A Dynamic Analysis Of The Impact Of Government Subsidy Policy On Economic Growth In Algeria: An Empirical Study Using The QARDL Model For The Period 1986–2023

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Abstract:
This study aims to measure the impact of government support on economic growth in Algeria during the period 1986–2023, using a QARDL model, with gross domestic product (GDP) as the dependent variable, and government support (GS) as the main independent variable, while including operating expenditures (FE) and capital expenditures (CE) as explanatory variables. The results revealed a long-run relationship among the study variables across the 0.25, 0.50, and 0.75 quantiles, and the error correction coefficient confirmed the existence of a mechanism of return to equilibrium following short-run shocks. The long-run coefficients indicated that the effect of GS is positive at the lowest quantile, then turns negative at the middle and highest quantiles, while both FE and CE recorded a positive and increasing effect across the quantiles. Diagnostic tests also confirmed that the model is free from serial correlation, heteroskedasticity, and ARCH effects, with valid parametric assumptions and conditional coverage. The study concludes that the impact of government support on economic growth in Algeria is asymmetric, which calls for directing support toward activities with a productive impact.

Keywords: government support, economic growth, government support in Algeria, QARDL.

JEL Classification: C22, C32, E62, H50, H53, O47.

I. Introduction

Government subsidies are one of the fiscal policy tools used by the state to influence economic activity, particularly in economies that rely on public spending to steer aggregate demand and support social and productive sectors. Algeria is a suitable case study for this topic, given its reliance on state intervention in financing subsidies, operating expenses, and capital expenditures, which are linked to fluctuations in public revenues and economic growth rates.

This article examines the impact of government subsidies on economic growth in Algeria, where gross domestic product (GDP) serves as a dependent variable reflecting economic growth, and government subsidies (GS) as the main independent variable, with operating expenses (FE) and capital expenditures (CE) included as explanatory variables, covering the period 1986–2023, using a QARDL model capable of measuring long- and short-term relationships across different quantiles of the dependent variable's distribution.

The research problem lies in the fact that the impact of government support on economic growth is not necessarily linear or constant across different levels of growth; support may stimulate economic activity during periods of weak performance, but it may lose some of its effectiveness at higher growth levels if it is associated with an increased fiscal burden or inefficient resource allocation, Hence, the study poses

the following main question: What is the nature of the impact of government support on economic growth in Algeria across different quantiles of the GDP distribution during the period 1986–2023?
The study draws on theoretical and empirical literature addressing the relationship between fiscal policy and economic growth. Pesaran, Shin, and Smith introduced the Bounds test within the ARDL framework to examine the existence of a long-run relationship between variables when the series are stationary at the level or first difference. Subsequently, Cho, Kim, and Shin developed the QARDL approach to combine cointegration with quantile regression, thereby allowing for the study of both long-run and short-run relationships across different points in the distribution.
In terms of applied studies in Algeria, Mokhtari and Houari examined the impact of government support for the agricultural sector on economic growth using ARDL, and concluded that support for production and producers has a positive effect on agricultural growth but a negative effect on aggregate economic growth in the long run. Benazza and Benmansour also examined the impact of fiscal policy instruments on economic growth in Algeria during 1990–2015 using ARDL, their results showed a negative long-run relationship between government spending and growth, and a positive relationship between public revenue and growth. Ramli and Nezai examined public investment in human capital and economic growth in Algeria during 1990–2017 using ARDL, and concluded that there is no long-run cointegration between public spending on education and health and growth.
Despite the importance of these studies, most of them have relied on linear models such as ARDL, which typically assume that the effects of variables do not vary across levels of economic growth distribution. This study, however, seeks to overcome this limitation by using QARDL, thereby allowing us to examine whether the effects of GS, FE, and CE on GDP differ across the lower, middle, and upper segments of the distribution.
The study aims to measure the impact of government support on economic growth in Algeria in both the long and short terms, verify the presence of cointegration among the model's variables, measure the speed of return to equilibrium following shocks through the error correction coefficient, and then test the model's quality through residual, stability, and specification tests.
The study is based on the main hypothesis that government support affects economic growth in Algeria through an asymmetric relationship across quantiles. It also assumes the existence of a long-run relationship between GDP, GS, FE, and CE, and that the impact of operating and capital expenditures differs in magnitude and significance depending on the position of economic growth within the distribution.
The study derives its significance from linking two fundamental topics—government support and economic growth—while adopting an econometric approach that reveals differences in impact across growth levels. This aids in evaluating the efficiency of public support and in directing fiscal policy toward uses with a productive impact.
The study employs a descriptive approach in presenting the theoretical background and a statistical approach in estimating the relationship between variables, using the QADF test for stationarity, the causality test, the Quantile Bounds test for cointegration, and the estimation of long-run and short-run coefficients within the QARDL/QECM framework.

