The Economics and Finance Letters
2023 Vol. 10, No. 1, pp. 78-93.
ISSN(e): 2312-430X
ISSN(p): 2312-6310
DOI: 10.18488/29.v10i1.3299

An analysis of the government revenue–expenditure nexus: A wavelet approach for the Romanian case

Marius-Razvan Surugiu[1+]
Valentina Vasile[2]
Raluca Mazilescu[3]
Camelia Surugiu[4]
Razvan Vasile[5]

[1,2,3]*Institute of National Economy, 13 Calea 13 Septembrie, Bucharest, Romania.*
[1]*Email: mariussurugiu@ince.ro*
[2]*Email: valentinavasile2009@gmail.com*
[3]*Email: ralucamazilescu@ince.ro*
[4]*Faculty of Administration and Business, University of Bucharest, 4-12 Regina Elisabeta Blvd., Bucharest, Romania.*
[4]*Email: cameliasurugiu@faa.unibuc.ro*
[5]*"Costin C. Kiriţescu" National Institute of Economic Research, 13 Calea 13 Septembrie, Bucharest, Romania.*
[5]*Email: vasile.razvan89@gmail.com*


(+ Corresponding author)

Article History
Received: 28 November 2022
Revised: 12 January 2023
Accepted: 26 January 2023
Published: 20 February 2023

Keywords
Expenditures
Government
Government revenue
Spend-tax
Tax-spend
Wavelet analysis.

JEL Classification:
H71; H72.

ABSTRACT

The turbulent economic environment of the last decades, the social effects associated with the responsibilities of the state to support the development of the green economy, and the increase of involvement in sustainable social inclusion make it necessary to increase budget revenues. Evaluating the link between government revenues and expenditures is a complex approach defined by several factors related to tax compliance and the perception of the efficiency of the expenditure. In addition, recent endogenous and exogenous shocks have considerably influenced the fundamentals of long-term fiscal policy and budget balancing. The type of relationship between government revenue and expenditure is analyzed to identify the leading and lagging variables, and the wavelet approach and monthly data for Romania for 2000–2021 are used. In various periods, the revenue led the expenditure, or vice versa. The spend–tax and tax–spend hypotheses are confirmed for different periods. The analysis highlights the intervals of behavioral asymmetry, which helps to monitor the implementation of fiscal policy. Also, the results could represent a starting point for outlining measures in the fiscal policy area.

Contribution/Originality: The analysis uses the wavelet approach to highlight the leading and the lagging variables in the revenue–expenditure nexus in the case of Romania. The results might be helpful management tools for institutions in developing a fiscal policy supporting sustainable development.

1. INTRODUCTION

The assessment of the nexus between government revenue and expenditure is an increasingly important issue for developing a sustainable fiscal policy, mainly because of the turbulent economic environment, the difficulty of tax collecting, and the increasing need for budget revenues. Moreover, the recent endogenous and exogenous shocks have considerably influenced the fundamentals of long-lasting fiscal policy and budget balancing.

Although the national specificity of the state's responsibility and involvement is a significant factor in defining fiscal policy, the causality between revenue and expenditure has highlighted mixed results. On the one hand, empirical research shows that, in the long term, in less developed countries, government expenditure cause the revenue (Lojanica, 2015), but also that government revenue can cause the expenditure (Sahed, Mékidiche, & Kahoui, 2020).

Different opinions start from the empirical results that underlined the cointegration between the two variables of the budget in developed countries and suggested that the asymmetric adjustment of imbalances is significant in conditions where the budget is worsening (Ewing, Payne, Thompson, & Al-Zoubi, 2006).

More than in other areas of economic policy, the balancing measures are influenced by the development model, the scope and size of the government sector, public ownership (OECD, 2015, 2022), and the political profile of the government; the levers are a combination of tax increases and budget savings (Kaya & Şen, 2013; Mutascu, 2016). So, it is widely recognized that the nature and composition of government expenditure influence economic growth and the social welfare dynamic. Also, government expenditure has an increasing impact on the degree of tax revenue collection, considering not only the aspects of tax compliance and the perception of the tax burden but also the efficiency of the effects and indirect benefits from the spending model of the revenues collected.

In this study, the hypotheses are as follows:

- *H1: There are various models that determine the government revenue–expenditure nexus by country.*
- *H2: In the analyzed period, there is only one model of the government revenue–expenditure nexus for Romania.*

The study is comprised of following sections: Section 2 explains some essential Romanian tax policy changes in the analyzed period; Section 3 contains the literature review; Section 4 discusses the data and methodology; Section 5 contains the results and discussions; and the last section presents the conclusions of the study.

2. IMPORTANT CHANGES IN ROMANIAN TAX POLICY

Regarding the tax policy in Romania, the period between 2000 and 2021 was marked by various changes in the legal framework. However, to understand the impact and relevance of these changes, it is vital to highlight some aspects before 2000.

2.1. Direct Taxation (Personal Income)

In 1997, the tax on personal income was introduced in Romania, targeting income of any kind and from any activity, except income subject to tax on salaries or agricultural tax, for example. There were five tax brackets, with a minimum of 10% and a maximum of 40%.

In 2000, there were five tax brackets, with the lowest tax rate of 18% and the highest of 40%, but in 2004, Romania strengthened existing laws into a single tax code, which came into force on January 1, 2004. In the same year, the income tax was applied to income from self-employment, salaries, rental and leasing, investments, pensions, agriculture, prizes, and gambling.

On January 1, 2005, a flat income tax of 16% was introduced, which was applied to income from self-employment, wages, rental and leasing, pensions, agricultural activities, prizes, and other sources. Policymakers cancelled the progressivity to stimulate the business environment and ensure legislative stability. In 2005, the flat tax was set to be also applied to corporate profits. Incomes from the salaries of information technology (IT) sector employees were exempt from income tax, and income from pensions was taxed only for the amount which exceeded a certain level.

During the financial crisis that started in 2007, the Romanian government adopted measures to counteract the effects of the recession, such as providing support for employees and employers that had to suspend their activities temporarily and for people who lost their jobs (Ciutacu, 2009). At least 75% of the nominal salary was offered to employees of companies that had to suspend their activities temporarily. Also, the employers and employees were exempted from paying social security contributions for three months. During the temporary suspension of business activities, the amount paid to workers was income tax-free, and the unemployment benefit period increased by three months for all contribution brackets.

In 2013, the tax rate on income from gambling was 25%. In the case of the transfer of immovable property, different tax rates were applied depending on the period for which the property was owned and the value of the real

estate (1%, 2%, or 3%). Starting from January 1, 2018, income tax is 10% for all taxable income, except for dividend income, for which there is a 5% rate.

During the pandemic period that started in 2019, some measures were adopted in the tax area, such as if an employment contract was suspended, the benefits for employees were at 75% of the base salary, and a 5%–10% bonus for the payment of income tax and contributions was put in place KPMG (2020b).

2.2. Direct Taxation (Profit)

The tax on profit was adopted in Romania in 1991, with various progressive rates, but in 1995 the profit tax rate was set at 38%. In 1999, the tax on profit rate was reduced from 38% to 25%, and some tax incentives were cancelled.

In June 2002, the tax on profit changed, and the reduced rate for profit from exports was 12.5%. In 2005, the profit tax rate was set at 16% (flat tax). Reducing the profit tax rate to 16% was a measure to stimulate the business environment. There was a minimum turnover tax of 5% for gambling, nightclubs, and casinos. Microenterprises could opt for a tax rate of 2% of turnover instead of the standard corporate tax rate (the tax rate changed to 2.5% in 2008 and 3% in 2009). During the financial crisis that started in 2007, a non-refundable state aid scheme was adopted for small and medium enterprises (SMEs), with a maximum value of 200,000 euros per SME (Ciutacu, 2009).

