Journal of Administrative and Economic Sciences • Vol 18, Issue 1 (2025) • p 479-502
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Wagner's Law: Empirical Evidence from Saudi Arabia using the Augmented-NARDL Method

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Abstract:

This study reinvestigates the relationship between government expenditure and economic growth using several types of Wagner's Law. Using Saudi Arabian data covering the period between 1971 and 2019, the authors estimate the study models using the new augmented NARDL method, which, in turn, is based on Sam, McNown, and Goh's (2019) augmented ARDL. The estimation shows that Goffman's (1968), Peacock-Wiseman's (1961), Gupta's (1967), and Murthy's (1993) models succeed in proving the relationship between economic growth and government expenditures in Saudi Arabia. The Peacock-Wiseman (1961), Murthy (1993), and Gupta (1967) models reflect symmetric relationships in the long term, whereas the Goffman model indicates an asymmetric relationship. Based on these findings, the authors recommend that Saudi Arabia rationalize its current government expenditure and focus on developmental expenditure to optimize economic growth and personal income.

Funding Statement: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sector.

Ethical Compliance: This article does not contain any studies with human participants or animals performed by any of the authors.

Keywords: Augmented-NARDL, government expenditure, Saudi Arabia, Wagner's law.

JEL Classification codes: C22; C50; E62; H50; O40

1. Introduction

The effects of taxation and public (government) expenditures on economic growth are of great importance to scholars. This academic interest dates back to the beginning of scientific economic thinking, especially since the time of Adam Smith and his proponents, and up to the pioneers and developers of modern growth theory. Indeed, it remains an extensive topic of discussion for public economists and policymakers. Many researchers have empirically assessed the relationship between economic growth and public expenditure because of its relevance to economic policy and welfare.

Two important theoretical approaches have emerged to identify the direction of the relationship between public expenditure and economic growth: Wagner's Law and the Keynesian hypothesis. Wagner's law states that there exists a relationship between public expenditure and economic growth and that it moves in the direction of growth to expenditure. Further, enhanced economic performance (economic growth) affects government expenditures because of the need to increase security and public administration expenditures, as well as securing education and literacy expenditures (Magazzino, 2012b, p. 891). Wagner claims that economic development and changes in technology require the government to manage natural monopolies to enhance economic efficiency. Thus, the expansion of public expenditure can be seen as a product of economic development and not vice versa (Irandoust, 2019).

The Keynesian hypothesis states that public expenditures are essential to improving economic performance; they increase the economic growth rate by increasing the size of the effective aggregate demand under the effect of the government expenditure multiplier. This approach monitors the relationship between two variables in the short term. After World War II, war-ravaged and developing countries widely used fiscal policies for reconstruction, economic development, and the promotion of economic growth.

Moreover, the endogenous economic growth theory, as well as its applications, indicates that government size—referred to as the public expenditures' ratio to GDP—directly or indirectly affects real GDP growth (Brons, Groot, & Nijkamp, 1999). Dar and AmirKhalkhali (2002) claimed that most endogenous growth models include fiscal policy indicators to monitor their effects on growth. These models include indicators of tax policy, public expenditure, and the deficit of the national budget, in addition to other variables, such as investment and technical progress rate, inflation, and human capital rate.

This study seeks to answer a fundamental question within the scope of the macroeconomic literature: does real GDP in Saudi Arabia affect government expenditure? This question can be divided into several sub-questions: Is there cointegration between government expenditure and economic growth in Saudi Arabia? Is there a difference in the effects of positive and negative shocks of the independent variables on the dependent variables? Alternatively, is the relationship between GDP and government expenditure symmetric or asymmetric?

This study aims to provide a deeper understanding of the nature of the relationship between economic growth (growth of real GDP) and public expenditure, as one of the argumentative issues in macroeconomics, and to retest the validity of Wagner's law in the Saudi economy—an economy representing the group of oil-exporting countries—by using modern econometric techniques.

This study uses non-linear autoregressive distributed lags (NARDL) in order to try to capture an asymmetric relationship between government spending (as a dependent variable) and economic growth (as an independent variable). Many empirical studies do not distinguish between the positive and negative effects of independent variables on the dependent variable. It is often assumed haphazardly that the relationship between these variables is linear, that is, the cointegration between government spending and economic growth is "represented as a linear combination of non-stationary stochastic regressors"(Raza, Zoega, & Kinsella, 2018). Granger and Yoon (2002) introduced the term 'hidden cointegration'. "It is hidden in the sense that it illustrates a situation in which the variables in original form do not cointegrate but when the impact of positive shocks is separated from the impact of negative shocks then cointegration is potentially found between the components of the variables"(Hatemi-J, 2020).

This study attempts to gain deeper insight into the effect of economic growth on government spending in Saudi Arabia by using a developed method of NARDL incorporating the NARDL method presented by Shin, Yu, and Greenwood-Nimmo (2014) and tests proposed by McNown, Sam, and Goh (2018) and Sam, McNown, and Goh (2019) to answer the question of whether the estimated NARDL model falls into the degenerate lagged (in)dependent variable case.

The remainder of this paper is organized as follows. The second section presents the theoretical framework and previous studies. In the third section, we review government spending and economic growth in Saudi Arabia during the period 1970-2019. In the fourth section, the study model and the method for estimating this model are introduced. In the fifth section, the results of the study model and a discussion of these results are presented. The final section concludes the study and provides policy recommendations.

2. Government Expenditure and GDP in Saudi Arabia

Saudi Arabia is an emerging economy that ranks among the world's 20 largest economies (G20). The dataset of the Saudi Arabian Monetary Authority (2020) shows the Saudi Economy as a rental economy that relies primarily on oil revenues to finance approximately 45 percent of the government budget for finance development projects. It also contributes to GDP at a rate of 45 percent. Over the last five decades, the real GDP has steadily grown at an average annual growth rate of 6.5 percent. In contrast, the non-oil economy in the Kingdom has grown as a result of the development plans that began in the early 1970s and government development expenditures, particularly in infrastructure (roads, electricity, water systems, and telecommunications).

Currently, Saudi Arabia has put ambitious development plans in the form of Vision 2030 to overcome the oil phase by reducing the government budget's dependence on oil revenues. This objective also entails increasing the dependence of economic growth on the private sector–an economy that is necessarily a non-oil economy.

Given this reality, the previous phase of the Saudi economy is expected to follow Wagner's law, as government expenditure is primarily driven by GDP through oil revenue. Notably, this expenditure reached 40 percent of the total GDP during the second decade of the twenty-first century, which is greater than the optimal rate of expenditure estimated at 28 percent by Almosabbeh (2019).

