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Revisiting the Validity of Wagner's Law in Algeria during 1970-2018: New Evidence from Linear and Nonlinear Models

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Abstract:

This research aims to verify the validity of Wagner's Law in Algeria during 1970-2018. Both linear and nonlinear models (ARDL, NARDL) are used to investigate this Law's long-run relationship. The results showed a one-way connection from economic growth to government spending, also a linear and nonlinear cointegration of the relationship between them. Consequently, this result provides the theoretical support for the Wagner's Law in Algeria for the six recognized versions that reflect the validity of this Law during the period of study.

Keywords: *Government Spending; Economic Growth; Wagner's Law; ARDL; NARDL; Algeria.*

Jel Classification Codes : *E62; H30; H50; O47; N47.*

الملخص

يهدف هذا البحث إلى التحقق من صلاحية قانون فاجنر في الجزائر خلال الفترة 1970-2018. يتم استخدام كل من النماذج الخطية وغير الخطية (ARDL، NARDL) للتحقق من العلاقة طويلة المدى لهذا القانون. أظهرت النتائج الأولية أن هناك علاقة أحادية الاتجاه من النمو الاقتصادي نحو الإنفاق الحكومي، كما أظهرت أن هناك تكاملا خطيا وغير خطي للعلاقة بينهما. توفر هذه النتيجة الدعم النظري لقانون فاجنر في الجزائر للإصدارت الستة المتعارف عليها والتي تعكس صلاحية هذا القانون خلال فترة الدراسة.

الكلمات المفتاحية: الإنفاق الحكومي؛ النمو الاقتصادي؛ قانون فاغنر؛ ARDL؛ NARDL؛ الجزائر.

أكواد تصنيف جال: *E62 ؛ H30 ؛ H50 ؛ O47 ؛ N47.*

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I. Introduction

Government spending as an instrument of economic policy is of great importance in achieving the most important economic policy objectives, especially in terms of promoting economic growth, reducing unemployment, and redistributing income. This tool is of great economic importance to developing countries that cannot achieve the desired economic policy objectives just on monetary policy.

The debate on the effectiveness of the government expenditure tool as a means of maintaining economic stability has been characterized by considerable attention and the remarkable development over the past 50 years, whether through several theoretical studies or applied studies, and various arguments about the relationship between government expenditure and economic growth. This scientific debate has helped many governments take advantage of this research to properly use fiscal policy instruments to reach the established economic and social goals.

Algeria has adopted a package of fiscal policy reforms, including reform of the tax system and introducing policies to guide and rationalize spending in the early 1990s. However, after the rise in oil prices in early 1999, the country adopted an expansionary spending policy (an economic and other stimulus packages to support and promote economic growth) based on Keynesian trends from 1999 to 2017. The aim was to support economic growth and reduce unemployment.

This article aims to contribute to the follow-up of the theoretical literature to test the adequacy of Wagner's Law of the Algerian economy using modern techniques in econometrics and to know how far this Law can be relied upon in defining, rationalizing, and directing public spending. Examining the long-run relationship between government spending and economic growth is essential as it provides policymakers with precise information about the effectiveness of the fiscal policy. The researchers will evaluate an expansionary budgetary policy instrument in Algeria and its relation to economic growth. In the end, we offer proposals that increase the role and effectiveness of state intervention by guiding and rationalizing public spending as a tool for achieving economic and social balance.

The main question of this research paper can be formulated as follows: Is an increase in government expenditure responsible for the increase in economic growth in the region or the other way round? In literature, the linear and nonlinear cointegration test has been considered as a veritable tool of analysis to solve this question in this study.

To answer the main question and confirm one of the two main hypothesis, whether the Keynesian hypothesis or Wagner's law in this field. We will apply

these tests; we hope to obtain a better understanding of the relationship between government spending and real GDP to distinguish between Wagner's law and the Keynesian hypothesis and to assist the Algerian policymakers to make their strategic decisions.

The remainder of this paper is structured as follows. Section 2 contains a brief description of Wagner's Law and reviews the empirical literature on fiscal sustainability and Wagner's Law in some countries. Section 3 provides a short review of the estimated models; Section 4 describes the data, the empirical results obtained in this paper, and the discussion. Section 5 states the conclusions and some remarks.

II. Theoretical Framework and Previous Studies

II.1 Theoretical Framework of Wagner's Law

Fiscal policy plays a significant role in promoting economic activity and achieve price stability. Government spending is one of the most important tools of fiscal policy. Policymakers use government spending in driving growth and macroeconomic performance, whether during crisis or recovery periods. Due to its great importance, the relationship between government spending and economic growth is still debated and studied.

During the 20th century, governments sought to provide more public goods and services to citizens to meet their growing needs with increasing growth. This is known as Wagner's Law or the 'law of increasing state activities,' which states that governments expand their spending activities with increased economic growth. The German political economist Adolph Wagner (1835–1917) explained the expansion of state activity with the advancement of industrialized countries in three ways: increased demand for administrative and protective functions, increased demand for cultural and welfare services, and the expansion of the markets accompanying industrial progress require state intervention in order to regulate them (Nirola & Sahu, 2020, p. 242).

