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Public Expenditure Composition and Economic Growth in Algeria : A Time-Series Econometric Analysis Using Python (2000–2024)

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Abstract :

In this study, we investigate the connection between the efficiency of public expenditures and economic growth in Algeria using a time-series econometric methodology. We use a sample of annual macroeconomic data to conduct our empirical analysis with various techniques for quantitative modeling in Python. We examine the statistical characteristics of the variables used in this analysis, i.e., the models and tests that we carry out will be based on dynamic regression models that produce heteroskedasticity-robust standard errors, combined with an examination of the causality relationship between fiscal quality and economic growth. Our results indicate a positive relationship between efficiency in public expenditures and economic performance over time, but we find varying levels of strength and duration of the association depending on the individual public spending component. Our causality analysis indicates that fiscal quality contributes an important, structural element to the long-run growth process; however, does not provide for short-run adjustments.

We conclude that reallocating public resources to more productive uses and strengthening fiscal discipline through institutional mechanisms would enhance economic performance. Finally, this study contributes methodologically to the use of Python-based econometric tools for the analysis of time-series data in applied macroeconomic research.

Keywords : Public Expenditure Efficiency; Economic Growth; Time Series Analysis; Fiscal Policy; Econometric Modeling.
JEL Classification: C22; E62; H50; O40; C51

Introduction:

The public expenditure has been a crucial factor in determining macroeconomic outcomes, especially in resource-based economies where fiscal policy is considered a major tool in stabilizing and developing national economies. In the case of Algeria, public expenditure has been a major factor in determining macroeconomic outcomes, considering its historical importance in shaping aggregate demand, infrastructure development, and social investment. Nonetheless, in addition to the volume of public expenditure, its efficiency is considered a major factor in determining its actual contribution towards economic growth and the expansion of economic activities.

The purpose of this study is to evaluate the efficiency of public expenditure in Algeria and its impact on economic growth and the expansion of economic activities. The research aims to

evaluate this relationship in addition to its volume in order to assess its actual contribution towards economic growth and expansion. This is considered a major tool in understanding this relationship and determining its effectiveness in developing national economies.. The central research question of this study is:

- **Does the efficiency of public spending contribute significantly to economic growth, or are growth dynamics still driven by external and resource-related factors?**

Sub-Research Questions :

1. Is the structure of public expenditure, specifically in the areas of education and health, a statistically significant factor in economic performance in a time series model?

2. Is there a causal relationship between the components of public expenditure and economic growth, or is fiscal policy a reaction to economic growth?

Research Hypotheses:

H1: Public expenditure efficiency has a positive and significant impact on the economic performance of the economy in the long run.

H2: Education and health expenditure variables are found to have long-run effects on the economic expansion process of the economy.

H3: There is a unidirectional or bidirectional causal relationship between the various components of the fiscal policy variables and the dynamics of economic growth.

Research Objective :

The primary aim of the present paper is to empirically examine the efficiency of the public expenditure variables in promoting the economic expansion process of the economy, particularly in the case of Algeria, using time series econometric analysis.

Contribution and Novelty

The present study has a number of contributions to the existing literature. First, whereas most of the existing research has concentrated on aggregate public expenditure, this study focuses on composition and efficiency in a dynamic time series model. Second, this research has employed recent advances in econometric analysis, including robust OLS and causality tests, and Python-based analysis tools, adding a degree of transparency and replicability in methodology. Finally, whereas most of the existing research has employed cross-country panels, a common feature of public finance analysis, this research offers a country-specific approach, providing a more in-depth analysis of structural growth dynamics in a resource-based economy. The integration of fiscal efficiency analysis and causality tests offers a more complex analysis of structural dynamics in economic growth.

I. Theoretical Foundations of Public Expenditure and the Role of the State :

The role of government expenditure in the economic system has been a subject of debate in the theories of public finance and macroeconomics. One of the earliest theories explaining the expansion of government expenditure is Wagner's Law, developed by Adolf Wagner (1890). Wagner's Law states that with the increase in income levels due to the process of economic development or industrialization, the demand for public services such as

administration, infrastructure, education, etc., increases naturally. And the expansion in public expenditure is a result of economic development rather than a cause. This is a structural change in the economic system in which the role of public expenditure increases with the complexity of society and income elasticity of demand for public goods (Wagner, 1890/2015).

