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DECODING THE GOVERNMENT BUDGET PUZZLE: UNVEILING THE DYNAMICS OF TAXES AND EXPENDITURES IN TURKEY THROUGH CONTINUOUS WAVELET TRANSFORM ANALYSIS

Abstract

Purpose: The relationship between public expenditure and revenue that determines the budget balance in the explanation of budget deficits is very important. This study aimed to examine the association between public spending and income in Turkey.

Methodology: This article applies the continuous wavelet transform method (CWT) to study the relationship between government revenues and expenditures in Turkey. The study, which covers the period 2006-2020, consists of monthly data. The following four CWT tools were used in the analysis: Wavelet Power Spectrum, Cross Wavelet Power, Wavelet Coherence, and Phase Difference.

Results: The results of the study, controlling taxes rather than expenditures, play a key role in reducing fiscal deficits in Turkey in the short term. It is revealed that the dynamics of the budget balance in the medium term can be explained by the spend-tax hypothesis and that the tax burden can be alleviated by spending cuts. In the long term, results were obtained that support the spend-tax hypothesis.

Conclusion: The paper reveals that taxes play an important role in controlling budget deficits in the short run. It turns out that the dynamics of the budget balance can be explained in the medium term by expenditure cuts and then the tax burden can be alleviated. In the long run, implementing fiscal policies based on public spending rather than taxation will be more effective against budget deficits.

Keywords: Government revenue, government expenditure, wavelet approach, continuous wavelet coherence, Turkey

1. Introduction

Many countries have had the issue of budget imbalances after 1970. The relationship between public expenditure and revenue that determines the budget balance in the explanation of budget deficits is very important. In the field of public finance, the relationship between these two variables has been studied by many academics. This study aimed to examine the association between public spending and income in Turkey. The Turkish economy often faces the issue of a budget deficit. However, except for the years 2009 and 2019, the Turkish budget deficits/GDP have been meeting the Maastricht criteria since 2006. Due to the repercussions of the 2008 mortgage crisis in Turkey, there were deviations in the budget deficits in 2009 and 2010. In addition, the volatility experienced in public revenues and expenditures in Turkey over the years has laid the groundwork for the investigation of this issue. In this context, the co-movement of the relationship between public income and expenditure from 2006:1 to 2020:7 was tested by wavelet analysis. Although there exist many studies in the literature related to this issue, there are no studies that have conducted relevant tests by wavelet analysis for Turkey. In this respect, the study is expected to contribute to the literature concerning its empirical analyses of time-frequency analyses with wavelet coherence analyses. The studies available in the literature often employ field analysis/correlation analysis or time series models/panel data models to analyze the relationships between public expenditure and revenue, which is where this study differs from them in terms of the research approach (Bilgili et al., 2020, p. 4). These analyses often yield parameter estimates that do not change or alter as a result of two to three structural breakings throughout the sample period. However, for all sampling and subsampling periods at various frequencies in Turkey for the monthly period, this article employs continuous wavelet model estimates. Therefore, at sub-sample periods that correspond to both the low frequency and the high frequency of the observed time series data, prospective changes in the interactions of variables are taken into account. The method utilized here emphasizes the utility of the wavelet methodology by demonstrating how government revenue and spending interact at different frequencies and across time. The study also provides critical information about the health of the tax-spending nexus from both a cyclical and anticyclical approach (Mutascu, 2017, p. 2). Based on this, the wavelet approach used in this study enables the relationship between tax and expenditure to be revealed more clearly and strongly.

The rest of this study is organized in the following way. The theoretical context and empirical literature are presented in sections 1 and 2, respectively. The method is described in Section 3. The data are described in Section 4, together with the outcomes of empirical estimates. Finally, Section 5 summarizes the research findings and makes recommendations for further research.

2. Theoretical background

Government expenditures and revenues are important in terms of budget balance. They are the main determinants of the budget balance. A budget imbalance is when expenditure exceeds revenue. This is called a budget deficit. Otherwise, a budget surplus occurs. The topic of the budget deficit is one of the most contentious ones in public finance. The literature on this subject is quite extensive. The budget deficit issue is explained by four primary theories derived from the literature. The hypotheses are as follows: (a) the tax and spend hypothesis, (b) the spend and tax hypothesis, (c) the fiscal synchronization hypothesis, and (d) the fiscal independence or institutional separation hypothesis.

According to the tax-and-spend theory, increases in tax revenues should result in changes in government spending. In other words, this theory proposes a one-way causal relationship between taxes and spending. This theory is consistent with the central tenet of the Keynesian model according to which macroeconomic stability is sought through the management of aggregate demand through taxation and spending measures in fiscal policy. The Friedman (1978) and Buchanan and Wagner (1977) hypotheses offer two alternative points of view on the tax-spend relationship. Tax-related expenses were first discussed by Friedman in 1978. According to Friedman (1978), tax increases only lead to an increase in government spending, and not a reduction in the budget deficit (Chang et al., 2002, p. 1554). In other words, raising taxes will not reduce the budget deficit since increased tax collections will put pressure on lawmakers to increase spending. As a result, cutting taxes would be the wisest course of action because it would result in less government spending. Buchanan and Wagner

(1977), however, made the opposing case. They underlined that expenditure and taxes do indeed correlate, but that this link is negative because of the fiscal illusions of the taxpayers. When taxes are dropped, people perceive public goods and services to be cheaper, which raises demand and encourages government spending. Buchanan and Wagner (1977) recommended reducing public spending by restricting government access to deficit finance in order to reduce deficits (Mutascu, 2016, p. 3).