On the contrary, Keynes assumed an inverse relationship running from public expenditure to income. During the Great Depression, Keynes urged countries to pursue an expansionary fiscal policy to support the economy and avoid a long-term recession.

Wagner's Law is the first model of public spending in the history of public finances. The relationship between government expenditure and national production is vital for many policy issues. For instance, periods of recessionary hampers the ability of central authorities to stimulate their economy through fiscal measures unless the share of government spending increases to GNP. Wagner's Law states that when national income per capita increases, then part from government spending will rise to GNP. However, he did not provide any

mathematical formulation to examine these hypotheses (Paparas, Richter, & Kostakis, p. 271). Currently**,** although many different models reflect Wagner's fundamental Law, there is agreement on six reliable versions of the test the validity of this Law: (Peacock & Wiseman, 1961), (Gupta, 1967), (Goffman, 1968), (Pryor, 1969), (Musgrave, 1969), (Mann, 1980). These versions can be summarized as follows:

Table (01): The different versions of Wagner's Law

Model	Version	Functional Form
I	The Peacock-Wisemen (1961)	$LogEX_t = \alpha + \beta logGDP_t$
II	The Gupta-Michos (1967)	$Log(EX_t/POP_t) = \alpha + \beta \log(GDP_t/POP_t)$
III	The Goffman (1968)	$LogEX_t = \alpha + \beta \log(GDP_t/POP_t)$
IV	The Pryor (1969)	$LogCEX_t = \alpha + \beta logGDP_t$
V	The Musgrave (1969)	$Log(EX_t/GDP_t) = \alpha + \beta \log(GDP_t/POP_t)$
VI	The Mann (1980)	$Log(EX_t/GDP_t) = \alpha + \beta \log GDP_t$

Notes: GDP_t: is the real Gross Domestic Product, EX_t: is the actual government expenditures; FON_t is the real government consumption expenditure; POP_t is population; (EX_t/GDP_t) is the share of government spending in total output; (GDP_t/POP_t) real GDP per capita and (EX_t/POP_t) : is real total government spending per capita.

Source: Halicioğlu, F. (2003). Testing Wagner's Law for Turkey, 1960-2000. Review of Middle East Economics and Finance, 1(2), p 131.

Following a review of the most important versions of this Law in many empirical studies, and after attempts to select the most important formula to test the validity of Wagner's Law, we have shown the advantage of using the logarithmic formula for all versions. As it is common to economic studies, the logarithmic formula is applied to the variables. It is a suitable method, which has positives such as removing the exponential direction, the sharp directions, and converting the model formula for the linear formula if the original form is nonlinear.

II.2 Literature Review

Empirically, many researchers have tried to verify the validity of Wagner's Law by using different econometric methods and different samples during different periods**.**

Some studies have provided support for the validity of Wagner's Law from a number of economics such as Hondroyiannis and Papapetrou (1995) for Greece, Ahsan et al. (1996) for Canada, Asseery et al. (1999) in Iraq, Sahoo (2001) in the Indian economy, Olomola (2004) for Nigeria, Iyare and Lorde (2004) for nine Caribbean countries, Afzal and Abbas (2010) for Pakistan, Govindaraju et al. (2011) in Malaysia, Kesavarajah (2012) for Sri Lanka, Bashirli et al. (2013) in Azerbaijan.

In contrast, some studies reject this Law, among them Jaén-García (2018) for Spain, Kónya & Abdullaev (2018) in Australia, Sedrakyan & Varela-Candamio (2019) in Armenia and Spain.

Recently, several studies have emphasized the asymmetric effect of economic growth on government spending and the nonlinearity of the relationship: Kuckuck (2014), Leshoro (2017), Phiri (2017), Karceski & Kiser (2020), Raifu & Aminu (2020).

Andrew Phiri (2017) investigates the nonlinear relationship between government expenditure and economic growth for South Africa by applying momentum threshold autoregressive (MTAR) to six variations of Wagner's Law during the period 1960 – 2015. The author finds a positive long-run relationship between different proxies of government spending and output productivity, which is confirmed by Granger causality tests: government expenditure causes GDP, per capita, government expenditure engenders per capita GDP, national income affects government consumption, and share of government expenditure in GDP causes GDP. Therefore, these results support the Keynesian hypothesis because the findings indicate that positive increases in public spending lead to improved GDP levels. Moreover, adverse developments in the economic variables have longer-lasting effects than positive ones because the negative deviations are slower to be eradicated than the positive ones. The study suggests that government has to find alternative forms of financing to avoid overwhelming interest payments for a debt. It is necessary to coordinate between fiscal and monetary policies to increase economic growth (Phiri, 2017).