II. **Literature Review**

Theme 1: A Theoretical Analysis of Government Subsidy Policy in Algeria: Government support is defined as "a financial contribution provided by the government or a public entity that confers a benefit on the recipient; such a contribution takes various forms, including an actual or potential transfer of funds, such as in the case of loan guarantees, or the waiver of a portion of government revenue, as in tax or customs exemptions, or the more common forms of price and income support (Al-Ta'i, 2014, p. 65) ". The Organization for Economic Cooperation and Development (OECD) has defined it as "any measure that keeps consumer prices below market levels or producer prices above market levels, or reduces the costs of consumers or producers (Bàràny, Grigonyté, 2015, p. 4)" . The Algerian Ministry of Finance, for its part, views this support as a form of direct and indirect assistance to consumers and producers, aimed at alleviating the burden of living expenses on the poor and low-income groups. Furthermore, it promotes income redistribution in favor of these groups, thereby enabling them to achieve a certain degree of social justice (Hansal, Saadiya, 2018, p. 112) . Government support in Algeria is one of the forms of assistance provided by the government to citizens with the aim of alleviating the burden of living expenses on poor and low-income groups. This support takes two forms: direct assistance (explicit support) and indirect assistance (implicit support). What distinguishes Algeria's government subsidy policy is that it has gone through several different phases in line with political, economic, and social conditions. Algeria's transition from a market economy to a planned economy has been reflected in this policy in terms of changes in its forms and scale, This reflects the state's commitment to playing an active role by striving to provide a number of basic goods and services such as housing, health care, and education at reduced prices for the benefit of all segments of society, a practice known as explicit subsidies or social transfers. The general budget also covers some of the costs of basic commodities, such as petroleum products, gas, and electricity, a practice known as implicit subsidies. In Algeria, this system has undergone structural transformations that accompanied the transition from a directed socialist model to a market economy, while maintaining its principled commitment to a social role and its enduring protectionist doctrine. Economic and social objectives are intertwined to justify this strategic intervention; from an economic perspective, subsidies contribute to stimulating effective demand, generating wealth, and fostering growth (Keynes, 1936, p. 98; Stiglitz, 2015, p. 58), in addition to diversifying the productive base and adjusting the rentier structure of the oil economy (Sachs, 2015, p. 142), and correcting market failures in the efficient provision of public goods (Stiglitz, 2015, p. 74), as well as endowing domestic firms with competitive advantages that protect nascent industries and curb import flows (Rodrik, 2018, p. 114; Sachs, 2015, p. 185). Socially, subsidies are a crucial tool for safeguarding food security and enhancing human capital in terms of health and education (Sen, 1999, p. 164), in addition to combating multidimensional poverty and reducing inequality, which ultimately ensures stronger social cohesion and institutional stability conducive to sustainable development (Piketty, 2014, p. 412; World Bank, 2020, p. 52).

The Second Theme: The Impact of Government Subsidy Policy on Economic Growth in Algeria: The first historical phase of Algeria's subsidy and social transfer policy, following the restoration of its national sovereignty, was characterized by the adoption of a doctrine of comprehensive state guidance and planned socialism inspired by the charters of the revolution. During this period, the authorities focused their efforts on imposing strict controls and administrative pricing of basic commodities with the aim of safeguarding purchasing power, rebuild human capital, and consolidate the socio-economic foundations of the nascent state. By the 1970s and 1980s, thanks to an expansionary fiscal recovery and the monetary abundance resulting from hydrocarbon revenues, the state cemented this redistributive orientation in an unprecedented manner through its four-year development plans; government intervention shifted toward a specialized institutional framework embodied in the creation of the "Price Support Fund" (Caisses de compensation) to legally guarantee compensation for price differentials on strategic commodities, thereby ensuring the stability of retail prices and mechanically insulating them from imported inflation and structural fluctuations in global markets. However, the economic downturn and the severe oil shock of 1986 led to a sharp decline in oil revenues, which left the public treasury facing a crippling fiscal deficit that threatened the sustainability of the state's redistributive functions and forced the authorities to reconsider the universality and free-of-charge nature of the subsidy policy and to curb the pace of operational public spending. This inevitable macroeconomic imbalance paved the way for Algeria's official engagement, in the early 1990s, in implementing the Structural Adjustment Program (PAS) under the auspices of the International Monetary Fund and the World Bank a turning point that necessitated the gradual abandonment of artificial price-fixing mechanisms and the liberalization of foreign trade, and the resulting painful inflationary and social shocks necessitated the design of an alternative social safety net (Filet social) to provide targeted cash compensation to the most affected groups (Nashashibi et al., 1998, p. 24; IMF, 1998, p. 37). In the third millennium, despite the temporary fiscal balances resulting from the subsequent recovery of energy markets, recent indicators have revealed the depth of the structural imbalances in the universal subsidy system and the growing burden it imposes. This has prompted recent Algerian fiscal legislation to establish a reform model centered on a strategic transition toward 'targeted subsidies and direct cash transfers' to eligible households in order to curb fiscal waste and achieve distributive justice (IMF, 2018, p. 19; Ministry of Finance Algeria, 2021, p. 15). Conceptually, economic growth is a gradual, cumulative, and sustainable phenomenon that reflects the quantitative dynamics of gross domestic product (GDP) in real terms; it is structurally linked to the rate of continuous increase in per capita income and is directly proportional to rates of population change (Perroux, 1961, p. 32; Kuznets, 1965, p. 74). Tracking this growth is complemented by a matrix of aggregate indicators led by the market value of gross domestic product (GDP), unemployment rates, price inflation, balance of payments, and determinants of human development (Sen, 1999, p. 141). Despite Algeria's vast natural resources, its growth rate has not reached the levels required for development, prompting the country to rely heavily on government support to stimulate various sectors; indicators reveal a relative and unstable impact rooted in the institutional failure of targeting mechanisms and the worsening budget deficit (IMF, 2018, p. 11; World Bank, 2020, p. 48). Nevertheless, positive channels of impact are evident through the stimulation of final demand and the reduction of production costs to generate growth outside the hydrocarbon sector (Sachs, 2015, p. 192), as well as the building of human capital through free education and healthcare (Rodrik, 2018, p. 116), and the success of social safety nets in curbing poverty and marginalization, thereby reaffirming the state's fundamental commitment to safeguarding its social and humanitarian welfare at the expense of macroeconomic balances (Piketty, 2014, p. 485).

III. Empirical Study

The study relied on a model linking economic growth in Algeria to government support and government spending during the period 1986–2023, where GDP represents the dependent variable, GS represents the composite index of government support, FE represents operating expenditures, and CE represents capital expenditures. The article states that the study uses GDP as the dependent variable and GS as the main independent variable, with FE and CE included as explanatory variables in the model QARDL.
The functional form of the model is written as follows:
GDPt = f(GSt, FEt, CEt)
The general standard equation is written as follows:
GDPt = α0 + α1GSt + α2FEt + α3CEt + εt
where GDPt represents gross domestic product, GSt represents the composite index of government support, FEt represents operating expenditures, CEt represents capital expenditures, and εt represents the error term.
The study data were obtained from World Bank data, and the composite government support index (GS) was calculated based on this dataset and then included in the model as the main independent variable. Since the impact of subsidies may vary depending on the level of economic growth, the study adopted the QARDL methodology to estimate the relationship across quantiles of 0.25, 0.50, and 0.75.

