Article

Analysis of the relationship between environmental taxes and environment protection expenditures in Turkey and European Union

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Received 23 April 2021; Accepted 31 May 2021; Published 1 September 2021

Abstract
In Turkey and European Union, the expenses spared for the prevention of pollution and environmental degradation, the recovery of the environment, and pollution elimination are called environmental expenditures. Environmental tax application is maintained according to the Polluter Pays Principle and within the framework of public collection provisions regarding the collection of these expenses from the polluter. In this study, a long-term relationship between the variables were examined using data from total environmental protection taxes in Turkey and from the Eurostat database of 30 countries from the European countries and total environmental protection expenditures (million/euro) covering the span between 2008-2018. In this study, Panel VAR and Panel VAR Granger Causality Analysis were conducted by investigating the 1st and 2nd generation panel cointegration tests. Results showed that there is a long-term positive correlation between environmental taxes and environmental protection expenditures which is statistically significant.

Keywords environmental taxes; environment protection expenditures; Panel VAR Analysis; environmental law; environmental management.

Proceedings of the International Academy of Ecology and Environmental Sciences
ISSN 2220-8860
URL: http://www.iaees.org/publications/journals/piaees/online-version.asp
RSS: http://www.iaees.org/publications/journals/piaees/rss.xml
E-mail: piaees@iaees.org
Editor-in-Chief: WenJun Zhang
Publisher: International Academy of Ecology and Environmental Sciences

1 Introduction

As stated in the clause g of the 3rd article of the Environment Law No. 2872, expenses for the prevention, limitation, elimination of pollution and degradation and improvement of the environment are borne by the polluter or degraded. In the event that the polluter fails to take the necessary measures to stop, eliminate or reduce the pollution or deterioration, or if these measures are taken directly by the competent authorities, necessary expenses incurred by public institutions and organizations are collected from the polluter in accordance with the provisions of Law No. 6183 on the Procedure for Collection of Public Claims (Anonymous, 2020). An environmental tax is charged in the collection of environmental expenditures made for the prevention of pollution by the public.

In EU countries, the significance coefficient of the F test revealed a significant correlation between environmental protection expenditure and gross domestic product, but not very strong (Todea et al., 2018). In the study on the impact of environmental protection participation behaviors on environmental protection expenditures, the effect of environmental protection on the environment was tried to be determined by regression analysis; and the age and education levels of the residents were found to have a significant effect on environmental protection efficiency and environmental participation behavior (Jia, 2019). It has been concluded that as the living standards increase in China there tends to be a concern about air pollution problems; that there are serious problems with environmental tax laws through the analysis of the trends of city, time and space; that there are obstacles in the implementation of environmental tax such as economic development, regional differences, and tax inequality (Xue and Xu, 2018). In a study on world bank group and environmental support, it has been determined that many financial institutions, including the world bank, are working on environmental improvements to global environmental problems and regional settlements, but further analysis is required to explore their environmental impact (Veljanoska, 2016). Another study concluded that new international regulations embracing individuals are needed as a result of the actions against the environment; and that the special tax implementation of a guarantee fund managed by an international institution under the auspices of the United Nations can prevent environmental damage, but policies that emphasize economic efficiency cause difficulties in maintaining balance in the environment and health areas (Tudor et al., 2016). In the study on environmental protection expenditures on environmental pollution, panel data analysis has been applied and it has been concluded that there is a cointegration relationship between environmental pollution and environmental protection expenditures in the long term, and that there is a causality in environmental protection expenditures for environmental pollution (Degirmenci et al., 2019). Various accounting data ought to be used in determining the physical and financial dimensions in order for enterprises to fulfill their environmental responsibilities in decision-making processes against environmental pollution (Haftaci et al., 2007). Furthermore, it has been put forward that the environmental protection expenditures in the European Union are mostly made by both public and private sector cooperatively, whereas environmental protection operations and the public expenditures in Turkey are generally carried out by local administrations; however, it reveals that the expenditures when cannot be adapted to the environmental policies as a whole, become feeble in terms of efficiency in improving the environment (Yalçin et al., 2015). The share of total environmental protection expenditures in GDP between 2008-2015 in Turkey is higher compared to EU and OECD countries for the public sector, yet it is lower for the private sector. It has also been underlined that in Turkey the environmental protection services are insufficient in rural areas and environmental protection expenditures need to be increased (Çiçekalan et al., 2019).

