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SCIENTIFIC PAPER

Panel Cointegration Analysis of Total Environmental Taxes and Economic Growth in EU Countries

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ABSTRACT

The paper investigates the nexus between total environmental taxes and economic growth for twenty-eight EU countries from 1994 to 2018. The objective of this research is to evaluate the long-run relationship between these variables based on panel data analysis. The analysis includes panel cointegration test as well as panel ordinary least squares such as DOLS and FMOLS models. The results identify long-run relationship between total environmental taxes and economic growth in selected countries. Likewise, there is a significant relation running from total environmental taxes to economic growth measured by gross domestic product rate. Empirical findings confirm that revenue of environmental taxes have positive impact on economic growth measured by gross domestic product rate.

Key words: *Environment taxation, economic growth, panel cointegration, EU countries*

JEL Classification: E60, H23, Q5

INTRODUCTION – THEORETICAL BACKGROUND

Economic growth has become the basic aim of developing countries without adequate consideration of environmental issues (Mitić et al. 2019). However, as environmental issues become more relevant, governments have realized the significance of balanced economic and environmental development (Gao et al. 2019). Pautrel (2009) argue that effect of the environmental policy can have positive implications to the economy when impacts of pollution on health are reduced. Zhou et al. (2020) detected that an increase in environmental tax rate can reduce the use of polluting consumer goods by households as well as investment in polluting factors by companies. Likewise, their growth can negatively impact employment, income and economic growth and include both effects: substitution effect and income effect on household consumption. Likewise, Wesseh et al. (2017) highlight that tax policy is often more efficient or less distorted than direct regulation. Accordingly, taxes are effective tools to modify consumers' behaviour in terms of sustainability (Kosonen and Nicodème, 2009). For most environmental problems, adequately determined fiscal policy is the most natural tools for including environmental detriment into the products price and non-market actions (Heine et al. 2012). Stram (2014) determined that tax revenues enables stability and support for research focused on energy sources and emissions reduction in the long-run. According that, many economists and international institutions determine environmental taxes as the most efficient market-based

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tools (Lin and Li, 2011). Mirović et al. (2019) highlight that tax forms should take an important place in the economic policy of each country.

The findings of Castiglione et al. (2014) suggest that countries should take advantage of the relationship between economic growth and institutional enforcement ie, the nexus between economic development and environmental awareness in order to provide an adequate environmental tax policy. Environmental taxes enhance the costs and price products for the environment and decrease the pressure on it. (Piciu and Trică, 2012) where Davidović et al. (2019) determined environmental taxes as crucial for more effective environmental protection. Andrei et al. (2016) emphasized that environmental taxes have significant impact on economic sustainability in post-transition countries. Environmental taxes are increasingly considered as essential part of the economic policy where their proper design can enable economic incentives, dynamic innovation. It implies that these taxes help achieving economic, social and environmental benefits (Withana et al. 2014). Accordingly, environmental taxes have a more relevant role in Europe and especially in the Scandinavian economies compared to the rest of the world at the beginning of the 2000 (Radulescu et al. 2017). Also, Bachus et al. (2019) determined that taxes are robust tool for reducing complex environmental problems in the world. Labeaga and Labandeira (2020) defined environmental taxes such as cost-effective corrective approach which contributes development and uses clean technologies. Liobikiene et al. (2019) argue that environmental taxes are imposed with the aim to decrease negative effects to environment. On the other hand, Borozan (2018) argue that energy taxes are not efficient policy tool for directly effecting electricity consumption due to various subventions and exemptions through European Union. Vukadinović and Ješić (2019) cite that ecological modernization that includes carbon tax, a decline of labour costs and subsidies for research and development. Tantau et al. (2018) determined significant impact of environmental tax revenues in European Union to recycling rate of municipal waste for the period 2010-2014. Further, Aubert et al. (2019) point out regressive effect of indirect taxes where environmental taxation decreases consumers' purchasing power and has regressive implications to poor consumers compared to rich.