In this framework, the increase in public spending is a manifestation of the development of institutions and socio-economic modernization. The augmentation of administrative, legal, and social institutions becomes imperative in order to maintain economic complexity. Thus, in Wagner's view, the causal relationship flows from economic growth to the increase in public spending, and hence, the expansion of fiscal policy is a result of economic dynamism, not its cause.

Conversely, the Keynesian model presents a radically different theoretical outlook. In his book, *The General Theory of Employment, Interest and Money*, Keynes (1936) asserted that government spending is a exogenous policy tool that can be used to boost aggregate demand, especially in times when aggregate demand is not adequately met by private investment. By the fiscal multiplier effect, when the government increases its spending, a chain reaction of income and consumption effects is created, which has multiplier effects on economic activity. Keynes stressed that in conditions of underemployment equilibrium, an active fiscal policy is required to achieve full employment of productive resources.

Therefore, although Wagner's Law considers public expenditure as demand-driven by economic development, the Keynesian hypothesis places government expenditure as an active stabilizer and economic growth promoter. These two major theories form the conceptual foundation for analyzing whether public expenditure is a dependent or independent variable in economic performance.

1. Public Expenditure Efficiency in Growth Theory:

Apart from the level of expenditure undertaken by the government, the recent literature on modern public finance has highlighted the role of efficiency in affecting macroeconomic outcomes. Efficiency is defined by the capacity of the government to maximize output or welfare with a given amount of resources.

Islam (2010) provides a discussion on the theoretical background to efficient public finance. He suggests that both sectors must operate with the principles of allocative efficiency and productive efficiency in order to ensure sustainable economic outcomes. In the context of the public sector, inefficiencies such as misallocation, corruption, waste in administration, or unproductive expenditure can have a distorting effect on the distribution of resources. inefficient expenditure can lead to higher fiscal costs without a corresponding rise in economic performance.

This efficiency-focused view is in the spirit of endogenous growth models, especially those that focus on public capital accumulation. In the model presented by Barro (1990), the role of government expenditure is incorporated in the framework of economic growth models.

The model shows that productive public expenditure can boost the productivity of the private sector and thus raise the economic growth rate in the long term. However, it also shows that excessive taxation used to fund public expenditure can negate its benefits. Hence, there is an optimal size of the government where the marginal productivity of public expenditure is equal to its marginal distortionary cost.

According to this theoretical view, efficiency is the criterion that makes public expenditure a driver of economic growth or a barrier to the dynamism of the private sector. Efficient management of public expenditure reduces waste, increases the rate of capital accumulation, and improves the quality of institutions—variables that jointly determine economic growth.

2. Composition and efficiency, and Empirical Evidence in Developing Economies:

Recent studies have further enhanced this theoretical understanding by making a distinction between the composition and efficiency of expenditure undertaken by the government. It is important to understand that the effects of fiscal policy not only depend on the amount of expenditure undertaken by the government but also on how it is utilized.

Productive expenditure undertaken by the government, such as spending on education, healthcare, and infrastructure development, is more likely to have a more pronounced effect on economic growth compared to general consumption expenditure. This is due to the fact that such expenditure enhances human capital formation and reduces transaction costs, thus increasing the productivity of the private sector. On the contrary, unproductive expenditure undertaken by the government may not have a multiplier or long-run effects.

Furthermore, if this argument is generalized, Trabelsi and Boujelbene (2024) offer empirical support for the idea that government spending may have heterogeneous effects depending on the quality and efficiency of the institutions in developing countries. The authors found that "although government spending may not be considered as a factor conducive to economic growth by itself, improving efficiency has a positive and significant impact on the positive relationship between government spending and economic performance."

Likewise, Sosvilla-Rivero, Ramos-Herrera, and Rubio-Guerrero (2025) highlight the significance of the analysis of public expenditure broken down by categories to grasp growth patterns. The authors found that some categories of public expenditure are more correlated with economic growth over the long run; this supports the theoretical argument of the significance of the quality of public expenditure over its quantity.

In the context of developing economies with features of resource dependency and structural vulnerability, the dimension of efficiency of public expenditure assumes particular significance.