Since January 1, 2017, the tax rate on dividends applicable to distributions between Romanian legal entities was reduced from 16% to 5%. In addition, a reduced rate to 1% for microenterprises income tax was introduced, which was applicable to Romanian start-ups with at least one employee. This rate was applied only for the first 24 months from the registration of legal persons.

During the COVID-19 pandemic, various countries adopted measures to fight the adverse effects of the crisis, with restrictions on the free movement of people and goods. These measures harmed economic activity, with global uncertainty eroding confidence (Saint-Amans, 2020). Romania adopted some measures in the tax area, such as KPMG (2020a) waiving interest and late payment penalties for non-payment of taxes on the due date, suspension of enforcement measures by seizure of budget receivables, and extension of the deadlines for the payment of various taxes. Other measures included a discount for timely corporate tax payments, microenterprises' income tax payments, and customs duties exemption for medical products (KPMG, 2020b).

2.3. Indirect Taxation (VAT)

The value-added tax (VAT) was adopted in Romania in 1990. Until 1998, the VAT standard rate rose to 22% for operations regarding the supply of goods, real estate transfers, and domestic and imported services. There was a reduced rate of 11% for products such as animal meat, fish and fish products, milk and powdered milk, oils and fats, birds' eggs of domestic species, and flour. In 1999, the standard VAT rate decreased to 19%. In addition, certain products and services previously exempt from VAT started to be taxed.

In 2004, the new Tax Code introduced a reduced VAT rate of 9%. In 2005, the standard VAT rate increased to 24%, but was 19% in 2008, and the reduced rate was 9% for pharmaceuticals, medical equipment for people with disabilities, books, newspapers, access to cultural services, and hotel accommodation. In 2009, the reduced VAT rate was 5% and was applied to social and private housing. In July 2010, due to the financial crisis which began in 2007, austerity measures were adopted to diminish the budget deficit, and the standard VAT rate changed to 24% and remained in force until January 2016 when the rate dropped to 20%. The reduced rate was 9% for pharmaceuticals, medical equipment for persons with disabilities, books, newspapers, schoolbooks, and access to cultural and accommodation services. Another measure adopted in the area of austerity reduced the salaries of employees in the public system by 25%. The standard VAT rate was reduced from 24% to 20% for 2016 and to 19% from January 1, 2017. In addition, the VAT rate was reduced from 9% to 5% for deliveries of schoolbooks, books, newspapers, some magazines, and services such as admission to castles, museums, and cinemas. This study analyzes the link between government revenue and expenditure, taking different frequencies and periods into account. This analysis framework

provides short-, medium- and long-term information. The results also provide information regarding the influence of one variable on the other and how the indicators are correlated (positively or negatively).

3. LITERATURE REVIEW

Determinants of fiscal sustainability and budget deficit are among the most studied topics in recent years in connection with Sustainable Development Goals (SDGs). In the literature, some works analyze the revenue–expenditure link and how it will continue to follow the trends recorded in the past (Cadman & Sarker, 2022; European Commission, 2006, 2019; OECD, 2013). The sustainability of public finances emphasizes the long-term ability to spend and tax while maintaining solvency (European Commission, 2016). Changes in tax revenues and government expenditures impact economic activities, resource allocation, and income distribution.

A scientometric analysis of the literature on the revenue–expenditure nexus indexed in the SCOPUS database after 2000 shows 135 works. These papers analyze economic development and fiscal policy, fiscal sustainability, government debts, health financing, and inflation issues (see Figure 1).

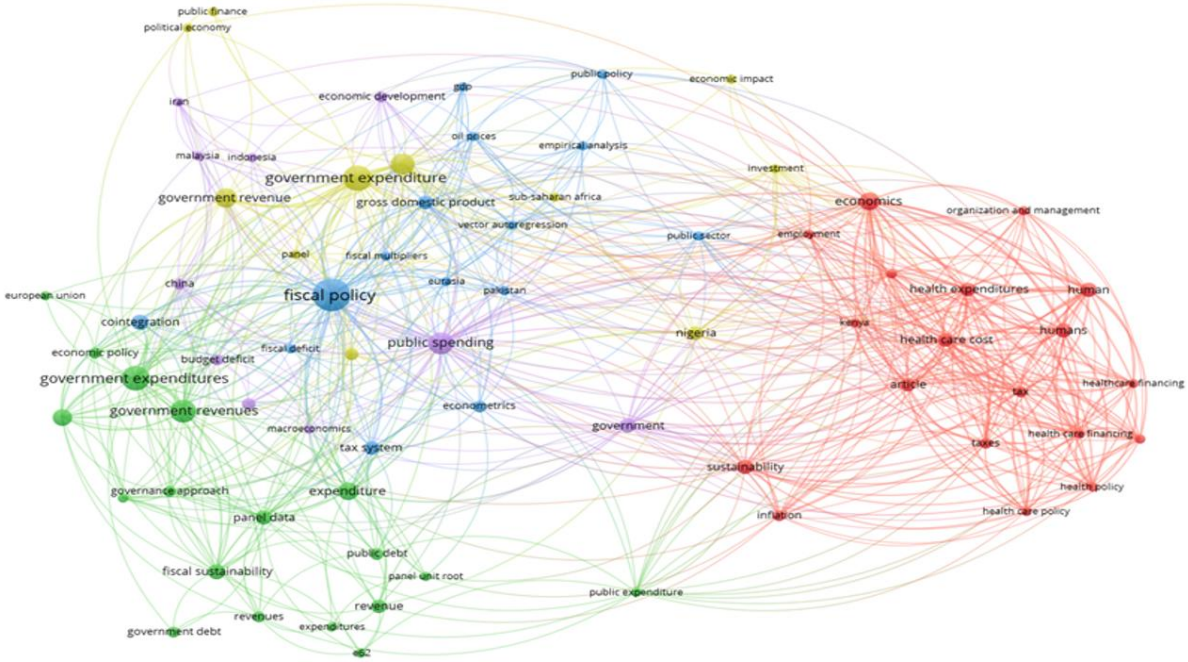

Figure 1. Research interest on government revenue and expenditure after 2000 – SCOPUS database scientometric analysis.
Source: Data from 2000 to present, papers published, Scopus database, keywords: Government revenue and government expenditure (3), data retrieved on November 15, 2022.

From the total of 5,697 works identified with the theme of tax revenue, only about 3% are associated with keywords such as government revenue and government expenditure. The analysis results are mixed from the perspective of policies and impact.

If we detail the content analysis of the works identified according to the selection mentioned above, we find the following research topics:

- For the analysis of the link between tax revenue and government expenditure, we find that the sub-areas of interest for experts are focused on the implementation of local policies, public investments, economic policy, cost-benefit analysis, environmental taxes, and constraints related to the limitation of budget revenues versus needs (see Figure 2);
- Regarding the tax revenue–government revenue relationship, the interest is detached, on the one hand, for the analysis of the relationship between economic growth and fiscal policy, tax avoidance, and non-tax revenue, and on the other hand, fiscal sustainability, the tax burden and the need to finance local development, poverty reduction, and vital sectors for the quality of life, i.e., health (see Figure 3).

