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THE FREQUENCY-DOMAIN CAUSALITY RELATIONSHIP BETWEEN GOVERNMENT SPENDING AND GDP FOR THE PERIOD 1967-2023: WHICH IS MORE VALID IN ALGERIA, THE KEYNESIAN HYPOTHESIS OR WAGNER'S LAW?

BOUALLEG NOURA[1], BOUAMRA HACENE[2], SAIDI MOHAMMED[3], MEKKAOUI ELHABIB[4], HICHEM TALHI[5], HADJ KOUIDER ABDELHADI[6]

[1]University of Larbi Tebessi – Tebessa, Algeria
[2] University of Larbi Tebessi – Tebessa, Laboratory of Economic Diversification Strategies for Achieving Food, Health, and Energy Security in Algeria, Algeria
[3]Oran Gradute School of Economics. LAMAPE Laboratory, Algeria
[4]Oran Gradute School of Economics. LAMAPE Laboratory, Algeria
[5] Higher National School of Renewable Energy, Environment & Sustainable Development, Algeria,
[6] University Ahmed Draia, The Spatial and Entrepreneurial Development Studies Laboratory, Algeria

bouallegnoura07@gmail.com[1]
hacene.bouamra@univ-tebessa.dz[2]
mohammed.saidi@ese-oran.dz[3]
elhabib.mekkaoui@ese-oran.dz[4]
hichem.talhi@hns-re2sd.dz[5]
H.abdelhadi@univ-adrar.edu.dz[6]

Abstract:

The purpose of this paper is to re-examine the relationship between government spending and Gross Domestic Product (GDP) in Algeria during the period 1967-2023. Using a novel approach known as frequency-domain causality, this methodology combines classical time-series analysis with spectral analysis, offering the advantage of assessing the co-movement of series in the context of both time and frequencies. In the case of the Algerian economy, we find that frequency-domain causality is able to identify the relationship between the variables in the short, medium, and long run, and these results have significant implications for both the Keynesian hypothesis and Wagner's Law.

The Gregory-Hansen cointegration test results indicated the presence of a long-run relationship between government spending and GDP in Algeria for the 1967-2023 period. The findings within the frequency-domain causality framework revealed that the short, medium, and long-term fluctuations between the variables are time-linked. The analysis of the continuous frequency-domain causality results pointed to a unidirectional causal relationship running from GDP to government spending across different frequencies (short, medium, and long term). This leads to the validation of Wagner's Law as the more accurate hypothesis for Algeria during the study period, in contrast to the Keynesian hypothesis and the absence of a relationship in the opposite direction.

Keywords: Frequency-Domain Causality, Government Spending, GDP, Algeria, Wagner's Law, Keynesian Hypothesis.

1. Introduction

The relationship between government spending and Gross Domestic Product (GDP) has attracted widespread attention among economists and policymakers over the years, giving rise to conflicting views due to a lack of consensus on the findings reached by economists and researchers. Some support the hypothesis that the relationship runs from GDP to government spending, while others support the hypothesis that the relationship runs from government spending to GDP; however, the debate on this topic continues. The essence of this existing disagreement among researchers and economists lies in the presence of two different schools of thought, each with different perspectives and hypotheses regarding the direction of the relationship between government spending and economic growth, which has sparked significant controversy.

According to the Keynesian hypothesis, Keynes believed that economic growth is driven by government spending. Conversely, Wagner posited that economic growth is the primary cause of public sector growth. Various empirical studies support the Keynesian viewpoint, while other studies support Wagner's view. Adolph Wagner proposed another theory regarding government spending in the 19th century, arguing that a state's more advanced economy impacts the size of government, which can be measured by the amount of government spending. Wagner's Law places greater emphasis on the effect of GDP on government

spending, stating that Wagner's Law is more closely related to the long-run relationship between per capita income and government administration. Thus, Wagner's hypothesis assumes a direct causal relationship between GDP and government spending (Maulid, Bawono, & Sudibyo, 2021, p. 27).

The Classical economists' perspective on the relationship between government spending and GDP is based on the argument that an increase in government spending will not lead to an increase in national output. Consequently, government spending is seen as a destabilizing force in the development of a state's economy, rather than a driving force for economic growth as assumed by the Keynesians. The Classicals believed in the magical forces of the invisible hand (free markets) to ensure full employment equilibrium in the economy. According to Classical economists, the economy should be left to operate on its own, assigning only a limited role for the government, such as promoting the rule of law. This is because they viewed government intervention in the economy as a problem that could impede growth and, therefore, lead to a decrease in output (Chipaumire, Ngirande, Method, & Ruswa, 2014).

Conversely, the Keynesians argue that the relationship extends from government spending to GDP; therefore, government spending is considered an exogenous factor that can be used as a tool to influence growth (Paparas, 2021). According to the Keynesian viewpoint, economic growth occurs when government spending increases. In the Keynesian approach, an increase in government spending leads to an increase in GDP through the multiplier mechanism (Korkmaz & Guvenoglu, 2021).

The purpose of this research paper is to review the theoretical literature that evaluates the arguments surrounding the relationship between government spending and GDP from the perspectives of Wagner's Law and the Keynesian hypothesis, in addition to reviewing the empirical literature. To achieve this objective, we utilized a novel methodology represented by frequency-domain causality over a long period to determine the direction of the causal relationship at different frequencies.

Based on the foregoing, the following research question (problematique) can be posed: Which is more valid for highlighting the relationship between government spending and GDP in Algeria in the frequency domain during the period 1967-2023: the Keynesian hypothesis or Wagner's Law?

2. Theoretical Literature on the Relationship Between Government Spending and GDP

The debate surrounding the relationship between government spending and GDP remains ambiguous; however, a significant body of theoretical and empirical literature has investigated the validity of the Keynesian hypothesis versus Wagner's Law.