The nexus between the environment and economic growth is one of the most essential relation for policy makers (Mitić et al. 2017). The standard way to evaluate economic success is by measuring economic growth (Petrov and Trivić, 2018). Analyzing causality between environmental taxes and economic growth, in OECD countries from 1995 to 2006, Morley and Abdullah (2010) identified long-run causality between economic growth and environmental taxation. Likewise, this analysis manifested short-run causality between these variables in the reverse direction. Liang et al. (2007) and highlight that effect of carbon tax may depend on the economic conditions of an economy. Hájek et al. (2019) indicate that it's more environmentally efficient if taxes have been collected for a longer time. Dökmen (2012) researched the relationship between environmental taxes and economic growth in twenty-nine EU countries for the period 1996-2010. The results of panel vector autoregressive models identified positive and statistically significant effect of environmental taxes on economic growth in these countries for the observed period. Abdullah and Morley (2014) investigated causality between environmental taxes and economic growth in EU countries and OECD countries for the period 1995-2006. Empirical results showed long-run causality running from economic growth to increased environmental tax revenues, as well as, short-run causality in the reverse direction. Loganathan et al. (2014) analysed the relationship between carbon taxation and economic growth in Malaysia from 1974 to 2010. Their findings suggest that there is bidirectional causality between these components for the analysed period. Li and Masui (2018) found that the environmental tax and carbon tax would lead to a GDP loss of 0.1% to 0.67% and highlighted that energy-intensive sectors will have bigger damage compared to service sector and agriculture that will have a small growth. He et al. (2019) confirmed that environmental taxes are cointegrated with energy consumption, economic growth, and CO2 emissions in China, Finland and Malaysia.

Similarly, Busu and Trica (2019) revealed significant and positive effect of environmental taxes on economic growth in EU countries for the observed period 2010-2017.

The need for research is manifested in providing information support and giving guidance to economic policymakers in EU about the long-run relationship between total environmental taxation and economic growth in these countries. It implies that fundamental goal of this research is to reveal are environmental taxes significant for economic growth in EU countries. The structure of this paper is as follows. After the introduction and definition of necessity of environmental tax approach, there is an analysis of environmental taxes and gross domestic product in EU countries from 1994-2018. The greatest part of this research includes empirical analysis and results which consist panel cointegration tests and different panel models such as POLS, DOLS and FMOLS. The last segment includes summarizes and conclusion about cointegration between total environmental taxes and economic growth in EU countries from 1994 to 2018.

THE NECESSITY OF ENVIRONMENTAL TAX APPROACH AND DOUBLE DIVIDEND HYPOTHESIS

Over the last three decades, ecological modernisation has emerged as a strong political discourse in which economic growth, environmental protection as well as energy security are jointly intensifying (Machin, 2019). The government should implement stricter and more comprehensive system of environmental policy in order to provide future sustainable development. It implies reasonable tax system and design of ecological policy system based on neutrality (Yang et al. 2019). According to European Environmental Agency green taxes are classified into three categories: cost-covering charges, incentive taxes and fiscal environmental tax forms (European Environmental Agency, 1996). The main purpose of cost-covering charges is covering the costs of regulation and control and implies that users pay for consumption of environmental resources. Further, incentive taxes are created in line with Pigouvian tax where core idea is to change the behaviour of the polluter in the long-term. Fiscal environmental taxes are main driving force of green tax reforms where highlight the tax for use of resources without significant change to the budgetary balance (Maxim and Zander, 2019). Environmental taxation has been increasingly seen as an effective economic tool to make incentives in terms of cleaner production and consumption habits (Freire-González, 2018). Own resources based on taxes for the European Union can be a powerful tool to the current lack of sustainability because they have the potential to cover existing sustainability gaps in tax systems in the EU (Krenek and Schratzenstaller, 2017). There is a growing consensus that environmental taxes are not only a promising instrument to reducing environmental effects, but also a way to increase public revenues and decrease fiscal pressure (Freire-González and Ho, 2019). Alexeev et al. (2016) argue that an emissions taxes are used as an environmental policy instrument to decline environmental damages. Bachus et al. (2019) highlight an importance of recycling the revenues from an environmental tax reform and defined a “Ladder of Acceptability of Revenue Recycling Options” based on: a) financing special environmental programmes; b) reducing taxes on labour, consumption, corporate income, property or other distortionary taxes; c) returning the additional tax forms from one sector to that same sector in a way that is not proportional to the emissions, pollution or resource use; d) eliminating regressive effects of the environmental taxes; e) reducing public debt or adding to the general budget.

