



# Nonlinear Relationship between Economic Growth and Tax Revenue in Turkey: Hidden Cointegration Approach

## Türkiye’de Ekonomik Büyüme ile Vergi Geliri Arasındaki Doğrusal Olmayan İlişki: Gizli Eşbütünleşme Yaklaşımı

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### ABSTRACT

The tax revenues, which constitute the most important income item of the state, provide the necessary financing for sustainable economic growth in evolved countries, development efforts in developing economies, and form the basis of social welfare. Therefore, the relationship between economic growth and tax revenues is significant and numerous empirical studies have been carried out on this subject. However, there is no study testing the hidden cointegration. This paper aims to test the presence of hidden cointegration between economic growth and tax revenues and intends to develop further typologies. To test the relationship, data on the ratio of annual tax revenues/GDP between 1985-2018 in Turkey was used, and Hidden Cointegration Approach developed by Granger and Yoon (2002) and crouching error correction model were applied. The analysis results demonstrated that the tax revenues decreased across variables and that there was a cointegration relationship in periods when the GDP increased. This manuscript is a contribution to the literature since a different technique was performed to examine the relationship between growth and tax revenues, and the results obtained will be crucial for decision-makers.

**Keywords:** GDP, Taxes, Hidden cointegration

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## 1. Introduction

Economic growth is a complex concept that began to be discussed when Adam Smith questioned its causes in its book named *"An Inquiry into the Nature and Causes of the Wealth of Nations"* published in 1776, and it has been experienced in various ways since the industrial revolution in 18th century (Yeldan, 2010).

According to Myles (2000), economic growth that remains up-to-date forms the basis of increased welfare. Growth is crucial for increasing individual welfare, and therefore, policies to be selected should be those that ensure growth. One of the necessary and significant factors for economic growth is the availability of an effective tax system. Although taxes (especially income tax) are thought to have a temporary effect in Neoclassical Growth models, tax rates are thought to affect the long-term growth rate or stable state growth rate in Endogenous Growth Models. Tax revenues, which constitute the most significant resource of income for the state, is a considerable tool reducing the gap between the rich and the poor in the society (Chigbu and Njoku, 2015). A well-designed tax system is a crucial element that may increase social welfare (Mankiw, Weinzierl, and Yagan, 2009). Taxation is a key factor in promoting sustainable growth and poverty reduction (Takumah, 2014).

The relationship between growth and tax revenues has been a subject of debate among economists since Smith (1776) for 244 years. In the contraction periods of economies, a decrease is seen in taxes, which constitutes the source of financing of governments, whereas tax revenues increase during economic expansion periods. In this context, the tax revenues of Developed Countries which show steady growth, are higher than the tax revenues of the Developing Countries with unstable growth rates (Goode, 1980). Many empirical studies show that GDP is a substantial variable in determining tax revenues (Piana, 2003). According to Tanzi (1987), the correlation between per capita income and overall tax revenue is positive, especially for developing countries; increased growth raises tax revenue by growing the tax base.

There is a strong relationship between growth and tax revenues, which is the focal point of many studies. Since the global economic crisis of 2008, many questions have been raised about measures to be taken by governments to promote economic activities (Mutaşcu and Dănuleşiu, 2011). In this context, determining the relationship between growth and tax will allow for establishing an effective tax policy that affects economic growth. In the present manuscript, as a sequel to the study conducted by iğdem, Altaylar, Kose, and Yılmaz (2020) in which the relationship between indirect taxes and GDP was analyzed using original data of the variables and in which it was concluded that there was a cointegration relationship among variables exercising the cointegration approach improved by Engle-Granger (1987), the hidden cointegration (HC) relationship between GDP and tax revenues will be studied.

## **2. Review of the Literature**

In addition to Smith (1776), Malthus (1798), Ricardo (1817), Ramsey (1928), Young (1928), Schumpeter (1934), Knight (1944), which constitute many elements of modern growth theories, Solow (1956) and Swan (1956) made the most recent and most important contribution (Parasız, 2008). Different approaches seem to be put forward in the discussions on the relationship between growth and tax. For example; the study of Solow (1956) and Swan (1956) indicates that consistent growth is not influenced by tax policies. Lucas (1988) states that a higher rate of income taxes would cause a temporary decrease in growth rate. Romer (1990), carried out studies suggesting that tax policies may have long-term or permanent effects on growth. Easterly and Rebelo (1993) discovered that the standard deviation in the domestic tax revenue-to-consumption-to-investment ratio had a substantial and negative effect on economic growth.