2.1 The Relationship Between Government Spending and GDP According to Wagner's Law

Numerous theories have explored the relationship between government spending and economic growth, leading to the emergence of three distinct perspectives. For instance, Wagner's Law (1883) revealed a positive relationship between economic growth and government spending, specifically in the areas of transportation, infrastructure, social services, and various other economic services.

The first attempt to explain the growth of government spending was by Adolph Wagner. Wagner's (1883) "Law of Increasing State Activity" (Gesetz der wachsenden Staatstätigkeit) addressed the phenomenon from a historical, economic, and financial perspective. He attributed the increase in the volume of government spending to industrial development, whereby expenditures increase at a faster rate than output. The law was primarily based on empirical observation of Western Europe. Wagner argued that social progress led to increased state activity, implying more government spending. He also noted a relationship between economic growth and government spending, as the fundamental idea behind this relationship is that the growth of government spending is a natural consequence of economic growth (Sandford, 1987, p. 33).

The role and size of the public sector increased significantly, especially after World War II. To explain this role, various theories were proposed attempting to touch upon the different aspects (economic, political, institutional, and international) of this phenomenon, which the German economist Adolph Wagner termed the "Law of Increasing State Activity." He posited that there is a long-term tendency for government activities to grow relative to total economic activity. Wagner stated that during the industrialization process, as a country's real per capita income increases, the share of its public spending in total expenditure increases. Wagner gave three main reasons for this growing expansion:

i. First, as industrialization progresses, there is a tendency for the public sector to increase administrative functions to ensure the smooth operation of market forces.
ii. Second, many public services such as education, cultural activities, health services, and social welfare expenditures are income-elastic (elasticity greater than one), meaning that as income increases, the demand for them increases more than proportionally. This creates social pressure to provide such services, leading to an increase in the state's role and its spending.
iii. Third, to remove monopolistic tendencies in the state and invest in areas where the private sector is reluctant to invest but which are necessary for technological advancement, the state will play a leading role, resulting in increased spending (Masroor, 2014, p. 80).

Wagner's Law also stipulated that long-term economic growth causes an increase in government spending, and public expenditures are viewed as an endogenous factor. As real income rises, there is a long-term tendency for the share of public spending to rise relative to national income. In short, Wagner's Law suggests that government spending rises faster than national output. This means that as national income increases, the volume of government spending increases to meet the growing social and administrative functions of the state. The German economist Adolph Wagner sought to explain the real reasons leading to the increase in government spending, based on a study he conducted on a group of countries. This study involved researching the relationship between income growth and expenditure growth. He issued a law related to it in 1892 which states: "If a society achieves a certain rate of economic growth, this works to expand the activity of the state" (Gartchie Gatsi, Owusu Appiah, & Addo Gyan, 2019).

2.2 The Relationship Between Government Spending and Economic Growth According to Keynesian Theory

Both the Keynesian theory and Barro's (1990) endogenous growth model emphasize the pivotal role of fiscal policy in shaping economic performance. On one hand, Keynesian theory asserts that implementing expansionary fiscal policies, such as increasing government spending, can effectively stimulate real GDP by leveraging the multiplier effect. On the other hand, Barro's endogenous growth model posits that government spending has the potential to stimulate private investment, thereby fostering long-term economic growth. The endogenous growth model also suggests that government spending can be classified as "productive" or "unproductive." Productive expenditures enhance private sector productivity, while unproductive expenditures primarily affect the welfare of citizens. This model challenges the classical perspective by asserting that fiscal policy can influence both the production trajectory and long-term growth rates. For example, an increase in public investment not only leads to an increase in the private return on capital but also enhances private investment spending, leading to sustainable output growth in the long run. The endogenous growth model also indicates that fiscal policy may have lasting effects on economic development by influencing the dynamics of private investment and overall productivity. This model has transformed the transient effects of fiscal policy (of which government spending is a component) into permanent effects over a long period (Jama, Mohd Daud, & Nayan, 2024, p. 4).

The Keynesians hypothesized that an increase in government spending leads to an increase in aggregate demand and an increase in GDP. This suggests that the causal relationship runs from government spending to GDP. According to Keynes, government spending is an exogenous variable determined by the state, and a change in government spending leads to a larger change in GDP due to the multiplier. Unlike classical theory, Keynes focused on the demand side and assumed that aggregate demand consists of private investment, private consumption, government spending, and net exports. Keynes also assumed that government spending, as a component of the aggregate demand side, is an exogenous variable determined outside the model, as a change in government spending leads to a multiplied change in aggregate output due to the effect of the Keynesian multiplier (Dennis, 1981).

3. Review of Empirical Literature

In the context of continued research into the relationship between government spending and GDP from the perspective of Wagner's Law and Keynesian theory, and to identify the existing research gap, some of

the empirical literature that has addressed this topic will be highlighted. Some of these studies, by no means an exhaustive list, can be mentioned as follows:

(Magazzino, 2012), in his study titled "Wagner versus Keynes: Public Spending and Income in Italy," which aimed to evaluate its empirical evidence for the period 1960-2008 using Granger causality, found that the causality test results show evidence in favor of Wagner's Law only, not the Keynesian hypothesis. Similarly, (Ghazy, Ghoneim, & Paparas, 2021) confirmed in their study, which sought to examine the validity of Wagner's Law in Egypt for the period 1960-2018 by testing the relationship between government spending and GDP using the Johansen cointegration test and Granger causality, that a long-run relationship exists between the variables. Additionally, they found a bidirectional causal relationship, and thus this study supported Wagner's Law.

From another perspective, (Omar Mohmoud, 2015), when analyzing the causal relationship between government spending and GDP in Palestine ("An Econometric Analysis of Wagner's Law in Palestine") during the period 1994-2013 using the Engle-Granger cointegration test, found that the cointegration results related to the six hypotheses of Wagner's Law indicate the existence of a long-run relationship between government spending and GDP growth, and a negative impact between the two variables. Furthermore, both government spending and GDP growth are growing significantly.