Based on previous studies, the present study aims to analyze the relationship between environmental taxes and environment protection expenditures in Turkey and European Union.

2 Study Area and Methodology

2.1 Study site

The data set in the model applied determines the material of the study. Utilizing the data from Eurostat database (Anonymous, 2020), the existence and interpretation of a long-term relationship in determining the relationship between environmental protection expenditure by environmental taxes in Turkey and selected European countries are taken as a basis in the method. Besides, literature, articles, journals, books, research, and applications related to the subject of study were used.

2.2 Econometric model and methodology

This study aims to explain the relationship between taxes collected for environmental protection and environmental expenditures by analyzing Turkey and selected European countries in this context. Within this framework, it investigates the existence of a long-term relationship between variables, using data from 30 countries for the period 2008-2018, with the 1st and 2nd generation panel cointegration tests, and conducts panel VAR analysis.

2.3 Data analysis

Considering the given variables (Table 1, Table 2), an econometric model is created as the following:

$$lepe_{it} = \beta_0 + \beta_1 ltet_{it} + \varepsilon_{it} \quad (1)$$

Here, *i* indicates the cross section and *t* the time. β_0 and ε_{it} show the constant term and error term, respectively. So as to narrow the data range of the variables in the model and to interpret the coefficients directly as elasticity, a log-log model was used by calculating the logarithms of the variables.

Descriptive statistics of the variables included in the study are given in Table 2.

Table 1 Definition of variables.

Variables	Definition	Source
lepe	Environmental Protection Expenses(million euro)	Eurostat
ltet	Total Environmental Protection Tax(millioneuro)	Eurostat

Table 2 Descriptive statistics.

Variable	Average	Standard Deviation	Minimum	Maximum
lepe	7.104726	1.570392	3.555348	10.08793
ltet	8.390413	1.445993	5.250282	10.99771

3 Results and Discussion

In this study where panel data analysis is carried out, stability states of variables are primarily analyzed using the 1st and 2nd generation panel unit root tests; then, Panel VAR and Panel VAR Granger Causality Analysis are conducted.

Upon the examination of the results in Table 3, it is clear that the lepe and ltet variables are not stable at the level according to the Hadri (2000) and Breitung (2000) panel unit root test results, whereas according to the IPS panel unit root test, these two variables are stable.

However, due to the fact that the Breitung (2000) panel unit root test is stronger than the IPS panel unit root test and the variables are not stable at the level according to the Hadri (2000) panel unit root test, it has been decided that both variables are not stable at the level and then their differences are calculated. Accordingly, it is seen that the variables, whose differences are calculated, become stable.

One of the important problems that may arise in studies using panel data is the interdependence between units/sections. This problem is called cross section dependency in the literature. Not only does cross-section dependency decrease the efficiency of the obtained test statistics but it also causes erroneous evaluation of the results. In addition, since the first-generation panel unit root tests do not take into account the cross-sectional dependence between units, the effectiveness of the studies conducted according to the results obtained from these panel unit root tests decreases; if cross-sectional dependency is detected, second generation panel unit root tests are preferred. In this context, the CD test developed by Pesaran (2007), was performed to investigate cross sectional dependency between the units in the study.

Table 3 First generation panel unit root test results.

Variables		**Hadri Test**		**IPS Test**		**Breitung Test**	
		Test Statistics	Probability	Test Statistics	Probability	Test Statistics	Probability
Panel A: Levels							
lepe	Constant	13.1779	0.0000*	-2.9200	0.0018*	0.4702	0.6809
	Constant and Trend	3.6530	0.0001*	-3.5556	0.0002*	-0.5142	0.3036
ltet	Constant	24.7438	0.0000*	5.5532	1.0000	4.4672	1.0000
	Constant and Trend	10.8469	0.0000*	-2.6417	0.0041*	0.7703	0.7794
Panel B: First Differences							
dlepe	Constant	-2.3479	0.9906	-6.2356	0.0000*	-5.5111	0.0000*
	Constant and Trend	-0.4171	0.6617	-6.1394	0.0000*	-3.8187	0.0000*
dltet	Constant	0.2534	0.4000	-6.5801	0.0000*	-4.0838	0.0000*
	Constant and Trend	-0.6093	0.7288	-7.1365	0.0000*	-4.4672	0.0000*

Note: Hadri (2000) panel unit root test: "H_0: The whole panel is stationary." Breitung (2000) panel unit root test: "H_0: There is unit root in panels." Im et al. (2003) panel unit root test: "H_0: All panels contain unit root".