Studies of Tanzi and Lee (1996) found that there is no strong evidence associating with the growth with a proper tax policy (Yeldan, 2010). Numerous empirical studies are examining the relationship between growth and tax. Table 1 shows some of those studies.

**Table 1: Literature**

Researcher	Method	Result
Harberger (1964)	Equilibrium (Optimal) Analysis	It established that the growth is not enhanced by low taxes.
Marsden (1983)	Cross-Section Data Analysis, Linear Regression	A statistically significant (-) relationship was found between tax and GDP growth. The increase in the total tax/GDP ratio decreases the growth rate.
Romer (1986)	Descriptive Statistics and Equilibrium Analysis	External increase of taxes reduces growth. High income tax reduces the rate of sustainable growth.
Koester & Kormendi (1989)	A Systematic Cross-Country Analysis.	A (-) relationship was found between marginal tax rates and growth.
King & Rebelo (1990)	Equilibrium Analysis Descriptive Statistics (Mathematical Economics)	An increase in tax rates negatively affects growth.
Easterly & Rebelo (1992)	Equilibrium Analysis Descriptive Statistics (Mathematical Economics)	A (-) relationship was found between marginal tax rates and growth.
Easterly & Rebelo (1993)	Cross-Section Regressions	Little evidence were found on a strong correlation between marginal tax rates and growth.
Ferretti & Roubini (1995)	Equilibrium Analysis	They found that taxation would reduce growth.
Engen & Skinner (1992)	Cross-Section Data Analysis, Linear Regression (OLS Estimator)	An increase in taxation reduces growth rates.
Mendoza, Milesi-Ferretti & Asea (1997)	Cross-Country Regressions and Numerical Simulations	Taxes have no impact on economic growth in the long run.
Widmalm (2001)	Pooled Data Analysis Linear Regression (OLS-2SLS Estimators)	The increase in the income tax rate affects the growth negatively. Furthermore, it was found that the excise taxes have a weak growth-enhancing on DC. Tax → GDP
Koch, Schoeman & Van Tonder (2005)	Time Series Analysis, Linear Regression (Two-Stage Modelling)	A decrease in tax burden positively affects the growth. Decreased indirect taxation has a strong association with increased economic growth.
Durkaya & Ceylan (2006)	Time Series Analysis, Cointegration (Engle-Granger) and Causality (Granger) Analysis	There is a long-term relationship between growth rate and total tax revenues. GDP ↔ Direct tax No causality relationship was found between indirect taxes and growth.
Furceri & Karras (2008)	Panel Data Analysis Linear Regression (Fixed and Random Effects Estimator)	The increase in tax rates makes a lasting and negative impact on growth.

**Table 1: Continue**

Kong & Hoek (2008)	Engle-Granger Cointegration, Error Correction Model	The most important reason for an increase in tax revenues is the increase in GDP.
Temiz (2008)	Time Series Analysis, Cointegration (Johansen) and Causality (Granger) Analysis	While it is understood that there is a long-term relationship between growth and indirect - direct taxes, it was found that there is a positive relationship with direct taxes, and a negative relationship with indirect taxes. GDP ↔ Direct tax
Padda & Akram (2009)	Time Series Analysis, Linear Regression (OLS Estimator)	The increase in taxes affects the growth negatively.
Ger, Mercan, Bulut, and Dam (2010)	Time Series Analysis, ARDL Bounds Test	Total tax revenues and growth are cointegrated in both short term and long term.
Helhel & Demir (2012)	Time Series Analysis, Cointegration (Johansen) and Causality (Granger) Analysis	It was proven that there is an interaction between tax revenue and growth in the long term. No interaction was found in the short term. The effect of indirect tax on growth is weak.
Mangır & Ertuğrul (2012)	Time Series Analysis, ARDL Bounds Test Approach	Cointegration was found between tax burden and growth. Between tax burden and growth, a statistically negative relationship was found.
Stoilova & Patanov (2012)	The Regression Analysis Method	The tax structure based on direct taxes is more effective in supporting the growth.
Fenochietto & Pessino (2013)	Data Envelopment Analysis, Stochastic Bounds Analysis and Sensitivity Analysis, Stochastic Boundary Model and Mundlack Random Effects Model	There is a statistically significant and positive relationship between GDP per capita and tax revenues at different models and significance levels.
Ahmad, Sial & Ahmad (2016)	Time Series Analysis, ARDL Bounds Test Approach	It was found that the total tax revenues have a negative and significant effect on growth in the long term. They found that indirect taxes should be reduced and direct taxes should be increased in order to increase growth.
Organ & Ergen (2017)	Time Series Analysis, ARDL Approach and Causality (Granger) Analysis	It was found that tax burden and growth are cointegrated, and there is a negative correlation between the two variables in the long run.
Andrejovská & Puliková (2018)	Panel Data Analysis, Linear Regression (Random Effects Estimator for 5 countries, Fixed Effects Estimator for 23 countries)	In both country groups, GDP and employment have statistically significant and positive impact on tax revenues.