M. Cavicchioli & B. Pistoresi (2016) examine the nonlinear asymmetric effects of government spending and GDP in Italy during the period 1862–2009. The estimation of the linear vector error-correction model (VECM) indicates bidirectional in the two variables. Afterward, the authors apply threshold cointegration using simulation for both fixed regressor and residual bootstrap, and the result 5000 bootstrap replications. The LM test does not reject the null hypothesis of linearity at a 5% significance level. Moreover, asymmetric error-correction effects distinguish two different regimes: 87% of all the observations belong to the first regime (say, "normal") and the remaining 13% to the second regime (say, "extreme"). The irregular response to government expenditure of the "extreme" administration is due to temporary evolutions of defense spending during the wars, which imply a hyper-adjustment of total government spending. Furthermore, the findings show asymmetry between real per capita GDP and government expenditure in the "extreme" regime compared to the "normal" one. According to these results, the model of public spending is fundamentally linear and consistent with an expanding measure of government sectors as the economy progresses. At the same time, the nonlinearities are large and transitory due to the

national defense expenditures. This study suggests that the Italian government could improve the quality of human capital by applying substantial investments to stimulate long-term growth (Cavicchioli & Pistoresi, 2016).

Bayrakdar, S., Demez, S., and Yapar, M (2015) examine the direction of causation between public expenditures and GDP growth for the Turkish economy using quarterly series 1998:1–2014:4. According to the unit root test, these two variables are stationary in their first difference, allowing the application of the Hatemi-J Structural Breaks Cointegration Test. Both variables have two long-term structural breakpoints; the economic recovery of 2001 is manifested via breaks points obtained at the second quarter of 2002 and second quarter of 2003. However, breaks found in the third quarter of 2006 and the first quarter of 2007 caused the global crisis in 2008, which has decreased the economic growth rate. The results of the Granger causality test show a unidirectional causality from GDP to government expenditure; however, public spending does not cause GDP, which proves the validity of Wagner's Law in Turkey during the period of study (Bayrakdar, Demez, & Yapar, 2015).

Bashirli, S, and Sabiroglu, I.M. (2013) study the relationship between public spending and economic growth in Azerbaijan, including oil prices. The authors apply the bounds testing approach and autoregressive distributed lag (ARDL) based on quarterly data over the period 2001 – 2010. The results indicate that the growth of government expenditure is directly dependent on economic growth, as Wagner's Law states. Moreover, during the studied period, the real value of GDP has quadrupled, and the volume of government budget expenditure has increased about 15 times. This increase in public spending is caused by the favorable trend in the price of crude oil. That is why the authors take oil price as an exogenous variable in the sixth model, which confirms that in oil-exporting countries, a particular part of oil revenues enters directly into the state budget (Bashirli & Sabiroglu, 2013).

III. Government Spending Policy Evolution in Algeria

Usually, the size of public revenues is the most critical determinant of the size of public expenditures. Hydrocarbon exports constitute more than 90 percent of Algeria's exports. Oil revenues represent two-thirds of Algeria's revenues. Indeed, whoever follows the economic growth trends and economic policies in Algeria notes that it was closely related to the fluctuations that occurred in oil prices. For Algeria, the oil rents are both a source of crisis and a way out of them. This necessarily means that government spending policy often follows the fluctuations in the oil markets.

The sharp drop in oil prices in 1986 made it necessary for Algeria to undertake many reforms, especially in its spending policies. The significant drop

in oil prices and the resulting decline in revenues made Algeria reconsider its spending policy. Faced with a scarcity of resources, Algeria adopted an austerity spending policy.

The rapid rise in oil prices at the beginning of the third millennium enabled Algeria to pursue an expansionary fiscal policy. It has implemented many programs that support economic growth. The first is the economic recovery program covering the period 2001-2004 and whose final cost reached about 216.1 billion dinars (equivalent to 16 billion dollars). This program was followed by the Supplementary Growth Support Program during the period 2005-2009, which cost about 130 billion dollars. Finally, consolidation of Economic Growth Program 2010-2014 with a financial envelope equivalent to about 286 billion dollars**.**

During this period, Algeria achieved higher growth rates, as the rate of GDP growth increased from 1.6% on average during the 1990s to an average of 3.7% between 2000 and 2014. A public spending boom marked this period. Capital spending increased from 20% of state expenditures at the end of the 1990s to 40% between 2006 and 2014. Personnel costs and social spending, mainly subsidies (food, energy, and housing), accounted for 45.8% of GDP in 2015 (United Nations, 2020)

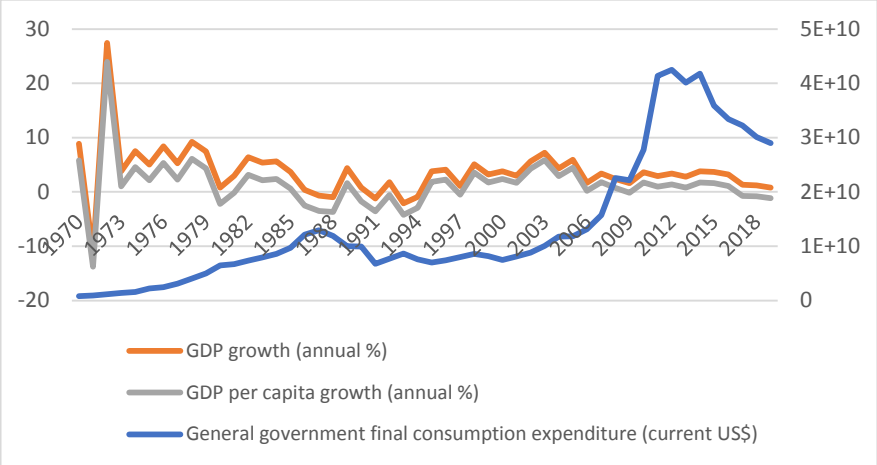
In 2014, the oil market experienced another shock, as prices fell dramatically and continuously in subsequent years. As a result, the budget balance showed a deficit of -15.3% in 2015, -13.2% in 2016, and -8.8% in 2017 (United Nations, 2020). To face this deterioration and budgetary restrictions, Algeria took a set of measures, the most important of which was reducing public expenditures, and it adopted an austerity spending policy.

