Measuring the Impact of Fiscal Policy on Output in Algeria For the Period 1990-2022 using the ARDL model

قياس أثر السياسة المالية على الناتج في الجزائر خلال الفترة 1990–2022 باستخدام نموذج ARDL

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Abstract:

This study aims to measure the impact of fiscal policy on output in Algeria during the period from 1990 to 2022, using the autoregressive distributed lag model, for testing cointegration and estimate the short- and long-run equilibrium relationship.

The empirical results showed a correlation between fiscal policy instruments and output, as well as a long-run cointegration between them, but the impact of fiscal policy was weak, as demonstrated by less than one's elasticity values, and the occurrence of a shock in output requires up to five years for output to return to its equilibrium level.

Keywords: fiscal policy, output, ARDL model, cointegration.

JEL Classification Codes: E62, J23, C22, C51.

ملخص:

تهدف هذه الدراسة إلى قياس أثر السياسة المالية على الناتج في الجزائر خلال الفترة الممتدة من سنة 1990 إلى سنة 2022، باستخدام نموذج الانحدار الذاتي للإبطاء الموزع، لاختبار التكامل المشترك وتقدير العلاقة التوازنية قصيرة وطويلة الأجل.

أظهرت النتائج التجريبية وجود علاقة طردية بين أدوات السياسة المالية والناتج، بالإضافة إلى وجود علاقة تكامل مشترك بينهما في الأجل الطويل، إلا أن تأثير السياسة المالية كان ضعيفا وهو ما أثبتته قيم المرونة الأقل من الواحد، كما أن حدوث صدمة في الناتج تتطلب مدة تصل إلى خمس سنوات حتى يعود الناتج إلى مستواه التوازني.

كلمات مفتاحية: السياسة المالية، الناتج، نموذج الانحدار الذاتي للإبطاء الموزع ،التكامل المشترك.

تصنيفات JEL: E62 ، J23، C22، C51.

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INTRODUCTION:

Fiscal policy has gained great importance since the world economic crisis in 1929, thanks to the contributions of the famous economist" John Maynard Keynes", who called for the need for state intervention in economic life, which had its repercussions on the role of Financial Policy and became a major tool of economic policy in guiding the course of the economy, addressing the shocks and crises, as well as its impact on economic development, especially in developing countries, Thanks to this development that has occurred in fiscal policy in contemporary systems, it has become the duty and obligation of the state to intervene in directing the national economy in all its aspects, and fiscal policy has begun to play a fundamental role through its tools represented by public expenditures and tax revenues, that allow determining their effects on macroeconomic variables.

Increasing production and thus the rate of economic growth is one of the strategic goals of countries, and an important element focused on economic plans, so the development strategy in Algeria since independence has relied on expanding and strengthening the public sector as a driving tool for political, economic and social life, with a focus on investment to activate the productive apparatus.

Starting in 1986, Algeria experienced a deteriorating economic situation, where the rate of economic growth declined and imbalances emerged in various markets. It has become necessary to reconsider existing economic policies and adopt a new economic policy. Algeria therefore agreed with the world's financial institutions at the beginning of the nineties of the last century to implement economic reform programs, by following economic policies that have led to a decline in output.

To emerge from this situation, Algeria has been working since 2001 to develop a new development pattern aimed at achieving high levels of output, through the implementation of economic recovery programs aimed at developing productive sectors and increasing economic growth.

the problematic:

We identified the problematic of the study as follows:

What is the impact of fiscal policy on the output in Algeria in the short and long term?

To take note of the aspects of the topic, we ask the following sub-questions:

- Does the adoption of a Keynesian fiscal policy allow for stimulating aggregate demand and thereby increasing output?

-Is there a cointegration relationship between fiscal policy and output?

- Did large public investments contribute to reaching the level of equilibrium output in the long run?

hypotheses

The study is based on a range of hypotheses that we present as follows:

- Fiscal policy according to Keynesian perspective is very effective in increasing output.