Peacock and Wiseman (1961; 1979) proposed the spend-and-tax hypothesis, which is the reverse of the tax-and-spend hypothesis and it is based on the idea that spending generates income. They said that because of crises or other extreme circumstances, the government will temporarily raise spending, which will cause taxes to go up forever. Barro's (1974; 1979) research also supports this strategy. War, uncertain political situations, and other structural breaches may boost public spending to the point that taxes rise. Ricardian equivalence is consistent with the spend-tax idea. In the tax smoothing hypothesis, according to Barro (1979), it is best to raise tax rates and create a budget deficit to finance changes in government spending. Barro, therefore, rejected the notion that taxpayers suffer from fiscal illusion.

These theories contend that adjustments to government spending result in adjustments to government revenues (taxes). The spend-and-tax strategy, therefore, assumes a favorable one-way relationship between government spending and revenue.

The third hypothesis - financial synchronization - was primarily put forth by Musgrave (1966), Meltzer and Richard (1981). According to this theory, governments might alter taxes and spending at the same time. In other words, it is anticipated that this technique will involve a two-way or mutual interaction. Revenue and expenditure are set simultaneously under financial synchronization, and it is said that the public is aware of the advantages of government services relative to their costs (Musgrave, 1966). According to this idea, cutting spending and making serious efforts to raise revenues is the best course of action for addressing issues with the budget deficit.

Conversely, it was stressed by Wildavsky (1975) and Baghestani and McNown (1994) that public revenues and expenditures will be decided separately because several institutions are involved in the budgeting process and there isn't any fundamental agreement among them. This "institutional separation" theory implies that decisions regarding spending and income may be made independently of one another. In other words, this theory suggests that there is no connection between spending and income.

3. Empirical literature

The "tax and spend", "spend and tax", "fiscal synchronization", and "institutional separation" hypotheses are crucial for illuminating the connection between budget deficits, government spending, and government revenue. In this section, the empirical studies in the literature on this subject (for other countries and for Turkey) are reviewed and their results are summarized in Table 1 and Table 2 in Appendix 1. While some of the studies examined the long-term relationship using cointegration analysis, others considered the short-term relationship using error correction models. In addition, it was found that techniques of time series analysis and panel data analysis were applied.

The tax spending hypothesis, also known as the "tax-and-spend" hypothesis, is a theory in economics that suggests that governments can stimulate economic growth by increasing their level of spending and taxation. The idea is that by increasing government spending, the government can create demand for goods and services, which can in turn lead to increased production and economic growth. At the same time, by increasing taxation, the government can collect additional revenue, which can be used to fund increased spending and support further economic growth.

There is a significant body of research on the tax-spend hypothesis, and the evidence suggests that it can be an effective tool for stimulating economic growth. For example, it was found that there was a one-way relationship between revenues and expenditures in single-country empirical studies by Kollias and Paleologou (2006) (for Italy, Spain and Luxembourg), Westerlund et al. (2011), Apergis et al. (2012), Mutascu (2016) (for Czechia, Hungary and Slovenia), Linhares and Nojosa (2020) (for Germany, the United Kingdom and Italy), Salvi and Schaltegger (2021), and Nzimande and Ngalawa (2022) (for Botswana). However, not all research studies support the tax-spend hypothesis. Some studies have suggested that an increase in public

spending will increase taxes, particularly in countries with high levels of public debt. For instance, the spend-tax hypothesis has been supported by numerous studies, including Kollias and Paleologou (2006) (for France, Finland and the United Kingdom), Paleologou (2013) (for Greece), Mutascu (2016) (for Bulgaria), Tiwari and Mutascu (2016), Linhares and Nojosa (2020) (for France), Salvi and Schaltegger (2021), and Nzimande and Ngalawa (2022) (for Mauritius and Mozambique).

The causal relationship between public spending and income was discovered to be mutually bidirectional by Kollias and Paleologou (2006) (for Denmark, Greece, Ireland, the Netherlands, Portugal, and Sweden), Paleologou (2013) (for Sweden and Germany), Mutascu (2016) (Slovakia), Akram and Rath (2019), Linhares and Nojosa (2020) (for Spain), and Arvin et al. (2021) (the financial synchronization hypothesis). However, some research studies, such as those by Baghestani and McNown (1994), Kollias and Paleologou (2006) (for Austria, Belgium, and Germany), and Mutascu (2016) (for Estonia, Latvia, Romania, Lithuania, and Poland) found no evidence of a direct association between public expenditures and revenues. This indicates that there is no relationship between income and spending and that revenue and expenditure are independent (the institutional separation hypothesis).

In the Appendix in Table 1, given the empirical multi-country studies, there are studies in which the "tax-spend", "spend-tax", "financial synchronization", and "institutional separation" hypotheses are valid. Factors, such as country groups, time series, and methods appear to influence the results of these studies. Since Turkey is the country on which this study focuses, it is more accurate to focus on the studies in which Turkey is involved.

As seen in Table 2 in the Appendix, it was determined that there is causality from expenditures to taxes in studies conducted for Turkey, Pınar (1998), Akçoraoğlu (1999), Günaydın (2000), Günaydın (2004a), Çavuşoğlu (2008), Aysu and Bakırtaş (2018), Kamacı and Kurt (2021), Yıldız and Demirkılıç (2022). According to this result, the expenditures to be made in Turkey are first determined, and then the revenues to cover the planned expenditures are sought. The policy proposal that emerged from these studies is to reduce public expenditures. However, Darrat (1998), Günaydın (2004b), Payne et al. (2008), and Yılancı et al. (2020) demonstrated the tax-spend hypothesis for Turkey. In other words, it was discovered that raising taxes causes a decline in public spending. The policy proposal of these studies is that taxes be raised to decrease public deficits.