Meanwhile, (Bazán, Alvarez-Quiroz, & Olivares, 2022) indicated in their study, which aimed to analyze the dynamics between public spending and economic growth in Peru using quarterly time series from 1980Q1-2021Q4 and Granger causality, that both Wagner's Law and the Keynesian hypothesis are valid. This was expressed as dynamic data allowing for the acquisition of short and long-run effects, permitting a mutual relationship between economic growth and government spending. (Sudarsono, 2010) also confirmed, based on his study that investigated the causal relationship between economic growth and government spending for the Organization of Islamic Conference (OIC) countries using annual data from 1970-2006, that both Wagner's Law and the Keynesian hypothesis are valid for the study. He found that the causality test results indicate that government spending causes economic growth in Iran, Nigeria, and "Ouns" (Tunisia), which aligns with the Keynesian theory. He also found that economic growth causes an increase in government spending in Algeria, Indonesia, Malaysia, and Saudi Arabia, which perfectly fits Wagner's Law. Hence, this study supports both the Keynesian hypothesis and Wagner's Law.

Conversely, (John Gartchie, Michael Owusu, & Joseph Addo, 2019) contradicted them in their study that sought to uncover the causal relationship between economic growth and government spending in Ghana during the period 1960-2017. Using the Johansen method, Toda-Yamamoto causality, and the ARDL model, they found an absence of a causal relationship between the variables, concluding that Wagner's Law is not valid for the Ghanaian economy and that the Keynesian theory (stating spending is an exogenous factor) does not hold in this case.

On another front, in the study by (Javed & Ahmad Khan, 2021), which aimed to study Wagner's hypothesis in India using annual time-series data from 1980 to 2019 and the ARDL model, they found a long-run relationship between GDP and government spending. Meanwhile, the unidirectional causality runs from GDP to government spending, which supports Wagner's Law. This was supported by (Menyah & Wolde-Rufael, 2013) when they investigated the relationship between government spending and economic growth in Ethiopia to test Wagner's Law for the period 1950-2007, using the Bounds test for cointegration. The results indicated a unidirectional causal relationship extending from GDP to government spending, which supports Wagner's Law.

However, (Gangal & Gupta, 2013) disagreed, through their study on the impact of public spending on economic growth in India from 1998 to 2012, using the Granger causality test. They found from the causality test results that the unidirectional relationship runs from government spending to GDP, which supports the Keynesian hypothesis. (Yilgor, Ertugrul, & Celepcioglu, 2012) concurred in a study aimed at analyzing the relationship between public spending and economic growth in Turkey, using data from 1980 to 2010. They found a unidirectional causality running from government spending to economic growth in Turkey; accordingly, the study supports the Keynesian hypothesis. (Wahyudi, 2020) also confirmed in his study, which aimed to analyze the relationship between government spending and economic growth in Indonesia during the period 2014-2018, that the Granger causality test showed no

support for the effect of economic growth on government spending. On the contrary, there is a significant effect of government spending on economic growth, which supports the Keynesian hypothesis.

Research Gap:

After reviewing the theoretical literature that presented the relationship between government spending and GDP according to Wagner's Law and Keynesian theory, and in order to enrich the study and identify what new contribution it will offer, a considerable number of empirical studies were reviewed. It was concluded that while many empirical studies have investigated the causal relationship between government spending and GDP, their findings are mixed. Some have supported both Keynes's and Wagner's views, such as the study by (Bazán, Alvarez-Quiroz, & Olivares, 2022). Conversely, some of these studies support Wagner's Law and oppose the Keynesian hypothesis, such as the study by (Javed & Ahmad Khan, 2021). Others found the Keynesian hypothesis to be valid for studying the relationship, unlike Wagner's Law, such as the study by (Gangal & Gupta, 2013).

Based on the empirical literature presented that addressed the relationship between government spending and GDP according to the Keynesian hypothesis and Wagner's Law, the novelty presented by this research paper is its comprehensive survey, covering a long period from 1967 to 2023. This is in addition to the methodology adopted; frequency-domain causality was employed. This makes this work an important contribution to the literature by identifying different time frequencies: short, medium, and long-term frequencies. This clarifies the relationship between government spending and GDP, which corresponds to the stages the Algerian economy went through during the study period (1967-2023). This contrasts with the methodologies used in other empirical studies; for example, the study by (John Gartchie, Michael Owusu, & Joseph Addo, 2019) relied on Toda-Yamamoto causality and the ARDL model, and the study by (Ghazy, Ghoneim, & Paparas, 2021) relied on the Johansen cointegration test and Granger causality to investigate the relationship.

3.2 Definition of the Tool Used in the Study

Studying the relationship between government spending and GDP from the perspective of the Keynesian hypothesis and Wagner's Law is important due to the differing viewpoints. This relationship may exist in different time periods and at different frequencies (short, medium, and long). Therefore, using wavelet analysis allows for the reconciliation of results from time-series analysis and frequency-domain analysis. Additionally, it enables the monitoring of structural breaks and non-linearities in the data series.

Frequency causality [sic] was proposed in the 1980s by Grossmann and Morlet (1984) and Goupillaud et al. (1984) to address the limitations of the Fourier transform. This method uses local basis functions that can be expanded and transformed with flexible precision in both frequency and time. More precisely, the wavelet transform routinely allows for adjustments at high or low frequencies, with a short window for high frequencies and a long window for low frequencies. Thus, the main advantage of the wavelet transform is its ability to perform a local analysis of a time series because the length of the wavelets changes endogenously. It is based on the causal relationship in the frequency domain, i.e., at frequency ω, which is confined to the interval $(\pi,0)$.

