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Environmental Tax Reform and the European Green Deal: Empirical Evidence from Panel Data Analysis

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RESEARCH ARTICLE

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A B S T R A C T

The European Green Deal, the European Union's roadmap for a green transition, was launched in 2019. With this strategy, the European Union aims to stop carbon emissions by 2050 through green policies in many sectors, especially in the energy sector. The European Union also uses various environmental tax instruments to achieve this goal. Environmental taxes, one of these instruments, are considered to have a regressive effect on employment and welfare, especially in carbon-intensive industries. In order to mitigate these negative social and economic impacts of the green transition, the European Union has implemented the Just Transition Mechanism. However, it is not known whether the Just Transition Mechanism will be sufficient after the newly introduced regulations such as the plastic tax, the Energy Tax Directive, and the Carbon Border Adjustment.

This study conducted a panel data analysis covering the period between 1994-2020 to analyze the impact of environmental taxes on employment. In this panel of 29 European countries, the dependent variable is the unemployment rate while independent variables are environmental taxes, gross domestic product, renewable energy supply and energy efficiency. As a result of this analysis, it is concluded that environmental taxes have an increasing effect on unemployment. Therefore, based on the panel data analysis, it is concluded that the Environmental Tax Reform package, which will provide double dividend in terms of both environment and employment, should be implemented in addition to the Just Transition Mechanism.

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1. Introduction

Environmental Tax Reform (ETR) has been a frequently discussed topic since the mid 1990's. Many academic studies have analyzed the environmental, economic, and social impacts of ETR. These studies focus on the principle of the double dividend of the ETR. The double dividend is a phenomenon that enables achieving socio-economic objectives such as increasing employment and easing the tax burden on labor and achieving environmental objectives such as reducing carbon emissions and pollution. This is where the main difference between the ETR from Pigouvian taxes emerges. In Pigouvian taxation, there is no target for how the revenue should be used. However, the purpose of the ETR is not only to raise revenue but also to plan how this revenue will be spent.

In the last month of 2019, the European Green Deal (EGD) adopted by the European Commission put the ETR back on the agenda. The EGD is a strategy that aims to zero carbon emissions of the European Union (EU) by 2050. Since it is thought that the Carbon Trading System alone will not be sufficient for this strategy to be successful, in addition to this system, plastic tax, Energy Tax Directive, and Carbon Border Adjustment regulations have been implemented. While these taxes are positive for the green transition, as Douenne & Fabre (2022) point out, they can also lead to increased inequalities. In France, making all taxpayer pay the carbon tax equally was the start of the Yellow Vest protests. Although Organization for Economic Cooperation and Development (OECD, 2023-d) data show that there is no major employment problem in the EU-27, these taxes may have negative impacts on a sectoral basis. Firms operating in carbon-intensive industries may choose to lay off workers due to the tax burden. However it is also known that the EU has implemented a Just Transition Mechanism to prevent low-income groups and those working in the fossil fuel industry from being negatively affected by the green transition. In fact, by blending tax-related steps with the Just Transition Mechanism, the ETR will not only make the green transition more successful but also bring about a more socially inclusive EGD. In this context, the aim of this study is to determine whether ETR is an important policy instrument in terms of green transition based on empirical findings.

In the first part of this study, the definition, origins and objectives of the ETR are discussed. In the second section, the EGD and the tax regulations implemented within the EGD are evaluated. The third section summarizes the literature on the relationship between environmental taxes and employment. In the fourth and final section of the study, an econometric analysis of the relationship between environmental taxes and employment is conducted. In this analysis, the dependent variable is unemployment while the independent variables are environmental taxes, renewable energy supply, energy efficiency, and gross domestic product (GDP). The results obtained from the analysis will contribute to the understanding of the importance of establishing a common ETR policy for Europe.