Akçağlayan and Kayıran (2010) found that there was no causal relationship between public expenditures and revenues for the period 1987-2005. This means that revenues and expenditures are decided independently. The findings of Çiçek and Yavuz (2014) confirm this result. However, it is not possible to separate the institutions that make tax and spending decisions in Turkey, as the central state budget is prepared by the government and comes into effect after it has been approved by the legislature.

There may be two reasons why these studies of Turkey reach different conclusions. The first reason is that the requirement of parameter constancy is not met in the estimated models due to political changes over time, especially in studies that include annual data and thus a long time interval, and this has not been demonstrated by any statistical tests. The second reason could be that the estimated econometric models are sensitive to the stationarity properties of the variables used and the lag lengths specified, but these sensitivities are ignored in econometric estimates (Çavuşoğlu, 2008, p. 146).

4. Methodology

In the time-frequency domain, time series are analyzed using the wavelet approach.[1] Despite its frequent use in macroeconomic research, wavelet analysis is not expressly employed in the study of public economics. In this paper, the area of public economics is addressed using four continuous wavelet transform tools, i.e. wavelet power spectrum, cross-wavelet power, wavelet coherence, and phase difference. This section describes these four wavelet analysis tools. Before introducing the tools, let us provide simple definitions of wavelet and continuous wavelet transform.

For the majority of applications, it is sufficient to demand the mother wavelet to have a zero mean, or $\int_{-\infty}^{\infty} \psi(t)dt = 0$, and functions with adequate decay. As a result, the function ψ must shift the t-axis higher and downward as it gets closer to zero; in other words, it must act like a tiny wave that gets weaker the farther it gets from the center. Effective

1 In this section, we refer to Torrence and Compo (1998) and Aguiar-Conraria et al. (2008).

localization in both time and frequency is made possible by this capability.

The continuous wavelet transforms (CWT) with respect to the wavelet ψ, and is a two-variable function $W_{x,\psi}(\tau,s)$, given a time series $x(t)$:

$$W_{x,\psi}(\tau,s) = \int x(t)\frac{1}{\sqrt{s}}\bar{\psi}\left(\frac{t-\tau}{s}\right)dt, \quad (1)$$

where s stands for a scaling factor that regulates the wavelet width, and τ stands for a translation parameter that regulates its position where the bar denotes complex conjugation.

A wavelet can only be stretched or compressed if s is greater than or less than 1, respectively, while it can only be translated if its position in time is changed[2].

Wavelet functions are a mathematical tool that comes in various forms, each with its own characteristics and uses. Some examples of wavelet functions include the Morlet, Mexican Hat, Haar, and Daubechies. Among these, the Morlet wavelet is particularly popular because it has both a real and an imaginary component, which allows it to capture both the amplitude and the phase of a signal. This makes it useful for various applications, from signal processing to image analysis. For this reason, we used Morlet wavelets in the analysis, a simple version is defined as follows:

$$\psi_\eta(t) = \pi^{-\frac{1}{4}} e^{i\eta t} e^{-\frac{1}{2}t^2}, \quad (2)$$

where ψ denotes the central frequency of the wavelet, here taken to be 6 to satisfy the admissibility condition (Farge, 1992), which is often used in economic applications[3].

The wavelet power spectrum is a measure of the local variance of a signal, and can be calculated as the square of the absolute value of the wavelet coefficient $|W_n^x|^2$. The statistical significance of this measure can be assessed by its comparison to the null hypothesis that the data is generated by a stationary process with a known background power spectrum (P_f). Torrence and Compo (1998) developed methods for calculating the wavelet power spectra of white and red noise processes, and provided the corresponding distributions for the local wavelet power spectrum under the null hypothesis:

$$D\left(\frac{|W_n^x(S)|^2}{\sigma_x^2} < p\right) = \frac{1}{2}P_f\chi_v^2 \quad (3)$$

at each time n and scale s. P_f indicates the mean spectrum at the Fourier frequency f that corresponds to the wavelet scale s (in our case, $s \approx \frac{1}{f}$). The variable v is equal to 1 or 2, for real or complex wavelets, respectively. For more general processes, one must depend on Monte Carlo simulations.

The concepts of cross wavelet power (XWT), wavelet coherency, and phase difference are extensions of the basic wavelet analysis tools that allow us to study the time-frequency dependencies between two time series. The cross wavelet transforms of two time series, *x (t)* and *y (t)*, are calculated as follows:

$$W_{xy}(\tau,s) = W_x(\tau,s)\overline{W_y}(\tau,s), \quad (4)$$

where W_x and W_y are the x and y wavelet transforms, respectively. The XWT is determined as $|W_{xy}(\tau,s)|$. The XWT of two time series is a measure of the local covariance between them at each time and frequency. This allows us to quantitatively assess the similarity of power between the two time series. In contrast, wavelet coherency (WTC) has the advantage of being normalized by the power spectrum of each time series. Similarly to Fourier spectral methods, the wavelet coherency (R_{xy}) of two time series, *x (t)* and *y (t)*, is defined as follows (Aguiar-Conraria et al., 2013, p. 395):

$$R_{xy}(\tau,s) = \frac{\left|S\left(W_{xy}(\tau,s)\right)\right|}{\sqrt{S(|W_{xx}(\tau,s)|)S\left(\left|W_{yy}(\tau,s)\right|\right)}}, \quad (5)$$

where S indicates a smoothing operator in both time and scale, and $0 \le R_{xy}(\tau,s) \ge 1$. As previously mentioned, one of the key benefits of utilizing a complex wavelet is that we can compute the phase of the wavelet transform for each series and, as a result, get information about potential delays in the undulation (cycles) of the two series as a function of time and scale frequency. Equation 6 may be used to get the phase difference from the cross-wavelet transform.