-There is a cointegration relationship between fiscal policy and output.

- Given the volume of large public investments, the speed of adjusting the short-run disequilibrium towards long-run equilibrium is significant.

Importance of Study:

The importance of this study is to measure the impact of fiscal policy on real product in the short and long run, which helps to know the right time to make changes in the instruments of

this policy, in a way that enables its authors to achieve the desired goals related to increasing real output and thus economic growth.

Objectives of the study:

The study aims to analyze the economic impacts of the various economic programs applied during the study period on output, while studying the fiscal policy variables affecting it, namely public expenditures and tax revenues. The impact of these variables is measured by building a econometric model using the autoregressive distributed lag methodology, which allows the assessment of long-run and short-run components (relationships) at the same time.

Study methodology:

The descriptive approach was used, which is one of the most appropriate approaches that provides a descriptive overview of the studied phenomenon, in addition to the statistical approach that uses percentages and rates to analyze the various stages that the fiscal policy has passed and its impact on output. The subject also required a econometric study by building a econometric model that explains the nature of the relationship between fiscal policy and output.

previous studies:

The study conducted by Emad Attia Mohamed Omran (2015), titled **"The Impact of Fiscal Policy on Output: A Case Study of Egypt,"** The aim was to examine the immediate effects of fiscal policy shocks, encompassing government spending and tax revenues, on the real Gross Domestic Product (GDP). The researcher concluded that a shock in government spending has a negative effect on real GDP, Conversely, the impact of taxation appears to be efficient as it has a positive, with a relatively weak influence on real GDP.

Study by Fouzia Hibour and dalila taleb (2023), titled **"The Impact of Fiscal Policy on Economic Growth in Algeria During the Period 1990-2019"**. The study aims to determine the impact of fiscal policy on economic growth in Algeria for the period 1990-2019, using the Autoregressive Distributed Lag (ARDL) model. The study concluded that there is a significant relationship between public expenditures and Gross Domestic Product (GDP), while there is no significant relationship between tax revenues and Gross Domestic Product (GDP).

The study conducted by Hani Salim Hawari and Ahmed Fawzi Hamed (2021), **titled "The Influence of Fiscal Policy on Gross Domestic Product in Japan"** endeavors to assess the influence of fiscal policy instruments on Japan's Gross Domestic Product (GDP) from 2001 to 2015. The findings derived from econometric analysis of the dataset reveal that public expenditure emerges as the most noteworthy factor driving the augmentation of GDP, with public debt following suit. Conversely, tax revenue exhibits a negligible impact on GDP.

1. Evolution of fiscal policy and output volume during the period 1990-2022

During the study period, Algeria applied two types of fiscal policy: a deflationary fiscal policy during the transition to a market economy, and an expansionary fiscal policy during the implementation of economic recovery programs, so the government adopted one of the two options was not subject to economic studies, but to changes in oil prices, when oil prices rise, the petroleum levy rises with it, and therefore tax revenues, which pushed the government towards the option of expansionary fiscal policy and vice versa. The development of fiscal policy and its impact on output during the period 1990-2022 can be shown as follows:

1.1. Transition to a Market Economy (1990-2000):

The economic orientation of the reform programs is to cause a large-scale economic downturn, and despite all this, it is necessary to proceed with these programs because the delay in accepting their effects makes them more severe in the future and correcting them more expensive, and so the various policies that make up the economic reform programs have joined forces to bring about fundamental reforms, Through the implementation of stabilization and structural adjustment programs, the deflationary nature of this phase has been reflected in the implementation of a series of measures, the most important of which are the reduction of wages, the suspension of employment in government sectors and public economic institutions, the reduction of public investment, the reduction of Government subsidies and aid expenditures, the improvement of the tax structure and the raising of public service prices (BENCHAHRA, 2009, p. 210).