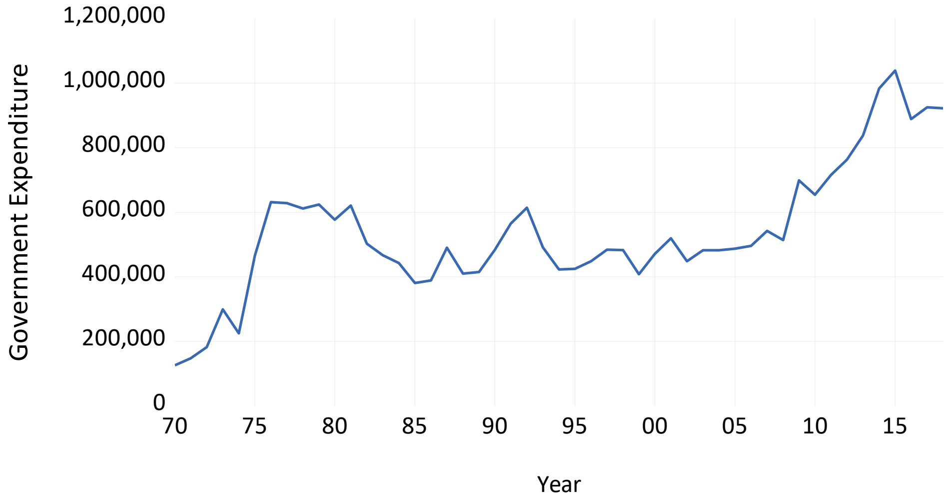

Figure 1. Progress in real government expenditure (Billion dollar, 2010=100)

Over the past few decades, Saudi Arabia has witnessed a significant increase in government expenditures. The data indicate that the volume of government expenditure at constant prices increased from $125 billion in 1970 to $927 billion in 2017. Figure 2 shows that the period between 1970 and 1976 witnessed the highest rates of growth in the volume of government expenditure due to successive increases in oil prices, especially after the oil boom. On the other hand, government expenditures declined from 1981 to 1985 because of the decline in oil prices. Notably, in the following period, until 2008, real government expenditure was relatively stable with only marginal changes, but began to rise gradually starting in 2009 because of the increase in oil prices. First, the trends in the government expenditure rate were not similar to those of expenditure during the same period.

As for the relationship between the two variables, or rather the effect of changes in GDP on government spending, Figure 3 shows that there is a common walking to a large extent between the two variables during the period 1971-2019. It is clear that positive changes in GDP have positive effects on government spending and that negative changes in GDP lead to negative changes in government spending in Saudi Arabia. Despite this generalization, the period from 2003 to 2007 was excluded. In other words, the positive changes in GDP were offset by a decrease in government spending at constant prices (2010 = 100). This symmetric relationship can be explained, in the first place, by the fact that GDP is greatly influenced by oil export revenues, which mainly finance government expenditures. That is, the increase (decrease) in oil prices will positively (negatively) affect Saudi GDP first and then government expenditures.

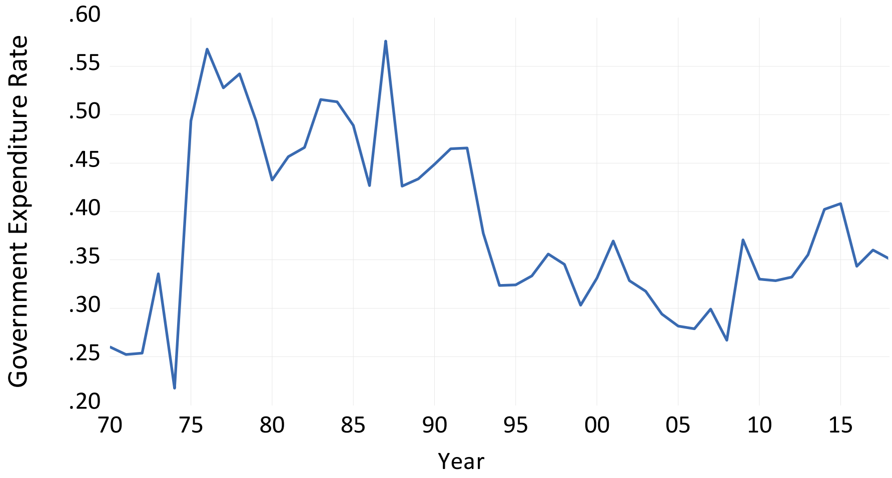

Figure 2. Progress in government expenditure rate to GDP

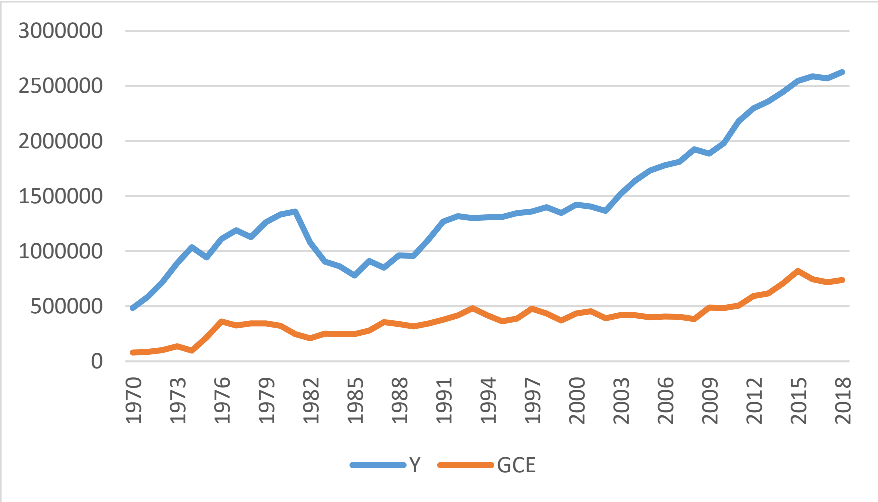

Figure 3. Government expenditure rate and GDP

3. Theoretical Background and Literature Review

3.1 Theoretical Background

In all their discussions regarding the relationship between government expenditure and economic growth, economists recognize contrasting perspectives concerning the direction of the relationship between the two variables. The most common explanation of Wagner's law is that an increase in economic activity leads to an increase in government activities, which in turn leads to an increase in the amount (or GDP rate) of government expenditure. This hypothesis has three reasons are given to justify it (Abu-Bader & Abu-Qarn, 2003, p. 571):

- public functions substitute private activity;
- economic development results in the expansion of cultural and welfare expenditures; and
- government intervention may be needed to manage and finance natural monopolies.