Few researchers have paid attention to the problems related to the non-stationarity of time series. One of the possible solutions proposed in the literature is frequency-domain analysis. However, a more appropriate and suitable method would be one that combines time-domain and frequency-domain analyses. This methodology also allows for the reconciliation of time-series and frequency-domain analyses. For this purpose, Breitung and Candelon (2006) introduced a new method based on a Bivariate VAR model. With the aim of studying the causal relationship between y_1 and y_2 at frequency ω, the following relationship is calculated (Gul & Ozer, 2018, p. 89):

$$(1)M_{y1\ cause\ y2}(\omega) = \log\left[1 + \frac{|\psi_{12}(e^{-i\omega})|}{|\psi_{11}(e^{-i\omega}|}\right]$$

Where: i is a complex number and $\psi(L)$ is a polynomial according to the following form:

$$(2)\psi(L) = \begin{bmatrix} \psi_{11}(L)\psi_{12}(L) \\ \psi_{21}(L)\psi_{22}(L) \end{bmatrix}$$

This is done according to the following hypothesis:

$$H_0: \text{My1cause y2}(\omega) = 0$$

The VAR model is written in the following form:

$$(3)M_t = \omega_1 M_{t-1} + \ldots + \omega_p M_{t-p} + \ldots + \partial_1 N_{t-1} + \partial_p N_{t-p} + \varnothing_t$$

Breitung and Candelon (2006) posited the null hypothesis equal to:

$$R(\omega) = \begin{bmatrix} \cos(\omega)\ \cos(2\omega) \ldots \cos(p\omega) \\ \sin(\omega)\ \sin(2\omega)\ \ldots \sin(p\omega) \end{bmatrix}$$

It should be noted here that high and medium frequencies represent the short run, while low frequencies represent the long run. The frequency $\omega = 0$ represents the causal relationship in the long run.

4. Stationarity Study Results

The study of stationarity is the most critical step when conducting an econometric study based on time series. A time series is stationary if it does not contain a unit root. This necessitates relying on the Ng-Perron (2001) test, which is based on four statistical tests using the Generalized Least Squares (GLS) method. These tests are modified versions of the Phillips-Perron (1988), Bhargava (1986), and ERS tests, which are considered robust in cases of negatively correlated residuals (Bourbonnais & Terraza, 2010, pp. 179-182). The following table presents the results of the variables' stationarity.

Table (2): Ng-Perron Test Results

Variables	MZa	MZt	MSB	MPT
DLGDP	-26.1275	-3.60940	0.13815	3.51731
DLGS	-25.6783	-3.57835	0.13935	3.57754
DLEE	-27.2237	-3.68844	0.13549	0.35307
DLME	-27.3043	-3.65988	0.13404	3.54296
Critical Values at 5%:	-17.3000	-2.91000	0.16800	5.48000
D: Represents the first difference				

Source: Prepared by the researchers based on Appendix (1).

The results in Table 2 above indicate that all calculated values of the four statistics (MZa, MZt, MSB, MPT) are less than their corresponding critical values at the 5% significance level, for the time series (logarithm of government spending (DLGS), logarithm of operating expenditures (DLME), logarithm of capital expenditures (DLEE), and logarithm of Gross Domestic Product (DLGDP)). This is after taking the first difference, which indicates that the series are stationary at the first difference. This leads to the acceptance of the alternative hypothesis (absence of a unit root) and the rejection of the null hypothesis (presence of a unit root).

As a second step, after determining the order of integration of the time series, we will also detect whether these series contain structural changes (breaks) or not, by relying on the Zivot-Andrews test.

Table (3): Zivot-Andrews Structural Break Unit Root Test Results

Variables	t-Statistic	Break Year	Critical Value	Decision
DLGDP	-2.316	2013	-4.80	Variables are stationary
DLGS	-3.143	2013	-4.80	
DLEE	-3.80	2013	-4.80	

Variables	t-Statistic	Break Year	Critical Value	Decision
DLME	-1.171	2013	-4.80	

Source: Prepared by the researchers based on Stata 17.

Based on the results of Table 3, it is evident that:

The results shown in Table 3 above, related to the Zivot-Andrews test for structural breaks, indicate that the time series (logarithm of government spending (DLGS), logarithm of operating expenditures (DLME), logarithm of capital expenditures (DLEE), and logarithm of Gross Domestic Product (DLGDP)) are non-stationary at the level. Rather, they became stationary at the first difference with a structural break in the year 2013. This necessitates the use of the Gregory-Hansen threshold cointegration tests.

4. Cointegration Test with Structural Breaks

The integration of series at the same order suggests the presence of cointegration. From this perspective, the existence of a cointegration relationship between government spending and its components (capital expenditures and operating expenditures) and Gross Domestic Product (GDP) will be examined using the Gregory-Hansen (1996) test. This test determines whether a long-run equilibrium relationship exists, particularly as the Gregory-Hansen test accounts for an existing structural break. A prerequisite for this test is that the series must be integrated of the same order.

Since the prerequisite condition—that the series are integrated of the same order, $I(1)$—is met, we can proceed to implement the Gregory-Hansen cointegration test with structural breaks. The results are illustrated in the following table.

Table 4: Gregory-Hansen Test Results

Gregory-Hansen Test for Cointegration with Regime Shifts

Model: Change in Regime and Trend — Number of obs = 57

Lags = 0 chosen by downward t-statistics — Maximum Lags = 2

	Test Statistic	Breakpoint	Date	Asymptotic Critical Values 1%	5%	10%
ADF	-6.85	41	2007	-6.89	-6.32	-6.16
Zt	-6.92	41	2007	-6.89	-6.32	-6.16

Source: Prepared by the researchers based on Stata 17.