Collectively, the body of literature supports the following refined theoretical proposition: the macroeconomic effect of public expenditure is conditional upon its efficiency, composition, and context. The theoretical synthesis presented in the foregoing paragraphs provides a coherent basis for the examination of the relationship between the efficiency of public expenditure in Algeria and economic performance.

II. Standard quantitative study:

As stipulated by the basics of data analysis, in this aspect we first collected data with the various variables necessary for this study in an Excel spreadsheet over the required time period. Then we used the Byton program, which is a powerful statistical program, where we started by cleaning the data of missing values. After that, we presented a general overview of the means, maximum and minimum values, then we moved on to extracting the correlation between the variables. Now we directly extracted the tests, the regression model, the Granger test, and others. This is a presentation of the work details:

1. First Observations:

Table 01: Data Preview (first five lines)

	Years	HDI	IPC	TC	PIB pc Courant M.dollars	INF	T Chomage (% de la population active)	Education % PIB	Santé % PIB	GOV	PETR
0	2000	0.651	70.4	75.26	1772.9	0.3	29.8	5.5	3.21	-1.01	28.66
1	2001	0.659	73.4	77.22	1896.3	4.2	27.3	6.5	3.54	-0.88	24.46
2	2002	0.669	74.5	79.68	1937.5	1.4	25.9	6.8	3.44	-0.61	24.99
3	2003	0.677	77.6	77.39	2283.8	4.3	23.7	6.4	3.33	-0.67	28.85
4	2004	0.685	80.7	72.06	2817.0	4.0	17.6	6.2	3.29	-0.56	38.26

Source : output python

The first table displays the initial five observations of the data set (2000-2004), which provide a preliminary picture of the macroeconomic evolution in the country. During the period under consideration, the GDP per capita expanded significantly from 1772.9 to 2817.0. At the same time, the unemployment rate recorded a sharp decrease from 29.8% to 17.6%. These facts suggest that the economy might be in the expansion period. Expenditure in the education sector recorded a moderate rise from 5.5% to 6.2% of the GDP. On the other hand, expenditure in the health sector was relatively stable in the range of 3.2-3.3%. Inflation was relatively stable in the range of single-digit numbers. Oil revenues (PETR) fluctuated significantly in the period under consideration. The data suggest that the economy might be in the expansion period, as the unemployment rate recorded a sharp decline.

2. Data Structure and Summary :

The table gives structural information about the data set. The data set consists of 24 observations and 11 variables. All the variables in the data set are available (24 is the number of observations, and all variables have 24 non-null observations).