The effect and orientation of the relationship between developed and developing countries are different because economic growth in developing countries largely depends on their ability to spend on education, health, security and defense, and infrastructure. Therefore, the government's ability to expand in various sectors depends on the ability of these sectors to increase domestic production, and consequently, increase and diversify national production. This enhances the government's capital accumulation and pushes its growth rate to a remarkable level. Thus, expanding government expenditure is seen as the product of economic development and not vice versa (Bird, 1971).

3.2 Models of Wagner's Law

Most studies examined the nature of the relationship between government expenditure and economic growth, focusing on the application of Wagner's law using different formulas for this law. Table 1 illustrates the different formulas approved for examining Wagner's law.

Table 1. Version of Wagner's law

No.	Function	Version	Null hypothesis (H_0) of Regression Parameter β
1	$LGE = f(LY)$	Peacock-Wiseman (1961)	$\beta \leq 1$
2	$LGCE = f(LY)$	Pryor (1968)	$\beta \leq 1$
3	$LGE = f(LYPC)$	Goffman (1968)	$\beta \leq 1$
4	$LGEY = f(LYPC)$	Musgrave (1969)	$\beta \leq 0$
5	$LGEPC = f(LYPC)$	Gupta (1967)	$\beta \leq 1$
6	$LGEY = f(LY)$	Mann (1980)	$\beta \leq 0$
7	$LGEY = f(LYPC, LDIFY)$	Murthy (1993)	$\beta \leq 0$

Note: LGE is the logarithm of real government expenditure, $LGEPC$ is logarithm of real government expenditure per capita, $LGEY$ is the logarithm of government expenditure percentage to GDP, $LGCE$ is the logarithm of real public consumption, LY is the logarithm of real GDP, $LYPC$ is the logarithm of real GDP per capita, and $LDIFY$ is the logarithm of the percentage of budget deficit to GDP.

The first formulation was adopted by Peacock-Wiseman (1961), who interpreted the law as follows: "public expenditures should increase by a higher rate than GDP." The second formulation was created by Pryor (1968), who stated that in developing countries, the share of public consumption expenditure on national income is increasing. In the same year, Goffman (1968) expressed the law differently: "During the development process, the GDP per capita increase should be lower than the rate of public sector activities increase." According to Musgrave (1969), that is, the fourth equation, "the public sector share to GDP is increasing as the GDP per capita raises [sic], during the development process." Gupta (1967) considers per capita government expenditure as a function of per capita GDP (fifth equation). Finally, Mann (1980), in an attempt to empirically verify Wagner's law, adopted the sixth formulation: "Public expenditure share to GDP is a function of GDP."

The last Wagner's law formula was developed by Murthy (1993). This is an augmented or modified version of the formula introduced by Musgrave (1969). The inclusion of the last explanatory variable in Equation 7 is justified because it does not contradict the spirit of law. It is normally expected that as economic development progresses, the budget deficit ratio would increase in the case of developing countries, since government revenue increases less in proportion to expenditure. This problem would be further alleviated if developing countries adopted financial and economic liberalization policies (Murthy, 1993).

In this study, Wagner's law models were estimated in line with previous studies. The first six models are estimated using the logarithmic conversion for both variables, while the Murthy (1993) model is estimated without a logarithmic conversion of the budget deficit ratio (Dify) because some of the fiscal deficits are negative.

3.3 Literature Review

Over the past decades, the relationship between government expenditure and economic growth has been extensively studied, but the results remain inconclusive, or there is no academic consensus on the nature and direction of this relationship. These studies fall largely into four types based on their results: studies supporting the Keynesian hypothesis, studies supporting Wagner's law, studies that have found a reciprocal relationship between the two variables, and studies with inconclusive results or indicating no relationship. This discrepancy in the results is due to the use of data from different economic systems and econometric methods to test the hypotheses.

Sinha (2007) is one of the most critical studies to examine which of the two frameworks controls the relationship between government expenditures and economic growth. Sinha shows a long-run relationship between GDP and government expenditure based on Malaysian data for the period between 1950 and 2003 but a short-term relationship between national income and government expenditure, indicative of Wagner's law. Magazzino (2012b), in a study of the EU-27, found that the data supported augmented Wagner's law (the Murthy (1994) version of Wagner's Law), but not the Keynesian hypothesis. Experimental studies of Wagner's law offer mixed results, with some supporting the law and others finding no support.

The works that support Wagner's law include those by Ram (1986), Henrekson (1993), Ashworth (1995), Hondroyiannis and Papapetrou (1995), Nomura (1995), and Park (1996). Bohl (1996) studied G7 countries, whereas Anwar, Davies, and Sampath (1996) analyzed data on 88 economies. Ogbonna (2012) found that Wagner's law applied to Nigeria's economy during the period between 1950 and 2008. Similarly, Ibok and Bassey (2014) proved Wagner's law in the Nigerian primary sector for the period 1961–2012. The analysis by Afonso and Jalles (2014) supported the law for 155 countries over 30 years; Fedeli (2015) also showed the existence of Wagner's law for Italy between 1982 and 2009. Further, Jobarteh (2017) indicated this for Gambia, Kaur, and Afifa (2017) for India, Cergibozan, Cevik, and Demir (2017) for Turkey using the bounds test and data from 1960 to 2015, and Eldemerdash and Ahmed (2019) for Egypt over 1980–2012 using the autoregressive distributed lag (ARDL) method. The latter found cointegration between government expenditure and GDP and causal support for Wagner's law.

However, the Keynesian hypothesis also finds support among scholars such as Gupta and Gangal (2015) for India and Chimobi (2009) using the Granger causality test for Nigeria; Ighodaro and Oriakhi (2010) and Sevitenyi (2012) for Nigeria; Ghosh and Gregoriou (2008) for 15 developing countries; Sinha (2007) for Thailand; Blankenau, Simpson, and Tomljanovich (2007) for developing countries; Halicioĝlu (2003) for Turkey; and Ebaidalla (2013) for Sudan using the Granger causality test for the period 1970–2008.