$$\phi_{xy}(s,\tau) = tan^{-1}\left(\frac{\Im\left(W_{xy}(s,\tau)\right)}{\Re\left(W_{xy}(s,\tau)\right)}\right) \quad (6)$$

The value of $\phi_{xy} \in [-\pi, \pi]$ in its entirety, as well as details about the signs of each component. The time

2 In fact, we are concerned with a discrete time series $x = \{x_t, t = 0, \dots, T-1\}$ of T observations with a uniform time step. It is necessary to discretize the integral in (1), which is altered by a sum over the T time steps.

3 See, for instance, Torrence and Compo, 1998; Aguiar-Conraria et al., 2008; Aguiar-Conraria et al., 2012.

series moves together at the appropriate frequency when the phase difference is zero. The series advances in phase If $\phi_{xy} \in \left[0, \frac{\pi}{2}\right]$ although time series y goes ahead of x. If $\phi_{xy} \in \left[-\frac{\pi}{2}, 0\right]$, x is in the lead. An antiphase relationship may be seen in the phase difference $(or - \pi)$. If $\phi_{xy} \in \left[\frac{\pi}{2}, \pi\right]$, then x leads. Time series y leads if $\phi_{xy} \in \left[-\pi, -\frac{\pi}{2}\right]$.

5. Data and empirical result

Using a wavelet method[4], the results of this study demonstrate the correlation (co-movements) between taxation and government expenditure in Turkey. Table 1 provides the symbols, explanations, and sources of the variables.

Table 1 Data explanations: 2006:1-2020:7

Variable	Definition	Acronym	Source
Government Revenue	Revenue comprised of taxes, social contributions, grants received, and other sources.	x	Republic of Turkey Ministry of Treasury and Finance
Government Expenditure	Total expenditure comprised of total expense and the net acquisition of non-financial assets	y	Republic of Turkey Ministry of Treasury and Finance

Source: Authors

The monthly data (2006M1-2020M7) in the study were taken from the database of the Ministry of Treasury and Finance (Turkey). Both series are translated from Turkish Lira into US Dollars and described in real terms to take inflation into account. These monthly series need to be adjusted for the seasons. Therefore, using the Census-X11 approach, these series were corrected for seasonal effects. Since GDP has cyclical impacts on the analysis and is not available in Turkey at monthly frequencies, the method of modifying variables by GDP was rejected in this study.

The wavelet transformation was used to measure the degree of linear relationship between two non-stationary time series in the frequency domain (Aguiar-Conraria et al., 2008, p. 2877). Before conducting the empirical study, we applied unit root tests to assess the stationarity of relevant variables. We used the Augmented Dickey-Fuller (ADF, 1979), Kwiatkowski–Phillips–Schmidt–Shin (KPSS, 1992), and Zivot-Andrew (ZA, 1992) tests to determine the statistical stationarity of the series. The ADF method tests the null hypothesis of a unit root, while the KPSS and ZA tests are designed to test for stationarity. The results of these unit root tests for government revenues and expenditures are summarized in Table 2.

Table 2 The unit root tests of government revenues and expenditures

	ADF (H0 = the series has a unit root)		KPSS (H0 = the series is stationary)		ZA (H0 = the series has a unit root with a structural break)	
Variable	Intercept	Trend and intercept	Intercept	Trend and intercept	Intercept	Trend and intercept
(x)	-3.776[a]	-3.696	0.467	0.358[a]	-3.345[a] *(k=5)*	-4.628 *(k=5)*
(y)	-2.876	-2.448	0.607	0.353[a]	-3.355[a] *(k=7)*	-3.781 *(k=7)*
Breakpoint in (x)					2009M12	2012M10
Breakpoint in (y)					2009M07	2012M10

Notes: (i) α denotes 1% levels of significance, which is significant. (ii) According to the Schwarz Information Criterion, k is the optimal lag.
Source: Authors

[4] R codes recommended by Rösch and Schmidbauer (2016) were used for all wavelet estimations.

The ADF test indicates that both series with trend and intercept are nonstationary in levels, and the null hypothesis cannot be rejected in either series. For both series, the KPSS test rejected the null hypothesis with intercept, that is, both series are nonstationary in levels. The ZA results demonstrate that for both series with intercept, the unit root null hypothesis cannot be rejected at a 1% significance level. The estimated breakpoint for the government revenue series is in 2009M12, and for the government expenditure series, it is in 2009M07. The estimated breakpoints coincide with the fact that the mortgage crisis experienced all over the world in 2008 affected Turkey as well, followed by the deteriorating economic conditions since the end of 2009. As a result, the variables are non-stationary series depending on the demands of the wavelet tool (Mutascu, 2017, p. 9).

Figure 1 (the wavelet analysis results are presented in Appendix 2) indicates that the wavelet power of x is high and significant at 0.25–1 month of scale, for the period 2006M8-2007M9, and 2018M4-2019M10. In addition, it demonstrates that the wavelet power of x is high and significant on the 8-month scale for the 2012M4-2014M4 periods. As seen in Figure 2 (in Appendix 2), the periods of the wavelet power of y show similarities with Figure 1.