This policy resulted in a decrease in the ratio of public expenditures to GDP, from 34.42% in 1988 to 24.6% in 1991, And reached 28.57% in 2000 compared to 38% in 1994, the ratio of budget deficit to gross domestic product witnessed varying proportions, with the highest two years estimated (1993.1998) equivalent to 6.1% and 3.6% respectively (BOUDJEMA, 2011, p. 121). Attempts to save bankrupt public institutions by pumping additional funds under various labels as restructuring or financial cleansing of enterprises had strong negative effects on the periodic deficit in the public budget (TOUMI, 2002, p. 321).

The decline in petroleum tax revenues which remains the main source of tax revenues, contributed to the decline in the budget deficit. Despite the tax reforms carried out by the state and the changes adopted through the finance laws to affect the structure of public revenues, however, their contribution reached 50% and 64% during the years 1990 and 1991, respectively, and reached 59% in 1999, in light of the deterioration of the percentage of ordinary taxes of tax revenues, where it remained within 40% during the period 1991-2000, due to the deterioration of the tax collection system outside the fuel sector, despite numerous attempts at reform that did not reach the desired goals, in addition to the security conditions that have increased and encouraged tax evasion.

Economic conditions throughout this period have adversely reflected the GDP growth rate, which has experienced many fluctuations, where its value reached --1.8% in 1991 and 2.2% in 1993, as this period also experienced positive growth rates, but it was low reaching 0.2% in 1994 and 1.1% in 1997, arriving at 3.2% in 1999, up from 6.2% in 1998, owing to the recent decline in petroleum prices, which adversely affected revenues. In addition to the extension of the privatization process that did not stop at the end of the application of structural adjustment programs.

1.2. The phase of deepening economic reform (2001-2022)

The state has worked through the application of development programs to raise public expenditures, in a desire to pursue a development financial policy of a Keynesian nature aimed at stimulating aggregate demand, as public expenditures witnessed a remarkable development during the period 2000-2014, as a result of the development projects carried out by the state within the framework of economic recovery programs, where its percentage of gross domestic product increased from 28.31% in 2000 to about 40.57% in 2014, and the balance of the general budget achieved a surplus throughout the period from 2000 to 2008, and this can be explained by the rise in oil prices on world markets, which led to an increase in petroleum tax revenues,

which in turn contributed to raising tax revenues at a rate that exceeds the Public expenditures during that period (KERROUCHE, 2022, p. 314).

Starting in 2009, the balance shifted from surplus to deficit. The general budget balance amounted to 7.33% and 18.7% of gross domestic product (GDP) during 2014 and 2015 respectively, Compared to a surplus of 9.7% in 2000, owing to the decline in petroleum tax of 2327.7 billion dinars in 2009 compared to 4003.6 billion dinars in 2008, it also fell to 3388.4 billion dinars in 2014 and 2373.5 billion dinars in 2015 compared to 4184.3 billion dinars in 2012 (ALGERIA, 2015, p. 159). Despite the economic reforms applied at the outset of the nineties, to shift to a market economy, however, the general budget remained unable to find alternatives to finance government expenditure outside petroleum taxation's.

It is generally noted that the operational expenses exceeded the capital expenses in terms of volume, as the operational expenses in 2000 were estimated at 856.2 billion dinars, reaching in 2014 to 4494.3 billion dinars, while the capital expenses in 2000 were estimated at 321.9 billion dinars, and in 2014 amounted to about 2501.4 billion dinars. The increase in expenditures caused a deficit in the budget balance, however, the budget deficit is covered through the revenue Control Fund, which was established under the supplementary finance law of 2000. It aims to pay off the principal debt in order to cover the budget balances, and it includes in the revenue section the surplus of the tax value caused by the rise in fuel prices more than the estimates specified in the finance law (Council, May 2001, p. 73), the strategic role of the revenue Control Fund allowed to mitigate external shocks and thus achieve stability in budget expenditures.