There are also a wealth of studies that offer mixed evidence. That is, these studies support the trade-off between economic growth and government expenditures. These studies include Balamurali and Sivarajasingam (2010) for Sri Lanka using the Granger causality test; Wu, Tang, and Lin (2010) used the Granger causality test for panel data of 182 countries covering the period 1950–2004; Chow, Cotsomitis, and Kwan (2002) for the United Kingdom using the Granger causality test for the period 1948–1997; and Abu-Bader and Abu-Qarn (2003) for Syria, Egypt, and Israel using the Granger causality test for 1963–1998. Furthermore, Dritsakis and Adamopoulos (2004), using the Granger causality test for the period between 1960 and 2001, show the complexity of the underlying interactions, with most of the relationships being bi-directional in the causality models.

However, inconclusive results are common in the literature. These studies include Rauf, Qayum, and Zaman (2012) for Pakistan; Kumar (2009) for five East Asian countries; Chimobi (2009) for Nigeria; Afzal and Abbas (2010) for Pakistan; Magazzino (2012a) for the EU-27; Bagdigen and Cetintas (2004) for Turkey, covering data from 1965 to 2000; Huang (2006) for China, including Taiwan, using the bounds test Toda–Yamamoto causality test and data covering 1979–2002; and Oktayer and Oktayer (2013) for Turkey, using cointegration and data for 1950–2010.

Literature on Saudi Arabia in this regard is scant. One prominent regional study was conducted by Al-Hassoon (2005), where the author experimented with the application of Wagner's law to the data of Arabian Gulf countries. Al Hassoun used the Granger causality test and the cointegration of six Gulf countries using six versions of Wagner's law. Furthermore, Berry (2001) focused on identifying the optimal size of government expenditure in Saudi Arabia using the Barro formula and data covering 1970–1998. Berry claims a direct correlation between government expenditure and economic growth, supporting the Keynesian hypothesis. Similarly, Khayat (2003) examined the effect of government expenditure on economic growth in Saudi Arabia from 1970 to 1998. This study noted a certain stability in the economic growth function and the existence of a bidirectional reciprocal relationship between government investment expenditure and economic growth. Ageli (2013) supports the sixth version of Wagner's law using the cointegration test for Saudi Arabia and a dataset covering the period 1970-2010. Using the Granger causality test, Al-Obaid (2004) supports Wagner's law in Saudi Arabia for 1970–2001. Similarly, Wijeweera and Garis (2009) tested Wagner's law for 1969–2007, using the Engel and Granger two-step cointegration method. They found that government expenditures from GDP expansions increased public welfare for Saudis over the examined period.

This study is novel in that it examines Wagner's law using a new technique called augmented NARDL (A-NARDL), which combines the augmented ARDL (A-ARDL) developed by Sam et al. (2019) with the nonlinear ARDL developed by Shin et al. (2014). This technique enables the authors to reveal real cointegration between the variables of the study and offers a deeper understanding of the dynamics of the relationship between the variables, that is, whether they are symmetric (H_0) or asymmetric (H_1).

4. Model and Methodology

4.2. Unit Root Test

A unit root test was administered to explore additional statistical characteristics of the time series and to identify the proper method for estimating the study model. Several tests can be conducted in this context. This study used augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests. If the time series are integrated in the same order, especially in the first order, Johansen's procedure is used. In the case of different orders of integration of the variables, the ARDL (ARDL) approach is adopted.

4.3. A-ARDL and NARDL

The augmented ARDL model relaxed the rigidity of the I(1) dependent variable in the ARDL model of Pesaran et al. (2001) and added an additional F-test to check the degenerate lagged independent variables. The main difference between A-ARDL and ARDL is that, after the confirmation of the significance of the overall bounds test, it also eliminates the possibility of the degenerate lagged dependent variable and degenerate lagged independent variable(s).

Although the F-Wald test, as in Pesaran, Shin, and Smith (2001), is important for testing the joint significance of long-run parameters in the ARDL model, this test does not explain whether cointegration is real or degenerate. Sam et al. (2019) show that the degenerate lagged dependent variable case (as a null hypothesis) can be determined by testing the joint significance of lagged independent variables using the t-test. The authors divided the possible results of the three tests in the ARDL model as follows.

(a) F-test ($F_{overall}$) on the lagged levels of all variables with null the hypothesis $H_0: \rho = \theta = 0$

(b) T-test (T_{DV}) on the lagged level of the dependent variable with the null hypothesis $H_0: \rho = 0$

(c) F-test (F_{IDV}) on lagged level of the independent variable with the null hypothesis $H_0: \theta = 0$

If we accept the null hypothesis of (a) as a possibility, then we can conclude that no cointegration exists between the variables. Otherwise, if we reject the null hypothesis of (a) and accept the other two possibilities, or only one of them, we observe degenerate cointegration between the variables. Table 2 summarizes the potential results of the cointegration tests using the A-ARDL bound test method.

Table 2. Summary of the potential results of the cointegration tests under the A-ARDL bounds test method

	Null Hypothesis		
	a: $H_0: \rho = \theta = 0$	b: $H_0: \rho = 0$	c: $H_0: \theta = 0$
– No-cointegration	✓	X	X
– Degenerate lagged dependent variable	X	✓	✓
– Degenerate lagged dependent variable	X	✓	X
– Degenerate lagged independent variable	X	X	✓
– Cointegration	X	X	X

Note: ✓accepts the null hypothesis and *X* rejects the null hypothesis.

Table 3. The $\boldsymbol{F_{IDV}}$ critical values in case III

Sig. Level	Obs.	I(0)	I(1)
0.01	40	5.14	8.58
	45	5.06	8.38
0.025	40	4.04	6.94
	45	3.99	6.78
0.05	40	3.26	5.68
	45	3.21	5.62
0.10	40	2.45	4.46
	45	2.41	4.43

Sources: (Sam et al., 2019, p. 134).

Sam et al. (2019, p. 139) present the limiting distributions of the test on the lagged level of the independent variable(s) and tables of bounds for the critical values, including both small-sample and asymptotic cases. This allows for a straightforward test of the degenerate lagged independent variable(s) case that can be used concurrently with the other two tests from Pesaran et al. (2001). Table 3 presents a summary of the bounds of the critical values for the two independent variables at significance levels of 0.01, 0.025, 0.05, and 0.10 and in case III (unrestricted intercepts; no trends).