Kirchner et al. (2019) provided that carefully designed tax policy about CO2 can potentially enable an equitable double dividend, where the double dividend hypothesis implies the possibility of realizing economic and environmental benefits as a result of implementing an environmental tax policy and recycling revenues (Wesseh et al. 2019). This theoretical approach is a widely examined topic that considers the possibility of producing additional economic benefits using environmentally beneficial tax measures (Maxim and Zander, 2019). The early version of the double dividend hypothesis can also be determined as the efficiency double

dividend in which the essence was that green tax reform can decrease pollution and increase economic efficiency (Maxim et al. 2019). Double dividend hypothesis arises from progress of the environmental conditions as a result of environmental tax incentives as well as improvement of economic conditions due of the shift from high distorting taxes to less distorting taxes (Freire-González, 2018). Sasmaz (2016) examined the effect of environmental tax reforms on environment and employment in fifteen countries in EU (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, United Kingdom) for the period 1995-2012. Using panel cointegration and fully modified ordinary least square tests, this analysis showed the validity of double dividend hypothesis in these countries.

METHODS AND MATERIALS

In this research twenty-eight EU countries are analysed for the period 1994-2018. The research used Eurostat for environmental taxation and IMF for gross domestic product. In order to stationary, panel unit root tests are applied for selected variables. After we determined that variable are stationary at first difference and integrated of order one process or I(1), we have applied cointegration analysis. After identifying long-run relation between variables, an analysis has included different panel models such as POLS, DOLS and FMOLS. Before presenting panel cointegration estimation it is necessary to develop research hypothesis which is defined as follows:

H_1: Environmental taxes have significant and positive impact on economic growth in EU countries.

Panel cointegration test is often used to identify a potential long-run relation between two or more variables. The long-run relationship implies the variables move together over time. The panel cointegration test allows for cross-sectional interdependence with both different individual effects and deterministic trends can be determined as follows:

$$lnYit = \alpha_{it} + \delta_i t + \beta_i lnE_{it}\, \varepsilon_{it} \quad (1)$$

$$\varepsilon_{it} = \rho_{it}\varepsilon_{it-1} + u_{it} \quad (2)$$

where i = 1,…N reflects the panel member, t = 1,…T refers to the time period, Y reflects the GDP, TET reflects the total environmental taxes and βi reflects the slope coefficient. The parameters α_{it} and δi allow for possibility of country-specific effects and deterministic trend effects, where ε_{it} manifests the evaluated residual deviations from the long-run relation (Adhikari, Chen, 2012).

EMPIRICAL ANALYSIS AND RESULTS

This segment includes analysis trend of gross domestic product rate and total environmental taxes from aspect of their share and collected revenue from 1994 to 2018. After that, empirical study implies panel cointegration tests and three models such as POLS, DOLS and FMOLS.