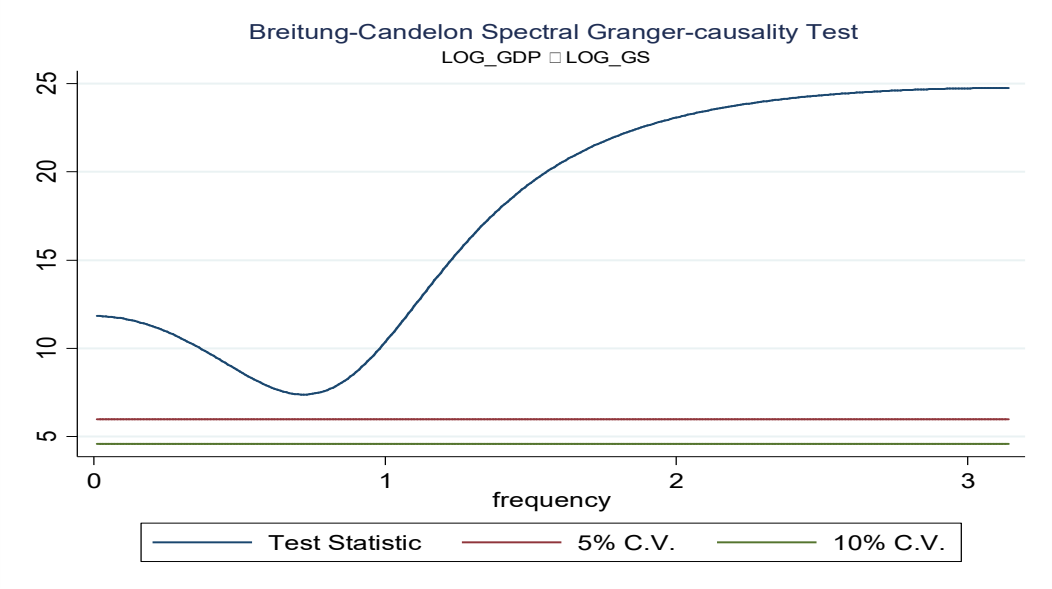
The results of the Gregory-Hansen threshold cointegration test, presented in Table 4, indicate the existence of a cointegration relationship among the study variables, identifying a structural break in 2007. This is evidenced by the calculated test statistics being greater than the critical values at various significance levels (5% and 10%).

This confirms the presence of a long-run relationship between government spending, its components (operating and capital expenditures), and GDP during the study period. This implies that the variables utilized in the study move together in the long run, which suggests the existence of a causal relationship between them.

3.4 The Direction of the Causal Relationship Between Government Spending and GDP in Algeria for the Period 1967-2023

To determine whether Wagner's Law or the Keynesian hypothesis is valid in the Algerian economy, and to identify the direction of causality between government spending (and its components) and GDP, the Breitung-Candelon (2006) frequency-domain causality test will be conducted, as illustrated in the following figures.

Figure 1: Direction of the relationship from GDP to Government Spending



Source: Prepared by the researchers based on Stata.

It is clearly evident from Figure 1—which plots the calculated Breitung-Candelon test statistics (blue curve) against the critical values (red curve) to determine the relationship between government spending and GDP—that the blue curve, representing the test statistics at frequencies ($(0, \pi) = 3.14$), is located above the red line (at the critical value of 6) across all frequencies from 0 to 3.14.

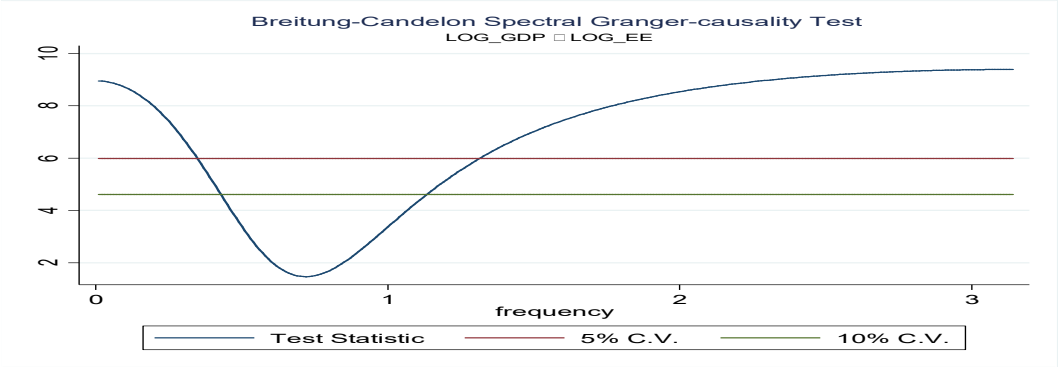
This indicates the existence of a causal relationship in the short, medium, and long run that runs from GDP to government spending. This confirms the validity of Wagner's Law. The interpretation is that government spending is an endogenous factor driven by the growth of national income. In contrast, in the Keynesian model, economic growth occurs as a result of increased government spending, which is considered an independent, exogenous variable for influencing economic growth. Wagner, however, assumes that causality extends from GDP to government spending, contrary to the Keynesian hypothesis. According to Wagner's Law, as the national economy grows, the public sector will grow at a faster rate than the private sector (Sandford, 1987, p. 33). Wagner (1883) stressed that as the state develops, the share of government spending tends to rise to meet the increasing administrative and social functions of the state. This view indicates a unidirectional causal relationship running from GDP to government spending (Keho, 2017).

Wagner posited that an increase in GDP leads to an increase in government spending, supporting the direction of causality from economic growth to government spending. Wagner outlined three main reasons for the increase in government spending due to economic growth:

1. First, as industrialization progresses, the public sector's activity in terms of administrative and protective functions of the state will increase in importance.
2. Second, the state's role in maintaining law and order, in addition to its role in activities related to economic regulation, is likely to become more pronounced due to the increasing complexity of the economy and the urbanization that occurs during industrialization.
3. Finally, technological change and the increasing size of firms tend to create monopolies, the effects of which the state must compensate for (Emmanuel, Amaghiondiwe, Adesola, & Yasiru Alimi, 2015, p. 419).

In continuing the investigation into the direction of the relationship from GDP to government spending, the relationship between GDP and the components of government spending (operating and capital expenditures) was also studied, as shown in the following two figures.