Table 02 : structural data set information

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 24 entries, 0 to 23
Data columns (total 11 columns):
 #   Column                                Non-Null Count  Dtype
---  ------                                --------------  -----
 0   Years                                 24 non-null     int64
 1   HDI                                   24 non-null     float64
 2   IPC                                   24 non-null     float64
 3   TC                                    24 non-null     float64
 4   PIB pc Courant M.dollars              24 non-null     float64
 5   INF                                   24 non-null     float64
 6   T Chomage ( % de la population active) 24 non-null    float64
 7   Education % PIB                       24 non-null     float64
 8   Santé % PIB                           24 non-null     float64
 9   GOV                                   24 non-null     float64
 10  PETR                                  24 non-null     float64
dtypes: float64(10), int64(1)
memory usage: 2.2 KB
```

Source : output python

The variables in the data set are one integer type and ten floating-point types. Therefore, the data set is fully compatible with econometric modeling without the need for further transformation. The absence of missing values in the data set is beneficial for reliable estimation in time series modeling. However, the small sample size (n = 24) imposes some methodological constraints. Specifically, it imposes the need for parsimonious modeling, limited lag selection in the context of VAR modeling, and the interpretation of the results in terms of statistical significance. From an econometric viewpoint, the data set is structurally clean, and modeling needs to be done in a disciplined way.

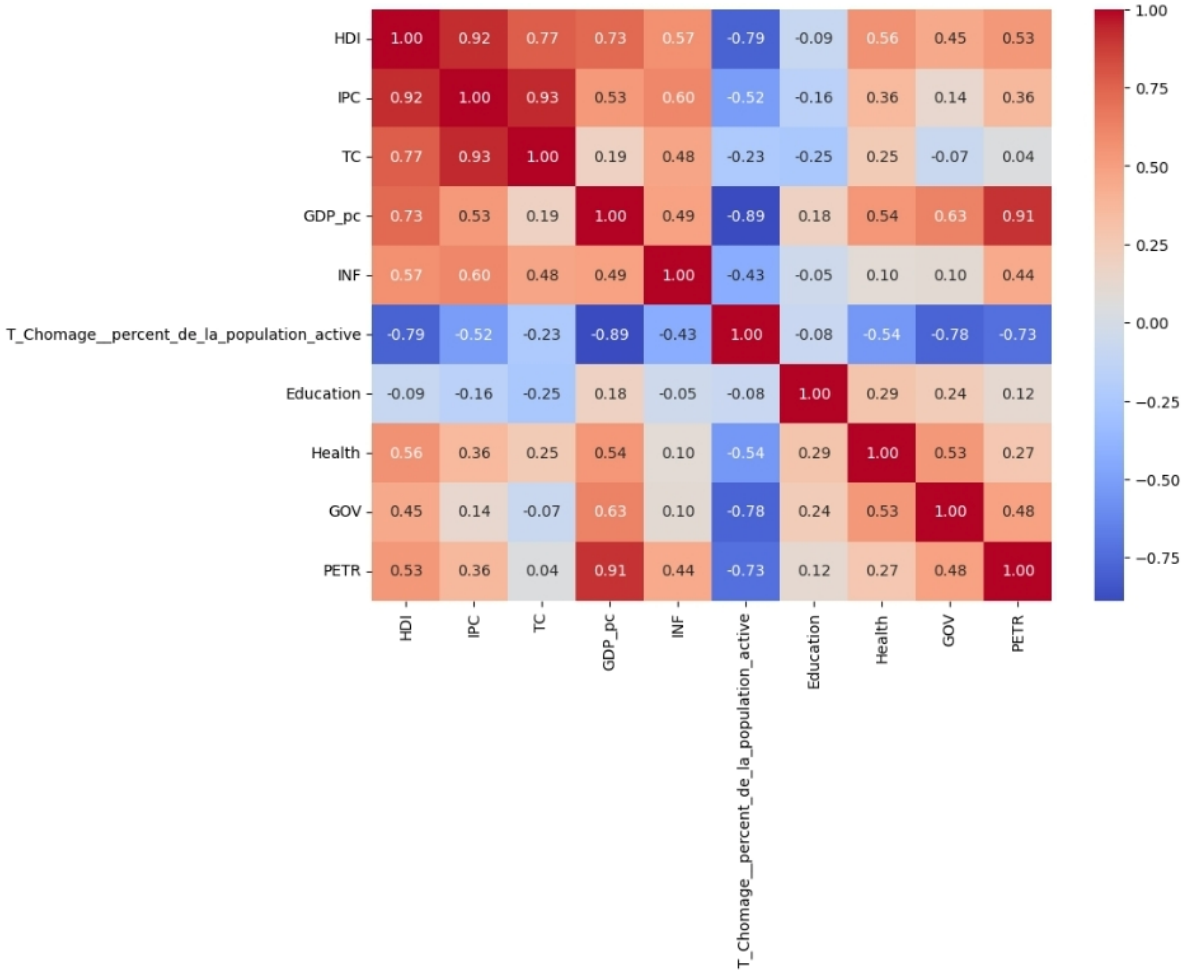
3. Missing Values Assessment :

The third image verifies that there are no missing observations for any variable in the data set. This is a major benefit in the context of time series econometric analysis, as it ensures a balanced and continuous annual data series. The fact that there are no missing observations obviates the need for imputation methods, which may introduce potential biases into the dynamic properties of macroeconomic variables. In addition, preserving the entire time series is especially important when conducting causality tests using the Toda-Yamamoto method or VAR model estimation, in which the inclusion of lags further reduces the sample size. In other words, from a data quality perspective.

4. Correlation Matrix :

From the correlation matrix, it can be observed that there are many strong linear relationships between the variables. There is a very strong linear relationship observed in the data between the GDP per capita and the revenues received from oil (r = 0.91). This confirms the high hydrocarbon dependence of the economy of Algeria. There is a strong linear relationship observed in the data between the GDP per capita and the unemployment rate in the country (r = -0.89). This indicates that the economy is performing well in times of economic growth. There is a moderately strong linear relationship observed in the data between the governance levels in the country and the GDP per capita (r = 0.63).

Figure 01 : Correlation Matrix

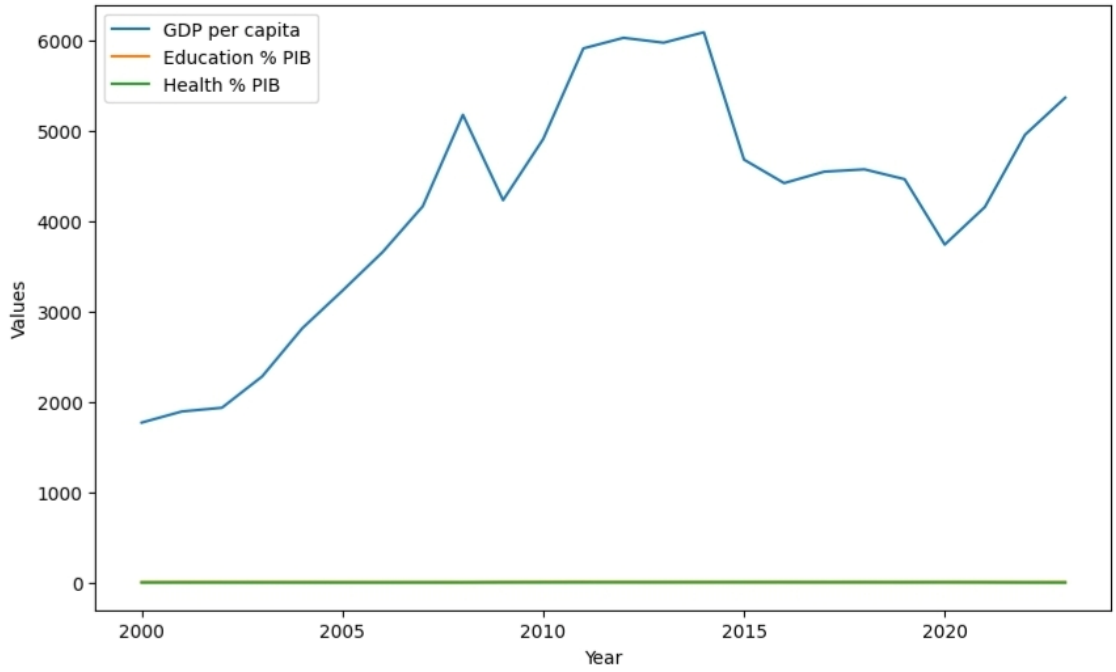


Source : output python

There is a weak linear relationship observed in the data between the expenditure on education and the GDP per capita (r = 0.18). There is a moderate linear relationship observed in the data between the expenditure on health and the GDP per capita (r = 0.54). However, the high value of correlation observed in the data between the GDP and the revenues received from the oil sector indicates that multicollinearity should be taken into account while conducting the regression**.**

From the time series plot, it can be observed that the trend in the data for GDP per capita in comparison with the trend in education and health expenditures as a percentage of GDP shows that the former increases significantly from 2000 to around 2014, then decreases in the mid-2010s before rising again towards the end of the period. On the other hand, the trend in education and health expenditures is relatively flat with mild fluctuations in the levels without any significant upward or downward trend. Therefore, the data supports the hypothesis that public expenditure might play a stabilizing role in the economy but might not be the most dominant factor in the fluctuations in economic growth in the short run.

Figure 02 : Time-Series Dynamics (GDP and Public Expenditure)



Source : output python

Augmented Dickey-Fuller (ADF) Unit Root Test:

In order to verify the econometric soundness of the time-series model analysis, the Augmented Dickey Fuller (ADF) unit root test was performed to find out whether or not the series employed in the model are stationary. Null hypothesis for ADF is that there is a unit root in the series and it is not stationary.