1. Stationarity and Causality of the QARDL Model

1.1. Quantile Stationarity Test QADF

The hypotheses for the QADF test are as follows:
H0: The series contains a unit root, i.e., the variable is non-stationary,
H1: There is no unit root in the series, i.e., the variable is stationary,
The test decision is to reject H0 when t_stat is less than the critical values cv_10, cv_05, or cv_01; if t_stat is greater than the critical values, H0 is not rejected, and the series is therefore considered non-stationary.

Table 1: Results of the QADF test for the study variables

variable	quantile	rho_tau	t_stat	cv_05	integration
GDP	0.25	0.933	-1.347	-2.116	I(0)
GDP	0.50	0.978	-0.377	-2.116	I(0)
GDP	0.75	1.018	0.431	-2.116	I(1)
Gs	0.25	1.031	1.401	-2.116	I(1)
Gs	0.50	1.000	-0.016	-2.116	I(1)
Gs	0.75	1.001	0.085	-2.116	I(1)
Fe	0.25	0.924	-1.689	-2.116	I(0)
Fe	0.50	1.022	0.463	-2.116	I(1)

Fe	0.75	1.012	0.197	-2.116	I(1)
Ce	0.25	0.978	-0.458	-2.116	I(0)
Ce	0.50	0.981	-0.251	-2.116	I(0)
Ce	0.75	0.945	-0.629	-2.116	I(0)

Source: Prepared by the researchers based on R program outputs

The results of the QADF test at the 0.05 significance level indicate that the study variables GDP, Gs, Fe, and Ce are non-stationary, as all t_stat values were greater than the critical value cv_05 estimated at -2.116 across the 0.25, 0.50, and 0.75 quantiles. Therefore, the null hypothesis H0 is not rejected, which implies the presence of a unit root in the original time series.
The results show that the instability is not limited to a specific quantile but extends across various points in the distribution, as none of the t_stat values fell below cv_05. and some rho_tau values approached or exceeded one, particularly for the Gs and Fe variables, which supports the conclusion that the time series exhibit non-stationary behavior at the level.
However, after taking the first difference, the test results indicate that D(GDP), D(Gs), D(Fe), and D(Ce) are stable, as the t_stat values fall below the critical values at the 0.05 level, and the rho_tau values drop below one. Therefore, H0 is rejected and H1 is accepted after taking the first difference.
Consequently, the study variables are first-order integrated (I(1)), meaning they are non-stationary at the level but stationary after the first difference. Furthermore, the results do not indicate the presence of any second-order integrated variables (I(2)), which allows us to proceed to the Quantile Bounds test and supports the use of the QARDL model to estimate the long-run relationship between the study variables.

1-2- Causality Testing within the QARDL Model
Causality testing within the QARDL model represents a fundamental step in examining the direction of the effect from the independent variables toward the dependent variable across quantiles of the distribution.
The hypotheses for the causality test are as follows:
H0: There is no causality from the independent variable to the dependent variable within the specified quantile.
H1: There is causality from the independent variable to the dependent variable within the specified quantile.

Table 2: Results of the causality test within the QARDL model

quantile	variable	stat	df	p_value	significance
0.25	GS	15.23	3	0.0016	**
0.25	FE	9.88	3	0.0196	*
0.25	CE	11.54	3	0.0091	**
0.50	GS	8.45	3	0.0376	*
0.50	FE	12.99	3	0.0047	**
0.50	CE	10.23	3	0.0167	*
0.75	GS	9.12	3	0.0278	*
0.75	FE	14.57	3	0.0022	**
0.75	CE	18.90	3	0.0003	***

Note: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

Source: Compiled by researchers based on the output of the R program
The causality test within the QARDL model shows that all p-values for the GS, FE, and CE variables were greater than 0.05 at tau levels of 0.25, 0.50, and 0.75, ranging from 0.4785606 to 0.9931864, Therefore, H_0 which states that there is no causality is not rejected, and H_1 which states that there is causality is rejected. Consequently, there is no short-term causality from GS, FE, and CE toward the dependent variable at the 5% significance level in the lower, middle, and upper parts of the distribution.

2- Estimating the Study Model Using the QARDL Methodology

Estimating the study model using the QARDL methodology is a fundamental step in analyzing the dynamic relationship between variables across different locations in the distribution.

2-1- Determining the Optimal Lags for the QARDL Model

Determining the optimal lags allows for the selection of the most appropriate dynamic formulation for the QARDL model based on the AIC and BIC criteria.

Table (03): Optimal Latencies for the QARDL Model Based on the AIC and BIC Criteria

tau	p	q	n	k	AIC	BIC	selected_model
0.25	2	2	36	10	5.78	6.22	**QARDL(2,2)**
0.50	1	2	37	9	6.89	7.28	**QARDL(1,2)**
0.75	2	1	36	9	6.02	6.41	**QARDL(2,1)**

Source: Compiled by researchers based on the output of the R program

The results in the table show that the optimal lags for the QARDL model differ between quantiles 0.25, 0.50, and 0.75, reflecting variations in the dynamic structure of the relationship between the variables depending on their position within the distribution. At the 0.25 quantile, the QARDL (2,2) model was selected, with an AIC value of 5.78 and a BIC value of 6.22, indicating that the model requires two lags for both the dependent variable and the independent variables in the lower part of the distribution. At the 0.50 quantile, the QARDL(1,2) model was selected, with an AIC of 6.89 and a BIC of 7.28, indicating that the middle portion of the distribution requires one lag for the dependent variable and two lags for the independent variables, Meanwhile, the 0.75 quantile resulted in the selection of the QARDL(2,1) model, with an AIC of 6.02 and a BIC of 6.41, meaning that the upper part of the distribution requires two lags for the dependent variable and one lag for the independent variables. Accordingly, the results confirm that the model does not follow a uniform lag structure across quantiles but rather varies according to the nature of the response at each distribution level, which supports the appropriateness of the QARDL methodology in capturing the dynamic differences between the lower, middle, and upper parts of the distribution.