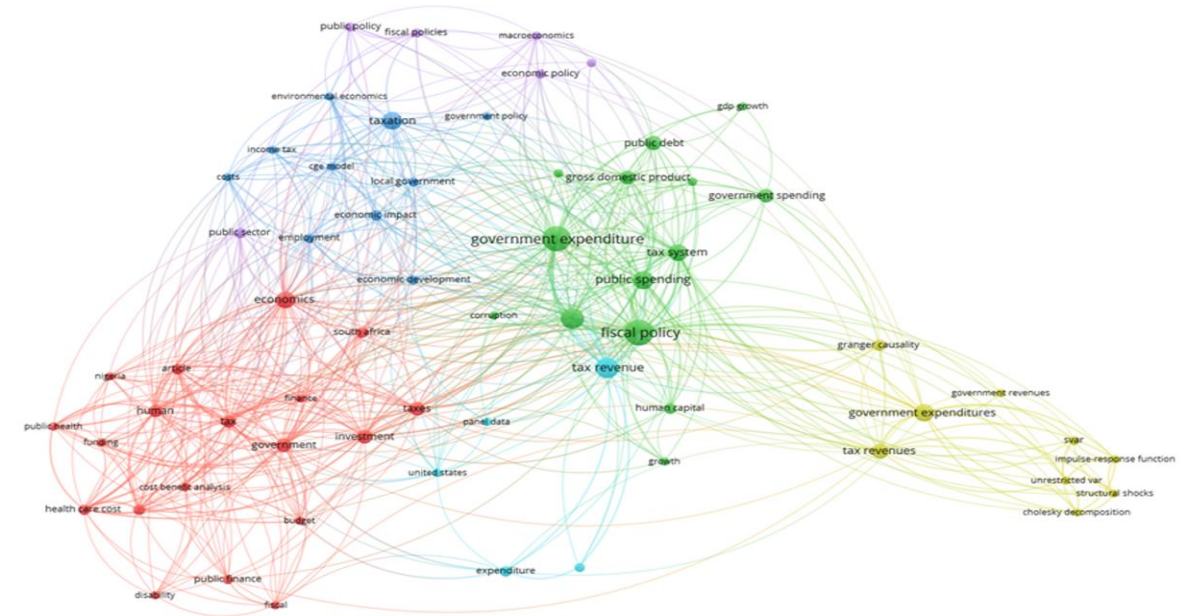

Figure 2. Research interest on tax revenue and government expenditure after the year 2000 – SCOPUS database scientometric analysis (155 works after 2000).

Source: Data from 2000 to present, papers published, Scopus database, keywords: Tax revenue and government expenditure (3), data retrieved on November 15, 2022.

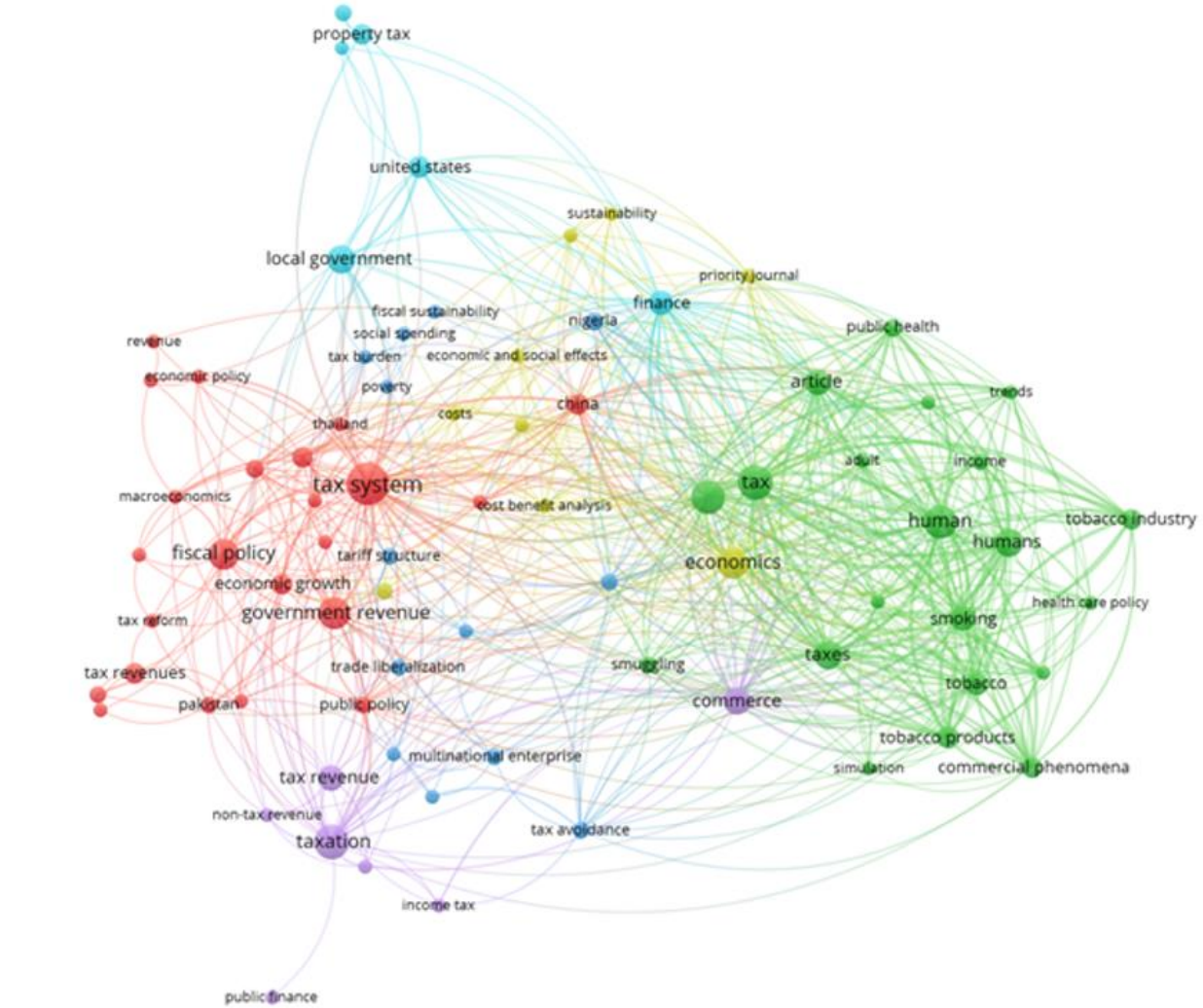

Figure 3. Research interest on tax revenue and government revenue after 2000 – SCOPUS database scientometric analysis (183 works after 2000).

Source: Data from 2000 to present, papers published, Scopus database, keywords: Tax revenue and government revenue (3), data retrieved on November 15, 2022.

Beyond this presentation, some results from the literature support our research approach and motivate the specific course of the present study according to the research hypotheses and the methodology used. Thus, we briefly present some significant studies on the topic.

Payne (2003) identified four directions of investigation regarding the relationship between public revenues and expenditures (see Table 1): (a) the tax-spend hypothesis, (b) the spend-tax hypothesis, (c) the fiscal synchronization hypothesis, and (d) the independence of revenue and expenditure, or the institutional separation hypothesis.

Table 1. The directions of investigation regarding the public revenues-expenditures link.

No.	Hypothesis	Description	Source
1.	Tax-spend (The state first taxes and only then spends)	• Tax revenue determines the level of expenditure • The increase in taxes, which also leads to increased resources available to the government to reduce the budget deficit, only increases public spending. If revenue positively affects expenditure, a reduction in revenue would result in a decrease in expenditure.	Friedman (1978)
2.	Spend-tax hypothesis (The state first spends and then uses taxes to attract revenue)	• Expenditure causes taxes • Crises, which lead to increased public spending more than taxation, can change the public's attitude toward the appropriate level of public expenditure • The result is a permanent acceptance of tax increases, initially justified by the problems caused by the crisis • Increasing public spending will lead to higher taxes	Peacock and Wiseman (1979); Barro (1979)
3.	Fiscal synchronization hypothesis (Taxes cause expenditure, but also expenditure causes taxes)	• The decisions are taken simultaneously for revenue and expenditure areas • Voters decide together on the desired expenditure and taxes, weighing the costs and benefits of any budget change • Voters can express their preferences by choosing between various programs or budget plans (On public revenue and expenditure) • The redistribution of income, taxes, and expenditure changes with this rule	Musgrave (1966); Meltzer and Richard (1981)
4.	Revenue and expenditure independence (the hypothesis of institutional separation of government functions)	• Taxation decisions are not connected to those in the area of public expenditure	Wildavsky (1988); Baghestani and McNown (1994)

Various studies have analyzed the revenue–expenditure link based on the above hypotheses. Thus, different methods are used to find the direction of the relationship between variables (see Table 2, Table 3, and Table 4).