Table 02 : ADF Test

Variable	ADF Statistic	p-value	Conclusion
GDP	-2.071	0.2565	Non-Stationary
EDU	-2.221	0.1988	Non-Stationary
HEALTH	-2.429	0.1338	Non-Stationary
INF	-2.145	0.2268	Non-Stationary
UNEMP	-3.804	0.0029	Stationary
GOV	-3.624	0.0053	Stationary
OIL	-2.187	0.211	Non-Stationary
HDI	0.245	0.9747	Strongly Non-Stationary

Source: Output Python

Table 03 : First Difference Results

Variable	p-value after First Difference	Conclusion
GDP	0.001	Stationary
INF	0.0001	Stationary
OIL	0.0006	Stationary
HDI	0.0	Stationary
UNEMP	0.0095	Stationary
GOV	0.0	Stationary

Source : Output Python

From the outcomes of the Augmented Dickey Fuller test, it is clear that the majority of the macroeconomic variables are non-stationary when considered in level form. But, after considering their first difference, it is found that the variables become stationary, indicating that the majority of the variables have an order of integration equal to 1, i.e., I(1).

On the contrary, the variables unemployment and governance are found to be stationary in their level forms, indicating their order of integration equals to 0, i.e., I(0). This justifies the use of dynamic time series econometrics techniques that can deal with integration order heterogeneity, such as the ARDL approach.

5. Johansen Cointegration Test :

Given that most variables were found to be integrated of order one, the Johansen cointegration test was conducted to examine the existence of long-run equilibrium relationships among the variables.

Table 04 : Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Conclusion
None	34.73	29.79	Cointegration Exists
At most 1	15.73	15.49	Cointegration Exists
At most 2	1.28	3.84	No Additional Cointegration

Source : Output Python

Cointegration analysis through the Johansen cointegration test indicates the existence of long-run equilibrium relationships between the chosen macroeconomic variables. Indeed, the

obtained trace statistics exceed the critical values at the 5% significance level for the first two regressions; hence, there exists at least one cointegration relationship.

From an economic point of view, cointegration implies that economic growth, oil rents, and indices of human development grow simultaneously in the long term, irrespective of short-run movements. The existence of cointegration also implies that the researcher can apply a long-run model such as ARDL-ECM or VECM, as opposed to pure OLS estimation techniques.

In terms of economics, cointegration is consistent with the structure of the Algerian economy, where growth processes are associated with oil rents and human development indices.

6. Variance Inflation Factor (VIF) Test :

To evaluate the presence of multicollinearity among the explanatory variables, the Variance Inflation Factor (VIF) test was performed.

Table 04 : VIF Test

Variable	VIF
EDU	1.32
HEALTH	2.16
INF	1.83
UNEMP	9.61
GOV	3.78
OIL	2.53
HDI	4.9

Source : Output Python

The outcome from VIF indicates the lack of serious multicollinearity problems in the estimated model, as most of the variables have a VIF value less than 10, the conventional cut-off value. It is worth noting that the unemployment variable presents a relatively high VIF value of 9.61.

According to econometric theory, multicollinearity might affect the accuracy and statistical significance of the estimations without necessarily compromising the ability of the model to explain variations in the dependent variable. In any case, the observed VIF values fall within acceptable econometric parameters for macroeconomic time-series data analysis.

In conclusion, the diagnostic findings reveal that the explanatory variables used in this empirical estimation can be considered acceptable, except when interpreting specific coefficients, especially those involving structurally correlated macroeconomic variables.

7. Granger Causality Test Results :

The Granger causality test outcome shows that, for both lag orders (1 and 2), the null hypothesis of no causality cannot be rejected. This is because the F-statistics are small (F = 1.0850 for lag 1 and F = 0.9703 for lag 2), and the respective p-values are well above the standard significance levels (p > 0.30). Moreover, the Chi-square and LR tests also support the fact that there is no statistically significant predictive causality. These results imply that, for a given lag structure, the variable of interest does not Granger-cause the GDP per capita. From an economic perspective, this indicates that the chosen component of public expenditure does not have a tendency to precede or predict changes in economic growth in the short term. Nevertheless, due to the small sample size and possibly structural features of the Algerian economy, these results should be treated with caution and further analysis using a robustness check, such as the Toda-Yamamoto causality test, would be appropriate.

Table 05 : Granger Causality