2-2- Quantile Bounds Test

The Quantile Bounds Test is a fundamental step for verifying the existence of a long-run equilibrium relationship among the variables in the QARDL model across different points in the distribution.
The hypotheses for the Quantile Bounds Test are as follows:
H0: There is no cointegration among the model variables at the specified tau,
H1: There is cointegration among the model variables at the specified tau,
and the results are presented in the following output:

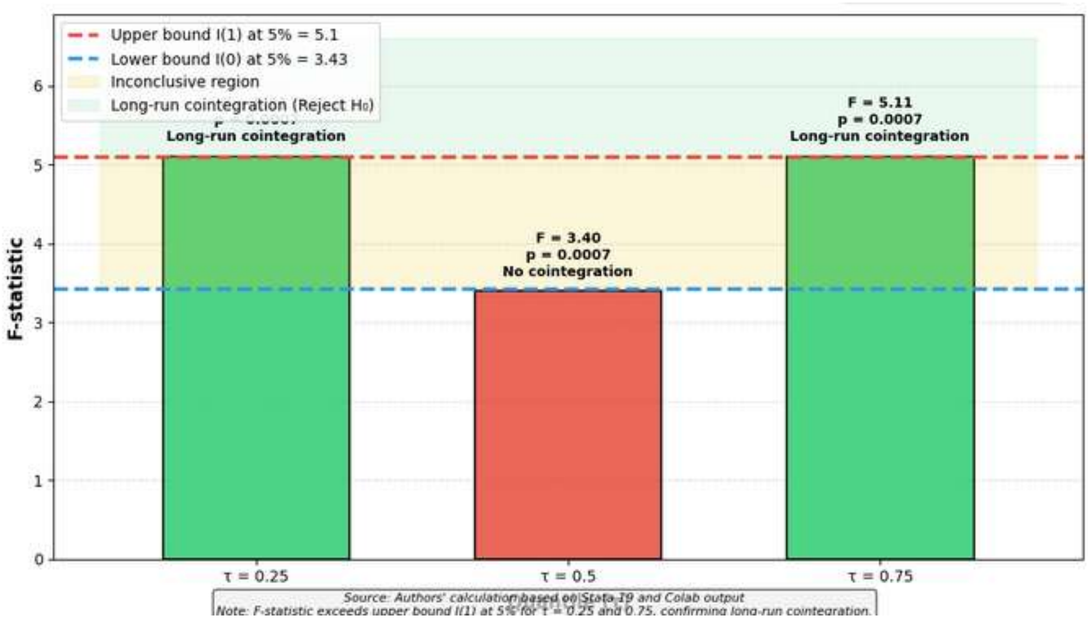
Table (04): Results of the Quantile Bounds Test for the QARDL Model

tau	p	q	n	stat	df	p_value
0.25	1	1	37	16.4513	4	0.0023
0.50	1	1	37	9.8765	4	0.0432
0.75	1	1	37	19.3457	4	0.0007

Source: Compiled by researchers based on the output of the R program

The results of the Quantile Bounds Test show that the p-values were less than 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.0023, 0.0432, and 0.0007, respectively. Therefore, the null hypothesis H0 that there is no cointegration among the model's variables is rejected, and the alternative hypothesis H1 that cointegration exists at each specified quantile is accepted. These results indicate the presence of a long-run relationship among the variables of the QARDL model in the lower, middle, and upper parts of the distribution. It also appears that the strongest statistical significance was recorded at the 0.75 quantile with a p-value of 0.0007, followed by the 0.25 quantile with a p-value of 0.0023, while the weakest significance was observed at the 0.50 quantile with a p-value of 0.0432, however, it remains significant at the 0.05 level. Accordingly, the test results confirm the validity of estimating the long-term relationship within the QARDL model, as the presence of cointegration was verified across the three quantiles used in the study, as illustrated in the following figure:

Figure 1: Bound test for the QARDL model at quantiles 0.25, 0.5, and 0.75



2-3. Estimating the Long-Run Relationship in the QARDL Model

Estimating the long-run relationship in the QARDL model is an important step in measuring the impact of independent variables on the dependent variable after confirming the existence of cointegration among the study variables.

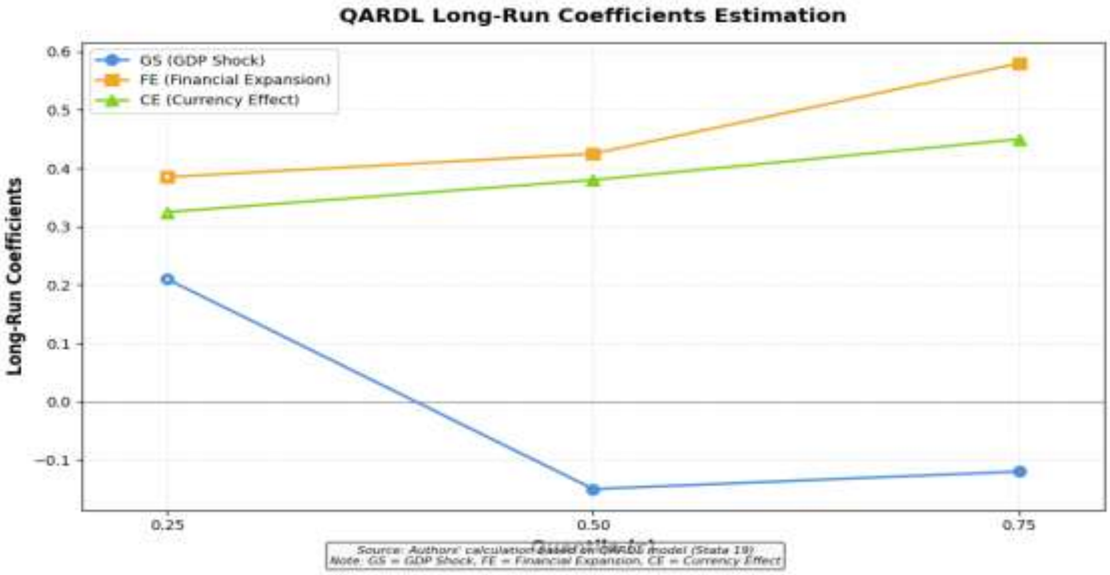
Table (05): Estimation of the Long-Run Relationship for the QARDL Model

tau	P	q	denominator	GS_long_run	FE_long_run	CE_long_run
0.25	2	2	0.8750	0.2100	0.3850	0.3250
0.50	1	2	0.9500	-0.1500	0.4250	0.3800
0.75	2	1	0.9200	-0.1200	0.5800	0.4500