**Table 1: Continue**

Karabulut & Şeker (2018)	Time Series Analysis, Linear Regression	GDP positively affects tax revenues.
Karamelikli (2018)	Time Series, NARDL Approach	It found an asymmetrical relationship between growth and tax income.
Basheer, Ahmad & Hassan (2019)	Panel Data Analysis, Linear Regression (LSDV, Fixed and Random Effects and POLS Estimator)	It was found that growth has a positive and significant effect on tax revenues.
Akıncı (2019)	Time Series Analysis, Cointegration (Maki) Analysis	Cointegration was found between growth and tax revenues in the long run.
Ozturk, Şaşmaz, Bayar & Odabaşı (2019)	Time Series Analysis, Linear Regression (OLS Estimator)	It was determined that economic growth positively affects tax revenues.
Polat (2019)	Time Series Analysis, Cointegration (Maki) Analysis, Canonical Regression	A positive relationship was found between growth and tax revenues in both short term and long term.
Boğa (2020)	Time Series Analysis, NARDL Approach	It was seen that the total tax revenues increase economic growth in both short term and long term and the relationship between the two variables is asymmetric in both periods.
Çiğdem et al. (2020)	Time Series Analysis, Cointegration (Engle-Granger) Analysis	It was determined that an increase in growth causes a decrease in indirect tax revenues.

As can be viewed from Table 1, varied methods were used in distinct periods. This study will contribute to the literature since no HC was found between growth and tax revenues.

### 3. Methodology, Data, and Empirical Results

Analyzed in the present study, annual total tax rates of the period 1985-2018 and GDP data were compiled from the OECD database. Details about the indicators are indicated in Table 2.

**Table 2: Variables**

Variables			Source
<b>Tax</b>	Total Tax Revenue (% GDP)	Rate	OECD
<b>GDP</b>	Gross Domestic Product - Spending	Million Dollar	OECD

Econometric analyses were conducted using the E-views 10+ software. The regression model examined in the research is as follows:

$$\text{Tax} = f(\text{GDP}) \quad (1)$$

$$\ln \text{Tax}_t = \alpha_0 + \beta_1 \ln \text{GDP}_t + \varepsilon_t \quad (2)$$

### 3.1. Unit Root Test

This part includes the theories of the customary unit root tests and the unit root tests with structural breaks.

#### 3.1.1. ADF Unit Root Test

The Augmented Dickey-Fuller (ADF) unit root test, often preferred in unit root and stationarity analyses in time series, is described as another version of the Dickey-Fuller (DF) test based on the AR(1) process. However, in cases when there is a higher degree of correlation in time series, " $\varepsilon_t$ " (error term series) loses the white noise feature. Therefore, AR(p) process is used, rather than AR(1) process in the ADF test to solve the problem of a high-degree autocorrelation, and " $p$ " lagged difference terms are included in DF equations (Dickey and Fuller, 1979). After this modification process, the ADF equations with intercept, with intercept and trend, and none.

$$\Delta y_t = \delta y_{t-1} + \sum_{i=1}^p \beta_i \Delta y_{t-i} + \varepsilon_i \quad (3)$$

$$\Delta y_t = \mu + \delta y_{t-1} + \sum_{i=1}^p \beta_i \Delta y_{t-i} + \varepsilon_i \quad (4)$$

$$\Delta y_t = \mu + \beta t + \delta y_{t-1} + \sum_{i=1}^p \beta_i \Delta y_{t-i} + \varepsilon_i \quad (5)$$

"In equations (3), (4), and (5) " $\mu$ " is the constant, " $t$ " is the deterministic trend, " $p$ " is the lag length, and " $\varepsilon_t$ " is the error term series. Null hypotheses for all three of these ADF equations are the same, indicating that there is a unit root in the series (Gujarati, 2015).