4.4. NARDL and A-NARDL Methods

The ARDL method suffers from an intrinsic defect by assuming linearity and symmetry in the relationship between the variables. Indeed, “linearity suggests that there should be a proportional change to the dependent variable in reflection of changes to the independent variable” (Affendi & Masih, 2018). Therefore, the NARDL method of Shin et al. (2014) under the assumption of nonlinearity, will lead to more general and insightful results for such a relationship. Using this method, we can identify the mechanism of the effect of the positive and negative shocks of the explanatory variable in the short and long term. The long-run equation between Y (as dependent variables) and X (as independent variables) using NARDL can then be written as follows (Shin et al., 2014):

$$Y_t = a + \beta_1 X_t^+ + \beta_2 X_t^- + e_t \tag{1}$$

where β_1 and β_2 are long-run asymmetrical effects of X on Y; and X_t is the vector of regressors decomposed into positive (X^+) and negative changes (X^-), and the initial value at time $t = 0$. X_t can be represented as follows:

$$X_t = X_0 + X_t^+ + X_t^- \tag{2}$$

X_t^+ and X_t^- are computed as in equations 3 and 4, respectively, as follows:

$$X_t^+ = \sum_{n=1}^{t} \Delta X_n^+ = \sum_{n=1}^{t} max\ (\Delta X_n, 0) \text{ and} \tag{3}$$

$$X_t^- = \sum_{n=1}^{t} \Delta X_n^- = \sum_{n=1}^{t} min\ (\Delta X_n, 0), \tag{4}$$

where Δ denotes the first different operator. The estimation of the previous model using NARDL is treated in a manner similar to ARDL, but it includes positive and negative variables of the independent variable that was decomposed to capture the asymmetrical effect of Y on GOV. Then, Wagner's Law NARDL model (for several types, as in Table 1) can be written as follows:

$$\begin{aligned} \Delta GOV_t = \mu - \rho GOV_{t-1} + \theta^+ LY_{t-1}^+ + \theta^- LY_{t-1}^- + \gamma LDIFY_{t-1} \\ + \sum_{j=1}^{p} a_j \Delta GOV_{(t-j)} + \sum_{j=0}^{q1} \pi_j^+ \Delta LY_{t-j}^+ + \sum_{j=0}^{q2} \pi_j^- \Delta LY_{t-j}^- \\ + \sum_{j=0}^{m1} \lambda_j \Delta LDIFY_{t-j} + \beta Dum93_t + \varepsilon_t \end{aligned} \tag{5}$$

,

where GOV is the government expenditure. It varies according to different types of Wagner's laws. LY is the economic growth variable, which varies according to different types of Wagner's law. Dum_{93} is a time dummy variable, where Dum=1 after 1992 and Dum=0 before 1993. ρ is the error correction term (ECT), and θ^+ and θ^- denote the long-run information of the level equation. a, π^+, π^-, β and λ are short-run coefficients. p, $q1$, $q2$ and m are the lag orders for the variables chosen based on critical information, such as the AIC, Schwarz criterion (SC), or Hannan–Quin criterion (HQ). The optimal lags are when the model has minimum AIC, SC, or HQ. Finally, μ is the constant of the equation and ε is the error term. Table 5 presents the results of the selection models based on the AIC.

Next, the long-run coefficient must be computed to write the long-run or level equation, as follows:

$$a = -\frac{\mu}{\rho};\ \beta_1 = -\frac{\theta^+}{\rho}\ and\ \beta_2 = -\frac{\theta^-}{\rho}. \quad (6)$$

As in the ARDL method, the presence of a cointegrating relationship can be checked using the bounds test with the null hypothesis $H_0\colon \rho = \theta^+ = \theta^- = 0$ as above. Next, the standard Wald test must be run to capture the symmetric effect in the long term for the null hypothesis $H_0\colon -\frac{\theta^+}{\rho} = -\frac{\theta^-}{\rho}$, and in the short term for the null hypothesis $H_0\colon \sum_{n=0}^{q1} \pi^+ = \sum_{n=0}^{q2} \pi^-$. Finally, the cumulative dynamic multiplayer effect of a unit change in X_t^+ and X_t^- on Y_t was investigated as follows:

$$m_h^+ = \sum_{j=0}^{h} \frac{\delta Y_{t+1}}{\delta X_t^+};\ m_h^- = \sum_{j=0}^{h} \frac{\delta Y_{t+1}}{\delta X_t^-}, h = 0, 1, 2, ... \quad (7)$$

Note that when h approaches infinity ($h \to \infty$), $m_h^+ = \beta_1$ and $m_h^- = \beta_2$. “Depicting and analyzing the paths of adjustment and/or the duration of the disequilibrium following initial positive or negative perturbations in economic growth, mh^+ and mh^- add useful information to the long- and short-run patterns of asymmetry” (Fousekis, Katrakilidis, & Trachanas, 2016, p. 501).

This paper suggests generalizing A-ARDL to include tests of asymmetry because the variables x^+ and x^- can be treated as independent variables, regardless of whether they are a basic part of the asymmetry model. Thus, the search for symmetry requires that the requirement of cointegration be met in accordance with the requirements of A-ARDL. In other words, the null hypothesis tests that the relationship between the dependent variable GOV and the independent variable GDP is symmetric by first testing the cointegration relationship as in Sam et al. (2019), and then adding a fourth test to this group, that is, a symmetry test. This generalization, now technically called Augmented NARD or A-NARDL, allows for testing a real (and not degenerate) symmetric relationship between the two variables under investigation. that is, government expenditures and GDP.

5. Econometrics Results and Discussion

5.2. Unit Root Test

Table 3 presents the results of unit root tests (ADF and Phillips–Perron) with constant (C) and with constant and trend ($C\&T$), at the level and at the first difference for all time series. This study reveals that the series are not stationary at levels; they are integrated in the order of I(1), except $LGEPC$, which is integrated in the order of I(0). In this way, it is possible to use the ARDL and NARDL methods to examine Wagner’s law in Saudi Arabia.

Table 4. Unit root test

Panel A. Unit root test (Phillips–Perron)

	At Level		At First Difference	
	C	$C\&T$	C	$C\&T$
LGE	-2.3689	-2.8534	-7.7126***	-7.8594***
LGE_Y	-2.0724	-2.0228	-8.2033***	-8.6502***
$LGEPC$	-2.792*	-2.9804	-7.8729***	-7.8578***
LY	-2.0368	-3.1072	-5.2262***	-5.1142***
$LYPC$	-1.5905	-2.0598	-4.9761***	-4.8783***
$LDIFY$	-2.934*	-2.7035	-7.550***	-7.506***

Panel B. Unit root test (ADF)

	At Level		At First Difference	
	C	$C\ and\ T$	C	$C\ and\ T$
LGE	-2.3689	-2.901	-7.7058***	-7.8594***
LGE_Y	-2.1931	-2.1507	-8.0456***	-8.0468***
$LGEPC$	-2.8062*	-3.0673	-7.8729***	-5.5747***
LY	0.8618	-2.9302	-3.8778***	-4.2003**
$LYPC$	-2.2274	-2.2203	-3.2447***	-4.076**
$LDIFY$	-2.5972*	-2.608	-6.8498***	-6.7716***

Note: ***, **, and * denote significance at the 0.01, 0.05, and 0.1 levels, respectively.

