083	0.3224
D(Total investments)	-0.960125	5.265166	-0.182205	0.8579
D(Access to electricity)	20.10994	91.06124	0.220840	0.8289

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The table presents the results of the ARDL model examining the short-term relationship between life expectancy (LE), a proxy of health status and Economic takeoff represented by Real GDP.

- Real GDP and Life expectancy are highly significant ($p < 0.01$).

Other variables, including Total investments, Primary school completion rate, Political stability and Access to electricity, show high p-values, indicating that they are not statistically significant at conventional levels.

- Coefficients Interpretation:

C (Constant Term): The intercept is not statistically significant.

Real GDP Shows a negative and significant relationship, indicating that a 1-unit increase leads to a decrease of 0.411 in the dependent variable.

Life expectancy has a positive and significant relationship, suggesting that an increase in life expectancy positively impacts the dependent variable.

In summary, the analysis indicates that the GDP (in constant prices) and life expectancy have significant impacts on the dependent variable, with GDP showing a corrective, negative relationship and life expectancy showing a positive influence. Other variables in the model, such as total investment, education, political stability, and access to electricity, do not exhibit significant effects within the sample period and model specification.

The results also indicate a dynamic of error correction towards the long-term equilibrium of life expectancy. Indeed, the coefficient **CointEq (-1)** represents the speed of adjustment towards long-run equilibrium. The value of -0.41134 is significant ($p = 0.0001$), indicating a rapid adjustment of short-term imbalances, as illustrated in the table below.

Table -6-: Error Correction Model (ECM)

Variable	Coefficient	Std. Error.	T Statistic	Probability
D(total_investment)	-10.96025	3.418095	-3.206537	0.0075
D(Access t)	20.10994	55.82713	0.360218	0.7249
CointEq(-1)	-0.411134	0.022149	-18.56255	0.0000***

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

4-3- Estimation of long-term parameters:

Table -7-: Long-term ARDL model results

Variable	Coefficient	Std. Error.	T Statistic	Probability
Total investment	3.186192	12.57585	0.253358	0.8043
Primary school completion rate	23.98118	30.12725	0.795996	0.4415
Political stability	168.2342	236.7324	0.710651	0.4909
Life expentency	620.6064	87.00996	7.132591	0.0000***
Access to electricity	-280.0354	294.8166	-0.949863	0.3609
C	-13330.77	25085.13	-0.531421	0.6048

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$,

❖ Levels of Significance :

- ✓ **Life expentency:** Highly significant with a probability of 0.0000 ($p < 0.01$).
- ✓ The other variables are not significant at conventional levels ($p > 0.05$).

❖ Interpretation of the Coefficients :

- **Life expentency:** The coefficient of 620.6064 shows a positive and highly significant relationship, suggesting that the increase in life expectancy contributes positively and significantly to GDP.

In summary, With the exception of life expectancy, none of the other variables appear to be statistically significant. These results should be interpreted with caution, taking into account the specificities of the Algerian context. A first possible explanation lies in a strong collinearity between certain explanatory variables, in particular between total investment, access to electricity and life expectancy. According to the correlation matrix calculated from the data (EViews), the correlation between total investment and life expectancy is 0.89, and the correlation between access to electricity

and life expectancy is 0.87. These high levels of correlation indicate that these variables change in a very similar way over time.

The econometric model thus struggles to isolate the specific effect of each of them, which reduces their individual significance despite their potential economic importance. These strong correlations are not just a statistical artifact; they reflect structural interdependencies. The investment contributes directly to the improvement of health, education and energy infrastructure, which mechanically increases life expectancy. Especially since during this period, public policies, within the framework of five-year programs, have often been oriented towards colossal public health projects, thus amplifying the effect of these investments on the health conditions of the population.

In other words, life expectancy plays the role of a synthetic variable, summarizing the combined effects of several other determinants of development such as investment, education, infrastructure and public health policies.