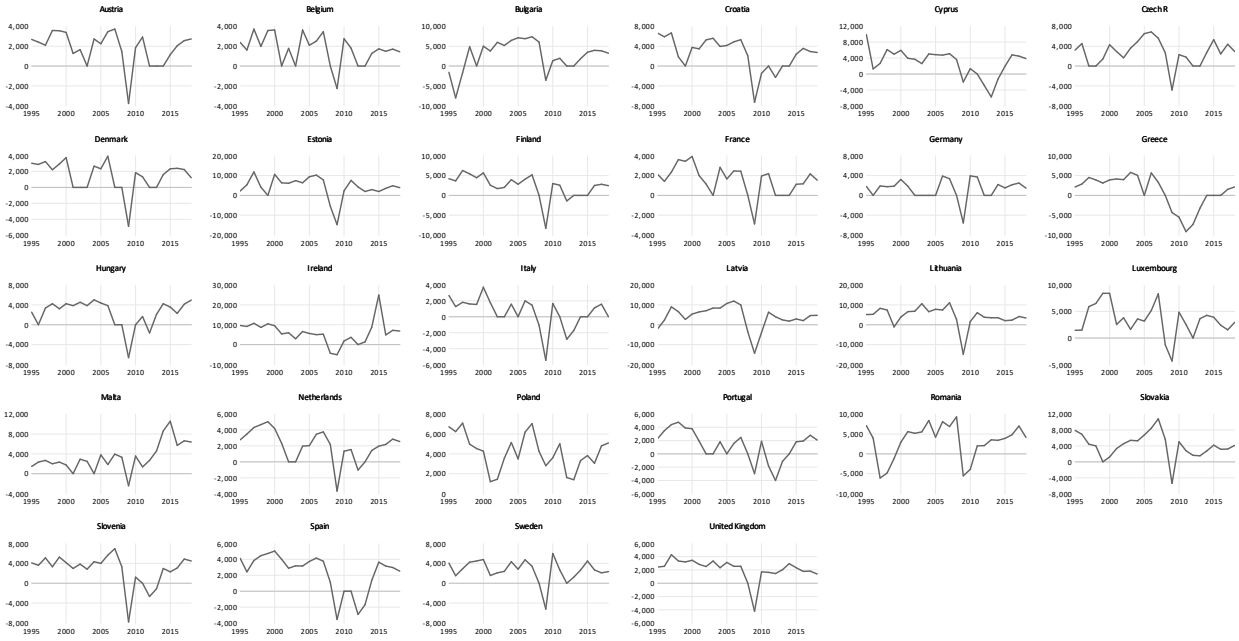

Figure 1. GDP rate in EU countries

Source: Authors calculation based on IMF

Although gross domestic product is being criticized for not adequately representing social welfare in terms of development, the GDP is a dominant and widely used indicator for measuring economic activity (Sanyé-Mengual et al. 2019). The gross domestic product in the European Union was around 13.94 trillion euros which reflects the total value of all goods and services produced in EU countries. Figure 1 shows trend of GDP rate in EU countries for the period 1994-2018. The average GDP rate was 2.68%, where Ireland had the highest average GDP rate of 6.05% during observed period. On the other hand, Italy had the smallest average GDP rate of 0.69%. Analyzing by countries, Estonia, Lithuania and Slovakia had average GDP rate above 4%, while other countries had smaller growth rate of gross domestic product. The level of average GDP rate of 2% was recorded in Latvia, Luxembourg, Malta and Romania, while most of countries had mean GDP rate around 2%. Twelve of twenty-eight economies had mean GDP rate below EU average, while Greece and Italy recorded average GDP rate below 1%.