C: with constant, C and T: with constant and trend.

5.3. Wagner's Law Test Using A-NARDL

Adopting case III (unrestricted intercepts and no trends) and setting the maximum lag length to four for dependent and independent variables, the seven equations are estimated to test Wagner's law for Saudi Arabia using the A-NARDL technique. The dummy variable is added to all equations to reflect the structural changes in 1993 fiscal policy, as shown in Figure 3. Evidently, this indicates the validity of the selection for this year and that the parameter of the dummy variable was significant at less than 1 percent in most cases (*see* Table 5).

Table 5. Long term estimation from the NARDL models (Wagner's law tests)

Model	Peacock-Wiseman (1961)	Pryor (1968)	Goffman (1968)	Musgrave (1969)	Gupta (1967)	Mann (1980)	Murthy (1993)
β^{+}	1.068***	0.620***	2.427***	0.254	1.173***	0.077	0.399***
	(12.433)	(5.668)	(12.260)	(1.448)	(6.875)	(1.058)	(4.602)
β^{-}	1.220***	0.146	0.948***	0.167	1.153***	0.156	0.330***
	(9.490)	(0.371)	(9.862)	(1.966*)	(13.287)	(1.444)	(7.054)
γ							-0.840***
							(-7.548)
Constant	9.555***	9.096***	9.375***	-0.689***	8.164***	-0.622	-1.081***
	(8.954)	(7.186)	(8.866)	(-5.636)	(8.855)	(-5.742)	(-10.563)
Dum_{93}	-0.275***	-0.000	-0.254***	-0.287***	-0.269***	-0.378	-0.270***
	(-4.468)	(-0.008)	(-4.135)	(-4.338)	(-4.330)	(-5.344)	(-6.373)
$ECT\rho$	-0.771***	-0.767***	-0.798***	-0.812***	-0.772***	-0.900***	-1.184***
t_{DV}	-8.923	-7.103	-8.788	-8.922	6.208	-8.889	-15.193
$F_{overall}$	28.339	18.282	23.337	28.386	29.159	28.333	59.937
P_value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
F_{WL}	2.249	14.091	112.526	0.448	0.025	0826	1.154
P_value	0.142	0.000	0.000	0.508	0.876	0.369	0.257
F_{WS}	---	0.735	1.597	2.506	---	28.556	-2.463**
P_value	---	0.397	0.215	0.122	---	0.000	0.019
F_{IDV}	32.794	9.100	27.288	2.065	36.626	1.123	22.600
Selection Model	ARDL(1, 0, 0)	ARDL(4, 2, 0)	ARDL(1, 0, 3)	ARDL(1, 0, 1)	ARDL(1, 0, 0)	ARDL(2, 1, 0)	ARDL(2, 0, 3, 0)

Note: ***, **, and * denote significance at the 0.01, 0.05, and 0.1 levels, respectively.

The numbers in parentheses are the t-statistic.

t_{DV}: t-test of the lagged level of the dependent variable. It complies with the Pesaran et al. (2001) critical values of the t-bounds test for case III.

$F_{overall}$: F-test on lagged levels of all variables. It complies with the Narayan (2004) critical values for the bounds F-statistics.

F_{WS}: F test on the long-run positive and negative coefficients of the independent variables.

F_{WS}: F test on the short term of positive and negative coefficients of the independent variables.

F_{IDV}: F-test of the lagged level of the independent variable.

Further, the five models achieve the necessary conditions significant at 0.01, that is, a long-run relationship, using the Pesaran et al. (2001) critical values for overall F-statistics, Narayan (2004) critical values for t_{DV}, and Sam et al. (2019) critical values for the lagged independent variables. These are Peacock-Wiseman (1961), Pryor (1968), Goffman (1968), Gupta (1967), and Murthy (1993). The Musgrave (1969) and Mann (1980) models fall into the degenerate lagged dependent variable case because of the insignificant F_{IDV}. Although both models pass the t_{DV} and $F_{overall}$ tests at a significance level of 0.01, they fail to pass the lagged independent variables test. The F_{IDV} values are 2.065 and 1.123 for the Musgrave and Mann models, respectively. Notably, the upper critical values for the two explanatory variables with 44 observations are close to 8.40, as shown in Table 3.

Table 6 summarizes the diagnostic tests for the seven estimated equations. These include the normality distribution of residuals test (Jarque–Bera), autocorrelation test (Lagrange multiplier test), homoscedasticity of residuals test (Breusch–Pagan–Godfrey test), and no functional misspecification test (Ramsey RESET test). The results show that the Pryor (1968) model estimations suffers from two problems: autocorrelation (using the Lagrange multiplier test) and misspecification (using the Ramsey RESET test). For the two tests, it is not possible to accept the null hypotheses at a 0.10 significance level, while the other equations pass all diagnostic tests.

Table 6. Summary of the diagnostic tests

Model	Peacock-Wiseman (1961)	Pryor (1968)	Goffman (1968)	Musgrave (1969)	Gupta (1967)	Mann (1980)	Murthy (1993)
JB	0.508	0.394	0.785	0.084	0.596	0.298	0.035
LM test	1.205	3.398*	0.959	1.883	1.061	1.336	0.358
Homo. Test	0.593	1.452	1.183	0.550	0.517	0.855	1.207
F_RESET1	2.953*	7.041**	1.122	1.700	1.638	2.703	0.044
F_RESET2	2.090	4.841**	2.095	1.584	2.184	1.651	1.237

Note: ***, **, and * denote significance at the 0.01, 0.05, and 0.1 levels, respectively.

For the symmetry test, the results in Table 5 show that the null hypotheses cannot be rejected for the three models in the long term. The results for Peacock-Wiseman (1961), Gupta (1967), and Murthy (1993) show that the F_{WL} for the symmetric test is less than the critical value even at a 0.10 level of significance. Thus, the relationship between government expenditures and economic growth is symmetrical in these models. When the F_{WS} test is run for short-run symmetry, the two results are generated because there are no lags for the independent variables in the Peacock-Wiseman (1961) and Gupta (1967) models. Table 5 indicates that the F_{WS} of Goffman 's(1968) model reflects a symmetric relationship, but the relationship is asymmetric for Murthy's (1993) model in the short term.