Table 2. Research on the government revenue–expenditure nexus (Non-European Union (EU) countries).

No.	Source	Country	Period	Method	Results
1.	Champita (2016)	Zambia	1980–2016	Granger causality tests, vector autoregressive (VAR)	• Government expenditure causes revenue (Spend-and-tax hypothesis)
2.	Phiri (2019)	South Africa	1960–2016	Momentum threshold autoregressive threshold error correction (MTAR-TEC) model	• Bidirectional causality between revenue and expenditure (The fiscal synchronization hypothesis)
3.	Ghazo and Abu-Lila (2018)	Jordan	1976–2016	Causality in the error correction model	• Bidirectional causality between direct tax revenue and capital expenditure • Bidirectional causality between non-tax revenue and current and capital expenditure • Current expenditure causes direct and indirect tax revenue • Capital expenditure causes indirect tax revenue

No.	Source	Country	Period	Method	Results
4.	Akram and Rath (2019)	Indian states	1980–2015	Dumitrescu–Hurlin panel causality test	• The fiscal synchronization hypothesis
5.	Kazungu (2019)	Tanzania	2000–2017	VAR model, Granger causality test, impulse response function, and variance decomposition	• Government expenditure causes government revenue
6.	Raza, Hassan, and Sharif (2019)	Pakistan	1972–2014	Nonlinear autoregressive distributed lag (NARDL) model	• The fiscal synchronization hypothesis
7.	Karlsson (2020)	China	1980–2015	Wavelet decomposition, Granger causality	• The tax-and-spend hypothesis • Bidirectional causality (Fiscal synchronization)
8.	Sahed et al. (2020)	Algeria	1990–2019	Granger causality test	• Government revenue causes the expenditure
9.	Kaya and Arslan (2020)	Turkey	2006–2019	Asymmetric causality test	• The fiscal synchronization hypothesis • The spend-and-tax hypothesis
10.	Linhares, Nojosa, and Bezerra (2021)	Brazil	1996–2019	Time-varying Granger causality tests	• Fiscal synchronization • Spend-and-tax • Tax-and-spend
11.	Febriani and Rambe (2022)	Six Indonesian regions	2006–2017	Granger panel causality	• Bidirectional causality between tax revenue and spending • The tax-spend hypothesis
12.	Maulid, Bawono, and Sudibyo (2022)	Indonesia	1973–2019	Vector error correction model and Granger causality test	• Two-way causality relationship
13.	Nzimande and Ngalawa (2022)	Southern African development community	1980–2018	Panel bootstrap Granger causality	• The tax-spend hypothesis • The spend-tax hypothesis

The studies on the government revenue-expenditure link for non-EU countries emphasize the Granger causality method used for the analysis. Also, the predominant model of the relationship is fiscal synchronization.

Table 3. Research on the government revenue–expenditure nexus (EU countries, except Romania).

No.	Source	Country	Period	Method	Results
1.	Bröthaler and Getzner (2015)	Austria	1948–2013	Granger causality test, VAR, VEC (Vector error correction)	• The spend-tax fiscal policy decision process
2.	Irandoust (2018)	Sweden	1722–2011	Hidden cointegration technique, a modified version of the Granger non-causality test	• Long-run and asymmetric relationships • Bi-directional causality (Fiscal synchronization hypothesis)
3.	Jaén-García (2020)	Spain	1850–2015	Wavelet methodology	• Spending leads to revenue • Fiscal synchronization • Bidirectional causality
4.	Karakas and Turan (2019)	Croatia, Czechia, Hungary, Poland, and Slovenia	1995–2016	NARDL model	• Fiscal synchronization • Spend-tax • Tax-spend • Institutional separation or fiscal neutrality

The research regarding the revenue–expenditure link for EU countries (except Romania) shows no predominant method for analysis. Instead, a review of the papers shows that the predominant model for this relationship is spend-tax.

Table 4. Research on the government revenue–expenditure link in Romania.

No.	Source	Period	Method	Results
1.	Campeanu and Catarama (2007)	1991–2005	Granger causality tests	• The fiscal synchronization hypothesis
2.	Stoian (2008)	1991–2005	Granger causality tests	• The causality relationship runs from revenue to expenditure
3.	Dima, Lobona, and Nicolescu (2009)	1993–2013	Cointegration tests, vector error correction model	• The fiscal policy focused on taxation adjustments against the reduction of spending
4.	Hye and Anwar (2010)	1998–2008	Autoregressive distributive lag approach to cointegration, variance decomposition, rolling regression method	• The fiscal synchronization hypothesis
5.	Rosoiu (2014)	1998–2014	Granger causality test, cointegrated VAR	• The fiscal synchronization hypothesis
6.	Tiwari and Mutascu (2016)	1999–2012	Threshold autoregressive (TAR) and momentum-TAR (MTAR) models	• The spend-tax hypothesis
7.	Mutascu (2017)	1991–2015	Wavelet analysis	• The tax-spend hypothesis • The spend-tax hypothesis
8.	Karakas and Turan (2019)	1995–2016	NARDL model	• Institutional separation or fiscal neutrality • No significant effect of government revenue (Spending) on spending (Revenue)

The research on the government revenue–expenditure link in Romania shows that Granger causality is the most used analysis method. Furthermore, the analysis of the studies showed that the predominant models of the government revenue–expenditure link are tax-spend and fiscal synchronization. If we summarize based on the articles discussed in this research, we can state that:

- For non-EU countries and Romania, the Granger causality method is most used for analysis, but for EU countries (except Romania) there is no predominantly used method for analysis.
- The predominant model of the government revenue–expenditure nexus is fiscal synchronization (non-EU countries), spend and tax (EU countries, except Romania), and tax-spend/fiscal synchronization (in the case of Romania).
- For each group of countries (non-EU countries and EU countries, including Romania), only one study was found that employed the wavelet approach in the analysis. This is why it is essential to employ the wavelet analysis for Romanian time-frequency space and to identify the dominant modes of variability and the variation over time (Torrence & Compo, 1998).

Based on the literature analysis, the first hypothesis is confirmed. There are various models of the government revenue–expenditure link by country, which is in line with the classification developed by Payne (2003).

4. METHODOLOGY AND DATA USED

The wavelet approach highlights the time series characteristics and the relationship between these series. This analysis provides information related to the time series, which refers to the spectral characteristics (frequency). Thus,

the changes in the frequency domain can be identified. In addition, this analysis allows isolation of the series' features that occur only at specific timescales. The analysis highlights the intervals of behavioral asymmetry, which helps monitor the implementation of the fiscal policy. For example, identifying the intensity of the government revenue–expenditure link is possible using the wavelet approach and the relationship in both frequency and time. Also, it is possible to identify if the series move in the same direction, if they are positively related or not, and determine which series is leading the other. In this study, the wavelet technique is used to analyze the government revenue–expenditure link in Romania (the state budget). Monthly data is used for the period between January 2000 and December 2021 from the National Bank of Romania (monthly bulletin). Series are transformed from Romanian currency (lei) into US dollars. Also, Census-X13 methodology is used to adjust for seasonal components. The final step was the log transformation. R software was used for the wavelet analysis (with *ggplot2*, *readxl*, and *biwavelet* packages). Wavelet analysis is an essential element in applications related to signal theory, which studies and defines signals' mathematical and statistical properties as mathematical functions.