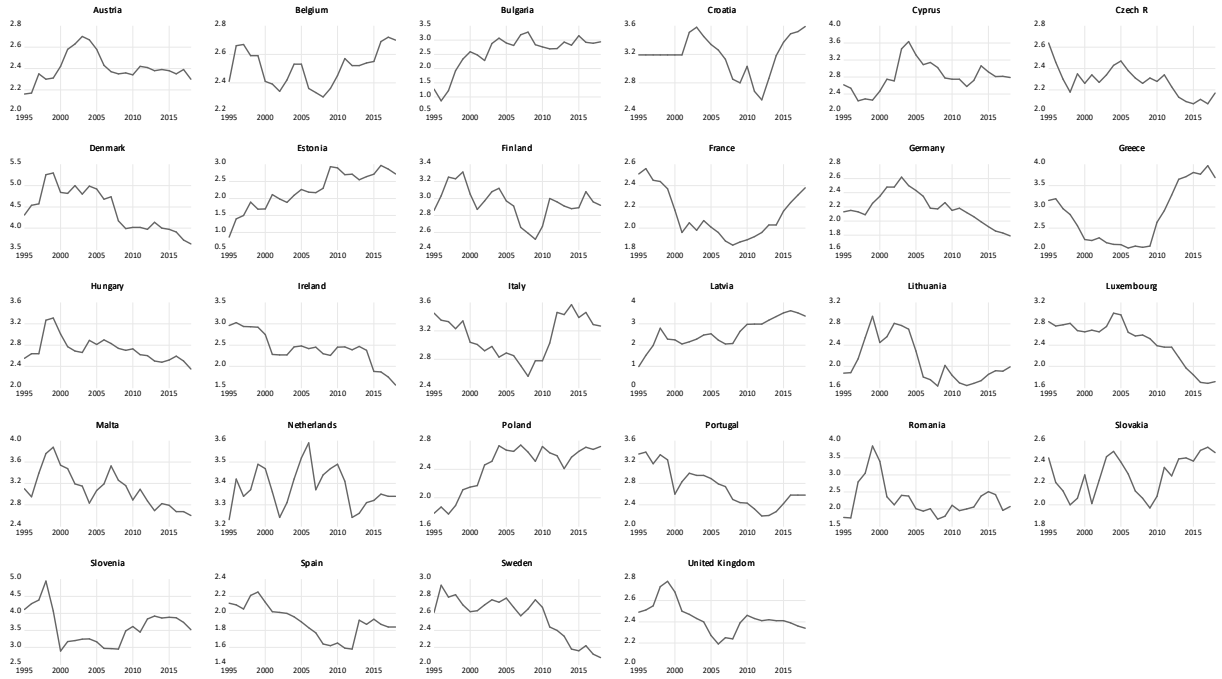

Figure 2. Total environmental taxes in EU countries

Source: Authors calculation based on Eurostat

After presenting GDP rate in EU countries, next figure manifests share of total environmental taxes in the gross domestic product from 1994 to 2018. Environmental tax revenues in the European Union totalled 324.6 billion euro which is 3% increase in nominal terms compared to previous year and 49% higher than in 2002 (https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20200219-1). European Union has growth of the environmental tax revenues in the period 2005-2008, but since 2008 the revenue based on environmental taxes decreased in these countries (Munitlak Ivanović and Golušin, 2012). Total environmental taxes had average share 2.66% of GDP during observed period, where Denmark had the highest mean share 4.43% of GDP. On the other hand, Spain is a country with the smallest average share 1.9% of GDP for the analyzed period. Economies such as Croatia, Italy, Malta, Netherlands and Slovenia had average share above 3% of GDP, while most of analyzed countries had mean share around 2%. Seventeen of twenty-eight countries recorded mean share of total environmental taxes below EU average during observed period. In most cases, environmental taxes refer to exploitation of natural resources such as energy and water as well as waste generation. The highest part of the revenue is raised through taxes on energy products where significant level of revenues is also collected via taxes on motor vehicles (Golušin et al. 2013). An increase of environmental taxes in the European Union resulted in a growth of revenues based on environmental taxes where fifteen countries increased environmental taxes including excise duties on energy products and electricity (Hodžić and Bratić, 2015).

Table 1. Descriptive statistics of total environment tax revenue

Country	Mean	Std. Dev	Min	Max
Austria	6532.03	1485.61	3974.84	8855.83
Belgium	8231.15	2125.01	5303.99	12407.2
Bulgaria	826.56	485.71	84.2	1648.09
Croatia	1289.79	210.53	1001.29	1853.35
Cyprus	430.93	143.06	188.62	589.4
Czech R	2726.52	1046.46	1205.44	4507.93
Denmark	9567.33	1404.39	6099.74	11065.4

Country	Mean	Std. Dev	Min	Max
Estonia	325.14	214.89	25.61	708.95
Finland	4993.47	1095.01	2930.92	6848
France	38132.77	7260.88	30139	55949
Germany	53626.48	6113.61	41524.55	59737
Greece	4933.84	1371.79	3190.58	7162
Hungary	2263.69	706.98	905.53	3142.61
Ireland	3754.73	1089.64	1565.12	5186.03
Italy	45331.86	8566.98	31015.51	58735
Latvia	453.99	296.92	40.74	982.72
Lithuania	477.46	202.47	95.99	899.78
Luxembourg	812.43	204.56	468.77	1039.61
Malta	186.48	62.04	87.6	321.75
Netherlands	19100.53	4280.41	11190.14	25832
Poland	7352.46	3546.65	1939.76	13500.41
Portugal	4146.89	587.75	3047.89	5270.52
Romania	2154.67	1167.89	499.25	4239.84
Slovakia	1155.87	642.48	374.32	2232.7
Slovenia	1099.30	323.05	632.25	1609.66
Spain	16594.21	3486.29	9976.01	22066
Sweden	8582.46	1472.35	5292.38	10341.43
United Kingdom	46627.26	8772.09	25538.44	63763.36
Total	10418.23	15691.72	25.61	63763.36

Source: Authors calculation

Results of descriptive analysis show that France, Germany, Italy and United Kingdom have the highest mean level of total environment tax revenue in the analyzed period. In these countries, environment revenue are above thirty-five billion euro which is far more than other economies. The mean total environment tax revenue are 10418.23 billion euro, where only six countries recorded higher revenue level compared to average value in observed period. It implies that there is a greater difference between selected countries, where for example Germany has more than fifty billion euro which is far more than Baltic countries (Estonia, Latvia and Lithuania). The smallest standard deviation is identified in Malta (62.04), while United Kingdom and France had the highest value of standard deviation. It implies that these economies had no stability in environment revenue level in observed period.