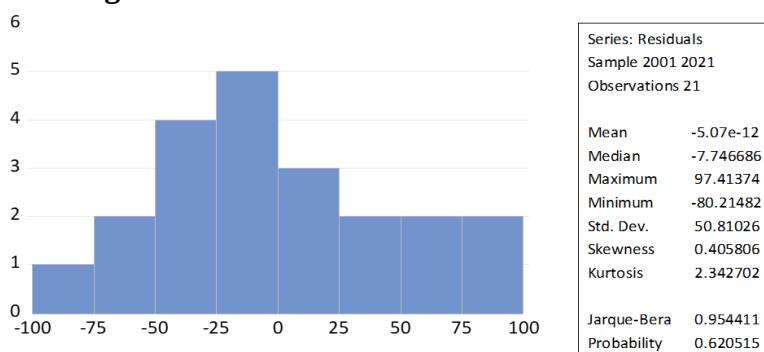
4-4- Robustness tests :

To evaluate the robustness and reliability of our model, we carry out several robustness tests. These tests make it possible to verify whether the underlying assumptions of the model are respected and whether the results obtained are stable under various conditions. In this section, we'll use three main tests :

- Residue Normality Test: To check if residuals follow a normal distribution, which is a key assumption for many statistical tests and regression models.
- Heteroscedasticity test: To check if the variance of the residuals is constant across all predictive values. Heteroscedasticity could indicate problems with coefficient estimates and hypothesis testing.
- Residue Correlation Test: To check the absence of autocorrelation of residues, especially important in time series where residues can be correlated over time.

❖ Normal distribution of residues:

Figure -2- : Residue Histogram



Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

To determine whether the residues follow a normal distribution, we used the Jarque-Bera test. This statistical test evaluates the null hypothesis that the data follows a normal distribution against the alternative assumption that they do not follow a normal distribution.

Assumptions of the Jarque-Bera Test

- **Null Hypothesis (H0):** The residuals follow a normal distribution.
- **Alternative Hypothesis (H1):** Residuals do not follow a normal distribution.

The Jarque-Bera test calculates a statistic that combines these two measures and compares it to a distribution of chi-square to determine the p-value.

The resulting p-value (0.620515) is well above the typical significance level of 0.05. Therefore, we do not have enough evidence to reject the null hypothesis. This means that we accept the null hypothesis and conclude that the residuals follow a normal distribution.

❖ Residue correlation test:

Figure -3- : Residue correlation test

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.723526	Prob. F(2,10)	0.5088
Obs*R-squared	2.654666	Prob. Chi-Square(2)	0.2652

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The figure below shows the results of the Breusch-Godfrey serial correlation LM test, which is used to check for the presence of serial correlation in the model residuals. The null hypothesis of the test is that there is no serial correlation up to a specified number of lags.

Both p-values (0.5088 and 0.2652) are higher than common significance levels (e.g., 0.05 or 0.01). Since the p-values are greater than the level of significance, we do not reject the null hypothesis. This means that there is no evidence of serial correlation in the residuals of the regression model up to 2 lags.

❖ Heteroscedasticity Test

Figure -4- : the variance of the residuals

Heteroskedasticity Test: ARCH			
F-statistic	2.123114	Prob. F(1,18)	0.1623
Obs*R-squared	2.110124	Prob. Chi-Square(1)	0.1463

Source: Data processed by the authors using Eviews, Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

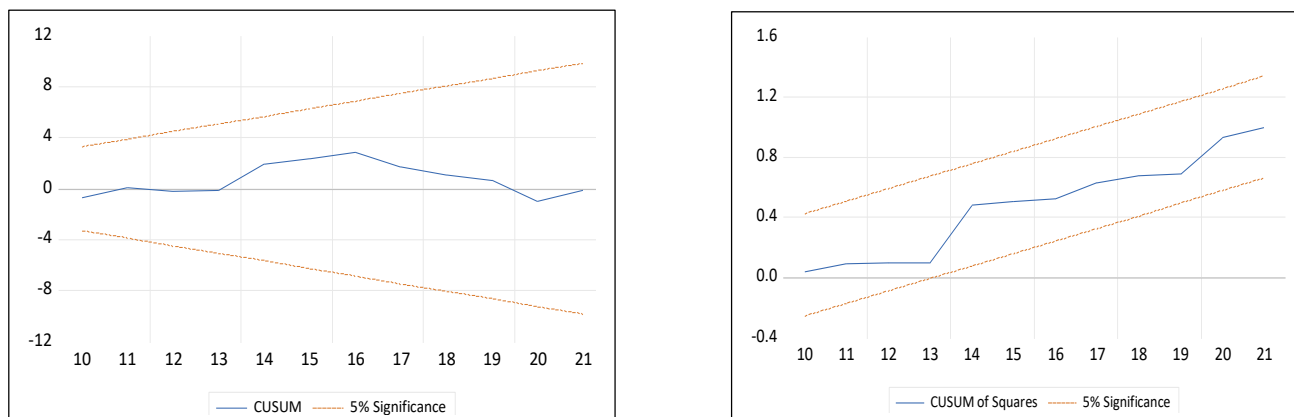
The figure above shows the results of the ARCH assay to verify the presence of conditional heteroscedasticity in the model residuals. The null hypothesis of this test is that there is no conditional heteroscedasticity. The results demonstrate that both p-values (0.1623 and 0.1463) are higher than the common levels of significance (e.g., 0.05 or 0.01).