In general, when the CWT power spectrum of the public revenues (x) and expenditures (y) series is analyzed, the 0.25-1-month and 8-month scales cover the periods mentioned above, the cross-wavelet power of the series should be taken into account since these similar features might appear as a result of a basic coincidence. Additional details about covariance and co-movement of the variables under consideration can be found in the cross-wavelet power. The XWT outcomes are displayed in Figure 3 (in Appendix 2).

Two series, government revenue, and government spending appeared to be evolving in terms of behavior. According to the XWT power spectrum analysis, Figure 3 monitors the co-movements between government revenue and spending, and it shows that in the short-term cycle (a 1-4 month frequency):

i. In the 2007-2014 period, the arrows pointing to the right and down indicate that the variables are in phase. This demonstrates that spending has a positive impact on income.

ii. In the 2016-2019 period, the variables are in an upward and to the right phase, showing that tax revenues positively affect government expenditure. However, the correlation between the variables during this period and one another appears to be much smaller than it was between the variables from 2007 to 2014.

In the medium-term cycle (over an 8-month frequency):

i. In the 2012-2014 period, the arrows pointing down and to the right indicate that the variables are in phase. The arrows point to the right and down, and expenditures have a positive impact on revenues.

We may learn about coherence and delay between the oscillations of two time series from the phase difference. We can determine the strength of the association using the cross-wavelet transform. Since there is some overlap between the two measurements and wavelet coherence has the benefit of being normalized by the power spectrum of the two time series, we chose to focus on wavelet coherence (WTC) rather than the wavelet cross-spectrum (XWT) for cross-wavelet analysis. A strong local correlation is a term used to describe regions with significant coherence between two countries (Aguiar-Conraria & Soares, 2011, p. 484). For these reasons, WTC was chosen as a better wavelet power tool over the XWT.

According to the WTC study and Figure 4 (in Appendix 2), which monitors changes in government revenues and expenditures in the short-term cycle (frequency of 2-8 months):

i. In the 2011 period, more spending led to higher revenues (frequency of 2-4 months), shown by the arrows pointing to the right and down. The 2010 plan aimed to boost the economy after the 2008 crisis by focusing on global crisis recovery, increased public investment, and more state revenue through taxes. As a result, public spending rose, reaching its peak in tax revenues in 2011.

ii. In the 2016-2017 period, government expenses had a negative impact on revenues (frequency of 2-4 months), indicated by the left and up arrows. Global events like war,

terrorism, decreased tourism, and political changes affected the budget, with internal turmoil in 2016 leading to an economic crisis in Turkey, impacting the budget negatively.

iii. In the 2019 period, government revenues positively led expenditures (frequency of 2-4 months), shown by the right and up arrows. Law No. 6736 of 2016 expanded the tax base, and increased income tax, corporate income tax, and value-added tax. Additionally, the corporate tax rate temporarily rose to 22% after 2017, leading to extra revenue being spent.

iv. In the 2006-2007 period, the left and up arrows indicated a negative impact of government spending on revenues (frequency of 4-8 months), confirming a structural breakpoint (Zivot & Andrews) in government revenues since 2009. Budget deficits increased due to the 2008 global crisis in Turkey, but reducing some tax rates (from 30% to 20% of the corporate tax rate) effectively countered a decline in demand.

v. In the 2008, 2010-2011, and 2012-2013 periods, the right and up arrows indicated a positive impact of government revenues on expenditures (frequency of 4-8 months). However, this association appeared comparatively weaker in the 2010–2011 period. After 2008, fiscal policy aimed to stimulate investment, and in 2010, the government increased taxes (the value-added tax and the special consumption tax) to control the rising budget deficit.

vi. In 2014, the right and down arrows showed positive impacts of expenditures on revenues (frequency of 4-8 months), following Law No. 6736 of 2013, which increased some tax revenues.

vii. In 2015, the arrows pointing up indicated no clear relationship between public expenditures and revenues (frequency of 4-8 months).

viii. In 2015, as the arrows point not to the right or to the left but up, there is no relationship between public expenditures and revenues (frequency of 4-8 months).

ix. In the 2018-2020 period, the right and up arrows revealed a positive relationship, where government revenue positively impacted spending (frequency of 4-8 months). Law No. 6736 of 2016 expanded the tax base and increased income tax, corporate income tax, and value-added tax. Additionally, the corporate income tax was raised from 20% to 22% in 2018, 2019, and 2020.

In a medium-term cycle (frequency of 8-24 months):

i. In the 2006-2007 and 2008-2011 periods, the arrows pointing down and to the right indicate that spending has a positive impact on income. However, this connection seems stronger in the 2006-2007 period compared to the 2008-2011 period (frequency of 14-16 months). The economic crisis led to increased public expenditures from 2008 to 2011, resulting in the highest growth in tax revenues in 2011. This is supported by the ZA structural breakpoint test, and interest expenses showed an upward trend from 2006 to 2009.

ii. In the 2015-2018 period, the arrows pointing up and to the right signify that increasing tax revenue leads to higher government spending (frequency of 14-24 months). An increase in some tax revenues was a result of Law No. 6736 enacted in 2016.