It can be said that the expansionary fiscal policy did not succeed much in raising economic growth rates, especially in the period 2001-2014.despite the high ratio of public expenditures to output, the output growth rates remained modest, rarely exceeded 5%, as is the case in 2003 and 2005, where they were estimated at 7.2% and 5.9%, respectively, while it fell to 1.6% in 2009 and 3.8% in 2014, due to the decline in the average annual price of a barrel of oil after exceeding the 100 dollars per barrel (GOURI, 2015, p. 07).

The 2015-2019 period witnessed the implementation of the Program for the Consolidation of Growth, the aim of which was to promote productive investment in wealth and employment, However, as the price of petroleum continued to fall, the authorities initiated several actions aimed at rationalizing public expenditures. The account of this program was closed with the date of December 31, 2016, and an account was opened in the name of the Public investment Program, which includes a sum of 300 billion Algerian dinars, this gives a Sign of a decrease in Financing for public investment programs during The rest period (2017/2019) (Messaoudi., 2017, p. 221).

Starting in 2020, the State has initiated the Economic recovery plan (2020-2024), which aims to improve the efficiency of investment and the quality of infrastructure, by strengthening the Development Equipment Fund and diversifying the sources of equipment financing through the preference of public-private partnerships (Adda & Lakhal, 2022, p. 415).

The ratio of public expenditures to GDP went from 45.81% in 2015 to 37.76% in 2019 and 35% in 2022, while tax revenues experienced many fluctuations depending on changes in oil prices. As its ratio to GDP moved from 27.24% in 2015 to 32.20% in 2019 and 29.65% in 2021.

to rise again to 33.35% in 2022. The Public budget also witnessed a deficit throughout this period.

The deflationary fiscal policy Applied during the period of the growth consolidation program negatively affected the output growth rate, as it moved from 3.7% in 2015 to 1% in 2019 and then -5.1% in 2020, to rise again to 3.2% in 2022, as a result of the rise in oil prices from 43.49 dollars per barrel in 2020 to 95.68 dollars per barrel in 2022.

2. Econometric study:

This econometric study aims to measure the effects of fiscal policy on output, by determining the impacts of changes in tax revenues and public expenditures.

2.1. Data source:

The study uses annual data covering the period from 1990 to 2022 (33 views), the primary source of these data is the National Statistical Office, the World Bank and the Bank of Algeria. The variables are real public expenditures and real public revenues, which are the fiscal policy variables obtained by dividing the monetary value of each by the expenditure price index and the gross domestic product (GDP), respectively, in addition to the real product represented in real value added.

The neberian logarithm was used for all variables with the aim of obtaining constant linear relationships, The estimated parameters are defined as economic elasticities. Based on the above, the variables used in estimating the model are:

LQ: the neberian logarithm of the real product ،

LRG: the neberian logarithm of real public expenditures

LRT: the niberian logarithm of real tax revenues, and therefore we propose to estimate the ARDL model with the following linear formula:

$$(1)\mathrm{LQ} = \mathrm{f}(\mathrm{LRG}, \mathrm{LRG})$$

In order to measure the short-run and long-run effects of explanatory variables on the product, we estimate the ARDL model of the previous formula as follows:

$$\Delta \mathrm{LQ}_t = \mathrm{a}_0 + \sum_{\mathrm{i}=1}^{\mathrm{p}} \mathrm{a}_{1\mathrm{i}} \Delta \mathrm{LQ}_{t-i} + \sum_{\mathrm{i}=0}^{\mathrm{q}} \mathrm{a}_{2\mathrm{i}} \Delta \mathrm{LRG}_{t-i} + \sum_{\mathrm{i}=0}^{\mathrm{q}} \mathrm{a}_{3\mathrm{i}} \Delta \mathrm{LRT}_{t-i} + \mathrm{b}_1 \mathrm{LQ}_{t-1} + \mathrm{b}_2 \mathrm{LRG}_{t-1} + \mathrm{b}_3 \mathrm{LRT}_{t-1} + \mathrm{e}_\mathrm{t} \qquad (2)$$

so that:

Δ: First variable difference

a_0 : constant term.

a_i :Short-term Parameters.

b_i:Long-term Parameters.

e_t: Error term.