### 3.1.2. Phillips Perron Unit Root Test

DF and ADF unit root tests assume that error terms are independent and homoscedastic (Enders, 2004). However, it has been observed that the many time-series have error terms that are heterogeneously distributed and weakly dependent.

To solve this problem, Phillips and Perron (1988) developed a new test (nonparametric adjusted), thinking that there might be autocorrelation between error terms. Moreover, Phillips and Perron (1988) found nonparametric modifications in the PP unit root test. The equation, forming the basis for the PP unit root test is shown below:

$$\Delta y_t = \alpha y_{t-1} + x_t' \delta + \varepsilon_t \quad (6)$$

In equation (6) it refers to " $\alpha = \rho - 1$ " whereas " $x_t$ " indicates deterministic components (intercept or intercept and trend) while " $\varepsilon_t$ " indicates the error term. Null and alternative hypotheses of the test are as follows: " $H_0: \alpha = 0$  and  $H_1: \alpha < 0$ ". The null hypothesis indicates that the time series includes a unit root (Çağlayan and Saçaklı, 2006).

### 3.2. Hidden Cointegration Relationship

The *HC* relationship developed by Granger and Yoon (2002) criticizes the traditional cointegration finding methods based on the logic suggesting that a cointegration relationship occurs when economic variables synchronously react to shocks (Granger and Yoon, 2002).



$$x_t = x_{t-1} + \varepsilon_t = x_0 + \sum_{i=1}^t \varepsilon_i \quad (7)$$

$$y_t = y_{t-1} + \varepsilon_t = y_0 + \sum_{i=1}^t \varepsilon_i \quad (8)$$

In equations (7) and (8)  $t=1,2,\dots$ , " $x_0$  and  $y_0$ " indicate initial values whereas " $\varepsilon_i$  and  $\varepsilon_i$ " indicate the white noise series. Both variables in these equations ( $x_t$  and  $y_t$ ) demonstrate the original data of the series. The decomposition process to be conducted in the first phase is based on the decomposition of error terms by positive and negative shocks. The decomposition process is as follows:  $\varepsilon_i^- = \min(\varepsilon_i, d)$  and  $\varepsilon_i^+ = \max(\varepsilon_i, d)$ ;  $\varepsilon_i^- = \min(\varepsilon_i, d)$  and  $\varepsilon_i^+ = \max(\varepsilon_i, d)$ . The variables that this process is applied to are shown as  $\varepsilon_i = \varepsilon_i^- + \varepsilon_i^+ + d$  and  $\varepsilon_i = \varepsilon_i^- + \varepsilon_i^+ + d$ . Furthermore,  $\varepsilon_i^+$ ,  $\varepsilon_i^-$ ,  $\varepsilon_i^+$ , and  $\varepsilon_i^-$  are assumed to follow the I(1) process (Granger and Yoon, 2002, p. 6). The " $d$ " values in these equations indicate the threshold value and are often assumed to be zero. When these values are replaced in equation (5),  $x_t = x_{t-1} + \varepsilon_t = x_0 + \sum_{i=1}^t \varepsilon_i^- + \sum_{i=1}^t \varepsilon_i^+$  and  $y_t = y_{t-1} + \varepsilon_t = y_0 + \sum_{i=1}^t \varepsilon_i^- + \sum_{i=1}^t \varepsilon_i^+$  equations are acquired respectively. In the next phase, when it is assumed that  $x_0$  and  $y_0$  are constant values, it can be reformulated as  $x_t = x_0 + x_t^- + x_t^+$  and  $y_t = y_0 + y_t^- + y_t^+$ . At this point, the shocks obtained constitute the first phase of the HC analysis. Moreover, in their studies, Granger and Yoon (2002) studied the cointegration relationship for four different states of two variables such as X and Y (Granger and Yoon, 2002). This relationship was presented by implementing the Engle and Granger (1987) test on positive and negative components.