Figure 2: Direction of the relationship from GDP to Capital Expenditures (EE)

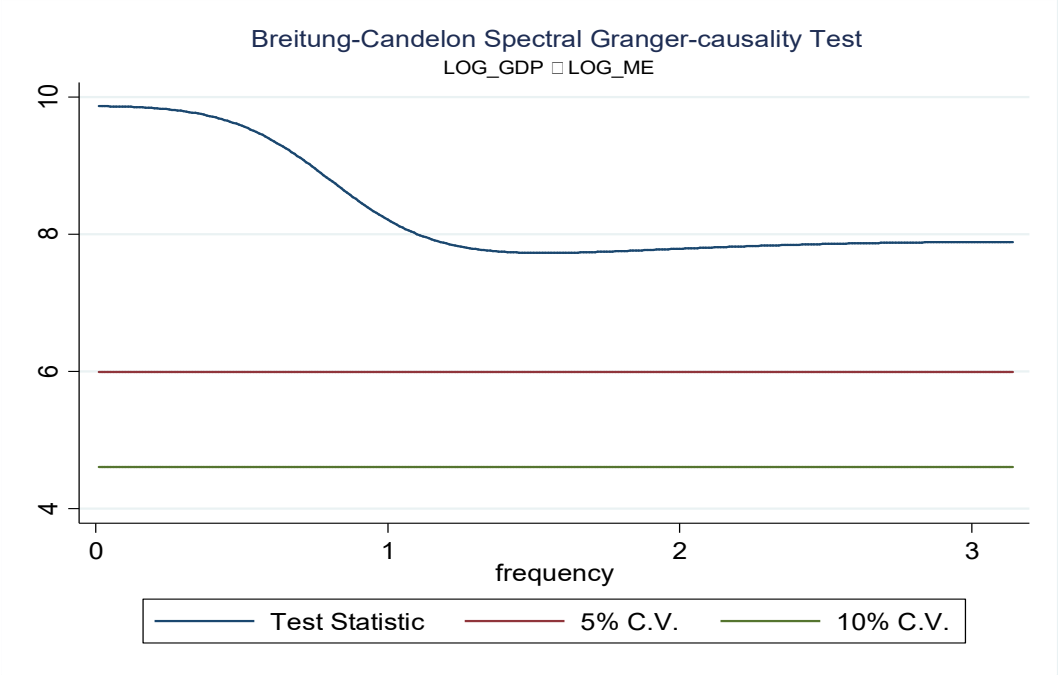


Source: Prepared by the researchers based on Stata 17.

What can be observed from Figure 2 above is that its results indicate a causal relationship running from GDP to capital expenditures in the short run. This is confirmed by the blue curve (test statistic) being above the red curve (critical value 6) at frequencies from approximately 0 to 0.5. Meanwhile, an absence of the relationship in the medium run was recorded, as the blue curve fell below the red curve, indicated by the test statistics at frequencies from 0.5 to 1.2. However, a causal relationship from GDP to capital expenditures was quickly registered again in the long run. This is confirmed by the test statistics at frequencies from 1.4 to 3.14 (represented by the blue curve) which fell above the red curve.

This leads to the confirmation of a causal relationship running from GDP to capital expenditures (a component of government spending) in the short and long run, with an absence of the relationship in the medium run. This, in turn, also supports the results of the relationship between GDP and total government spending, thereby supporting the validity of Wagner's Law.

Figure 3: Direction of the relationship from GDP to Operating Expenditures (ME)



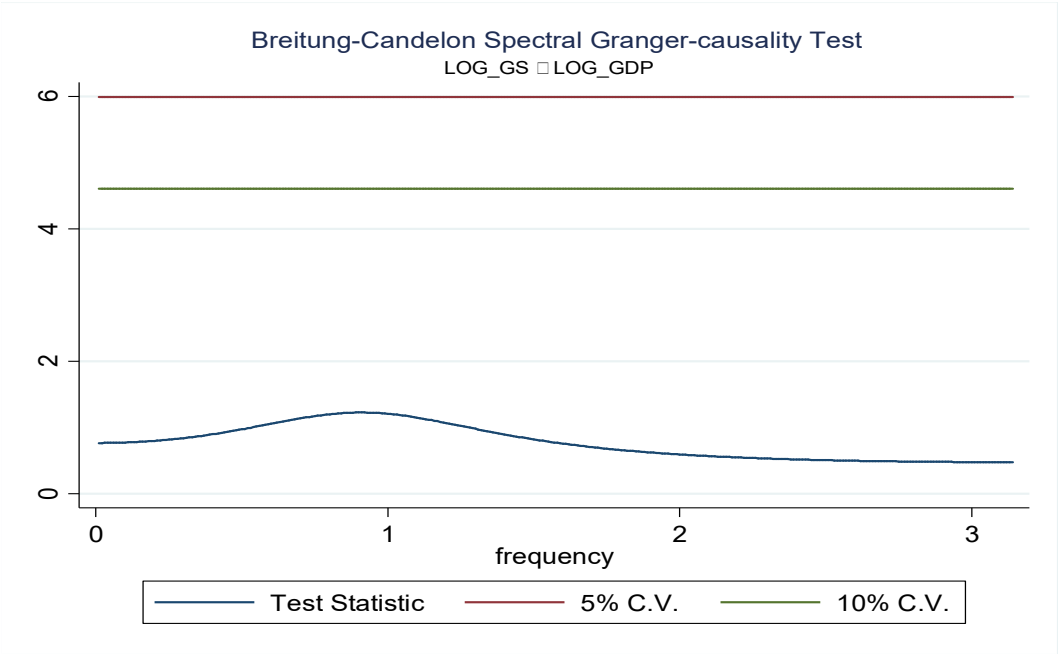
Source: Prepared by the researchers based on Stata 17.

As observed in Figure 3, the graph indicates a causal relationship running from GDP to operating expenditures. This is evidenced by the test statistics at all frequencies from 0 to 3.14 (the blue curve) being located above the red curve (critical value 6). This confirms a causal relationship extending from GDP to operating expenditures (a component of government spending) in the short, medium, and long run. This also supports the findings for the relationship between GDP and total government spending, meaning the validity of Wagner's Law is confirmed.