The signal is a measurable physical quantity that carries information and can be transmitted at a distance, received, and processed. A one-dimensional signal is a function of time x(t), t ∈ R, and the variable physical quantity representing the signal can be, for example, voltage or air pressure (Ceangă, Munteanu, Bratcu, & Culea, 2001).

A signal is studied through a mathematical model or function in a wavelet analysis. For example, the spectral representation of signals (power spectrum) is a formal description of signals (time functions) in the frequency domain. So, a wavelet is a function that satisfies specific mathematical criteria (in the time domain) (Ceangă et al., 2001) and presents a sudden and finite increase in energy and oscillations. According to Torrence and Compo (1998), one wavelet type is the Morlet wavelet function (see Equation 1).

$$\psi_0(\eta) = \pi^{-1/4} e^{i\omega_0\eta} e^{-\eta^2/2} \quad (1)$$

In this equation, η is the nondimensional time parameter, and ω_0 is the nondimensional frequency parameter. One feature of the function is a zero mean, and it belongs to the time frequency space (Farge, 1992). For a discrete sequence x_n, the continuous wavelet transform (CWT) is the convolution of x_n with a scaled and translated version of $\psi_0(\eta)$ (Torrence & Compo, 1998) (see Equation 2).

$$W_n(s) = \sum_{n'=0}^{N-1} x_{n'} \psi * \left[\frac{(n'-n)\delta t}{s}\right] \quad (2)$$

In this equation, * shows the complex conjugate, s is the wavelet scale, and n is the time index. It is possible to divide the wavelet transform $W_n(s)$ into amplitude, $|W_n(s)|$, and phase, $\tan^{-1}[\mathrm{I}\{W_n(s)\}/\mathrm{R}\{W_n(s)\}]$, where $\mathrm{R}\{W_n(s)\}$ is the real part of the transform and $\mathrm{I}\{W_n(s)\}$ is the imaginary part. The wavelet power spectrum is $|W_n(s)|^2$ (Torrence & Compo, 1998) and shows the time series variance.

The wavelet coherence concept examines the government revenue–expenditure link and the correlation in time and frequency between series. The coherence is the square of the cross-spectrum normalized by the individual power spectra. The cross-wavelet spectrum is presented in Equation 3.

$$W_n^{XY}(s) = W_n^X(s) W_n^{Y*}(s) \quad (3)$$

In this equation, X and Y are the time series, $W_n^X(s)$ and $W_n^Y(s)$ are the wavelet transforms, and $W_n^{Y*}(s)$ is the complex conjugate of $W_n^Y(s)$ (Torrence & Compo, 1998).

The works that use the wavelet method to analyze the revenue–expenditure links are few. However, a selection from the scientometric analysis based on the publications indexed in SCOPUS for the period analyzed showed fewer than ten published papers with topics such as wavelet analysis and government expenditure, spending and wavelet analysis, and tax revenue and wavelet analysis (Jaén-García, 2020; Karlsson, 2020; Zhang, Wang, & Yao, 2019).

5. DISCUSSION OF RESULTS

The analysis using the wavelet method emphasizes the government revenue–expenditure link, and it confirms one of the four hypotheses from Payne (2003).

Figure 4 shows the evolution of state budget revenue and expenditure, computed as the growth rate (compared to the 12th month of the previous year). Thus, one can state that:

- In the last month of 2000, budget revenue increased by 29.1% and budget expenditure increased by 39.6% compared to December of 1999 (this is the highest value of the growth rate for budget expenditure recorded in the 2000–2021 period).
- The highest value of the budget revenue growth rate is observed in December of 2003 (40.9%, compared to the value of December 2002).
- Negative rate values were recorded for budget expenditure in December 2012, but also for budget revenues, during the financial crisis (December 2009), in December 2016, and during the Covid-19 pandemic crisis (in December 2020).

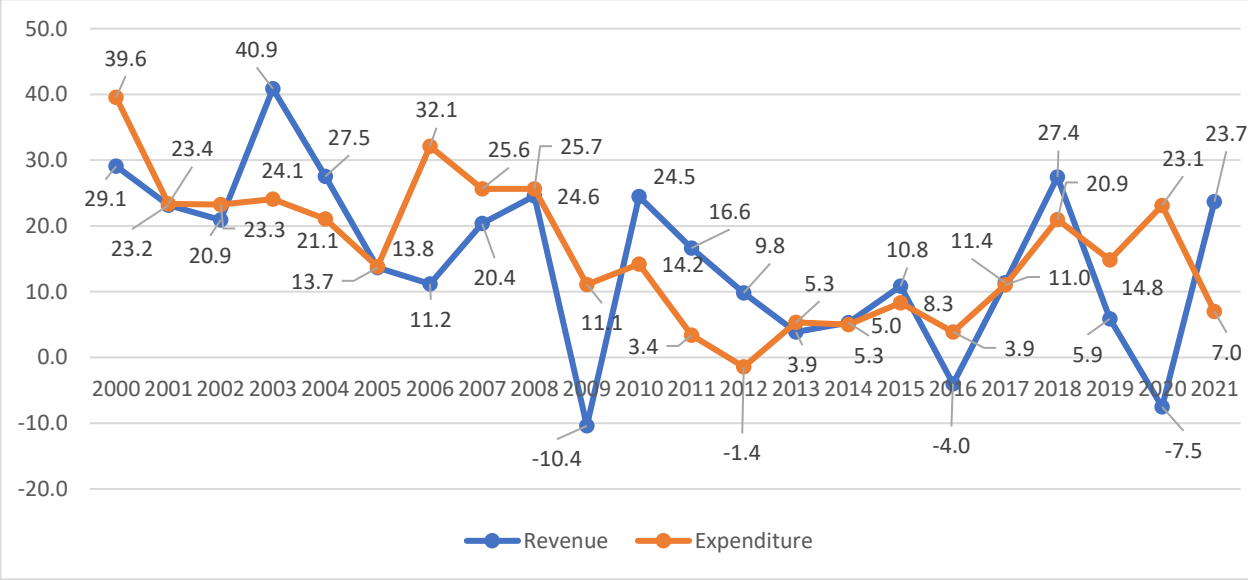

Figure 4. Romanian state budget revenue and expenditure, growth rate (%).
Note: The growth rate compares the values from December of each year. The formula is: growth rate = (Current value – previous value / Previous value) x 100.

The unit root tests represent the first step of the empirical analysis (see Table 5). The results show that the series are non-stationary at level, thus the wavelet approach can be employed.

Table 5. Unit root test results.

Variable	Augmented Dickey–Fuller (H0 = the series has unit root)		Phillips–Perron (H0 = the series has unit root)	
	Intercept	Trend and intercept	Intercept	Trend and intercept
Government revenue	-1.318	-1.526	-1.321	-1.643
Government expenditure	-0.994	-1.367	-0.999	-1.565

For both variables, the continuous wavelet transformation (CWT) power spectra are presented in Figure 5 and Figure 6. Figure 5 shows that the wavelet power of government revenue is low and not significant at 0–14 months of the scale for the whole period, except in 0–4 months and the 2007–2008 period. The series registers high wavelet power in two cases:

- Between 32 and 62 months of the scale, during 2005–2011.
- Over 64 months of scale, during 2009–2013.