However, despite the measures taken, the budget deficit continued during the following years. The general fiscal balance of the Algerian central government deteriorated from -6.8% of GDP in 2018 to -9.6% of GDP in 2019. International reserves decreased to $ 61.5 billion at the end of 2019, compared to $ 78.6 billion at the end of 2018**.** In 2019, government revenues decreased by 1.2% of GDP due to the lower hydrocarbon revenues, and at the same time, government spending increased by 1.6% of GDP (World Bank, 2020). Simultaneously, the Algerian economy recorded a slowdown in growth, to 1.6% in 2017, 1.2% in 2018, and 0.8% in 2019.

Once again, this year, Covid-19 caused a significant decrease in budget revenues due to the reduction of oil profits and gains from taxes because of the suspension of activity in many sectors. In the face of this dual crisis, Algeria has tended to cut expenditures in half through a supplementary finance law, at a time when spending in the health field has increased. Especially while the continued decline in foreign reserves to 44 billion US dollars in July 2020, compared to 195

billion dollars at the end of 2013**.** It is expected that restrictions on government spending will increase in the coming years, which may affect growth.

Fig (01): Economic growth and government expenditure during 1970-2019



Source: WBI database.

IV. Study Methodology

The present study tries to investigate the validity of Wagner's law on the impact of government spending on economic growth in Algeria using annual data from 1970 to 2018. For the empirical investigation, the study has employed ARDL and NARDL bounds testing approach to cointegration model. Also, as an important condition of time series data, we utilized unit root test with structural breaks tests to make sure stationary in the variables.

IV.1. The ARDL Model

This study utilizes the autoregressive distributed lag (ARDL) model proposed by (Pesaran, Shin, & Smith, 2001) to examine the cointegration relationship between economic growth and government spending. This procedure has several advantages over numerous methods available for conducting the cointegration test such as (Engle & Granger, 1987) two-step (1987) test, the maximum likelihood-based (Johansen, 1991) and (Johansen & Juselius, 1990) tests. The econometric advantages of the ARDL method include:

- The simultaneous estimation of the model's long- and short-run parameters removes problems associated with omitted variables and autocorrelation;
- The main advantage of this testing lies in the fact that it can be applied irrespective of the regressors are I(0) or I(1), and this avoids the pre-testing problems associated with standard cointegration analysis, which requires the classification of the variables into I(1) and I(0);

- The inability to test hypotheses on the estimated coefficients in the long run associated with the Engle-Granger method are avoided;
- Pesaran and Shin (1999) argued that the ARDL technique could be reliably used in small samples to estimate and test hypotheses on the long-run coefficient in both cases where the underlying regressors are I(1) or I(0) (Pesaran & Shin, 1999). While the Johansen cointegration techniques require larger samples for the results to be valid (Ghatak & Siddiki, 2001). For the reasons above, we use the ARDL technique to examine the validity of Wagner's Law in Algeria with six versions. The first step in the ARDL approach is to estimate the following unrestricted ECM:

$$\Delta \mathrm{LEX_t} = \alpha + \beta_1 \mathrm{LEX_{t-1}} + \beta_2 \mathrm{LGDP_{t-1}} + \sum_{i=1}^{p} \gamma_1 \Delta \mathrm{LGDP_{t-1}} + \sum_{i=1}^{q} \gamma_2 \Delta \mathrm{LEX_{t-1}} + \varepsilon_t \quad (1)$$

The first step in the ARDL bounds testing approach is to estimate the model by ordinary least squares (OLS). We conduct a Wald test (F-Statistic) by imposing restrictions on the estimated long-run coefficients. The null and alternative hypotheses are:

H_0: $\beta_1 = \beta_2 = 0$: (no long-run relationship)

H_1: $\beta_1 \neq \beta_2 \neq 0$: (a long-run relationship exists)

The computed F-statistic value is compared with the critical values tabulated in the table of (Pesaran, Shin, & Smith, 2001). If the computed F-statistic falls outside the band (the values for I(0) and I(1) in Table F), a conclusive decision can be made.

- If the computed F-statistic exceeds the upper bound of the critical value band (denote I(1) in Table F), the null hypothesis can be rejected and then support cointegration, and;
- If the computed F-statistic falls well below the lower bound of the critical value band (denote I(0) in Table F), and hence the null hypothesis cannot be rejected, with no cointegration.