```
Granger Causality
number of lags (no zero) 1
ssr based F test:         F=1.0850  , p=0.3100  , df_denom=20, df_num=1
ssr based chi2 test:   chi2=1.2478  , p=0.2640  , df=1
likelihood ratio test: chi2=1.2151  , p=0.2703  , df=1
parameter F test:         F=1.0850  , p=0.3100  , df_denom=20, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=0.9703  , p=0.3990  , df_denom=17, df_num=2
ssr based chi2 test:   chi2=2.5114  , p=0.2849  , df=2
likelihood ratio test: chi2=2.3781  , p=0.3045  , df=2
parameter F test:         F=0.9703  , p=0.3990  , df_denom=17, df_num=2
```

Source : output python

8. ARDL Model Results:

Based on the ARDL model estimates, it is observed that there exists a significant dynamic link between oil earnings and economic growth in Algeria. This is because the lagged GDP variable is found to be positive and highly significant ($\beta = 0.668$; $p < 0.001$), implying the strong persistence in the dynamics of economic growth over time.

On the other hand, the contemporaneous value of oil revenues demonstrates a significant positive impact on GDP per capita ($\beta = 27.058$; $p < 0.001$), which implies the dependency of the Algerian economy on oil income. Nevertheless, the lagged oil revenues are found to be negative and statistically significant ($\beta = -10.717$; $p = 0.016$), showing the presence of short-term dynamics in the adjustment process, including volatility, due to oil price movements.

From the econometric point of view, the ARDL approach would be more suitable for the current research owing to the relatively small number of observations and varying integration order detected using the ADF test.

Table 06 : ARDL MODEL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	405.376	163.831	2.474	0.023
GDP(-1)	0.668	0.08	8.315	0.0
OIL	27.058	2.406	11.248	0.0
OIL(-1)	-10.717	4.073	-2.631	0.016

Statistic	Value
Observations	24
AIC	316.570
BIC	322.247
HQIC	317.998

Source : output python

This suggests that their contribution to GDP per capita in the short run is not statistically significant. Inflation rates and unemployment have statistically insignificant coefficients, while the coefficient on the governance variable is negative but statistically insignificant. The DW statistic is 1.439, suggesting a mild positive autocorrelation problem.and the relatively high condition number (987) raises concerns about potential multicollinearity. the results emphasize the structural dependence of Algerian growth on energy oil revenues, while the efficiency of public expenditure appears limited in the short run.

Table 07: Error Correction Model (ECM) Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	405.376	163.831	2.474	0.023
ECT(-1)	-0.332	0.08	-4.136	0.001
OIL(-1)	16.341	3.823	4.275	0.0
ΔOIL	27.058	2.406	11.248	0.0

Source : output python

From an ECM point of view, there is confirmation about the existence of long-run equilibrium between economic growth and hydrocarbons income in Algeria. The error correction term ECT(-1) is negative and statistically significant ($\beta = -0.332$; $p = 0.001$), hence fulfilling the condition theoretically set for long-run convergence towards the equilibrium.

From an economic perspective, the coefficient above shows that there is an economically high speed of adjustments in the economy through which approximately 33.2% of any short-run imbalance gets adjusted every year.

The effect of hydrocarbon income on the short-run is still found to be positive and highly significant, implying that short-run economic growth dynamics in Algeria is mostly influenced by oil incomes.

In summary, it has been demonstrated that from the ECM point of view, the Algerian economy is structurally dependent on the hydrocarbon sector.

Table 08 : Granger Causality Test (First Variable)