The ARDL model developed by Pesaran (1997), Shinand and Sun (1998) and Pesaran and Al(2001) applies if the variables are stable in their values, i.e, integrated of order Zero, or integrated of order one or the same order (Vijayalakshmi & Krishna, 2024, p. 14), and one of the variables must not be integrated of order 2 or higher, it can also be applied in the case if the

sample size is small, unlike most traditional cointegration tests that require the sample size to be large, we also enable us to separate short-term effects from long-term, and using this methodology, we can determine the cointegration relationship of the dependent variable and the independent variables in the long and short term in the same equation.

2.2. estimation results:

The model estimation goes through several stages, namely:

2.2.1. time series stability testing:

After performing the unit root existence test on time series using the augmented Dickey-Fuller test the results are as follows:

Table (1): testing the stability of time series using the augmented Dickey-Fuller ADF test:

Variants	The level		The first difference		degree of integration
	ADF	prob	ADF	prob	
LQ	-1.2358	0.8855	-4.8591	0.0025	**I(1)**
LRG	-2.2122	0.4671	-3.5881	0.0474	**I(1)**
LRT	-3.4087	0.0680	-6.1159	0.0001	**I(1)**

Source: eviews 12 outputs

Time series are stable after the first difference, i.e., they are integrated of the first-order, so the cointegration test can be performed using the bound test (the bound F-statistic) proposed by Pesaran (2001).

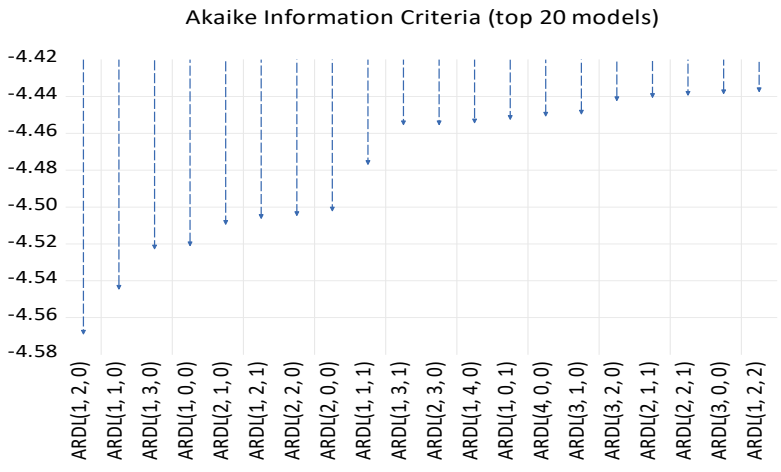
2.2.2. cointegration testing:

In order to test the cointegration, two basic stages must be passed:

2.2.2.1. optimal lag selection and estimation of the ARDL model:

Before estimating the model, the optimum lag length should be determined for the variables, as the ARDL model is highly sensitive for the slowing periods, in this case we use the Akaike criterion. The results are as shown in the following figure:

Fig (1): determination of the optimal deceleration period



Source: eviews 12 outputs

Based on Figure (1), the model selected is ARDL(1,2,0), where the lag period was determined by one time period for output, two periods for public expenditures and zero for tax revenues, that is, without delay. The result of the estimate is given in table 2 below:

Table (2): estimation results of ARDL (1,2,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LQ(-1)	0.796616	0.132913	5.993500	0.0000
LRG	0.191598	0.122164	1.568372	0.1294
LRG(-1)	0.016522	0.180440	0.091566	0.9278
LRG(-2)	-0.131412	0.101310	-1.297125	0.2064
LRT	0.065721	0.031953	2.056795	0.0503
C	2.847288	1.643656	1.732289	0.0955
R-squared	0.994948	F-statistic		984.7794
Adjusted R-squared	0.993938	Prob(F-statistic)		0.000000
		Durbin-Watson stat		1.949604

Source: eviews 12 outputs

The value of the determination coefficient shows that 99% of the change in output is explained by independent variables, the rest is attributable to other random factors, and Fisher's test indicates the high significance of the model, Since the probability value of the Fisher distribution is less than 5%, we accept the alternative hypothesis, that is, the model is suitable for representing the relationship between the dependent variable and the independent variables.