Since the p-values are greater than the level of significance, we do not reject the null hypothesis. This means that there is no evidence of conditional heteroscedasticity in the residuals of the regression model.

❖ Structural Stability Tests

The structural stability of a regression model refers to the constancy of the relationships between the independent (exogenous) and dependent (endogenous) variables over time. In other words, a model is structurally stable if its coefficients do not change significantly during the analysis period. Figure 4 shows the results of the CUSUM and CUSUM of squares tests for structural stability.

Graph -1- : CUSUM and CUSUM of squares structural stability tests



Source: Data processed by the authors using Eviews, **Note:** *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Both graphs show that the model's regression coefficients remain stable over time, as the CUSUM and CUSUM of squares lines do not exceed the limits of significance at 5%.

5- Conclusion:

The results of this ARDL model highlight the significant relationship between health and GDP in Algeria. In contrast, variables such as access to electricity and the other variables studied did not show a significant association with GDP in the short run.

In the long term, the results indicate that life expectancy has a positive and significant impact on GDP. This underscores the crucial role of investments in public health in improving economic outcomes. The other variables studied, such as total investment, continuation of primary education, political stability, and access to electricity, did not show a significant association with long-term GDP, suggesting that other factors or complementary policies may be needed to maximize their economic impact. Improving public health is a key strategy to stimulate economic take-off. By investing in health, governments can improve worker productivity, reduce health care costs, increase long-term investment, and create an attractive environment for foreign investors. The resulting economic benefits can be substantial, contributing to sustainable growth and improved well-being of the population. To maximize these benefits, it is crucial to implement robust and well-funded public health policies. These findings have important implications for policymakers in Algeria, highlighting the need to continue investing in public health to improve long-term economic outcomes.

In this study on economic growth in Algeria, several limitations have been identified, highlighting aspects to be taken into account for a more in-depth and accurate analysis. First, the sample size used is small, covering a relatively short period from 2000 to 2021 and based on only 21 observations. This limitation could compromise the robustness of the conclusions drawn from the study. In addition, some crucial variables that could influence GDP, such as fiscal policies, external demand, and exogenous shocks, were not included in the analytical model. This omission could bias

the interpretation of the results and limit the understanding of the determinants of economic growth in Algeria.

A potential avenue for future research would be to adopt a comparative approach using multiple model specifications. Specifically, alternating between models that include or exclude certain highly correlated independent variables could help assess the robustness of the results. This strategy may allow for a better understanding of the specific impact of each variable on economic growth while mitigating multicollinearity-related biases

To overcome these limitations, subsequent studies could be undertaken. A long-term analysis would provide a better understanding of the lasting effects of investments and other variables on GDP. A detailed sector exploration could reveal sector-specific trends and provide valuable information to guide economic policies.

Bibliography:

- ✓ Aghion, P., Howitt, P., & Murtin, F. (2010). Le bénéfice de la santé : Un apport des théories de la croissance endogène. *Revue de l'OFCE*, 1(112), 87-108. Récupéré sur <https://doi.org/10.3917/reof.112.0087>
- ✓ Akingba, I. O., Kaliappan, S. R., & Hamzah, H. Z. (2018). Impact of health capital on economic growth in Singapore: an ARDL Approach Cointegration. *International Journal of Social Economics*, 5(2), 340-356. doi:10.1108/IJSE-12-2016-0376
- ✓ APS. (2022, Décembre 13). 2022 "année économique par excellence": redressement et lancement d'une nouvelle dynamique dans plusieurs secteurs. Algérie Press Service. Consulté le 05 2024, 31, sur <https://www.aps.dz/economie/148737-2022-annee-economique-par-excellence-redressement-et-lancement-d-une-nouvelle-dynamique-dans-plusieurs-secteurs-vitaux#:~:text=Plusieurs%20secteurs%20ont%20contribu%C3%A9%20%C3%A0,du%20pays%20de%20mani%C3%A8re%20g%C3%A9n>
- ✓ Ahmed, M. U., & Pulok, M. H. (2013). The role of political stability on economic performance: The case of Bangladesh. *Journal of Economic Cooperation and Development*, 34(3), 61-100., 34(3), 61-100. Récupéré sur <https://jecd.sesric.org/pdf.php?file=ART12122901-2.pdf>
- ✓ Aisen, A., & Veiga, F. J. (2011). How does political instability affect economic growth? Washington, D.C.: International Monetary Fund. Récupéré sur <https://www.imf.org/external/pubs/ft/wp/2011/wp1112.pdf>
- ✓ Benslimane, T. (2024, 05 12). L'Algérie avance à pas sûrs sur la voie du développement: Les prémices d'un nouveau décollage économique se profilent. *L'ECHO D'Algérie*. Consulté le 05 31, 2024, sur <https://lechodalgerie.dz/lalgerie-avance-a-pas-surs-sur-la-voie-du-developpement-les-premices-dun-nouveau-decollage-economique-se-profilent/>
- ✓ Boufatah, M. (2024, Janvier 09). Boughali lors d'une journée parlementaire à l'APN «Les perspectives d'un décollage économique sont perceptibles». *L'EXPRESSION DZ*. Consulté le 05 31, 2024, sur <https://www.lexpression.dz/nationale/les-perspectives-d-un-decollage-economique-sont-perceptibles-377516>
- ✓ Cheng-Feng, W., Tsangyao, C., Chien-Ming, W., & Tsung-Pao, W. (2021). Measuring the Impact of Health on Economic Growth Using Pooling Data in Regions of Asia: Evidence From a Quantile-On-Quantile Analysis. *Front. Public Health*(9:689610). doi:10.3389/fpubh.2021.689610

-
- ✓ David N., W. (2014). Health and Economic Growth. Dans A. Philippe, & N. D. Steven, Handbook of Economic Growth (Vol. 2, pp. 623-682). Elsevier. doi:10.1016/B978-0-444-53540-5.00003-3
 - ✓ Hadjene, O., & Bakhtache, R. (2022). Crise sanitaire et crise économique: combinaison lourde pour une économie assez fragile le cas algérien (2010/2020). International Journal of Economic Performance, 5(1). Récupéré sur <https://cnrs.hal.science/hal-03723464>
 - ✓ Hussein, Z. (2014, june 1). Can political stability hurt economic growth? Consulté le avril 23, 2025, sur WORLD BANK BLOGS: <https://blogs.worldbank.org/en/endpovertyinsouthasia/can-political-stability-hurt-economic-growth>
 - ✓ KARA, R. (2018). Essai sur l'évolution de l'économie algérienne 1962-2015: Approche historique. Journal of economic, 8(2), 329-350. Récupéré sur <https://www.asjp.cerist.dz/en/article/51690>
 - ✓ Khadidja, M. (2022). L'impact des investissements directs étrangers au canada sur la croissance économique canadienne : une analyse empirique du modèle ardl et du test de cointégration aux bornes. Mémoire de maîtrise en économie financière. Université du Québec en Outaouais. Récupéré sur https://di.uqo.ca/id/eprint/1422/1/Gouloungou-Mpira_Khadidja_2022_memoire.pdf
 - ✓ Kuma, J. K. (2018). Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels. Licence. Congo-Kinshasa.
 - ✓ MESSAÏLI, M., & Nouara, K. T. (2020). Essai d'évaluation de la contribution de la santé à la croissance économique en Algérie. Revue CREMA(8).
 - ✓ Ozyilmaz, A., Bayraktar, Y., Isik, E., Toprak, M., Er, M. B., & Besel, F. (2022). The Relationship between Health Expenditures and Economic Growth in EU Countries: Empirical Evidence Using Panel Fourier Toda–Yamamoto Causality Test and Regression Models. Int. J. Environ. Res. Public Health(19, 15091). Récupéré sur <https://doi.org/10.3390/ijerph192215091>
 - ✓ Radhia, Z. (2019, Janvier). Analyse de l'effet de la politique industrielle sur le décollage du secteur industriel. Afaq journaak for research and studies(3).
 - ✓ Rabhi, A. (2020, 01 25). Equilibrium exchange rate and competitiveness in Morocco: Estimation by ARDL Cointegration Model. Munich Personal RePEc Archive(98294). Récupéré sur https://mpira.ub.uni-muenchen.de/98294/1/MPRA_paper_98294.pdf.