### 3.3. Crouching Error Correction Models

Granger and Yoon (2002) proposed a crouching error correction model (CECM) based on the results of the HC approach. If there is an HC relationship among the analyzed variables, CECM is as follows:

$$\Delta Y_t^+ = \varphi_0 + \varphi_1 \varepsilon_{t-1} + \sum_{i=1}^k \varphi_{xi} \Delta X_{t-i}^+ + \sum_{j=1}^p \varphi_{yj} \Delta Y_{t-j}^+ + v_t \quad (9)$$

$$\Delta X_t^+ = \gamma_0 + \gamma_1 \varepsilon_{t-1} + \sum_{i=1}^k \gamma_{xi} \Delta X_{t-i}^+ + \sum_{j=1}^p \gamma_{yj} \Delta Y_{t-j}^+ + v_t \quad (10)$$

In the Equations (9) and (10), and indicate error correction terms (ECT). Gonzalo and Granger (1995), defined variables that had insignificant ECT in the error correction equations as the permanent component of the system whereas variables with significant ECT were defined as temporary variables.

**Table 3: ADF, PP, ZA and LS Unit Root Tests (Level)**

Variables	ADF Unit Root Test		PP Unit Root Test		
	T-Stat. (Cons.)	T-Stat. (Cons. and Trend)	Adj. t Stat. (Cons.)	Adj. t Stat. (Cons. and Trend)	
Tax	-2.110525 (0.2420)	-1.237971 (0.8856)	-2.092883 (0.2486)	-1.321345 (0.8648)	
GDP	0.087354 (0.9599)	-1.286163 (0.8739)	0.055208 (0.9571)	-1.397253 (0.8341)	
Tax <sup>+</sup>	-2.093293 (0.2485)	-1.124963 (0.9088)	-2.433325 (0.1410)	-0.977117 (0.9333)	
Tax <sup>-</sup>	-0.164104 (0.9334)	-1.837102 (0.6629)	-0.095273 (0.9417)	-1.837102 (0.6629)	
GDP <sup>+</sup>	0.148854 (0.9646)	-1.527160 (0.7987)	0.150854 (0.9648)	-1.592102 (0.7737)	
GDP <sup>-</sup>	-1.161501 (0.6785)	-1.353465 (0.8553)	-1.161501 (0.6785)	-1.461132 (0.8220)	
	ZA Unit Root Test			LS Unit Root Test	
	T-Stat. (Cons.)	T-Stat. (Trend)	T-Stat. (Cons. and Trend)	t Stat. (Cons.)	t Stat. (Cons. and Trend)
Tax	-2.745 (0.09588)	-3.427 (0.00834)	-3.820 (0.04644)	-2.066	-5.753
GDP	-1.913 (0.00031)	-3.813 (0.00033)	-4.609 (0.00035)	-2.264	-5.784

Note: \*, \*\*, \*\*\* denote the significance levels of alpha at .01, .05, and .10 respectively.

Table 3 indicates the findings of ADF, PP, ZA, and LS tests. The results demonstrate that the series include a unit root.

**Table 4: ADF and PP Unit Root Tests (First Difference)**

Variables	ADF Unit Root Test		PP Unit Root Test	
	T-Stat. (Cons.)	T-Stat. (Cons. and Trend)	Adj. t Stat. (Cons.)	Adj. t Stat. (Cons. and Trend)
ΔTax	-4.973206 (0.0003)*	-5.166056 (0.0011)*	-4.969272 (0.0003)*	-5.147432 (0.0011)*
ΔGDP	-5.018333 (0.0003)*	-4.978882 (0.0018)*	-5.018325 (0.0003)*	-4.978882 (0.0018)*

$\Delta Tax^+$	-5.637007 (0.0001)*	-6.063683 (0.0001)*	-5.636548 (0.0001)*	-6.131408 (0.0001)*
$\Delta Tax^-$	-5.624554 (0.0001)*	-5.533307 (0.0005)*	-5.624185 (0.0001)*	-5.533332 (0.0005)*
$\Delta GDP^+$	-5.357046 (0.0001)*	-5.341829 (0.0007)*	-5.358488 (0.0001)*	-5.341829 (0.0007)*
$\Delta GDP^-$	-5.249796 (0.0002)*	-5.240197 (0.0010)*	-5.249796 (0.0002)*	-5.239229 (0.0010)*

Note: \*, \*\*, \*\*\* denote the significance levels of alpha at .01, .05, and .10 respectively.