Table 4 CD Test Results.

Variables	**CD Test Statistics**	**Probability Value**
lepe	5.30	0.000
ltet	41.27	0.000

Upon the examination of the results in Table 4, according to the Pesaran (2007) CD cross section dependence test results for both variables, the null of no cross-sectional dependence is rejected even at 1% level of significance. Accordingly, it is necessary to prefer the second-generation panel unit root tests as the cross-section dependency is detected in all series. In this context, in the following part of the study, the stationarity of the panel data is examined with the Pesaran (2007), panel unit root test.

Table 5 Second generation CADF panel unit root test results.

CADF Panel Unit Root Test			
Variables		**Test Statistics (t-bar)**	**Probability Value**
Panel A: Levels			
lepe	Constant	-1.747	0.447
	Constant & Trend	-2.287	0.448
ltet	Constant	-1.694	0.552
	Constant & Trend	-2.146	0.711
Panel B: First Differences			
dlepe	Constant	-4.923	0.000*
	Constant & Trend	-1.968	0.025**
dltet	Constant	-2.169	0.025**
	Constant & Trend	-2.871	0.014**

Note: * and ** signs indicate stagnation at 1% and 5% significance level, respectively. Delay length is determined as 1 according to Akaike Information Criterion (AIC).

Upon the examination of the results in Table 5, it can be observed that neither of the variables are stationary in level; on the other hand, it is seen that the variables become stationary after their differences are calculated. In addition, the results of the second-generation panel unit root test - Pesaran (2007) CADF, which is preferred due to the cross-sectional dependency between units, supports the Hadri and Breitung test results, which are the first-generation panel unit root tests.

As a result of the panel unit root tests, two variables that are determined to be stationary to the same degree can act together in the long term, in other words, they can be cointegrated. In order to investigate the cointegration relationship between the variables, Pedroni (2004) and Westerlund (2007) cointegration tests have been utilized.

Table 6 Cointegration test results.

Panel A: Pedroni (2004) Cointegration Test			
	Statistics		Probability
Panel v-Statistics	1.978		0.023
Panel rho- Statistics	-1.961		0.024
Panel PP- Statistics	-6.374		0.000
Panel ADF- Statistics	-5.259		0.000
Group rho- Statistics	0.491		0.688
Group PP- Statistics	-11.540		0.000
Group ADF- Statistics	-9.577		0.000
Panel B: Westerlund (2007) Cointegration Test			
Statistics	Value	Z-Value	Probability
Gt	-4.122	-14.347	0.000
Ga	-12.673	-5.531	0.000
Pt	-16.243	-8.061	0.000
Pa	-8.791	-5.294	0.000

Upon the examination of the results in Table 6, it can be concluded that there is a long-term correlation between total environmental taxes and environmental protection expenditures. It is apparent that there is a cointegrated relationship in all 4 panel tests of the Pedroni cointegration test (1% significance level in two and 5% significance level in two) and there is a cointegrated relationship in 2 of the 3 group statistics, as well. It is seen that the cointegration test results of Westerlund (2007), which are in the same table, support the results obtained from the Pedroni cointegration test. However, neither of cointegration tests takes into account the problem of cross-sectional dependency between units. For this reason, the bootstrap distribution and critical values and probability values are recalculated for the Westerlund (2007). Test and the results are given in Table 7.

Table 7 Westerlund (2007) panel cointegration test results.