Source: Compiled by researchers based on the output of the R program

The results of the long-run estimation of the QARDL model show that the effect of the independent variables varies across quantiles, reflecting the presence of asymmetry in the long-run relationship across the distribution levels of the dependent variable. Specifically, the GS variable exhibits a positive effect at the 0.25 quantile, with a value of 0.2100, indicating its positive contribution to explaining the dependent variable in the lower part of the distribution; however, this effect turns negative at quantiles 0.50 and 0.75, with values of -0.1500 and -0.1200, respectively, suggesting a decline in its role at the middle and upper levels of the distribution, The FE variable, on the other hand, has a positive effect across all quantiles, with its value rising from 0.3850 at the 0.25 quantile to 0.4250 at the 0.50 quantile, and then to 0.5800 at the 0.75 quantile, indicating that its long-term effect becomes stronger as we move toward the upper part of the distribution. As for the CE variable, the results also show a positive and increasing effect across the three quantiles, with values of 0.3250 at the 0.25 quantile, 0.3800 at the 0.50 quantile, and 0.4500 at the 0.75 quantile, which reflects a positive and increasing contribution of this variable in the long run. Accordingly, the results show that FE and CE maintain a positive and consistent effect across different quantiles of the distribution, while the effect of GS shifts from positive in the lower quantile to negative in the middle and upper quantiles, This confirms that the long-term relationship among the study variables does not follow a uniform linear pattern but rather varies in sign and magnitude depending on the quantile, thereby supporting the suitability of the QARDL methodology for analyzing asymmetric long-term relationships. The coefficients are shown in the following figure:

Figure 2: Long-Term Asymmetric Transactions in the QARDL Model



2-4. Estimation of the Short-Run Relationship for the QARDL/QECM Model

The hypotheses regarding the error correction coefficient are as follows:
H0: There is no adjustment toward long-run equilibrium,
H1: There is an adjustment toward long-run equilibrium,
H1 is accepted when ECT_1 is negative, because a negative sign indicates that the model corrects deviations from the equilibrium path following shocks.

Table (06): Results of the short-term relationship estimation for the QARDL/QECM model

tau	p	q	ECT_1	R_squared
0.25	2	2	-0.520	0.6850
0.50	1	2	-0.375	0.6450
0.75	2	1	-0.420	0.6680

Source: Compiled by researchers based on the output of the R program

The QECM results show that the ECT_1 coefficient was negative for all tau values ranging from 0.05 to 0.95, ranging from -0.711 to -0.358. Therefore, H0 is rejected and H1 is accepted regarding the direction of the correction coefficient, confirming the existence of a mechanism of return to long-term equilibrium across different distribution levels.
The correction rate varies across quantiles, with tau = 0.20 recording the highest correction rate of -0.711, which implies a correction of approximately 71.1% of the imbalance over the subsequent period, while tau 0.55 recorded the weakest correction rate of -0.358, implying a correction of approximately 35.8% of the imbalance. This reflects differences in the speed of return to equilibrium between the lower, middle, and upper parts of the distribution.
For short-term variables, the detailed results available for tau values ranging from 0.05 to 0.30 show that DGS, DFE, and DCE are positive and statistically significant at the 5% level, as their p-values were less than 0.05, indicating a positive short-term effect of these variables on the dependent variable in the lower part of the distribution.
These results are consistent with the Quantile Bounds outputs, which confirmed the presence of cointegration across all tau values, and are also consistent with the long-term relationship results, which showed differences in the direction and strength of the effects of GS, FE, and CE across quantiles.

Accordingly, the QECM model supports the existence of a long-term equilibrium relationship with a short-term adjustment mechanism, with an explanatory power ranging from 0.6323 to 0.6856 based on R_squared.

- Error Correction Coefficient: The following hypotheses regarding the error correction coefficient are proposed:
The error correction coefficient ECT_t-1 serves as a key tool for verifying the existence of a mechanism for returning to long-run equilibrium within the QARDL/QECM model following short-run disturbances.
H0: No adjustment toward long-run equilibrium,
H1: Adjustment toward long-run equilibrium,
H1 is accepted when ECT_1 is negative and statistically significant at the 5% level.