The result of the F_{WL} test for the Gupta (1967) model is smaller than the critical value, even at a 0.10 level of significance. Thus, all null hypotheses are accepted, indicating that the relationship between government expenditure and GDP per capita is symmetric or that the difference between the positive and negative shocks is not significant. However, a 1 percent increase in $LYPC$ led to a 1.173 percent (significant at less than 0.01) increase in $LGEPC$. Furthermore, a 1 percent decrease in $LYPC$ leads to a 1.153 percent (significant at less than 0.01) decrease in $LGEPC$. Arithmetically, the difference between the two long-run parameters was small (= 0.020) and statistically insignificant. Thus, this study can capture the symmetry of the short-run relationship from the cumulative dynamic multiplayer effect illustrated in Figure 4. This figure shows that the short-term transitions of the positive and negative effects curves are symmetrical. In other words, an improvement in the economic growth rate will have a positive effect on government spending in the short term to the same extent as a decline in the growth rate, but in the opposite direction.

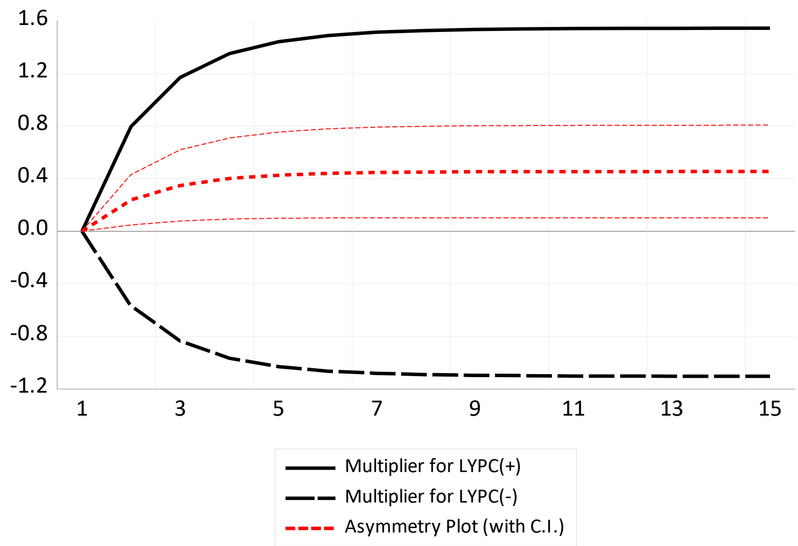

Figure 4. The cumulative dynamic multiplayer effect for Gupta (1967)

The result of the F_{WL} test for the Goffman (1968) model was higher than the critical value at less than the 0.01 significance level. Thus, we reject the null hypotheses and accept the alternative, that is, the relationship between government expenditure and GDP per capita is asymmetric or non-linear, and there exists a significant difference between the positive and negative shocks. A 1 percent increase in $LYPC$ leads to a 2.427 percent (significant at less than 0.01) increase in LGE. Moreover, a 1 percent decrease in $LYPC$ led to a 0.948 percent (significant at less than 0.01) decrease in LGE. Thus, the effect of positive shocks is also stronger here.

Figure 5 illustrates the short-run symmetric relationship. As shown in Table 5, the value of F = 0.735, which is a very small value. In addition to the corresponding probability value (P-value = 0.397), it is not possible to reject the null hypothesis; therefore, it can be said that there is a symmetric effect in the short term between economic growth and government spending in Saudi Arabia according to the Goffman (1968) model. On the other hand, Figure 4 shows that changes in government spending caused by positive shocks in economic growth are more pronounced than those caused by negative shocks in economic growth. Negative shocks to economic growth also have a fluctuating effect on government spending.

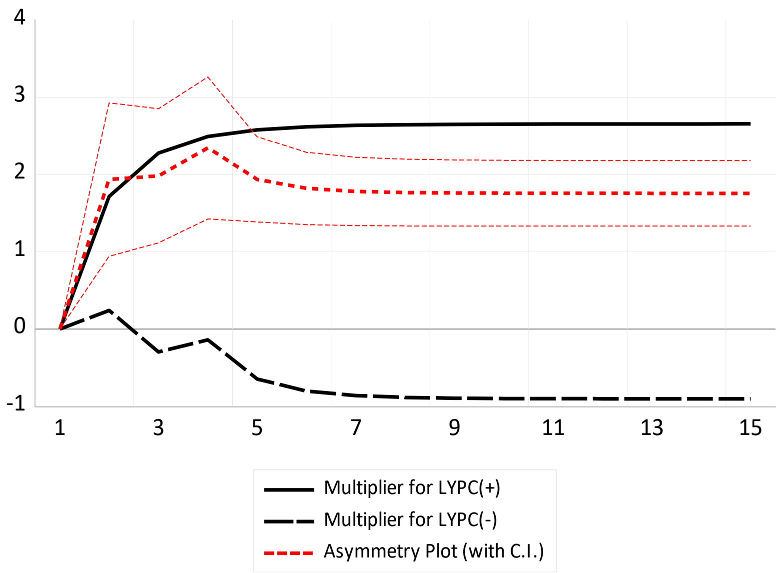

Figure 5. The cumulative dynamic multiplayer for Goffman (1968)

Regarding the Peacock-Wiseman (1961) model, Table 5 shows that the calculated F_{WL} (=2.249) is less than the critical value even at a 0.10 level of significance. Thus, the relationship between LGE and LY was symmetrical. Figure 6 illustrates this result using the dynamic multiplayer effect.

Because there are no lags in the two independent variables ($LY - POS$ and $LY - NEG$) in the selection equation in the Peacock-Wiseman (1961) model, the F_{WS} to test the short-run symmetry hypothesis cannot be calculated. From the results, if LY increases by 1 percent, LGE will increase by approximately 1.068 percent, while a decrease in LY by 1 percent will lead to a decrease in LGE by approximately 1.220 percent. Thus, the difference between the two variables was small and insignificant. However, the error correction term (ECT=-0.771) has a negative sign, is less than 1, and is significant at less than 0.01, based on the critical values of Pesaran et al. (2001) for t_{DV}. Thus, approximately 1.29 years (the inverse of absolute ECT) is needed to return to balance.