Statistics	**Value**	**Z-Value**	**Robust P-Value**
Gt	-4.122	-14.347	0.180
Ga	-12.673	-5.531	0.070
Pt	-16.243	-8.061	0.200
Pa	-8.791	-5.294	0.230

When the bootstrap distribution and probability values and critical values for the Westerlund (2007), test given in Table 7 are analyzed again, it becomes clear that the basic hypothesis that states that there is no cointegration relationship between the variables (at the 5% significance level) cannot be rejected, so there is no long-term relationship between the total environmental protection taxes (ltet) and environmental protection expenditures (lepe). The 4 different panel cointegration methodology results have failed to reject the underlying hypothesis for robust critical values. In other words, it is seen that countries react to shocks together and there is a mutual dependency.

One of the 2nd generation panel cointegration tests taking into account the cross-sectional dependency problem between units is the cointegration test by Gengenbach et al. (2016) which is derived based on error correction using the common factor structure. Accordingly, Gengenbach et al. (2016) panel cointegration test results are given in Table 8.

Table 8 Gengenbach (2016), Urbain and Westerlund(2007) panel cointegration test results.

d.y	Coefficient	T-bar	P-Value
y(t-1)	-0.838	-1.741	> 0.1

When the significance of Y_{t-1} for the panel cointegration test is examined according to the results in Table 8, (P-value>0.1) the basic hypothesis cannot be rejected, that is, there is no long-term relationship between the variables of total environmental taxes (ltet) and environmental protection expenditure (lepe).

When the first and second generation cointegration results, the former of which does not take into account the problem of cross-sectional dependency between units unlike the latter, are evaluated collectively, in the results of the Pedroni (2004) and Westerlund (2007) cointegration test (not cross-sectional), it has been concluded that there is a long-term relationship between the variables; whereas according to the results of the Westerlund (2007) panel cointegration test, which uses robust critical values at the end of the bootstrap process in the presence of cross-sectional dependency between units, and the panel cointegration test results of the 2nd generation Gengenbach et al. (2016) derived on the basis of error correction using the common factor structure, it has been reached as a result that there is no long-term relationship between the variables.

Panel vector autoregression analysis is one of the increasingly used methods for practically determining the relationships between variables. Panel VAR analysis is the traditional VAR analysis adapted to the panel data set. As with traditional VAR analysis, the appropriate lag length must be determined before applying panel VAR analysis.

In the next part of the study, Panel VAR analysis will be used to determine the relationships between variables. In this context, in order to apply the Panel VAR Analysis, firstly the appropriate delay length will be determined and then the impulse-response functions and VAR Granger causality analysis will be conducted.

Table 9 Determination of P-VAR optimal lag length.

Delay Length	J Test Statistics	J Probability Value	MBIC	MAIC	MQIC
1*	10.349	0.585	-30.464*	-13.650*	-19.029*
2	5.731	0.677	-21.477	-10.268	-13.854
3	0.897	0.924	-12.706	-7.102	-8.895

Upon the examination of the results in Table 9, it is seen that all information criteria (MBIC, MAIC and MQIC) have minimum values in the 1st delay. Accordingly, it has been determined that the optimal lag length of the model is 1. As a result of the analysis, whether the PVAR model with the 1st delay is stable or not has been shown in the figure below.

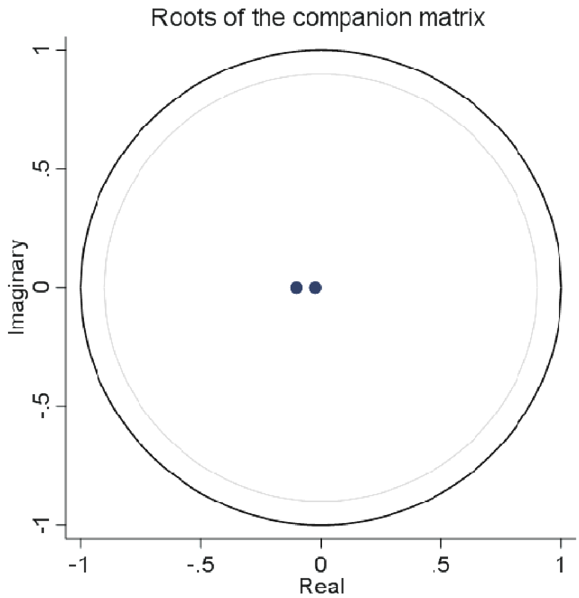

Fig. 1 AR characteristic roots in the unit circle.