Given the necessity of diagnosing the model to ensure obtaining unbiased linear estimators that one can rely on the accuracy of their results, The research incorporated the identification of econometric issues, through the utilization of multiple Lagrange Multiplier tests, for the detection of autocorrelation, heteroscedasticity, and non-normal distribution of the error term.

Table (3): Diagnostic tests results

Test hypothesis	Test	Test value	Probability
autocorrelation of errors	Breusch-Godfrey	0.797318	0.6712
heteroscedasticity	Breusch-Pagan-Godfrey	5.068402	0.4076
Non-normal distribution	Jarque- berra	0.836294	0.658265
Regression Specification Error Test	Ramsey (fisher)	2.910528	0.0596

Source: eviews 12 outputs

We note from the table that the probability value of diagnostic tests is greater than 5%, this prompts us to accept the null hypotheses, i.e, the model is free from the problem of correlation of errors, its variance is constant and it is normally distributed. Also, the function’s form fits the model used.

2.2.2.2.cointegration testing approach

To verify that there is a cointegration of variables in the model, we use ARDL approach to cointegration (bound test) described in the following table:

Table (4): bound Test Results

Calculated F-Stat value	Critical values for the bound Test	Level of significance			
		%1	%2.5	%5	%10
4.361297	Lower value I(0)	4.13	3.55	3.1	2.63
	Upper value I(1)	5	4.38	3.87	3.35

Source: eviews 12 outputs

Results show that the value of F-Stat Calculated at 4.36 is greater than the upper Critical values for the bound Test at significance levels of 10% and 5%, which means rejecting the null hypothesis and accepting the alternative hypothesis, i.e. there is a long-run relationship between the variables in the model.

2.2.3. Estimation of long-run coefficients

The change in explanatory variables does not have direct and immediate effects on economic phenomena, but it takes a period of time for these variables to exert their full effects, the long term allows the possibility of overcoming many institutional and market constraints, and thus the return of output to its equilibrium value, and the following table shows the estimate of long-run coefficients:

Table (5): long-run ardl model

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRG	0.377158	0.111187	3.392096	0.0023
LRT	0.323139	0.147477	2.191113	0.0380
C	13.99957	1.742567	8.033876	0.0000

Source: eviews 12 outputs.

The results of the estimate indicate that there is a positive and significant impact of public expenditures on output in the long run, which is consistent with economic theory, where the estimated value of elasticity was 0.37, this means that an increase in public expenditures by 1% with the constancy of the other variable, will lead to an increase in output by 0.37%, and thus the output is inelastic for public expenditures in the long run..

The results also indicate a positive and significant impact of tax revenues on output in long-run, as the estimated value of elasticity is 0.32, this means that the output increases by 0.32% with the constancy of the other variable, when the tax revenues increases by 1%, and that output is inelastic for tax revenues in long-run.

The positive coefficient of tax revenues that correspond to the realities of Algeria's economy can be explained through The petroleum tax share of total tax revenues in Algeria, which is greatly influenced by fluctuations in oil prices, consequently, an increase in tax revenues. allows the authorities to increase public spending. As a result, the aggregate demand for goods and services increases in the economy leading to an increase in output.

The low elasticity value (less than one) highlights the inefficiency of expansionary fiscal policy in increasing output from a Keynesian perspective. The driving force behind increasing output is a direct increase in aggregate demand through higher investment spending and an indirect increase through higher consumption spending. It can be said that an increase in production could have been achieved if the production apparatus in the Algerian economy exhibited a certain degree of flexibility and dynamism in performance concurrently with the recorded increase in aggregate demand, as a significant portion of the increase was met through higher imports.