2. An Overview of Environmental Tax Reform

The basic idea of an environmental tax is to shift the tax burden from employment, income and investment to pollution, resource depletion, and waste. In other words, the tax burden is shifted from economic good to environmental harm through environmental taxes. More specifically, it is the transfer of revenues from environmental taxes to socially acceptable areas, such as raising the level of employment, increasing investment, and reducing pollution (Bosquet, 2000: 19). Kuralbayeva (2019) states that governments can use environmental taxes[2,3] as a tool for transition to a green economy as well as for social and economic purposes. Similar to these definitions, Ekins et al. (2011) define environmental taxation as the diversion of resources from economically beneficial areas such as employment, investment and income to environmentally harmful targets such as resource use and pollution. According to the World Bank, environmental taxation is a tool that helps to achieve environmental objectives while at the same time generating revenue (Heine & Black, 2018).

Discussions on the above-mentioned environmental taxes date back to the 1920s. Arthur Pigou made a significant contribution to the theoretical background of the above-mentioned environmental taxation. However, while Pigou was interested in the revenue aspect of environmental taxation, he did not address the issue of how the revenues collected through environmental taxation would be spent. The ETR is an approach that fills this gap (Ekins et al., 2011: 448). According to many authors, the debate on the ETR started with Gordon Tullock. In a study he prepared in 1967, Tullock stated that pollution taxes should be considered in the system to ensure better utilization of natural resources. Later on, Tullock's contribution was taken one step further by Lee and Misiolek and treated as an extension of the pollution tax (Patuelli et al., 2004: 564).

According to Maxim and Zander (2019), ETR[4] is the shift of the tax burden from production to environmental pollution. Patuelli et al. (2004) define the ETR mechanism as the use of revenues from environmental taxes on carbon products, energy consumption or natural resource extraction to reduce other taxes used in production processes. This is often used by making labor cheaper. The revenues can alternatively be used in other economic areas to reduce distortionary taxes.

[2] Environmental taxes are based on taxing production and consumption activities that have a negative impact on the environment. Therefore, environmental taxes can be used to tax many sectors such as transportation, agriculture and heavy industry(Heine & Black, 2018: 8).

[3] The disadvantage of environmental taxes is that they are regressive. In other words, low-income groups will be more affected by environmental taxes than wealthy groups, and there will be a decline in the welfare levels of these groups (Chiroleu-Assouline & Fodha, 2014: 127).

[4] Some countries are skeptical of the ETR mechanism. The reason for this is that the ETR will harm the industries of these countries in international competition. According to Patuelli et al. (2004), this skepticism is unfounded. Because, although an environmental tax means additional costs, the decrease in labor costs thanks to the ETR will offset the cost created by environmental taxes (Patuelli et al., 2004: 564-565).

Canpolat Bıcakcı (2017) emphasizes two features of the ETR. The first one is subsidy shifting and the second one is tax shifting. This means that if environmental damages are to be reduced and economic good is to be strengthened in the economy, the ETR strategy should be used. Environmental taxes play an important role in the ETR system, but the success of ETR does not depend only on taxes. Therefore, the phenomenon called subsidy shifting gains importance. Subsidy shifting aims to end subsidies to environmentally harmful business lines and transfer these subsidies to environmentally beneficial sectors. For example, if it is desired to reduce the use of fossil fuels in agriculture and to stop the use of inorganic fertilizers that increase greenhouse gas emissions, a subsidy system should be put in place to promote the use of renewable energy and organic fertilizers as a replacement for government support for fossil fuels and fertilizers. In addition to new environmental taxes, the tax shifting aims to reduce the tax burden on labor and capital. Thus, on the one hand, environmental benefits are achieved and on the other hand, relief is provided in the labor market (Canpolat Bıcakcı, 2017: 354-356).

3. European Green Deal and Environmental Tax Regulations

In this section, firstly, the EGD prepared by the EU against the climate change is discussed. Then, the plastic tax, Energy Taxation Directive, and Carbon Border Adjustment regulations introduced in addition to the Carbon Trading System are evaluated.

3.1. European Green Deal

The EU has been at the forefront of addressing the impacts of the climate crisis for many years. The EGD represents the concretization of the steps taken by the EU on the climate crisis from the past to the present. This strategy, launched by the European Commission in 2019, is also recognized as the first climate law in the world. With the implementation of this strategy, the EU is committed to reducing carbon emissions to zero by 2050. While implementing the green transition, the EU will also implement the Just Transition Mechanism[5,6] to ensure that no one is left behind (Siddi, 2020: 6).