Table 4 shows the ADF and PP test conclusions of the series with their first difference calculated. It was concluded that the integration degree of all the series was "1", and it was observed that the first condition for the *HC* test was achieved at this phase.

Table 5: Hidden Cointegration

Engle-Granger (1978) Cointegration Approach				
Method	Engle-Granger			
Variables	$\tau$ Stat.	$\tau$ Prob.	$z$ Stat.	$z$ Prob.
Tax	-2.009270	0.2373	-4.068134	0.5317
GDP	-2.125379	0.1975	-4.224890	0.5157
Granger-Yoon (2002) Hidden Cointegration Approach				
Method	Engle-Granger			
Variables	$\tau$ Stat.	$\tau$ Prob.	$z$ Stat.	$z$ Prob.
Tax <sup>+</sup>	-0.270497	0.8988	-0.515114	0.8998
GDP <sup>+</sup>	-0.000631	0.9339	-0.001216	0.9339
Tax <sup>-</sup>	-1.788559	0.3258	-6.050994	0.3505
GDP <sup>-</sup>	-1.879333	0.2876	-6.488562	0.3175
Tax <sup>+</sup>	-0.868803	0.7521	-2.392472	0.7138
GDP <sup>-</sup>	-1.208930	0.6053	-3.316671	0.6109
Tax <sup>-</sup>	<b>-2.691608</b>	<b>0.0700***</b>	<b>-12.55261</b>	<b>0.0660***</b>
GDP <sup>+</sup>	<b>-2.704101</b>	<b>0.0682***</b>	<b>-12.45158</b>	<b>0.0680***</b>

Note: \*, \*\*, \*\*\* denote the significance levels of alpha at .01, .05, and .10 respectively.

Table 5 represents the results of both the cointegration (original variables) developed by Engle-Granger (1987) and the cointegration (positive and negative) ingredients of variables developed by Granger and Yoon (2002). The results demonstrated that the original variables did not form a cointegration relationship. In this phase, it was suspected that there was an *HC* relationship. Thus, four alternatives were found for the *HC* analysis. However, it was concluded that only

the tax variable decreased while there was a cointegration relationship in periods when GDP increased. Therefore, the long-run relationship structure between tax - GDP<sup>+</sup> variables should be estimated within the framework of HC and CECMs.

**Table 6: Hidden Cointegration Regression**

Dependent Variable: Tax-	Coefficient	Std. Err.	t Stat.	Prob.
Cons.	0.011610	0.017844	0.650629	0.5202
GDP <sup>+</sup>	-0.557359	0.109032	-5.111882	0.0000*
Trend	0.016261	0.007961	2.042681	0.0500*
Adj. R <sup>2</sup>	0.96			
F Stat. / Prob.	362.64 / 0.00000*			

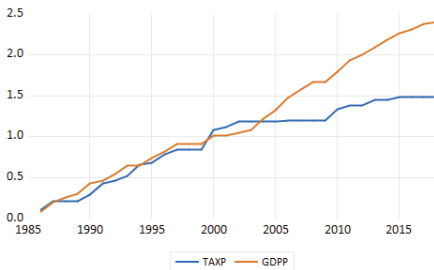
Note: \*, \*\*, \*\*\* denote the significance levels of alpha at .01, .05, and .10 respectively.

Table 6 shows the estimation of the HC model. A positive shock (a positive development) of 1% in GDP, in the long run, reduces negativities (decreases) in tax revenues by approximately 0.55%. The following HC regression is estimated with OLS:

$$Tax_t^- = 0.012 - 0.557 x GDP_t^+ + 0.016 x Trend \tag{11}$$

After this phase, the suggested CECMs will be estimated by Granger and Yoon (2002) for variables between which there is an HC relationship.