Once the cointegration is established, in the second step, the orders of the lags in the ARDL model are selected by inference to either the (AIC) or (SBC). Following (Pesaran & Pesaran, 1997, p. 353), the optimal lag order is chosen based on the highest value of AIC or SBC. The conditional ARDL long-run model for $\mathrm{LEX_t}$ can be estimated as:

$$\mathrm{LEX_t} = \alpha + \sum_{i=1}^{p} \beta_1 \mathrm{LEX_{t-1}} + \sum_{i=0}^{q} \beta_2 \mathrm{LGDP_{t-1}} + \varepsilon_t \quad (2)$$

We obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates in the final step. This is specified as follows:

$$\Delta \mathrm{LEX_t} = \alpha + \sum_{i=0}^{q} \gamma_1 \, \Delta \mathrm{LGDP}_{t-1} + \sum_{i=1}^{p} \gamma_2 \, \Delta \, \mathrm{LEX}_{t-1} + \varepsilon_t \qquad (3)$$

Where, γ_1 and γ_2 are the short-run dynamic coefficients of the model convergence to equilibrium and ϕ is the speed of adjustment parameter, and ECM is the error correction term that is derived from the estimated equilibrium relationship of Equation (2) and (3). Also, we employ a nonlinear ARDL cointegration methodology. This technique was advanced by Shin et al. (2011) and is an asymmetric expansion of the linear ARDL model (Pesaran & Shin, 1999); (Pesaran, Shin, & Smith, 2001).

IV.2 The NARDL Model:

We employ a nonlinear ARDL cointegration methodology. Shin et al. (2011) advanced this technique, and it is an asymmetric expansion of the linear ARDL model (Pesaran & Shin, 1999); (Pesaran, Shin, & Smith, 2001). In this study, an asymmetric cointegration approach is used to examine Wagner's law validity. The nonlinear autoregressive distributed lag NARDL model estimates short and long-run nonlinearities via positive and negative partial sum decompositions of explanatory variables. The asymmetric long-run relationship can be formulated as below:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t \qquad (4)$$

Where u_t is a stationary zero-mean error process that represents deviations from the long-run equilibrium, where β^+ is the long-run coefficient associated with the positive change in x_t and β^- is the long-run coefficient associated with the negative change in x_t.where $x_t$is a $k \times 1$ vector of regressors decomposed as:

$$x_t = x_0 + x_t^+ + x_t^- \qquad (5)$$

Where x_0 is an arbitrary initial value and x_t^+ and x_t^- denote partial sum processes which accumulate positive and negative changes in x_0, respectively, and are defined as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} max(\Delta x_j, 0) \qquad (6)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} min(\Delta x_j, 0) \qquad (7)$$

Shin et al. (2011) showed that by associating (4) with the linear ARDL (p,q) model (Pesaran & Shin, 1999); (Pesaran, Shin, & Smith, 2001), we could obtain

the NARDL(p,q) asymmetric conditional model. The asymmetric error correction model AECM is:

$$\Delta y_t = \mu + \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \phi_j \Delta y_{t-j} + \sum_{j=0}^{q} \left(\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{t-j}^-\right) + u_t \quad (8)$$

For $j = 1, \ldots\ldots q$, where $\theta^+ = -\rho/\beta^+$ and $\theta^- = -\rho/\beta^-$, Δ is the first difference operator and $u_t$is a white noise. This new technique presents the long and short-run asymmetric effect in four steps:

1- We would estimate Equation (8) using the OLS method.

2- The second step involves testing for the presence of a cointegration relationship between the levels of the series y_t, $x^+$and x^- using the F_{PSS} (based on a modified F-test) statistic proposed by Shin, Yu, and Greenwood-Nimmo (2014), which refers to the joint null hypothesis of no cointegration $\rho = \theta^+ = \theta^- = 0$, against the alternative of cointegration $\rho \neq \theta^+ \neq \theta^- \neq 0$.

The relevant testing procedure uses two critical bounds; the upper and the lower (Shin, Yu, & Greenwood-Nimmo, 2014). If the empirical value of the F_{PSS} statistic exceeds the upper bound, then there is evidence of a long-run equilibrium relationship; if it lies below the lower critical bound, the null hypothesis cannot be rejected; and if it lies between the critical bounds, the test is inconclusive.

3-In step three, using the Wald test, we examine for long-run symmetry where, $\theta = \theta^+ = \theta^-$and short-run symmetry, which can take one of the following forms:

$$(j) \quad \pi_j^+ = \pi_j^- \text{ for all } j = 1,,,,,q \text{ or } \Sigma_{j=0}^{q} \pi_j^+ = \Sigma_{j=0}^{q} \pi_j^- .$$

4- Once the existence of a cointegration relation is confirmed, the estimation of the asymmetric dynamic multiplier effects of a unit change in $x^+$and x^-on y_t, we can use the following Equation.

$$m_{\square}^+ = \sum_{j=0}^{\square} \frac{\partial y_{t+j}}{\partial x_t^+}, \quad m_{\square}^- = \sum_{j=0}^{\square} \frac{\partial y_{t+j}}{\partial x_t^-}, \quad \square = 0,1,2,\ldots\ldots$$

Whereas $\square \rightarrow \infty$, the $m_{\square}^+ \rightarrow \beta^+$ and $m_{\square}^- \rightarrow \beta^-$. Recall that β^+ and β^- are the asymmetric long-run coefficients and here can be calculated as $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$ respectively.