2.2.4. estimation of short-term coefficients

The short-term coefficients are estimated by estimating the error correction model, the results of which are as follows:

Table (6): results of the estimation of short-term coefficients

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LRG)	0.191598	0.093830	2.041969	0.0518
D(LRG(-1)	0.131412	0.086560	1.518167	0.1415
CointEq(-1)	-0.203384	0.046012	-4.420250	0.0002

Source: eviews 12 outputs

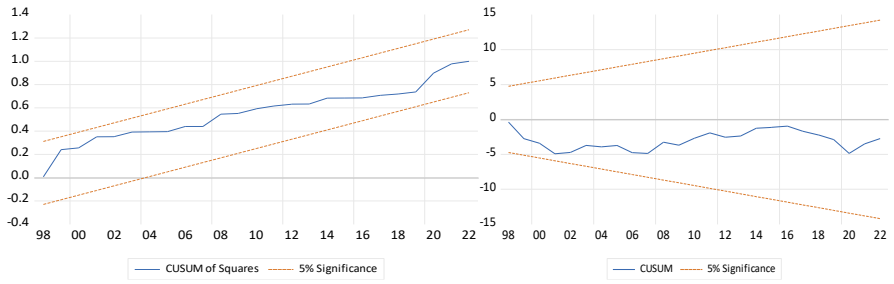
The results of the estimation show that the variable of public expenditures has no impact on output in the short term, because of its statistical insignificance, the lack significance of this variable can be explained by the low profitability, which resulted in poor productivity, due to the incompatibility of productive enterprises with competitive rules in the market, in addition to the high cost of local production compared to imported products.

The error correction coefficient is significant and negative, it measures the speed of adjustment in disequilibrium in the short term towards long-term equilibrium. When the output deviates in the short term from its equilibrium value in the long term, the equivalent of 20% of this disequilibrium from the prior years is corrected within one year, output reaches equilibrium in the long run after about five years, which is a low percentage.

2.2.5-testing the structural stability of ARDL model coefficients

It consists in testing the structural stability of short-term and long-term coefficients, to achieve this, two Tests will be used, namely the cumulative sum of residuals (CUSUM) test, and the cumulative sum of squares of residuals (CUSUMSQ) test, the structural stability of the estimated coefficients of the ARDL model is achieved if the graph of the CUSUM and CUSUMSQ statistics falls within the critical limits at a significant level of 5%.

Fig (2): testing the structural stability of the ARDL model coefficients



Source: eviews 12 outputs

It is clear from the figure that the estimated coefficients are structurally stable during the study period, as the plots of the two tests fall within the critical bounds at a 5% significance level.

Conclusion:

Through this paper, we analyzed the evolution of fiscal policy and its impact on output in Algeria during the period 1990-2022, as well as the construction of a econometric model using the autoregressive distributed lag methodology to measure this impact. We have reached a number of results that can be recapitulated as below:

- There is a direct relationship between fiscal policy instruments and real output, but their impact is weak, which is highlighted by the value of elasticity less than one, that is, following an expansionary fiscal policy by increasing expenditures or revenues by a certain percentage will lead to an increase in output by a smaller percentage.
- The impact of public expenditures on output exceeds the impact of public revenues on output, as an increase in public expenditures contributes to an increase in demand for goods and services, which stimulates economic activity and thus achieving greater economic growth.
-The low speed of return of output to its long-term equilibrium value is largely due to the inflexibility of Algeria's production system, which makes short-term output less adaptable to changes in fiscal policy instruments.
-In light of the above, the study suggests the following:
-Increase the effectiveness of fiscal policy by removing obstacles to the productive apparatus's flexibility, through the development of the financial and monetary market.
- Pursuing a balanced fiscal policy that takes into account current financial and economic challenges, such as the effects of inflation and budget deficits, to ensure sustainable growth and economic stability in the long term.