In the long-term cycle (frequency of over 24 months):

i. In the 2008-2011 period, the arrows pointing to the right and down indicate that expenditures have a positive impact on revenues (frequency of 24-32 months). The global crisis led to an increase in the share of public expenditures in GDP (40.10%). The ZA test reinforces the fact that this is a special time.

ii. In the 2014-2018 period, as the arrows point to the right and down, government expenditures positively influence revenues (frequency of over 32 months). After 2016, government expenditures increased due to internal turmoil in the country.

In summary, the tax-expenditure separation, expenditure-tax separation, and institutional separation hypotheses occurred in different periods and

with different frequencies. The results obtained partially correspond to those of the studies that treat the subject according to traditional methods, but only for certain periods and different frequencies (Pınar, 1998; Akçoraoğlu, 1999; Günaydın, 2000; Günaydın, 2004a; Çavuşoğlu, 2008, Darrat, 1998; Günaydın, 2004b; Akçağlayan & Kayıran, 2010). However, there is no evidence for the financial synchronization hypothesis for Turkey.

6. Conclusion

The relationship between public expenditures and tax revenues is important for reducing budget deficits. The fact that budget deficits have become a structural problem, especially in developing countries, has made the relationship between public expenditures and revenues even more important. The relationship between government expenditure and revenue has been studied by many researchers using traditional methods, such as area analysis/correlation analysis or time series models/panel data models. In contrast to previous research, this study employs a wavelet method using monthly data from 2006 to 2020 to examine the direction of causality between government expenditures and revenues in Turkey. The lead-lag relationship between variables under cyclical and anti-cyclical shocks is addressed in the study, which provides in-depth details about this relationship for special sub-periods and varied frequencies.

The results of the study support the view that taxes play an important role in controlling budget deficits. Accordingly, controlling taxes rather than expenditures plays a key role in reducing fiscal deficits in Turkey in the short term. It is revealed that the dynamics of the budget balance in the medium term can be explained by the spend-tax hypothesis and that the tax burden can be alleviated by spending cuts. In the long term, the results were obtained that support the spend-tax hypothesis. In this context, the implementation of fiscal policy based on public spending rather than tax policy will be more effective in the fight against budget deficits. However, it should be taken into account that public expenditures made without creating resources will cause an increase in the tax burden in the future.

Future studies should focus on more countries and data (which is a limitation of this study) to compare the duration and path of the budget deficit cycle (tax and spending). The limitations of our study do not limit the contribution to the field because this study aimed to provide empirical evidence by analyzing budget deficit cycles with the wavelet approach for the first time, specifically in Turkey (not to investigate them globally).

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Appendix 1

See tables 1 and 2.

Table 1 Summary of empirical literature

Article	Country	Sample	Methods	Results			
				T→S	S→T	FS	IS
Baghestani and Mc-Known (1994)	USA	1955-1989	ECM				✓
Kollias and Paleologou (2006)	15 countries	1960-2002 1962-2002 1970-2002 1973-2002	VECM GC	Italy Spain Luxem-bourg	France Finland United Kingdom	Denmark Greece Ireland Netherlands Portugal Sweden	Austria Belgium Germany
Westerlund et al. (2011)	50 US state–local government	1963-1997	Panel Coin-tegration	✓			
Apergis et al. (2012)	Greece	1957-2009	TAR MTAR EG	✓			
Paleologou (2013)	Sweden Germany Greece	1965-2009	TAR MTAR		Greece	Sweden Germany	
Mutascu (2016)	Bulgaria Czech Republic Estonia Hungary Lithuania Latvia Poland Romania Slovenia Slovakia	1995-2012	Bootstrap Panel GC	Czech Republic Hungary Slovenia	Bulgaria	Slovakia	Estonia Latvia Romania Lithuania Poland
Tiwari and Mutascu (2016)	Romania	1999-2012	TAR MTAR		✓		
Akram and Rath (2019)	26 Indian States	1980-2015	Dumitrescu–Hurlin Panel Causality			✓	
Linhares and Nojosa (2020)	Germany, United Kingdom France Italy Spain	1995-2019	Wald Test	Germany United Kingdom Italy	France	Spain	
Arvin et al. (2021)	Low-income countries Lower middle-income coun-tries	2005–2019	GC			✓	
Salvi and Schaltegger (2021)	Switzerland	1850-2018	VECM	✓			
Nzimande and Ngalawa (2022)	14 Southern African Development Community member states	1980-2018	Bootstrap Panel GC	Botswana	Mauritius Mozam-bique		

Note: T-S, S-T, FS, and IS stand for tax-spend, spend-tax, fiscal synchronization, and institutional separation, respectively.

Source: Authors

Table 2 Empirical studies on the revenue–expenditure nexus for Turkey

Article	Country	Sample	Methods	Results			
				T→S	S→T	FS	IS
Pınar (1998)	Turkey	1924-1997	ECM GC		✓		
Darrat (1998)	Turkey	1967-1994	EG ECM	✓			
Günaydın (2000)	Turkey	1950-1999	VECM		✓		
Günaydın (2004a)	Turkey	1964-2001	VECM		✓		
Günaydın (2004b)	Turkey	1983-2003	VAR	✓			
Çavuşoğlu (2008)	Turkey	1987-2003	VAR GC		✓		
Payne et al. (2008)	Turkey	1968-2004	VECM GC TAR MTAR	✓			
Akçağlayan and Kayıran (2010)	Turkey	1987-2005	ECM				✓
Çiçek and Yavuz (2014)	Turkey	2007-2011	VECM GC				✓
Aysu and Bakırtaş (2018)	Turkey	2006-2017	Toda-Yamamoto Causality		✓		
Yılancı et al. (2020)	Turkey	2006-2019	VAR	✓			
Kamacı and Kurt (2021)	Turkey	2006-2021	DOLS		✓		
Yıldız and Demirkılıç (2022)	Turkey	1972-2020	Hacker and Hatemi-J Bootstrap Causality		✓		