After studying the causal relationship from GDP towards government spending and its components, the relationship in the opposite direction will be investigated; that is, the causal relationship from government

spending and its components (capital and operating expenditures) towards GDP, which will be clarified in the following figure.

Figure 4: Direction of the relationship from Government Spending (GS) to GDP



Source: Prepared by the researchers based on Stata 17.

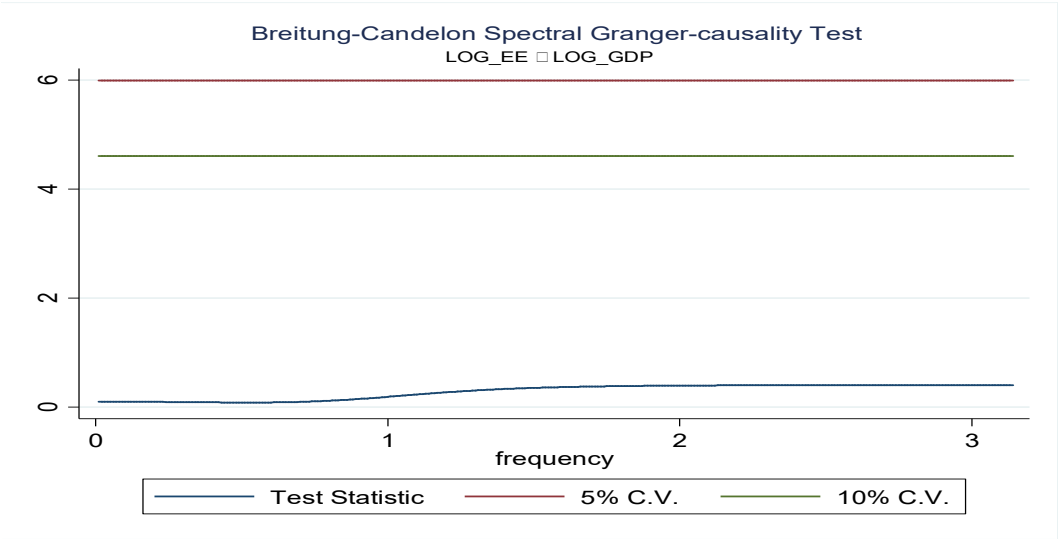
Based on the results of Figure 4, it is shown that the blue curve (test statistic) is located below the red curve (critical value at 5% significance) at all frequencies from 0 to 3.14. This indicates the absence of a causal relationship in the opposite direction—that is, causality running from government spending to GDP.

This confirms the viewpoint of Classical economists, who believe that increases in government spending, unless financed by money creation (and thus changes in monetary policy), will not affect employment or the price level. This is because if government spending increases while the money supply remains constant, the government will compete with private firms in the money market, leading to a rise in interest rates. High interest rates discourage private investment, leading to public investments "crowding out" private ones. According to classical theory, an increase in government spending with a constant money supply will not increase income but will only replace private business investments with public programs, as the government has the advantage of being able to borrow at any interest rate level (since it can print money or raise taxes to refinance borrowing costs). Therefore, according to classical theory, increases in government spending have no effect on a country's long-term economic growth, meaning there is no causal relationship running from government spending to economic growth (Chipaumire, Ngirande, Method, & Ruswa, 2014, p. 111).

This indicates that the Keynesian hypothesis is not valid in Algeria during the study period. Keynesian economists believed the causal relationship runs from government spending to GDP. Keynes was a proponent of this framework, believing that implementing an expansionary monetary [sic: fiscal] policy would lead to an inflow of financial resources into the economy, stimulating aggregate demand, and thus increasing productivity and global economic growth, which highlights the treatment of market failures and the provision of public goods (Yusuf Abdulle, 2024, p. 449).

To ascertain whether a causal relationship exists from the components of government spending (capital and operating expenditures), each individually, towards GDP, Figures (5 and 6) will be relied upon.

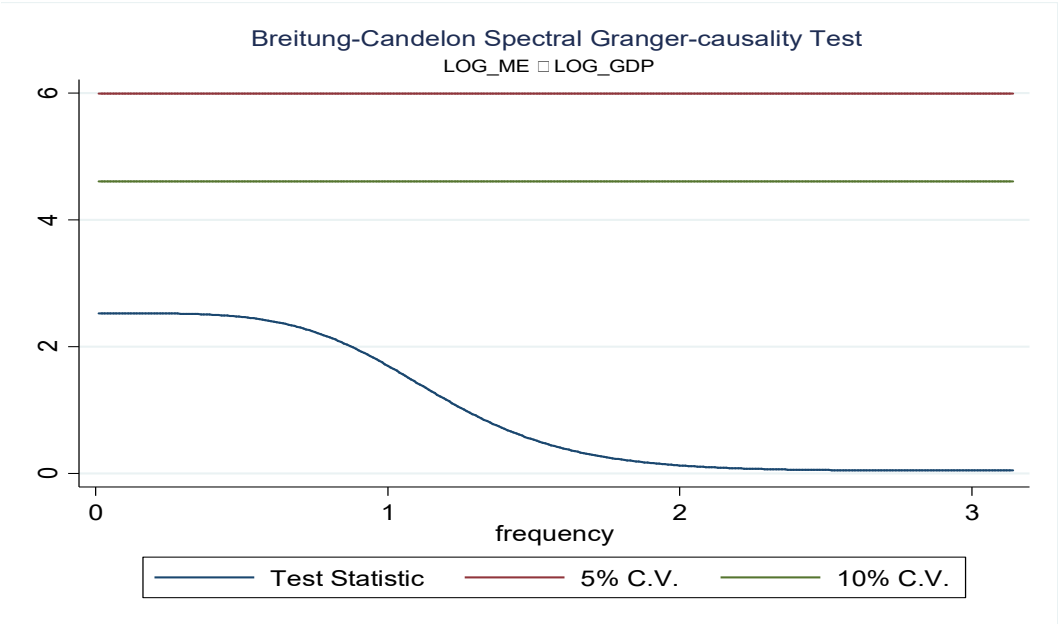
Figure 5: Clarifies the direction of the relationship from Capital Expenditures (EE) to GDP



Source: Prepared by the researchers based on Stata 17.