```
Granger Causality
number of lags (no zero) 1
ssr based F test:         F=1.1901  , p=0.2883  , df_denom=20, df_num=1
ssr based chi2 test:   chi2=1.3687  , p=0.2420  , df=1
likelihood ratio test: chi2=1.3295  , p=0.2489  , df=1
parameter F test:         F=1.1901  , p=0.2883  , df_denom=20, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=0.7292  , p=0.4968  , df_denom=17, df_num=2
ssr based chi2 test:   chi2=1.8874  , p=0.3892  , df=2
likelihood ratio test: chi2=1.8108  , p=0.4044  , df=2
parameter F test:         F=0.7292  , p=0.4968  , df_denom=17, df_num=2
```

Source : output python

The Granger causality tests with one and two lag terms suggest that the null hypothesis of no causality cannot be rejected. In both cases, the F-statistics are found to be low (F = 1.1901 and F = 0.7292), and the p-value for rejecting the null hypothesis of no causality is found to be greater than 0.28 and 0.49, respectively. The Chi-square and likelihood ratio tests confirm the absence of predictive causality. From an economic viewpoint, it may be inferred that changes in the values of the tested variable do not predict changes in GDP per capita within the short-run period under consideration. This lends further support to the possibility of the public expenditure growth link not being driven by short-run dynamic transmission mechanisms.

Table 09 : Granger Causality Test (Second Variable)