5- The last step consists of driving the asymmetric cumulative dynamic multiplier impacts of 1% increase and 1% decrease in each independent variable on the dependent variable.

V. Empirical Methodology:

V.1. Sources and Data:

This paper adopts six versions of Wagner's Law to investigate the relationship between government expenditure and economic growth. The data used in this econometric study is as follows: The genuine gross domestic product (GDP_t), real government expenditure (EX_t) are proxies by actual total government expenditure of goods and services, the share of real government expenditure is measured by the ratio of real government expenditure to real GDP. Moreover, Per capita real GDP (GDP_t/POP_t) and per capita government expenditure (EX_t/POP_t) were obtained by, respectively, dividing real GDP and tangible government expenditure by population and consumption expenditure CEX_t.

The data used covered the period 1970-2018, and they are obtained from national and international organizations (ONS, CNES, FMI WB). The authentic gross domestic product (GDP_t), real government expenditure (EX_t) are measured in 2000 constant prices (these variables have been deflated at 2000 prices by using an appropriate deflator). For analysis, all data series are transformed into natural logarithms and denoted by the following variable names; $LGDP_t$, LEX_t, $L(GDP_t/POP_t)$, $L(EX_t/POP_t)$, $LOPE_t$, $L(EX_t/GDP_t)$.

V.2 Unit Root Tests:

The first step for cointegration tests is to examine the stationery properties of all the variables. The unit root tests such as PP and ADF and other traditional unit roots often lead to spurious results by ignoring the series's structural break (Rahman & Ahmad, 2019). Thus, we performed the breakpoint unit root test[1], which is reported in Table 02.

[1] Perron (1989) proved that structural change in time series can influence the results of tests for unit roots.

Table (02): Breakpoint unit root test

Variable	At level				At 1st difference				I(..)
	Intercept		Intercept & Trend		Intercept		Intercept & Trend		
	Bd	T-stat	Bd	T-stat	Bd	T-stat	Bd	T-stat	
LEX_t	2000	-2.65	1988	-4.24	1982	-7.32*	1982	-7.28*	**I(1)**
$LGDP_t$	2004	-5.45*	1990	-7.33*	1979	-13.69*	1979	-13.63*	**I(0)**
$L(EX_t/POP_t)$	2006	-3.88	1988	-4.55	1982	-7.18*	1982	-7.19*	**I(1)**
$L(GDP_t/POP_t)$	2002	-6.57*	2002	-5.19**	1979	-12.32*	1996	-13.59*	**I(0)**
$LCEX_t$	2006	-2.48	1974	-3.84	2005	-8.67*	2005	-8.97*	**I(1)**
$L(EX_t/GDP_t)$	2006	-4.15	1988	-4.55	2015	-7.91*	2015	-7.81	**I(1)**

*, ** and *** represent significance at 1 %, 5% and 10% level respectively. The maximum lag is set at 4. The breakpoint is selected by Dickey-Fuller min-t method; the lag length is selected based on the Schwarz criterion. Bd Break date. Each test uses an intercept and intercepts with a trend.

Source: Elaborated by the authors from Eviews.10 output.

These results confirm that most series are integrated of order one but two series ($LGDP_t$ $L(GDP_t/POP_t)$) are integrated of order zero.

Since a unit root has been confirmed for the data series in this study, the question is whether there exists some long-run equilibrium relationship between economic growth and government expenditure.

Table (03): Bounds test approach to cointegration

Model	The stationarity of variables		A cointegration approach	The estimation methods
I	LEX_t	I(1)	1- Bounds testing approach 2- Bounds test results in a nonlinear specification	1- ARDL 2- NARDL
	$LGDP_t$	I(0)		
II	$L(EX_t/POP_t)$	I(1)		
	$L(GDP_t/POP_t)$	I(0)		
III	LEX_t	I(1)		
	$L(GDP_t/POP_t)$	I(0)		
IV	$LCEX_t$	I(1)		
	$LGDP_t$	I(0)		
V	$L(EX_t/GDP_t)$	I(1)		
	$L(GDP_t/POP_t)$	I(0)		
VI	$L(EX_t/GDP_t)$	I(1)		
	$LGDP_t$	I(0)		

Source: Elaborated by the authors based on a new approach developed by Pesaran et al. (2001) and Shin et al. (2014).

VI. Study Results

Table 04. reports the results of the ARDL and NARDL bounds testing procedure to cointegration between economic growth and government expenditure.