**Figure 1. Tax<sup>+</sup> - GDP<sup>+</sup>**



**Figure 2. Tax<sup>+</sup> - GDP<sup>-</sup>**

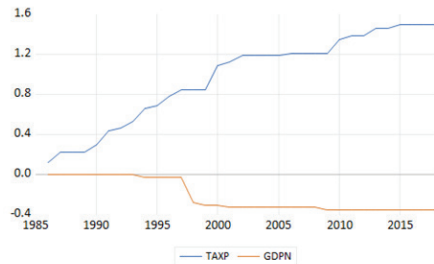


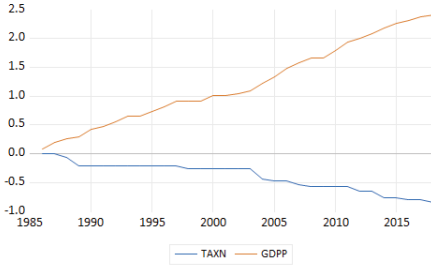
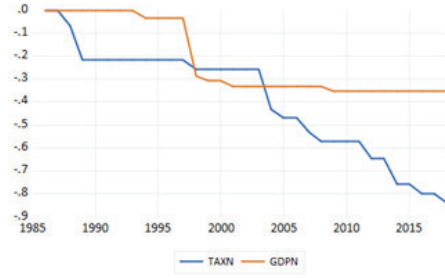
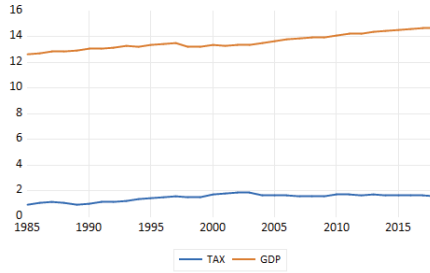
Figure 3. Tax<sup>-</sup> - GDP<sup>+</sup>Figure 4. Tax<sup>-</sup> - GDP<sup>-</sup>

Figure 5. Tax - GDP



Figures 1, 2, 4, and 5 demonstrate the cases in which evidence could not be found on the cointegration relationship even if the relationship was analyzed in the scope of the present study whereas Figure 3 demonstrates the case in which a cointegration relationship was found. Figure 5 should especially be noted: This figure shows the original data of variables (with both increases and decreases), and both increases and decreases occur in these series. It also indicates only one of the cases in which a cointegration relationship could not be found. After eliminating insignificant terms the CECMs are estimated.

**Table 7: Crouching Error Correction Models**

<b>Model 1</b>				
<b>Dependent Variable: Tax<sup>-</sup></b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t Stat.</b>	<b>Prob.</b>
$\Delta GDP^+_{t-8}$	-0.362431	0.095643	-3.789436	0.0009*
<b>Model 2</b>				
<b>Dependent Variable: GDP<sup>+</sup></b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t Stat.</b>	<b>Prob.</b>
<b>Cons.</b>	0.090955	0.029581	3.074783	0.0077*
$ECT_{t-1}$	-0.822944	0.332344	-2.476182	0.0257**
$\Delta Tax_{t-7}$	-0.461488	0.211884	-2.178026	0.0458**

Note: \*, \*\*, \*\*\* denote the significance levels of alpha at .01, .05, and .10 respectively.

Table 7 demonstrates the CECM proposed by Granger and Yoon (2002). It is observed that the ECT of the first model is not statistically significant; but, the ECT of the second model is statistically significant. These findings indicate that the Tax<sup>-</sup> is the permanent component whereas the GDP<sup>+</sup> is the temporary component. In the long run, the Tax<sup>-</sup> variable is the asymmetrical cause for the GDP<sup>+</sup> variable. It was therefore concluded that, between taxes and GDP, there was a one-way and long-run asymmetric causality.

#### 4. Conclusion

In the study conducted by Çiğdem et al. (2020) in which the tax-GDP relationship was studied, a cointegration relationship was found between variables, and it was noted that an increase in GDP would cause a decrease in indirect taxes. It was concluded in the present study which is a continuation of the previous one that one variable increased as the other one increased and that there was not an asymmetric and synchronous relationship when one variable decreased as well as demonstrating that only tax revenues decreased while there was a cointegration relationship in periods when GDP increased. The hidden cointegration relationship describes a much different cointegration structure, and it is based on the logic suggesting that variables do not always react in the same way to shocks. The results obtained are in parallel with studies by Musanga (2007), Greenidge and Drakes (2009), Karras and Furceri (2009), Romer and Romer (2010), and Dackehag and Hansson (2012) using the traditional approach

in terms of the direction of this relationship. The present study is an additive to the literature since it is the first study to have applied *the hidden cointegration technique* on variables analyzed. Moreover, the results obtained are crucial for policy-makers.

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