In Fig. 1, all of the characteristic roots of the model are in the unit circle. This means that the model is stable and fulfills the stationary conditions.

After testing the stationarity of the variables and determining the appropriate lag length for the model, PVAR model follows. Since the panel VAR model is not different from the traditional VAR model (except for its use of a panel data set), the coefficients of the model cannot be interpreted. Therefore, in the PVAR model, as in the traditional VAR model, the relationships between variables are examined with the help of impulse-response functions.

Table 10 PVAR Granger (1969) Causality Wald Test results.

Equation	Excluded	chi^2	df	Prob
dlepe	dltet	0.160	1	0.689
dlet	dlepe	1.517	1	0.218

Note: H_0: Excluded variable does not Granger (1969)-cause equation variable.

Upon the examination of the results in Table 10, it can be concluded that the two variables are not Granger (1969) reasons for each other.

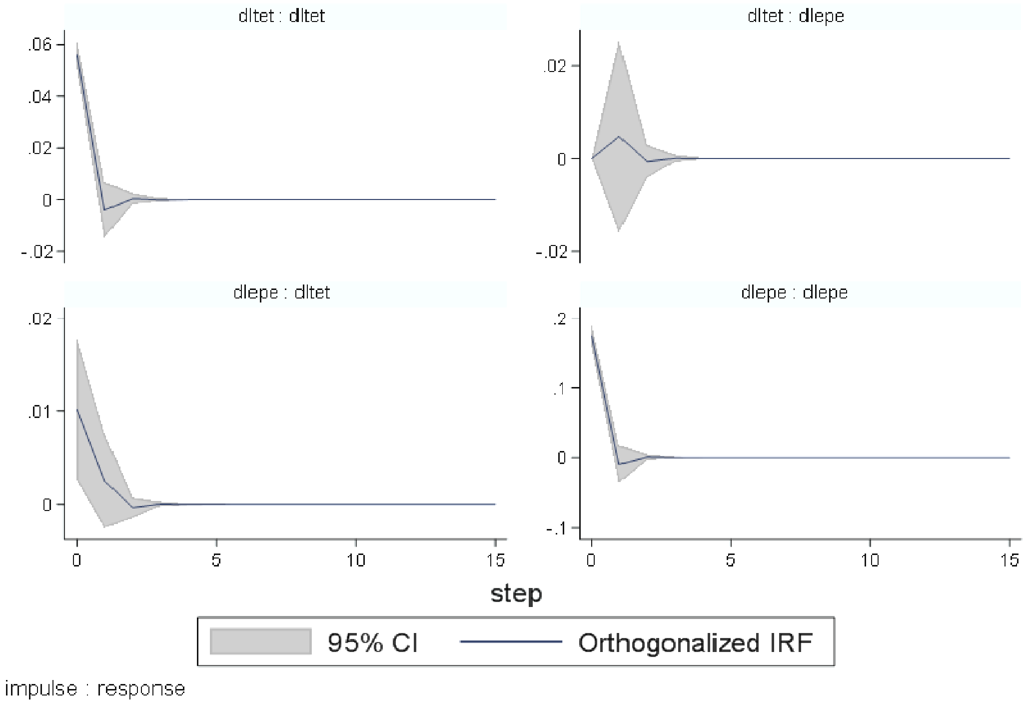

Fig. 2 Impact-Response functions.

According to the results of the impact-response analysis, despite the decline in the variable itself, it is seen that the total environmental protection tax variable reacts positively and statistically significantly for one year in the face of a standard deviation shock given to the error term, and this response decreases and disappears over time. Similarly, it is seen that the environmental protection expenditures variable reacts positively and statistically for a year in the face of a standard deviation shock given to the error term, just like the total tax expenditures variable, even if the variable itself decreases, and this response decreases and disappears over time.

4 Conclusions

In response to a standard deviation shock given to the error term of the environmental protection expenditure variable, it has been observed that the total environmental protection tax variable responds positively and statistically significantly for about two years (initially increasing and then decreasing) and this response diminishes and fades over time. In response to a standard deviation shock given to the error term of the total environmental protection tax variable, it is observed that the environmental protection expenditures variable reacts positively and statistically, albeit decreasing for about two years, and this response decreases and disappears over time.

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