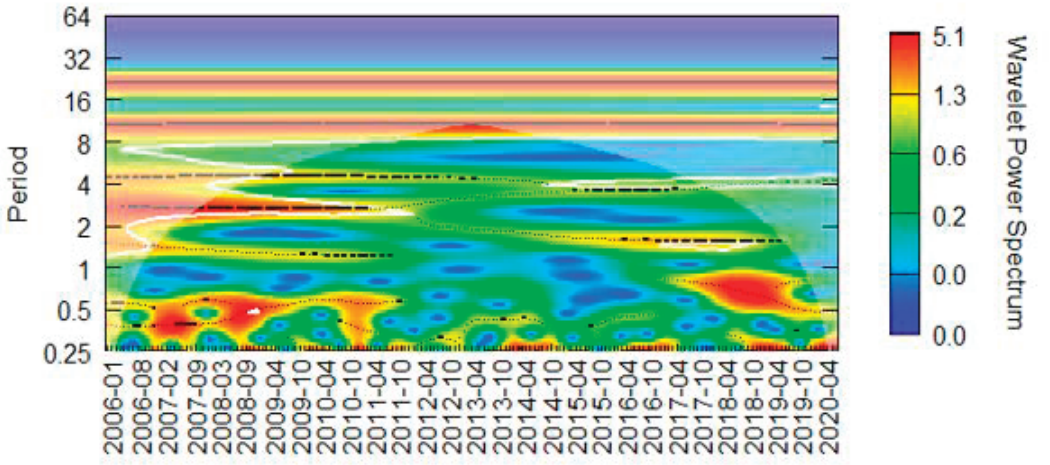
Note: T-S, S-T, FS, and IS stand for tax-spend, spend-tax, fiscal synchronization, and institutional separation, respectively.

Source: Authors

Appendix 2

See figures 1-4.

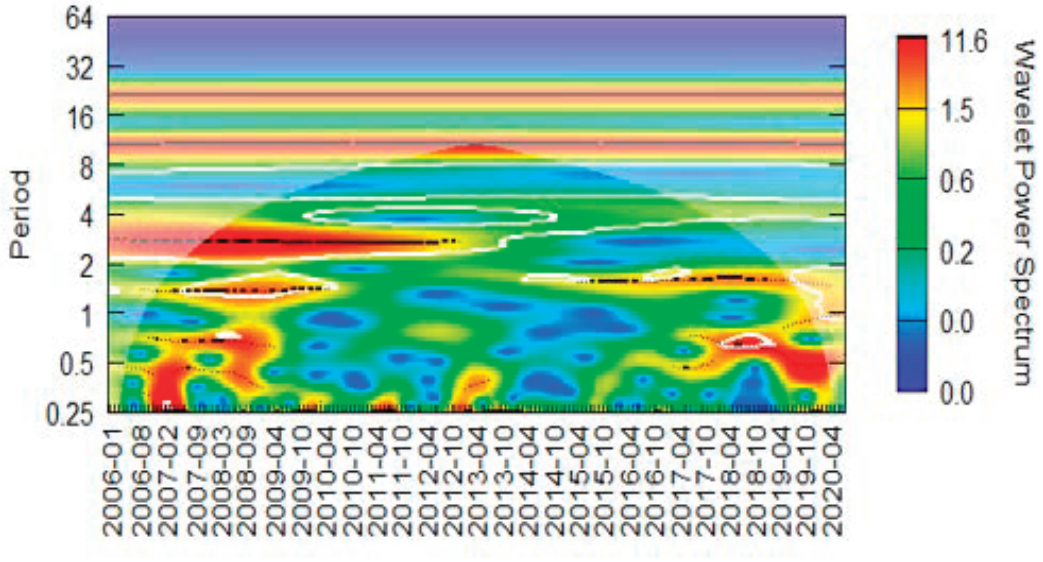
Figure 1 CWT power spectrum of (x)–government revenue, monthly series (2006:1-2020:7)



Note: (a) According to Monte Carlo simulation estimates, the thick white contour denotes a 5% significance level (95% confidence level) against red noise. (b) The plot is divided into dependable (full colors) and unreliable (pale colors) areas by the cone of influence, which is constructed as a light shadow and symbolizes the areas impacted by edge effects. (c) The strong power gradient of the major contours may be seen in the power ranges to the right of the CWT results. According to frequency intervals, blue and red denote the power with the lowest and the greatest coherency. (d) Time is shown on the X-axis, while frequency is represented on the Y-axis.