Table 2. Stationary tests

Variable	Levin-Lin-Chu test	Im, Pesaran Shin test	Augmented Dickey-Fuller test	Phillips-Perron test
GDP Intercept	-11.83	-9.99	201.483	192.91
GDP Intercept & trend	-10.81	-7.59	152.-55	149.92
Δ GDP Intercept	-23.68***	-22.77***	479.524***	1073.35***
Δ GDP Intercept & trend	-18.69***	-18.81***	362.08***	1255.52***
TET Intercept	-2.18	-6.47	25.35	32.25
TET Intercept & trend	-2.07	-0.04	64.32	50.18
ΔTET Intercept	-16.67***	-14.27***	293.24***	347.92***
ΔTET Intercept & trend	-15.29***	-13.21***	250.35***	310.03***

Source: Authors calculation

The results of these tests show that selected variables are not stationary at level, but variables are stationary at first difference. It implies that null hypothesis can be rejected at the 1% when applying each variable at first difference. It can notice that these variables are stationary at first difference and integrated of order one process. After we confirm that variables are the first

difference, the next step is to estimate the long-run nexus between selected variables (Nguyen and Kakinaka, 2018).

Table 3. Cointegration tests

Cointegration	GDP - TET		TET – GDP	
	Intecept	Intercept & trend	Intercept	Intercept & trend
Within-Dimension				
Panel v-statistic	-2.27**	-6.56***	-0.32**	-4.78***
Panel rho-statistic	-12.59***	-6.80***	-15.98***	-17.74***
Panel PP-statistic	-26.72***	-31.69**	-16.17***	-18.06***
Panel ADF-statistic	-19.48***	-23.18**	-15.51***	-17.98***
Between-Dimension				
Group rho-statistic	-10.45***	-14.92***	-9.52***	-15.16***
Group PP-statistic	-40.21**	-50.89***	-16.89***	-17.49***
Group ADF-statistic	-20.84***	-24.26***	-15.03***	-18.46***

Source: Authors calculation

Table 3 presents panel cointegration test statistics between GDP and TET for analyzed period 1994-2018. The analysis manifests a cointegration between GDP and TET and can reject the null-hypothesis of no cointegration. Presence of a cointegration between GDP and TET implies that these variables move together in the long-run and we can conclude there is a long-run relation between GDP and TET in EU countries from 1994 to 2018. After identifying the cointegration relationship, the next step is to examine the cointegration coefficients of independent variables by using panel fully modified ordinary least squares (FMOLS) and panel dynamic ordinary least squares (DOLS) models (Bilgili et al. 2016). The long-run cointegration vector is analyzed by these panel models.

Table 4. Results of different panel models

Variable	GDP		
Model	OLS	DOLS	FMOLS
TET	0.18 (0.03)	0.21 (0.01)	0.23 (0.02)
R-squared	0.41	0.72	0.68

Source: Authors calculation

Table 4 reflects the results of the panel OLS, DOLS and FMOLS estimators for EU countries. The empirical results show that TET have positive and significant effect on GDP. First, OLS shows that a 1% increase in revenue of total environmental taxes enhances GDP by 0.18% with 41% explanation of variations in this model. Second, DOLS reflects that a 1% increase in revenue of total environment taxes raises GDP by 0.21% with 72% explanation of variations in this model. Finally, FMOLS manifests that a 1% increase in revenue of total environmental taxes rises GDP by 0.23%.

CONCLUSION

Environmental policy is a necessary for sustainable economic development although some economists cite that society have to choose between environmental policy and economic growth. Environment taxes can be a very powerful tool to increase public revenues and contribute to the environment protection. Namely, these taxes can be more considered by EU countries to improve green economic activity and discourage"dirty" industries. This paper should reveal are environmental taxes statistically significant for economic growth in EU countries and the research examines the relationship between total environmental taxes and economic growth for

twenty-eight EU countries for the period 1994-2018. The objective of this paper is to evaluate the long-run relationship between these variables based on panel data analysis that includes panel cointegration test, and three models such as POLS, DOLS and FMOLS. The results show long-run relationship between total environmental taxes and economic growth in EU countries for the observed period. Empirical findings reflect that environmental taxes have a positive and significant impact on economic growth which implies that hypothesis H_1 can be accepted. Precisely, results of different panel models manifest that a 1% increase in total environmental taxes enhances GDP, where FMOLS model has shown a greatest change of GDP by 0.23%. These empirical findings confirm previous research studies (Morley and Abdullah, 2010; Dökmen (2012; Abdullah and Morley, 2014; He et al. (2019) that have shown positive and significant relationship between these components. The contribution of the research is manifested in the fact that we have ensured the quantitative measurement of relation between total environmental taxes and economic growth in EU countries. The research has provided a better understanding of the relation between this type of taxes and economic growth, as well as the direct taxes and macroeconomic aggregates, as well as the character and intensity of their effects.

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