Based on the results shown in Figure 5, it is clear that the blue curve is below the red curve (critical value) at all frequencies from 0 to 3.14. This indicates the absence of a causal relationship running from capital expenditures to GDP. This contradicts the Keynesian hypothesis, which posits that the relationship runs from government spending to GDP (as capital expenditures are meant to improve infrastructure like energy, roads, and ports, and contribute to industrial development, increasing production efficiency and lowering costs). Therefore, this result supports Wagner's Law.

Figure 6: Clarifies the direction of the relationship from Operating Expenditures (ME) to GDP



Source: Prepared by the researchers based on Stata 17.

The results of Figure 6 show that the red curve (critical value) is above the blue curve. This indicates the absence of a causal relationship at all frequencies from 0 to 3.14 running from operating expenditures to GDP. This contradicts the Keynesian hypothesis and supports Wagner's Law. The relationship between operating expenditures and GDP is complex; these expenditures are considered a catalyst for economic growth *if* directed towards activities that increase productivity and improve infrastructure, such as energy, roads, and ports.

5. Conclusion

This paper has reviewed the theoretical and empirical literature on the relationship between government spending and GDP from the perspective of two schools of thought: the Classical school, represented by Wagner's Law, and the Keynesian school, represented by the Keynesian hypothesis, with a focus on investigating which of these views aligns with the case of Algeria. For this purpose, this research paper aimed to determine the direction of the relationship between the variables and to clarify which hypothesis is more appropriate for the Algerian economy during the period 1967-2023, using frequency-domain causality.

By adopting the frequency-domain causality method, we decomposed the series based on the methodology outlined in the previous section, in addition to analyzing the relative importance of short, medium, and long-term dynamics. A set of results was obtained, which can be summarized in the following points:

- The results of the Gregory-Hansen cointegration test indicated the existence of a long-run relationship between government spending and GDP in Algeria during the 1967-2023 period.
- Frequency-domain causality allowed for the clarification and identification of the direction of the relationship, providing results across different time scales with three dimensions. This assessed whether changes in movement across frequencies and over time could distinguish between the two perspectives (Wagner's Law or the Keynesian hypothesis) and determine the hypothesis that matches the state of the Algerian economy.
- The results of the Breitung-Candelon test showed a unidirectional causal relationship running from GDP to government spending in the short, medium, and long run. Therefore, the obtained results support Wagner's Law as being the most appropriate for studying the relationship between government spending and GDP in the Algerian economy during the 1967-2023 period. That is, the causal relationship runs from GDP towards government spending, capital expenditures, and operating expenditures.
- The Breitung-Candelon test results also indicated the absence of a causal relationship running from government spending and its components towards GDP in the short, medium, and long run. This confirms that the Keynesian hypothesis is not valid and does not fit the Algerian economy during the study period.
- The frequency-domain causality results revealed a unidirectional causal relationship running from GDP to capital expenditures in the short and long run, with an absence of the relationship in the medium run.

Appendices

Appendix 1: Ng-Perron Test Results

Null Hypothesis: D(LGS) has a unit root
Exogenous: Constant, Linear Trend
Lag length: 0 (Spectral GLS-detrended AR based on SIC, maxlag=10)
Sample (adjusted): 1968 2023
Included observations: 56 after adjustments

		MZa	MZt	MSB	MPT
Ng-Perron test statistics		-25.6783	-3.57835	0.13935	3.57754
Asymptotic critical values*:	1%	-23.8000	-3.42000	0.14300	4.03000
	5%	-17.3000	-2.91000	0.16800	5.48000
	10%	-14.2000	-2.62000	0.18500	6.67000

*Ng-Perron (2001, Table 1)

Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant, Linear Trend
Lag length: 0 (Spectral GLS-detrended AR based on SIC, maxlag=10)
Sample (adjusted): 1968 2023
Included observations: 56 after adjustments

		MZa	MZt	MSB	MPT
Ng-Perron test statistics		-26.1275	-3.60940	0.13815	3.51731
Asymptotic critical values*:	1%	-23.8000	-3.42000	0.14300	4.03000
	5%	-17.3000	-2.91000	0.16800	5.48000
	10%	-14.2000	-2.62000	0.18500	6.67000

*Ng-Perron (2001, Table 1)

Null Hypothesis: D(LEE) has a unit root
Exogenous: Constant, Linear Trend
Lag length: 0 (Spectral GLS-detrended AR based on SIC, maxlag=10)
Sample (adjusted): 1968 2023
Included observations: 56 after adjustments

		MZa	MZt	MSB	MPT
Ng-Perron test statistics		-27.2237	-3.68844	0.13549	3.35307
Asymptotic critical values*:	1%	-23.8000	-3.42000	0.14300	4.03000
	5%	-17.3000	-2.91000	0.16800	5.48000
	10%	-14.2000	-2.62000	0.18500	6.67000

*Ng-Perron (2001, Table 1)

Null Hypothesis: D(LME) has a unit root
Exogenous: Constant, Linear Trend
Lag length: 0 (Spectral GLS-detrended AR based on SIC, maxlag=10)
Sample (adjusted): 1968 2023
Included observations: 56 after adjustments

		MZa	MZt	MSB	MPT
Ng-Perron test statistics		-27.3043	-3.65988	0.13404	3.54296
Asymptotic critical values*:	1%	-23.8000	-3.42000	0.14300	4.03000
	5%	-17.3000	-2.91000	0.16800	5.48000
	10%	-14.2000	-2.62000	0.18500	6.67000

*Ng-Perron (2001, Table 1)

Source: EViews 12 output.

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