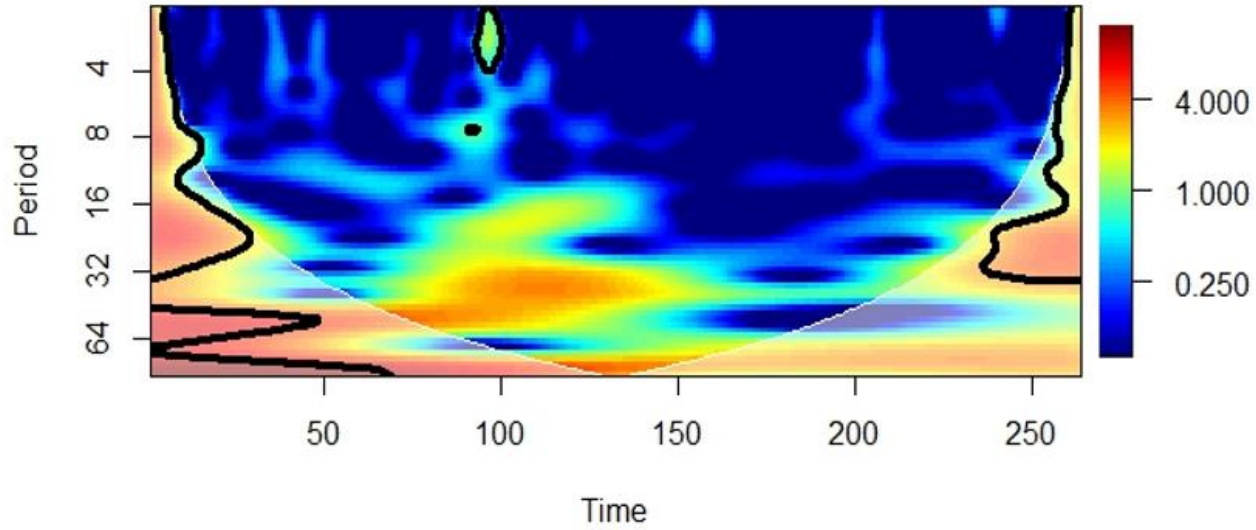

Figure 5. The CWT power spectrum of government revenue; monthly data for Romania.

Note: The horizontal axis shows the period. The vertical axis shows the frequency. The right-side vertical scale is for the power range. The red color indicates a high level of volatility and significant oscillation/fluctuation of the signal (frequency content changes with time).

Figure 6 shows the wavelet power of government expenditure, with significant power at 0–3 months for 2007–2008 and 0–2 months for 2014–2015. Also, there is substantial power at 48–62 months for 2005–2007.

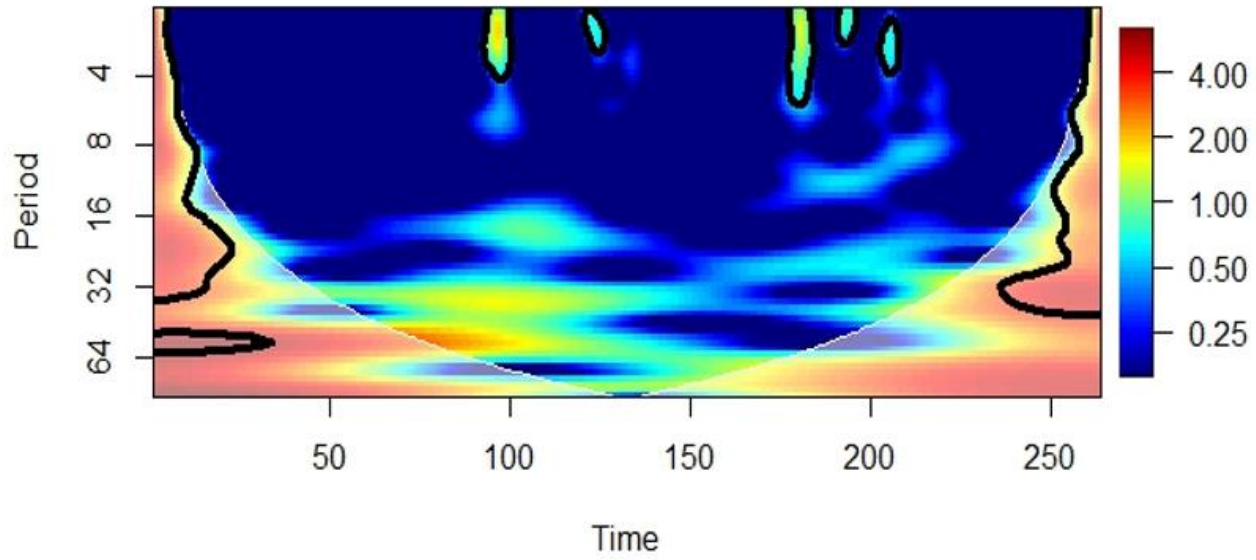

Figure 6. The CWT power spectrum of government expenditure; monthly data for Romania.

Note: The horizontal axis shows the period. The vertical axis shows the frequency. The right-side vertical scale is for the power range. The red color indicates a high level of volatility and significant oscillation/fluctuation of the signal (frequency content changes with time).

The CWT power spectra for both series shows some common characteristics in:

- 2007, at 0–4 months of the scale.
- 2005 and 2013, at 16–64 months of the scale.
- 2009 and 2012, over 64 months of the scale.

Wavelet coherence is a measure of the correlation between two signals. For example, red indicates that the two signals are highly correlated, and blue indicates no correlation. Figure 7 shows the wavelet coherence for the two variables and the relationships in both the frequency and time of the variables. In the short term, at 0–16 months of the scale (frequency band), there is a high wavelet power in the 2001, 2004–2005, 2007–2008, 2010–2011, 2013, and 2015–2020 periods. The arrows are pointing up to the right for all periods (meaning that expenditure leads revenue), except for the period between 2007 and 2008, where the arrows are pointing down to the right (meaning that revenue

leads expenditure) and also for the period between 2015 and 2020, but only for a scale between 0 and 6 months. In 2017, revenue is leading for a scale of 0–6 months, and expenditure is leading for a scale of 12–18 months.

In the medium term, at 18–32 months of the scale and between 2001 and 2002, revenue leads expenditure. The expenditure leads revenue for 2003–2005 and 2015–2019. At a scale between 32 and 48 months, the arrows are oriented down to the right for 2004–2014 and 2016–2018 (revenue is leading). For 2015, the arrows point up to the right, meaning that expenditure is leading. In the long term, over 48 months of the scale, between 2008 and 2014, the arrows point up to the right, meaning that expenditure is leading.

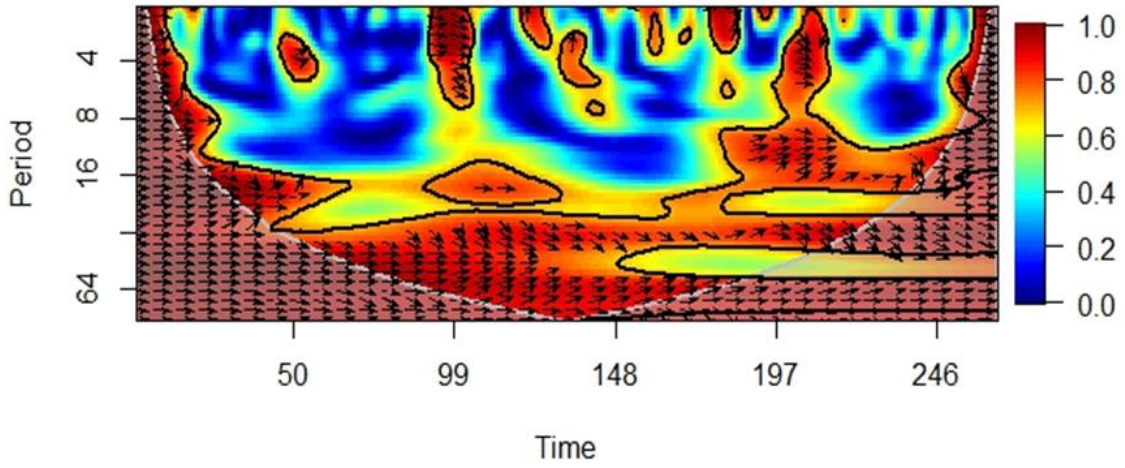

Figure 7. Wavelet coherence of the two variables; monthly data for Romania.