Source: Authors

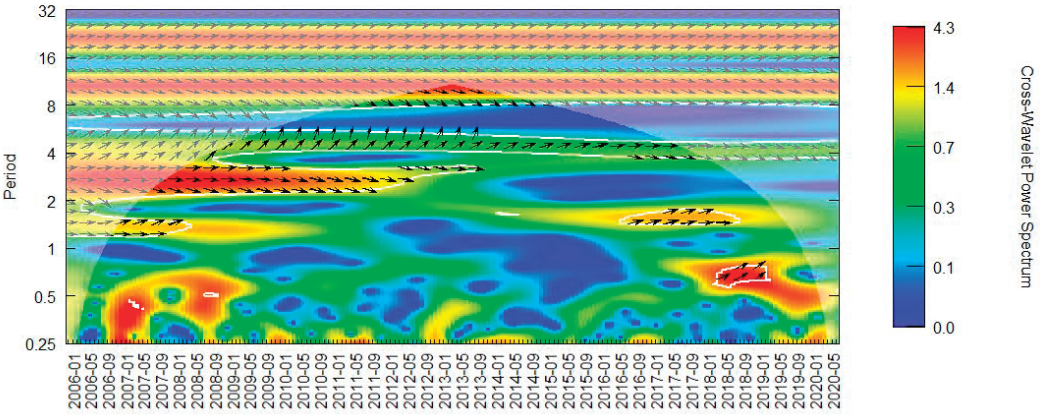
Figure 2 CWT power spectrum of (y)–government expenditure, monthly series (2006:1-2020:7)



Note: (a) According to Monte Carlo simulation estimates, the thick white contour denotes a 5% significance level (95% confidence level) against red noise. (b) The plot is divided into dependable (full colors) and unreliable (pale colors) areas by the cone of influence, which is constructed as a light shadow and symbolizes the areas impacted by edge effects. The strong power gradient of the major contours may be seen in the power ranges to the right of the CWT results. According to frequency intervals, blue and red denote the power with the lowest and the greatest coherency. (d) Time is shown on the X-axis, while frequency is represented on the Y-axis.

Source: Authors

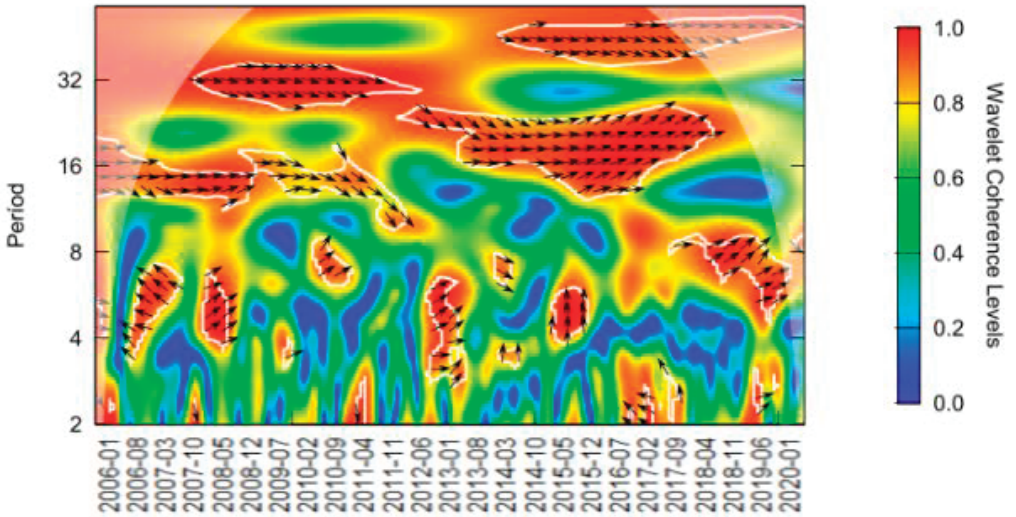
Figure 3 XWT of the pair (x)–(y), monthly series (2006:1-2020:7)



Note: (a) According to Monte Carlo simulation estimates, the thick white contour denotes a 5% significance level (95% confidence level) against red noise. (b) The plot is divided into dependable (full colors) and unreliable (pale colors) areas by the cone of influence, which is constructed as a light shadow and symbolizes the areas impacted by edge effects. The major contours have a strong power gradient, according to the power ranges to the right of the XWT findings. According to frequency intervals, blue denotes the lowest power (low coherency) and red denotes the highest power (high coherency). (d) The phase difference between the two series are shown by arrows. (e) Arrows pointing to the right (positively related) mean that the variables are in phase. Arrows pointing to the right and up indicate that government revenue is lagging, and government expenditure is leading, while arrows pointing to the right and down indicate that government expenditure is leading, and government revenue is lagging. (f) Arrows pointing to the left (negatively related) mean that the variables are out of phase. Arrows pointing to the left and up indicate that government expenditure is leading, and government revenue is lagging, while arrows pointing to the left and down indicate that government revenue is lagging, and government expenditure is leading. (g) Time is shown on the X-axis, while frequency is represented on the Y-axis.

Source: Authors

Figure 4 WTC of the pair (x)–(y), monthly series (2006:1-2020:7)



Note: (a) According to Monte Carlo simulation estimates, the thick white contour denotes a 5% significance level (95% confidence level) against red noise. (b) The plot is divided into dependable (full colors) and unreliable (pale colors) areas by the cone of influence, which is constructed as a light shadow and symbolizes the areas impacted by edge effects. The major contours have a strong power gradient, according to the power ranges to the right of the WTC findings. According to frequency intervals, blue denotes the lowest power (low coherency) and red denotes the highest power (high coherency). (d) The phase difference between the two series is shown by arrows. (e) Arrows pointing to the right (positively related) mean that the variables are in phase. Arrows pointing to the right and up indicate that government revenue is lagging, and government expenditure is leading, while arrows pointing to the right and down indicate that government expenditure is leading, and government revenue is lagging. (f) Arrows pointing to the left (negatively related) mean that the variables are out of phase. Arrows pointing to the left and up indicate that government expenditure is leading, and government revenue is lagging, while arrows pointing to the left and down indicate that government revenue is lagging, and government expenditure is leading. (g) Time is shown on the X-axis, while frequency is represented on the Y-axis.

Source: Authors