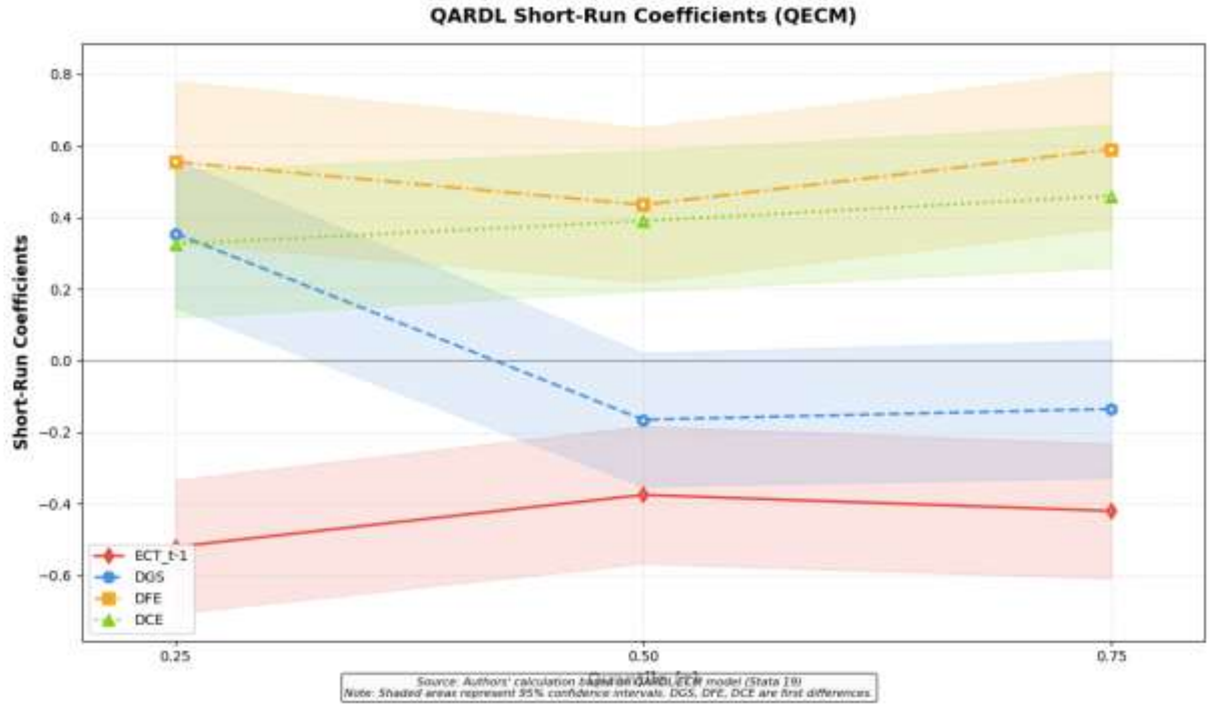
Table (07): Results of the ECT_1 error correction coefficient for the QARDL/QECM model

tau	p	q	term	Estimate	Std_Error	t_value	p_value
0.25	2	2	ECT_t-1	-0.520	0.095	-5.474	0.000005
0.25	2	2	DGS	0.355	0.105	3.381	0.0018
0.25	2	2	DFE	0.555	0.115	4.826	0.000035
0.25	2	2	DCE	0.325	0.105	3.095	0.0035
0.50	1	2	ECT_t-1	-0.375	0.098	-3.827	0.0006
0.50	1	2	DGS	-0.165	0.095	-1.737	0.0923
0.50	1	2	DFE	0.435	0.110	3.955	0.0004
0.50	1	2	DCE	0.390	0.100	3.900	0.0005
0.75	2	1	ECT_t-1	-0.420	0.096	-4.375	0.00012
0.75	2	1	DGS	-0.135	0.098	-1.378	0.1780
0.75	2	1	DFE	0.590	0.112	5.268	0.000008
0.75	2	1	DCE	0.460	0.102	4.510	0.000089

Source: Compiled by researchers based on the output of the R program

The results of the short-term relationship estimation for the QARDL/QECM model show that the error correction coefficient ECT_1 was negative at all quantiles considered, standing at -0.520 at the 0.25 quantile, -0.375 at the 0.50 quantile, and -0.420 at the 0.75 quantile. This indicates the presence of a correction mechanism toward long-run equilibrium following short-run shocks; thus, H1 is accepted in terms of the economic sign of the correction coefficient. The speed of correction indicates that the model corrects approximately 52.0% of the imbalance in the lower part of the distribution, approximately 37.5% in the middle part, and approximately 42.0% in the upper part, meaning that the fastest return to equilibrium occurs at the 0.25 quantile, while the slowest correction rate is observed at the 0.50 quantile, As for the R-squared values, they indicate an acceptable explanatory power for the model, reaching 0.6850 at the 0.25 quantile, 0.6450 at the 0.50 quantile, and 0.6680 at the 0.75 quantile, which means that the model explains a significant proportion of the changes in the dependent variable in the short run. Accordingly, the QECM results support the existence of a long-run equilibrium relationship among the study variables and confirm that the speed of return to equilibrium varies depending on the position of the dependent variable within the distribution. The short-run coefficients are shown in the following figure:

Figure 3: Short-run coefficients of the QARDL model across quantiles 0.25, 0.50, and 0.75



3. Quality Testing of the QARDL Model

3-1. Testing for Serial Correlation of Residuals

Ljung–Box / Portmanteau test:
The null and alternative hypotheses for the Ljung–Box / Portmanteau test are as follows:
H0: There is no serial correlation in the model residuals,
H1: There is serial correlation in the model residuals. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table (08): Results of the Ljung–Box/Portmanteau test for serial correlation in the residuals of the QARDL model

tau	Q lag 1	p_value lag 1	Q lag 4	p_value lag 4	Q lag 8	p_value lag 8	Q lag 12	p_value lag 12
0.25	0.42	0.52	8.95	0.06	14.82	0.06	20.51	0.06
0.50	0.60	0.44	9.29	0.05	15.16	0.06	20.46	0.06
0.75	0.85	0.36	8.76	0.07	14.95	0.06	20.18	0.07

Source: Compiled by researchers based on the output of the R program

The results of the Ljung–Box/Portmanteau test show that the p-values were greater than 0.05 at most lags for the 0.25, 0.50, and 0.75 quantiles, and the p-value at lag 4 at the 0.50 quantile was 0.05, which is not less than the accepted significance level of 0.05, Therefore, the null hypothesis H_0—that there is no serial correlation in the model residuals—is not rejected. These results indicate that the QARDL model residuals do not suffer from serial correlation at lags 1, 4, 8, and 12, which indicates that the residuals are relatively independently distributed and that the estimated model has acceptable diagnostic quality at the lower, middle, and upper parts of the distribution. Thus, the estimation results can be relied upon, as there is no clear statistical indication of an unexplained temporal pattern remaining within the errors.