Table (04): Results of Bounds Tests (ARDL / NARDL)

ARDL		
Versions	**F- statistic**	**Result**
Ⅰ	3.60***	Yes
Ⅱ	4.26 **	Yes
Ⅲ	7.39 **	Yes
Ⅳ	3.23	No
Ⅴ	4.26 **	Yes
Ⅵ	4.52 ** (No C No T)	Yes
NARDL		
Ⅳ	4.50 ***	Yes

Note: Border critical value achieved from Pesaran and Pesaran (1997). The lag structure was selected based on the SC. The bound critical values are obtained from 'Table CI (iii). Case III: unrestricted intercept and no trend' (Pesaran et al. 2001). *, ** and *** significant at 1%, 5% and 10% significance level.

F-statistic values are calculated using the bounds testing approach by Pesaran et al. (2001) and Shin et al. (2014). The null hypothesis of asymmetric cointegration is$\rho = \theta^{+} = \theta^{-} = 0$.

Source: Elaborated by the authors from Eviews.10 output.

In Table 04. there are the results of the bound testing approach. The computed F- stat for five models (Ⅰ , Ⅱ, Ⅲ, Ⅴ, Ⅵ) of Wagner's Law in the case of Algeria is greater than the greater bound critical values even at 5, 10 % level. These results indicate the existence of cointegration between economic growth and government spending in five versions of Wagner's Law using ARDL bound testing. However, in model Ⅳ, the computed F-stat is lower than the lower bound critical values even at the 10% level. These results indicate that there exists no cointegration between these variables. For this model (Ⅳ), we use NARDL (nonlinear) bound testing approach. For the asymmetric ARDL, bounds test results show that there is evidence of cointegration among $LCEX_t$, $LGDP_t$ because the computed asymmetric ARDL F-statistic value (4.50) exceeds the tabulated value of the upper bound at the 10% level of significance, the presence of cointegration implies short-run dynamics, which will lead to an equilibrium in the long-run. Therefore, it is possible to estimate the model in the long-term and an Error Correction Model (ECM) to know the short-run

dynamics between economic growth and the growth of public expenditure in Algeria. The results are registered in these Tables.

Table (05): Long-run and Error Correction Models Results

Variables	I ARDL(.,.) LEX_t	II ARDL(.,.) $L(EX_t/POP_t)$	III ARDL(.,.) LEX_t	V ARDL(.,.) $L(EX_t/GDP_t)$	VI ARDL(2,4) $L(EX_t/GDP_t)$
Long-run results					
C	-8.27 *	-9.76 *	---	-5.15 **	---
$LGDP_t$	1.25 *	---	---	---	0.12 *
$L(GDP_t/POP_t)$	---	1.74 *	1.47 *	0.74 *	---
$L(EX_t/POP_t)$	---	---	---	---	---
Short-run results					
C	---	---	5.81 *	---	---
Trend	---	---	0.01 *	---	---
$dLEX_t(-1)$	0.30 **	---	0.31 **	---	---
$dL\,EX_t/GDP_t\,(-1)$	---	---	---	0.30 **	0.27 ***
$dL\,EX_t/POP\,(-1)$	---	0.30 **	---	---	---
$dLGDP_t$	0.40	---	---	---	-0.73
$dLGDP_t(-1)$	-0.25	---	---	---	0.04
$dLGDP_t(-2)$	-0.35	---	---	---	-0.49
$dLGDP_t(-3)$	1.16	---	---	---	1.13 *
$L\,GDP_t/POP_t$	---	0.71	0.41	-0.29	---
$L\,GDP_t/POP_t\,(-1)$	---	-0.51	-0.59	-0.21	---
$L\,GDP_t/POP_t\,(-2)$	---	-0.66 ***	-0.94 **	-0.66 ***	---
$L\,GDP_t/POP_t\,(-3)$	---	0.85 **	0.70 ***	0.85 **	---
$ECM(-1)$	-0.41 *	-0.54 *	-0.58 *	-0.54 *	-0.34 *
Diagnostic Tests of ARDL model					
	I	II	III	V	VI
Serial Correlation (x^2_{SC})	0.25 (2) Prob = 0.88	0.01 (2) Prob = 0.99	0.02 (2) Prob = 0.98	0.01 (2) Prob = 0.99	0.004 (2) Prob = 0.99
Heteroskedasticity (x^2_{het})	2.72 (2) Prob = 0.25	1.23 (1) Prob = 0.26	1.63 (1) Prob = 0.20	1.23 (1) Prob = 0.26	1.65 (1) Prob = 0.19
Normality	JB = 1.83 Pro = 0.39	JB = 1.93 Pro = 0.38	JB = 2.41 Pro = 0.29	JB = 1.93 Pro = 0.38	JB = 1.63 Pro = 0.44
CUSUM	Stable	Stable	Stable	Stable	Stable
CUSUMSQ	Stable	Stable	Stable	Stable	Stable

Note: *, ** and *** significant at 1%, 5% and 10% significance level.

Source: Elaborated by the authors from Eviews.10 output.