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-Appendices:

Appendix 1: autocorrelation test of the errors

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.303588	Prob. F(2,23)	0.7411
Obs*R-squared	0.797318	Prob. Chi-Square(2)	0.6712

Dependent Variable: RESID
Sample: 1992 2022
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LQ(-1)	0.019029	0.149457	0.127323	0.8998
LRG	0.027821	0.133864	0.207830	0.8372
LRG (-1)	-0.057433	0.200370	-0.286633	0.7770
LRG (-2)	0.018557	0.107663	0.172365	0.8647
LRT	-0.001418	0.033029	-0.042917	0.9661
C	-0.221909	1.839740	-0.120620	0.9050
RESID(-1)	-0.012855	0.233885	-0.054961	0.9566
RESID(-2)	-0.187728	0.241311	-0.777950	0.4445

R-squared	0.025720	Mean dependent var	2.58E-16
Adjusted R-squared	-0.270800	S.D. dependent var	0.020703
S.E. of regression	0.023338	Akaike info criterion	-4.459794
Sum squared resid	0.012528	Schwarz criterion	-4.089733
Log likelihood	77.12681	Hannan-Quinn criter.	-4.339164
F-statistic	0.086739	Durbin-Watson stat	1.982974
Prob(F-statistic)	0.998608		

Source: eviews 12 outputs

Appendix2: Heteroskedasticity test of the error term.

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.977264	Prob. F(5,25)	0.4509
Obs*R-squared	5.068402	Prob. Chi-Square(5)	0.4076
Scaled explained SS	2.860746	Prob. Chi-Square(5)	0.7214

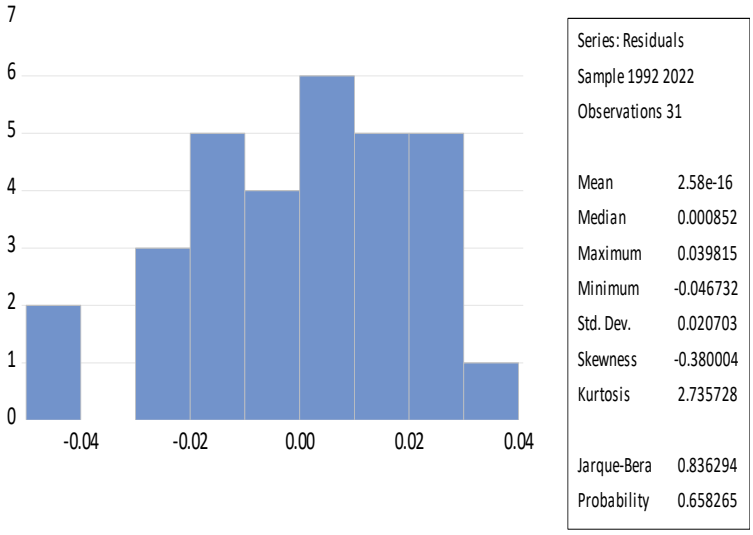
Sample: 1992 2022
Included observations: 31

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000305	0.040337	-0.007557	0.9940
LQ(-1)	0.000277	0.003262	0.085067	0.9329
LRG	-0.000618	0.002998	-0.206008	0.8385
LRG (-1)	-0.003779	0.004428	-0.853329	0.4016
LRG (-2)	0.004144	0.002486	1.666760	0.1080
LRT	4.54E-06	0.000784	0.005795	0.9954

R-squared	0.163497	Mean dependent var	0.000415
Adjusted R-squared	-0.003804	S.D. dependent var	0.000556
S.E. of regression	0.000557	Akaike info criterion	-11.97761
Sum squared resid	7.74E-06	Schwarz criterion	-11.70007
Log likelihood	191.6530	Hannan-Quinn criter.	-11.88714
F-statistic	0.977264	Durbin-Watson stat	2.180695
Prob(F-statistic)	0.450865		

Source: eviews 12 outputs

Appendix3: normal distribution test of the error term.



Source: eviews 12 outputs