```
Granger Causality
number of lags (no zero) 1
ssr based F test:         F=1.0313  , p=0.3220  , df_denom=20, df_num=1
ssr based chi2 test:   chi2=1.1860  , p=0.2761  , df=1
likelihood ratio test: chi2=1.1564  , p=0.2822  , df=1
parameter F test:         F=1.0313  , p=0.3220  , df_denom=20, df_num=1

Granger Causality
number of lags (no zero) 2
ssr based F test:         F=0.4030  , p=0.6745  , df_denom=17, df_num=2
ssr based chi2 test:   chi2=1.0430  , p=0.5936  , df=2
likelihood ratio test: chi2=1.0191  , p=0.6008  , df=2
parameter F test:         F=0.4030  , p=0.6745  , df_denom=17, df_num=2
```

Source : output python

the second Granger causality test does not show any predictive causality. The F-statistics for one and two lags are statistically insignificant because the p-values are much higher than 0.05. Therefore, it can be concluded that the tested variable does not Granger-cause economic growth in the short run. From an economic viewpoint, the results suggest that the components of public expenditure do not show any predictive causality with economic growth in the short run. The results of the OLS model suggest that the model of economic growth is driven by oil revenues rather than the components of public expenditure. However, it should be noted that the sample used in the model is relatively small, and the economy of Algeria might experience structural breaks. Therefore, it is recommended that the results be checked using alternative methods like the Toda-Yamamoto causality test.

Conclusion:

In the current research, the impact of public expenditure composition on the economic growth of Algeria during the years 2000–2024 was estimated through time-series econometrics in Python. The purpose of such empirical research was to understand how well the parts of public expenditures contribute to the economic growth considering the structural specifics of the country's economy.

The following outcomes were found by the descriptive and econometric analyses. Firstly, it is important to note that there was a very strong positive correlation between GDP per capita and the revenue from oil. This result confirmed the structural reliance of Algeria on hydrocarbons. Secondly, it should be stated that the direct correlation between economic performance and investments into education and health care was rather weak.

Most of the macroeconomic variables in the Augmented Dickey Fuller (ADF) unit root tests proved to be non-stationary at the level form. For instance, GDP was found to have an ADF statistic of -2.071 and p-value of 0.2565 while oil revenues had an ADF statistic of -2.187 and p-value of 0.2110; meaning that there are unit roots present in them. However, when the variables were subjected to first difference analysis, they were found to be stationary meaning that the variables are integrated of order one, I(1).

Johansen cointegration test also validated the presence of long-run equilibrium relations between the variables where the trace statistic was found to be 34.73 which is greater than the 5 percent critical value of 29.79 hence the existence of one cointegration vector was confirmed. Economically, this implies that economic growth, oil revenues, and development indicators move hand in hand in the long run.

In conclusion, the empirical evidence indicates that the Algerian economy continues to depend highly on revenues from energy sources, while the influence of social public expenditures on short-run economic growth seems rather insignificant. While expenditures on education and healthcare might be effective due to contributions through the process of human capital formation and institutional improvement, the immediate impact of expenditures on economic growth remains relatively low.

As a lesson for policymakers, the findings suggest that efforts should be made to increase the efficiency of public expenditures and ensure productive reallocation of such funds. Improving institutional quality, lowering the reliance on oil-related revenues, and increasing the productivity of investments in education, health, and infrastructure might be crucial steps towards sustainable economic diversification.

Lastly, this paper adds to the recent literature on applications of econometrics using Python programming language in macroeconomic studies. The applicability of time-series methods such as ARDL and ECM to the field of fiscal policies in developing economies rich in natural resources.

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