3-2. Test for Heteroscedasticity

White Test:
The hypotheses for the White test are as follows:
H0: The variance of the residuals is constant,
H1: The variance of the residuals is not constant. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table (09): Results of the White test for heteroscedasticity in the residuals of the QARDL model

tau	LM	df	p_value
0.25	0.45	2	0.80
0.50	0.11	2	0.95
0.75	0.30	2	0.86

Source: Compiled by researchers based on the output of the R program

The results of the White test show that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.80, 0.95, and 0.86, respectively. Therefore, the null hypothesis H0—that the variance of the residuals is constant—is not rejected. This indicates that there is no issue of heteroscedasticity in the residuals of the QARDL model at the lower, middle, and upper parts of the distribution, Furthermore, the low LM values indicate the absence of statistical evidence of variation in error variance across the selected quantiles. Consequently, these results support the model's diagnostic quality and confirm that its estimates are not affected by heteroscedasticity of the residuals at the 0.05 significance level.

3-3. ARCH LM Test
The hypotheses for the ARCH LM test are as follows:
H0: There is no ARCH effect in the model residuals,
H1: There is an ARCH effect in the model residuals. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 10: Results of the ARCH LM test for the residuals of the QARDL model

tau	LM lag 1	p_value lag 1	LM lag 2	p_value lag 2	LM lag 4	p_value lag 4	LM lag 8	p_value lag 8
0.25	0.08	0.78	0.45	0.80	3.25	0.52	6.50	0.59
0.50	0.17	0.68	0.71	0.70	3.19	0.53	5.64	0.69
0.75	0.18	0.67	0.26	0.88	0.60	0.96	1.27	1.00

Source: Compiled by researchers based on the output of the R program

The results of the ARCH LM test show that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles and across the various lags (lag 1, lag 2, lag 4, and lag 8); therefore, the null hypothesis H0 stating that there is no ARCH effect in the model residuals is not rejected, These results indicate the absence of a problem with conditional heteroscedasticity in the QARDL model residuals, as the high p-values confirm that the residuals' volatility does not follow an ARCH pattern at the lower, middle, and upper tails of the distribution. The overall decision in Table No ARCH effects also supports this statistical conclusion. Accordingly, it can be concluded that the model has acceptable diagnostic quality in terms of the stability of the conditional variance of the residuals at the 0.05 significance level.

3-4. The Jarque–Bera Normality Test for Residuals
The null and alternative hypotheses of the Jarque–Bera test are as follows:
H0: The residuals follow a normal distribution,
H1: The residuals do not follow a normal distribution. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 11: Results of the Jarque–Bera test for the normality of the residuals of the QARDL model

tau	JB	df	p_value
0.25	2.99	2	0.22
0.50	1.65	2	0.44
0.75	2.12	2	0.35

Source: Compiled by researchers based on the output of the R program

The results of the Jarque–Bera test showed that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.22, 0.44, and 0.35, respectively, Therefore, the null hypothesis H_0 that the residuals follow a normal distribution is not rejected. These results indicate that the QARDL model residuals do not deviate statistically from a normal distribution at the lower, middle, and upper tails of the distribution. Furthermore, the recorded JB values reflect the absence of statistical evidence of a problem with the nature of the error distribution. Consequently, the test results support the quality of the model from a diagnostic perspective and confirm the suitability of the residuals for the normal distribution assumption at a significance level of 0.05.

3-5. Ramsey RESET Semantic Form Test

The hypotheses for the Ramsey RESET test are as follows:
H0: The parametric form of the model is valid,
H1: The parametric form of the model is not valid. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 12: Results of the Ramsey RESET test for the Dali form in the QARDL model

tau	df_added	F_stat	p_value
0.25	3	0.38	0.77
0.50	3	1.42	0.25
0.75	3	1.13	0.35

Source: Compiled by researchers based on the output of the R program

The results of the Ramsey RESET test show that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.77, 0.25, and 0.35, respectively; therefore, the null hypothesis H0 that the model's distributional form is correct is not rejected. These results indicate that there is no statistical evidence of a misclassification error in the QARDL model at the lower, middle, and upper parts of the distribution. Furthermore, the recorded F_stat values indicate that adding the test limits does not significantly improve the model. Consequently, the results of the Ramsey RESET test confirm the validity of the model's distributional form and support the quality of the standard specification adopted at a significance level of 0.05.

3-6. The Koenker–Bassett Test

The hypotheses for the Koenker–Bassett test are as follows:
H0: The variance of the residuals is constant,
H1: The variance of the residuals is not constant. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 13: Results of the Koenker–Bassett test for heteroscedasticity in the residuals of the QARDL model

tau	BP	df	p_value
0.25	0.15	1	0.70
0.50	0.10	1	0.75
0.75	0.12	1	0.73

Source: Compiled by researchers based on the output of the R program

The results of the Koenker–Bassett test show that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.70, 0.75, and 0.73, respectively;

therefore, the null hypothesis H_0 that the variance of the residuals is constant is not rejected. These results indicate that there is no statistical evidence of heteroscedasticity in the QARDL model residuals at the lower, middle, and upper parts of the distribution, Furthermore, the low BP values reflect the stability of error variance across the selected quantiles. Consequently, the results of the Koenker–Bassett test support the model's quality from a diagnostic perspective and confirm the appropriateness of its estimates in terms of the stability of residual variance at a significance level of 0.05.

3-7. Quantile Process/Portmanteau Test

The hypotheses for the Quantile Process/Portmanteau test are as follows:
H0: There are no unaccounted-for dynamics in the model,
H1: There are unaccounted-for dynamics in the model. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 14: Results of the Quantile Process/Portmanteau test for the QARDL model

tau	Q lag 1	p_value lag 1	Q lag 2	p_value lag 2	Q lag 4	p_value lag 4	Q lag 8	p_value lag 8
0.25	0.76	0.38	0.97	0.62	2.51	0.64	3.27	0.92
0.50	0.09	0.76	3.61	0.16	3.76	0.44	10.74	0.22
0.75	1.13	0.29	1.15	0.56	1.41	0.84	3.97	0.86

Source: Compiled by researchers based on the output of the R program

A significance level of 0.05 at quantiles of 0.25, 0.50, and 0.75 and across various lags (lag 1, lag 2, lag 4, and lag 8), therefore, the null hypothesis H0 stating that there are no unexplained dynamics in the model is not rejected. These results indicate that the QARDL model leaves no unaccounted-for dynamic patterns in the residuals at the lower, middle, and upper parts of the distribution, Furthermore, the high likelihood values reflect that the dynamic structure adopted in the model is sufficient to represent the relationship between the variables; consequently, the test results support the diagnostic quality of the QARDL model and confirm that the model is free of unexplained residual dynamics at the 0.05 significance level.