In Figure 7, the arrows pointing up mean that the second variable leads the first one. Arrows pointing down indicate that the first variable leads the second one (Gouhier, Grinsted, & Simko, 2021). For all frequencies, the variables are in phase (arrows are pointing to the right), meaning that the series move in the same direction; the arrow represents the direction of movement of the two series considered, and the series are positively related. The horizontal axis is for the period, the vertical axis is for the frequency, and the right-side vertical scale is for the power range. Red indicates significant relationships (co-movement between variables), and blue represents the lack of a relationship between the series (no co-movement).

The information in Table 6 makes it easier to understand the exerted influences as the influencing variables, the frequencies, and the periods can be observed.

Table 6. Summary of the results for wavelet coherence of the two variables.

Leading variable	Frequency band		Time
Revenue	0–6 months	Short term	2015–2020, 2017
Revenue	0–16 months		2007–2008
Expenditure	0–16 months		2001, 2004–2005, 2010–2011, 2013
Expenditure	12–18 months		2017
Revenue	18–32 months	Medium term	2001–2002
Revenue	32–48 months		2004–2014, 2016–2018
Expenditure	18–32 months		2003–2005, 2015–2019
Expenditure	32–48 months		2015
Expenditure	Over 48 months	Long term	2008–2014

Table 6 provides the following important information:

- In the short term, expenditure leads revenue.
- In the medium term, there is a sign of equality regarding the number of relationships between variables (there are three cases when revenue leads expenditure and three cases when expenditure leads revenue).

- In the long term, expenditure leads budget revenue.

According to the results, the second hypothesis of this study is not validated. In the case of Romania, in the analyzed period, there is more than one model of the relationship between government revenue and expenditure.

6. CONCLUSIONS

This research analyzes the government revenue–expenditure nexus using the wavelet approach in the Romanian context. According to the literature, there are various models for this link detected for Romania, such as tax-spend or fiscal synchronization. Therefore, assessing this relationship is an increasingly important issue for developing a sustainable fiscal policy. The results of this study show that, in various periods, revenue led expenditure, or vice versa.

According to the results, both hypotheses from Payne (2003) (tax-spend and spend-tax) are valid in the case of Romania but for different periods. The results are in line with Stoian (2008); Dima et al. (2009) and Mutascu (2017) for the tax-spend hypothesis, and with Tiwari and Mutascu (2016) and Mutascu (2017) for the spend-tax hypothesis.

An important aspect that explains the results is the policy of collecting taxes. The results show that some taxpayers pay taxes in specific periods according to the quarterly or annual reporting schedule. There are different deadlines for various taxes, and the fluctuation arises from the administration of tax revenues. The behavior of revenues and expenditures in Romania is atypical, partially justified by the revenue collection model from the various categories of taxpayers.

This research could represent a starting point for outlining measures in the fiscal policy area. The use of a wavelet analysis in investigating the link between budget revenues and expenditures offers the possibility of obtaining results related to time-frequency space.

The paper emphasizes the periods in which various measures and policies were developed by the Romanian government. The tax-spend hypothesis is confirmed for specific periods, which means that policymakers should focus on changing the level of budget revenues/taxes to reduce budget imbalances (Nzimande & Ngalawa, 2022) and adopt measures to optimize taxation (Febriani & Rambe, 2022). For other periods, the spend-tax hypothesis is confirmed, which means that policymakers should focus on reducing expenses (Nzimande & Ngalawa, 2022), representing a fundamental approach in designing the fiscal policy (Bröthaler & Getzner, 2015) with government priorities regarding the spending component of fiscal policy and adjustments in the level and structure of public spending (Tiwari & Mutascu, 2016).

The influences identified can be correlated with changes in governance, which also bring changes in fiscal policy. Thus, progressive or flat taxation can be adopted, or various revenue collection methods may appear, as well as multiple government expenditure targets. However, the lack of stability in fiscal policy can negatively influence the sustainable approach to directing expenditures and collecting budget revenues.

This study developed two research hypotheses, and according to the results, only the first hypothesis is validated. For this hypothesis (H1), the literature shows various models of the government revenue–expenditure link by country. The predominant models for this link are fiscal synchronization (non-EU countries), spend-tax (EU countries, except Romania), and tax-spend/fiscal synchronization (Romania). For the second hypothesis (H2), the results show more than one model in the analyzed period for Romania.

Research employing the wavelet approach for Romania is in its infancy. There is a need for further development in this area for comparative research. Also, an extended analysis period would be appropriate in relation to economic cycles. Future research should consider the employment of a wavelet analysis for the government revenue–expenditure nexus with a comparative approach for various EU countries, based on the current debate on fiscal policy convergence.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study.

REFERENCES

Akram, V., & Rath, B. N. (2019). Is there any evidence of tax-and-spend, spend-and-tax or fiscal synchronization from panel of Indian state? *Applied Economics Letters*, *26*(18), 1544-1547. https://doi.org/10.1080/13504851.2019.1584363

Baghestani, H., & McNown, R. (1994). Do revenues or expenditures respond to budgetary disequilibria? *Southern Economic Journal*, *61*(2), 311-322. https://doi.org/10.2307/1059979

Barro, R. J. (1979). On the determination of the public debt. *Journal of Political Economy*, *87*(5), 940-971. https://doi.org/10.1086/260807

Bröthaler, J., & Getzner, M. (2015). The tax-spend debate and budgetary policy in Austria. *International Advances in Economic Research*, *21*(3), 299-315. https://doi.org/10.1007/s11294-015-9532-1

Cadman, T., & Sarker, T. (2022). *De Gruyter handbook of sustainable development and finance*. Berlin, Boston: De Gruyter.

Campeanu, E. M., & Catarama, D. F. (2007). Causality between government revenues and expenditures in Romania. *The Annals of the University of Oradea. Economic Sciences Tom*, *16*(2), 174–178.

Ceangă, E., Munteanu, I., Bratcu, A., & Culea, M. (2001). *Signals, circuits and systems. Part I: Signal analysis, Ed.* Galati, Romania: Academica.

Champita, M. (2016). Causality between government revenue and expenditure: Empirical evidence from Zambia. *Zambia Social Science Journal*, *6*(1), 1-19.

Ciutacu, C. (2009). *Tackling the recession: Romania, Eurofound*. Retrieved from https://policycommons.net/artifacts/1833956/tackling-the-recession/2576733/

Dima, B., Lobona, O., & Nicolescu, C. (2009). The fiscal revenues and public expenditures: Is their evolution sustainable? The Romanian case. *Annales Universitatis Apulensis Series Oeconomica*, *1*(11), 1-42.

European Commission. (2006). The long-term sustainability of public finances in the European union: European economy, 4/2006 In (pp. 226). Belgium: Directorate-General for Economic and Financial Affair.

European Commission. (2016). *European semester thematic factsheet. Sustainability of Public Finances*. Retrieved from https://ec.europa.eu/info/sites/default/files/european-semester_thematic-factsheet_public-finance-sustainability_en.pdf

European Commission. (2019). *Fiscal sustainability report 2018*. Retrieved from European Economy, Institutional Papers No. 094.

Ewing, B. T., Payne, J. E., Thompson, M. A., & Al-Zoubi, O. M. (2006). Government expenditures and revenues: Evidence from asymmetric modeling. *Southern Economic Journal*, *73*(1), 190-200. https://doi.org/10.1002/j.2325-8012.2006.tb00765.x

Farge, M. (1992). Wavelet transforms and their applications to turbulence. *Annual Review of Fluid Mechanics*, *24*(1), 395-458. https://doi.org/10.1146/annurev.fl.24.010192.002143

Febriani, R. E., & Rambe, R. A. (2022). Government revenue and spending nexus in regional Indonesia: Causality approach. *Economics, Management and Sustainability*, *7*(1), 34-42. https://doi.org/10.14254/jems.2022.7-1.3

Friedman, M. (1978). The limitations of tax limitation. *Quadrant*, *22*(8), 22-24.