Table (06): NARDL Estimation results (Model Ⅳ)

Variable Coefficient		T-Statistic	P-value
c	11.22 *	3.62	0.0008
$LFONC(-1)$	-0.43 *	-3.59	0.0008
$LGDP^{+}$	0.47 *	3.26	0.0022
$LGDP^{-}$	-0.40	-0.42	0.6737
ECM(-1)	-0.43 *	-3.75	0.0005
Long-run LR asymmetric			
$LGDP^{+}$ (θ^{+})		1.08 *	
$LGDP^{-}$ (θ^{-})		-0.93	
W_{LR}		3.05 *	
Statistics and Diagnostics tests of NARDL model			
Residuals test	Null hypothesis		P-Vlu
LM test	Residuals are not auto-correlated		0.98
ARCH test	Variances of Residual are homoscedastic		0.12
Normality test	Residuals are normally distributed		0.85
CUSUM and CUSUMSQ	Stable		

Note: *, ** and *** significant at 1%, 5% and 10% significance level. WLR: Wald test for the null of long-run symmetry.

Source: Elaborated by the authors from Eviews.10 output.

In the long-run, we note that coefficient (elasticity) is more significant than one in the models from Ⅰ, Ⅱ, Ⅲ, and Ⅳ. Nevertheless, in the Ⅴ, Ⅵ models, the coefficient was between 0 and 1. These results can be regarded as evidence in support of Wagner's Law. As presented in the model (Ⅳ), the result shows asymmetric long-run relations between government expenditure and economic growth. The increase in GDP growth is positive and significantly affects government expenditure, while the reduction in economic growth has a negative effect on government expenditure. In long-run, for example to model (Ⅰ), the result shows that a 1% increase in economic growth is affecting on the rise in the expected government expenditure by 1.25%. This finding implies that in the period of financial booms, the government spends more. The result shows that economic growth is a major factor influencing the expenditure of the government of Algeria.

In contrast, in the model (Ⅳ), the effect of the harmful component of economic growth on government expenditure is negatively significant and more minor in magnitude, with a 1% decrease in economic growth

resulting in about 0.93% decrease in government expenditure. In the long-run, the result of model (4) was also to show that positive economic growth has a considerably more significant impact on government expenditure than negative growth. It suggests that government expenditure responses to variations in economic growth do not need to be the same during the booms as during recessions. It depends on the intensity and magnitude of the economic fluctuations. In the short-run most coefficients estimated (elasticity) are between zero and one. This means that the impact of economic growth on the volume of government spending in the short term is less than its effect in the long-run.

We obtained estimations of model error correction (ECM) as shown in Tables 5 and 6. The error correction coefficient of all models is very significant, and it displays a speed adjustment, which is reasonably fast towards equilibrium after a shock. It was found that between 34% and 58% nonequilibrium had happened in last year's shock, and it was corrected to the long-term equilibrium in the current year.

Furthermore, a summary of residual diagnostics of ARDL or NARDL models suggests that residuals are normally distributed and are not auto-correlated. The variances in residual are homoscedastic, and there is no autoregressive conditional heteroscedastic (ARCH) effect. The results of CUSUM and CUSUMSQ confirm the stability of long-run parameters at the 5% level of significance.

VII. Conclusion

This paper provides empirical support to the strict version of Wagner's Law in the case of Algeria for the period 1970 to 2018. The popular six mathematical models of Wagner's Law have been estimated. An econometric-based bound testing cointegration analysis has been utilized to identify the long-run relationship between economic growth and government spending. This is the best-suited technique to find out short-run as well as long-run relationships between these variables

We examined the long-run relationship between government expenditure and economic growth for investigating Wagner's Law in Algeria. By using the bounds test approach to cointegration developed by Pesaran et al. (2001), and using the nonlinear autoregressive distributed lag bounds testing (NARDL), recently acquired by Shin & al (2014).

We found that there was a relationship running from economic growth to the size of government. Our empirical findings confirm the validity of Wagner's Law in the Algerian economy: Economic growth has been a significant factor in

the public sector growth (Especially the oil sector). It was that contributed to the increase in public spending.

We have achieved a very important result by declaring that this relationship applies to the Algerian economy. It explains the economic truth in Algeria that economic growth can direct and limit the volume of public spending, and from there, the increase in public expenditure in Algeria is only the result of the rise in GDP associated with high oil prices. Hence, the expansionary fiscal policy with Keynesian implications is ineffective in the case of Algeria.

We believe that our analysis may be helpful for policymakers and governments to determine which economic policies should be adopted and specially to identify the fiscal policy stance to be adopted by a particular government over time.

Based on the findings of the study, some suggestions can be made as follows:

- It is suggested that the Algerian government install some procedures to rationalize government expenditures to ensure fiscal discipline.

It is better for the government to reinvest the surplus from oil revenues into other sectors of the economy a priority base that will reduce the negative effects of a decrease in oil price.

- Use available resources efficiently by allocating more resources to productive sectors in the future to have output-enhancing government expenditure.

- There is a need for government to make a giant effort in diversifying the public revenue base to curtail the long-term effect of oil revenue fluctuation in the Algerian economy.

- There is an urgent need to the proper use of debt in financing-efficient projects in the Algerian economy.

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