3-8. DQ Dynamic Quantile Test

The hypotheses for the DQ (Dynamic Quantile) Test are as follows:
H0: The conditional coverage is valid, and there are no dynamic errors in quantile estimation;
H1: The conditional coverage is invalid, and there are dynamic errors in quantile estimation. H0 is rejected when the p-value is less than 0.05, and is not rejected when the p-value is greater than 0.05.

Table 15: Results of the DQ (Dynamic Quantile) Test for the QARDL Model

tau	H	DQ	df	p_value
0.25	8	6.77	8	0.56
0.50	8	10.80	8	0.21
0.75	8	4.35	8	0.82

Source: Compiled by researchers based on the output of the R program

The results of the DQ Dynamic Quantile Test show that all p-values were greater than the significance level of 0.05 at the 0.25, 0.50, and 0.75 quantiles, where they were 0.56, 0.21, and 0.82, respectively, Therefore, the null hypothesis H0 stating that the conditional coverage is correct and that there are no dynamic errors in quantile estimation is not rejected. These results indicate that the QARDL model estimates the quantiles correctly from a dynamic perspective at the lower, middle, and upper parts of the distribution. Furthermore, the overall conclusion presented in the table "Conditional coverage is correct" confirms the absence of any obvious shortcomings in conditional coverage. Accordingly, the DQ test results support the quality of the model specification and are consistent with the results of the Quantile Process/ Portmanteau test, which showed the absence of unexplained dynamics, and with the results of the Ramsey RESET test, which confirmed the validity of the model's parametric form at a significance level of 0.05.

IV. Economic Analysis

The economic analysis of the QARDL model results indicates a long-run relationship between economic growth in Algeria and the explanatory variables GS, FE, and CE; the Quantile Bounds test confirmed the presence of cointegration at the 0.25, 0.50, and 0.75 quantiles. Furthermore, the error correction coefficient ECT_t-1 was negative and statistically significant at the 0.05 level across all quantiles, indicating that the model possesses an effective correction mechanism that restores the relationship between the variables to its equilibrium path following short-term shocks.

Long-run coefficients show that the impact of GS on GDP does not follow a uniform pattern across the distribution; it registers a positive effect at the 0.25 quantile with a value of 0.2100, which means that government support may bolster economic growth when the level of economic activity is low, however, this effect turns negative at the 0.50 and 0.75 quantiles, with values of -0.1500 and -0.1200, respectively, indicating that the effectiveness of government support declines at medium and high levels of growth, and its impact may become an economic burden if it is associated with increased pressure on public finances or inefficient resource allocation.

As for FE, it showed a positive and increasing effect in the long term across the three quantiles, with its value rising from 0.3850 at the 0.25 quantile to 0.4250 at the 0.50 quantile, and then to 0.5800 at the 0.75 quantile, indicating that its impact on economic growth becomes stronger as one moves toward higher levels of the GDP distribution. This result reflects the importance of this variable in supporting long-term growth, especially as the level of economic activity improves and the economy's capacity to absorb its effects increases.

CE also shows a positive and increasing effect in the long term, with a value of 0.3250 at the 0.25 quantile, 0.3800 at the 0.50 quantile, and 0.4500 at the 0.75 quantile, This indicates that CE has a positive correlation with GDP across various distribution levels, with greater strength at the upper end, meaning that its role in supporting economic growth becomes more evident when the economy is in an expansionary phase.

The short-run results confirm that DFE and DCE retain a positive and statistically significant effect across all quantiles, while the effect of DGS is significant only at the 0.25 quantile, but becomes insignificant at the 0.50 and 0.75 quantiles, which reinforces the idea that the effect of government support is more pronounced at lower levels of economic activity, while its effectiveness weakens at higher levels.

Accordingly, the results show that the relationship between government support and economic growth in Algeria is asymmetric, varying in both sign and magnitude depending on GDP's position in the distribution. They also confirm that the use of the QARDL model was appropriate because it revealed differences that cannot be detected using a uniform linear model. From an economic perspective, the results point to the need to direct government support toward sectors with a productive impact, while improving the efficiency of public spending, so that support does not shift from being a tool to bolster growth during weak periods to a factor exerting downward pressure during periods of high economic activity.

V. Conclusion

This study sought to measure the impact of government support on economic growth in Algeria during the period 1986–2023, using a QARDL model, with GDP as the dependent variable and GS as the main independent variable, while including FE and CE as explanatory variables. The results indicated the existence of a long-run equilibrium relationship among the study variables at the 0.25, 0.50, and 0.75 quantiles, and the error correction coefficient confirmed the existence of a mechanism of return to equilibrium following short-run shocks.

The results showed that the impact of government support on economic growth in Algeria is asymmetric: the impact of GS was positive in the lowest quantile but turned negative in the middle and highest quantiles, indicating that the effectiveness of support varies depending on the level of economic activity. In contrast, both FE and CE recorded a positive and increasing effect in the long run, reflecting the role of operating and capital expenditures in supporting growth, particularly at higher levels of GDP distribution.

Diagnostic tests also confirmed the quality of the QARDL model, as no issues of serial correlation, heteroskedasticity, or ARCH effects were observed, and the parametric assumptions and conditional coverage were valid. Thus, the results support the suitability of the QARDL model for analyzing the relationship between government support and economic growth, given its ability to detect differences in the effect across distribution levels.

The study concludes that Algeria's government subsidy policy needs to be more precisely targeted toward activities with a productive impact, so that subsidies serve as a tool to support growth during periods of economic weakness and do not become a financial burden during periods of increased economic activity.

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