Ghazo, A., & Abu-Lila, Z. (2018). Causalities between components of public revenues, and public expenditures in Jordan. *Sciences*, *7*(2), 59-71. https://doi.org/10.6007/ijarems/v7-i2/4211

Gouhier, T. C., Grinsted, A., & Simko, V. (2021). Conduct univariate and bivariate wavelet analyses, package 'biwavelet'. In (pp. 40). USA: GitHub.

Hye, Q. M. A., & Anwar, J. M. (2010). Revenue and expenditure nexus: A case study of Romania. *Romanian Journal of Fiscal Policy*, *1*(1), 22-28.

Irandoust, M. (2018). Government spending and revenues in Sweden 1722–2011: Evidence from hidden cointegration. *Empirica*, *45*(3), 543-557. https://doi.org/10.1007/s10663-017-9375-5

Jaén-García, M. (2020). Tax-spend, spend-tax, or fiscal synchronization. A wavelet analysis. *Applied Economics*, *52*(28), 3023-3034. https://doi.org/10.1080/00036846.2019.1705238

Karakas, M., & Turan, T. (2019). The government spending-revenue nexus in CEE countries: Some evidence for asymmetric effects. *Prague Economic Papers*, *28*(6), 633-647. https://doi.org/10.18267/j.pep.697

Karlsson, H. K. (2020). Investigation of the time-dependent dynamics between government revenue and expenditure in China: A wavelet approach. *Journal of the Asia Pacific Economy*, *25*(2), 250-269. https://doi.org/10.1080/13547860.2019.1646573

Kaya, A., & Şen, H. (2013). How to achieve and sustain fiscal discipline in Turkey: Rising taxes, reducing government spending or a combination of both? *Romanian Journal of Fiscal Policy*, *4*(1), 1-26.

Kaya, H. F., & Arslan, Ş. N. (2020). The government revenue–expenditure nexus: Asymmetric causality test. *Current Research in Social Sciences*, *6*(2), 170-178.

Kazungu, K. (2019). The nexus between government expenditure and revenue in Tanzania. *Asian Journal of Economic Modelling*, *7*(4), 158-170. https://doi.org/10.18488/journal.8.2019.74.158.170

KPMG. (2020a). *GEO 29/2020 - Fiscal measures for the period of the state of emergency determined by the COVID-19 epidemic, 23.03.2020*. Retrieved from https://home.kpmg/ro/ro/home/publicatii/2020/03/oug-29-2020-fiscal-measures-for-the-state-of-emergency-period.html

KPMG. (2020b). *Romania - government and institution measures in response to COVID-19, 30.09.2020*. Retrieved from https://home.kpmg/xx/en/home/insights/2020/04/romania-government-and-institution-measures-in-response-to-covid.html

Linhares, F., Nojosa, G., & Bezerra, R. (2021). Changes in the revenue–expenditure nexus: Confronting evidence with fiscal policy in Brazil. *Applied Economics*, *53*(44), 5051-5067. https://doi.org/10.1080/00036846.2021.1915463

Lojanica, N. (2015). *Government expenditure and government revenue–the causality on the example of the Republic of Serbia*. Paper presented at the Management International Conference.

Maulid, L. C., Bawono, I. R., & Sudibyo, Y. A. (2022). Analysis of causality among tax revenue, state expenditure, inflation, and economic growth in Indonesia between 1973 and 2019. *Public Policy and Administration*, *21*(1), 143-157. http://dx.doi.org/10.5755/j01.ppaa.21.1.29950

Meltzer, A. H., & Richard, S. F. (1981). A rational theory of the size of government. *Journal of Political Economy*, *89*(5), 914-927. https://doi.org/10.1086/261013

Musgrave, R. (1966). Principles of budget determination. In Cameron, H., Henderson, W. (Eds.), Public finance: Selected readings. In (pp. 15-27). New York: Random House.

Mutascu, M. (2016). Government revenues and expenditures in the East European economies: A bootstrap panel granger causality approach. *Eastern European Economics*, *54*(6), 489-502. https://doi.org/10.1080/00128775.2016.1204237

Mutascu, M. (2017). The tax–spending nexus: evidence from Romania using wavelet analysis. *Post-Communist Economies*, *29*(3), 431-447. https://doi.org/10.1080/14631377.2017.1319170

Nzimande, N. P., & Ngalawa, H. (2022). Tax-spend or spend-tax? The case of Southern Africa. *Economies*, *10*(4), 1-10. https://doi.org/10.3390/economies10040085

OECD. (2013). *Fiscal sustainability, in government at a glance 2013*. Paris: OECD Publishing.

OECD. (2015). *National accounts at a glance 2015*. Paris: OECD Publishing.

OECD. (2022). *National accounts of OECD countries* (Vol. 2022). Paris: OECD Publishing.

Payne, J. E. (2003). A survey of the international empirical evidence on the tax-spend debate. *Public Finance Review*, *31*(3), 302-324. https://doi.org/10.1177/1091142103031003005

Peacock, A. T., & Wiseman, J. (1979). Approaches to the analysis of government expenditure growth. *Public Finance Quarterly*, *7*(1), 3-23. https://doi.org/10.1177/109114217900700101

Phiri, A. (2019). Asymmetries in the revenue–expenditure nexus: New evidence from South Africa. *Empirical Economics*, *56*(5), 1515-1547.

Raza, S. A., Hassan, S. Z., & Sharif, A. (2019). Asymmetric relationship between government revenues and expenditures in a developing economy: Evidence from a non-linear model. *Global Business Review*, *20*(5), 1179-1195. https://doi.org/10.1177/0972150919846800

Rosoiu, I. (2014). *The relation between government revenues and expenditures in Romania - A VAR approach*. Paper presented at the Proceedings of Virtual Multidisciplinary Conference QUAESTI.

Sahed, A., Mékidiche, M., & Kahoui, H. (2020). The relationship between government expenditures and revenues in Algeria during the period (1990-2019): Granger causality approach. *European Journal of Business and Management Research*, *5*(5), 1-5. https://doi.org/10.24018/ejbmr.2020.5.5.583

Saint-Amans, P. (2020). *Tax in the time of COVID-19, 23.03.2020.* Retrieved from https://www.oecd-forum.org/users/369395-pascal-saint-amans/posts/63721-tax-in-the-time-of-covid-19

Stoian, A. (2008). Analyzing causality between Romania's public budget expenditures and revenues. *Theoretical and Applied Economics*, *11*(11), 60-64.

Tiwari, A. K., & Mutascu, M. (2016). The revenues-spending nexus in Romania: A TAR and MTAR approach. *Economic Research*, *29*(1), 735-745. https://doi.org/10.1080/1331677x.2016.1197549

Torrence, C., & Compo, G. P. (1998). A practical guide to wavelet analysis. *Bulletin of the American Meteorological Society*, *79*(1), 61-78. https://doi.org/10.1175/1520-0477(1998)079%3C0061:apgtwa%3E2.0.co;2

Wildavsky, A. (1988). *The new politics of the budgetary process.* Glenview, IL: Scott, Foresman.

Zhang, Y., Wang, R., & Yao, X. (2019). Assessing determinants of health care prepayment in China: Economic growth or government willingness? New evidence from the continuous wavelet analysis. *The International Journal of Health Planning and Management*, *34*(1), e694-e712. https://doi.org/10.1002/hpm.2683