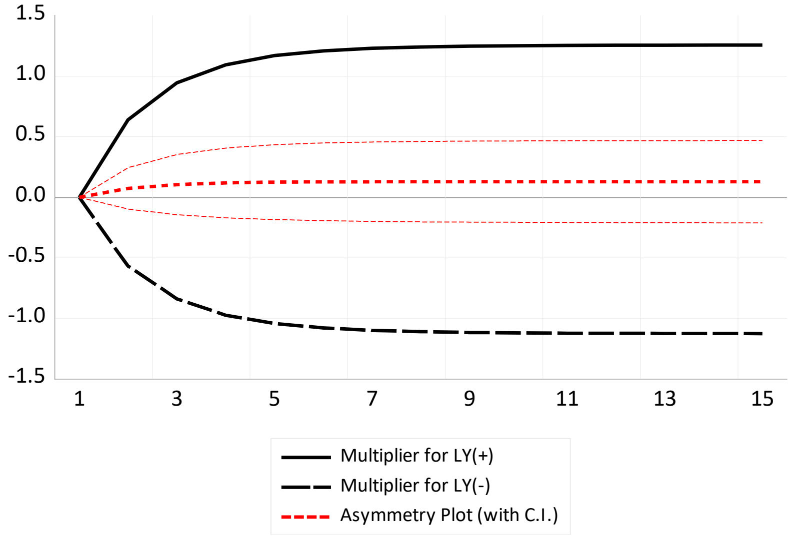

Figure 6. The cumulative dynamic multiplayer for Peacock-Wiseman (1961)

Table 5 shows the results for the Murthy (1993) model, with a long-run symmetrical relationship, where the F_{WL} (=1.154) is less than the critical value, and the P-value is higher than even 0.10. The result of F_{WS} (=-2.463) shows that the relationship between $LGE\ and\ LY$ is asymmetrical in the short term. Further, a 1 percent increase in LY leads to an increase in LGE of approximately 0.339 percent, whereas a 1 percent decrease in LY leads to a 0.330 percent decrease in $LGEY$. Figure 7 illustrates this symmetrical relationship. The cumulative positive effects are understated during the error correction trip, whereas strong fluctuations exist in the effect of negative shocks during the next five years.

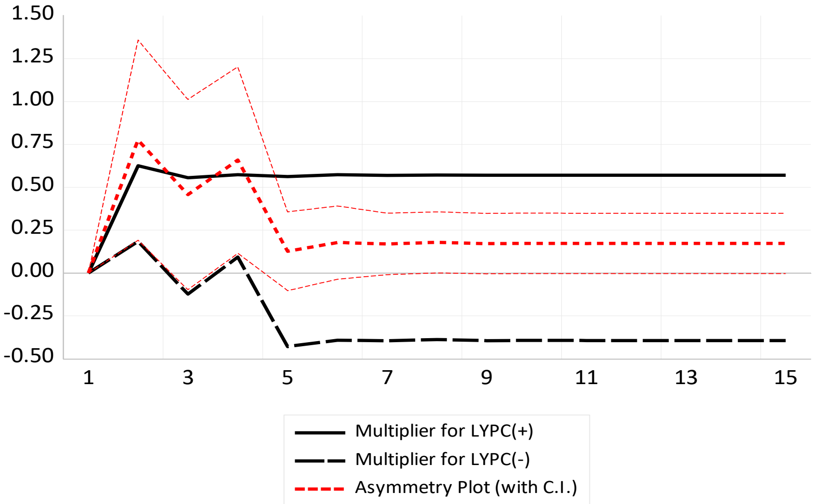

Figure 7. The cumulative dynamic multiplayer for Murthy (1993)

6. Conclusion and Recommendations

This study investigated the relationship between government expenditure and economic growth using data from Saudi Arabia covering the period between 1980 and 2019 based on Wagner's law. The law states that government expenditure is constantly growing, regardless of its absolute or relative size, because of societal development.

This study used econometric methods consistent with the statistical characteristics of the data, especially taking advantage of recent econometric developments, that is, the NARDL model. The statistical properties of the time series indicate that most time series are integrated in I(1), that is, they have a unit root. This makes the use of the ARDL method possible. It also enables the use of the NARDL method, which attempts to identify whether the relationship between the two variables is symmetric or asymmetric.

This study presents an advanced econometric method, A-NARDL, by combining the method of Sam et al. (2019) and the NARDL method of Shin et al. (2014), which distinguishes between cases of cointegration, non-cointegration, and degenerate lagged dependent and independent variable cases in the NARDL model.

The results show that the Gupta (1967), Goffman (1968), Peacock-Wiseman (1961), and Murthy (1993) models using the A-NARDL method succeeded in proving that a relationship runs from economic growth to government expenditure. The models passed all the tests, confirming the existence of true cointegration according to the terms set by Pesaran et al. (2001) and Sam et al. (2019); however, the other three models did not. The results of Pryor's (1968) model are unreliable owing to issues with the diagnostic tests for the residual of the regression equation.

The results show that the relationship between economic growth and government spending is symmetric in the long term according to the Gupta (1967) and Murthy (1993) models, but asymmetric according to the Goffman (1968) model. In the short term, the Murthy model reverses the asymmetric relationship, but not the Goffman (1968) and Peacock-Wiseman (1961) models. Thus, in the economies of a rentier state, such as Saudi Arabia, economic expansion leads to an increase in the size of the government and, thus, government services.

Regarding the validity of Wagner's law, this study is consistent with Henrekson (1993), Ashworth (1995), Hondroyiannis and Papapetrou (1995), Nomura (1995), Park (1996), Ram (1986), Bohl (1996), Anwar et al. (1996), Ogbonna (2012), Ibok and Bassey (2014), Afonso and Jalles (2014), Fedeli (2015), and Eldemerdash and Ahmed (2019).

Finally, in terms of policy recommendations, although the results do not decisively support a symmetric or asymmetric relationship, the study recommends that achieving an economic growth rate in the non-oil sector in the Saudi economy should be one of its most important objectives. Achieving a stable growth rate that exceeds the average during past periods is important for various aspects of the Saudi economy. However, it becomes more important in light of the changes that this economy is witnessing, especially its adoption of a vision (Vision 2030) that relies on financial stabilization and dependence on domestic products to provide the necessary revenues to finance the government budget. Over the past years, the Saudi government imposed a value-added tax of 5% starting in January 2018 and increasing to 15% in July 2020. Of course, this entails improving the incomes of all consumers by improving the conditions for economic growth.

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