According to the European Commission, for the EGD strategy to be successful, regulations should be made to reduce carbon emissions in many sectors. In this context, the most important sector in the EGD is the energy sector. Renewable energy is of great importance to meet the energy needs of European industries and households and to

[5] The European Green Deal is a climate law that was passed into law in 2019. Although the main goal of the EGD is to become a carbon neutral continent by reducing Europe's carbon emissions to zero, the EGD also aims to bring Europe in line with the requirements of the age in terms of employment, infrastructure and technology, which can be described as green developmentalism. It can also be seen as an opportunity to eliminate income and wealth inequality (Wolf et al., 2021: 101).

[6] In implementing these policies, the EU emphasizes a just transition so that no one is left behind. In other words, various arrangements will be made to ensure that those who lose their jobs during this transition are guaranteed to adapt to green jobs and to limit the impact of the increase in energy costs due to the transition on the lower and middle classes (European Commission, 2019).

reduce dependence on fossil fuels. Energy efficiency is another important issue in the energy sector. The energy-efficient retrofitting of old and inefficient public and corporate buildings as well as private residences within the EU borders is another action planned to be implemented in this sense. The recycling sector is a sector where resources are used efficiently and recycled into the economy, rather than a linear economy where waste cannot be recycled. Increasing the share of the recycling sector in the economy is one of the plans included in EGD. The transportation sector is one of the sectors that cause carbon emissions the most. Therefore, sustainable transportation without the use of fossil fuels is one of the critical issues for a green transition and therefore this sector has been included in the EGD. Agriculture is another sector that is planned to be reformed in the EGD. The aim is to move towards a sustainable agriculture and food system strategy, called Farm to Fork, for households to have access to healthy and sustainable food (decarbonized and produced without artificial fertilizers) (European Commission, 2019).

For these sector-based policies to be successful, various complementary financial instruments should also be used. Therefore, the EU has introduced environmental taxes such as the plastic tax[7], the Energy Tax Directive, and the Carbon Border Adjustment[8]. If these tax instruments are implemented together with the Just Transition Mechanism, a suitable structure will be created for double dividend. As Canpolat Bıcakcı (2017) points out, there are three approaches on how the revenues obtained in the ETR will be used. The first of these methods is the allocation of revenues to the budget, the second is the transfer of environmental taxes to funds, and finally, the third is a mix of the first and second approaches. In other words, the EU can realize the principle of double dividend by using the revenues generated by the new taxes it imposes to increase employment, reduce the tax burden on labor and capital, etc. through these approaches. Heine and Black (2018) also argue that an ETR could be implemented in the context of the EGD, in addition to the regulations it has already implemented. The ETR is a package of policies that combines environmental taxes with public expenditure and supply-side policies. The aim of the ETR is to reorganize taxes according to environmental priorities. The revenues generated can be spent in sectors such as education and health and used to increase employment. The ETR would significantly improve market efficiency, cost-effectiveness and increase local resources.

3.2. Environmental tax regulations within the scope of the European Green Deal

According to OECD data, plastic consumption was 460 million tons globally in 2019 and is expected to increase further in the coming years (OECD, 2022). The EU, which produces a significant portion of global plastic waste, has therefore taken a step towards a plastic tax. The main purpose of the plastic tax is to support a circular

[7] Environmental taxes are nowadays one of the main environmental policy instruments, along with incentives, levies, fees and trade permits, and environmental taxes account for about 2.5% of the EU's GDP. (Delgado et al. 2022: 677).

[8] Although this regulation is referred to as Carbon Border Adjustment, it is also referred to as Border Carbon Tax in the literature (Author note).

economy by reducing plastic waste generation. This tax can be imposed at the production stage of plastics as well as on final consumers (Walker et al., 2020: 198).

Since the plastics tax will be applied separately in each country, each EU country[9] should apply a plastics tax that is suitable for its own conditions. The new situation emerging with this tax can be explained through the example of Italy[10], one of the EU member countries. It is hoped that 3 different positive developments will emerge in Italy with the plastics tax (similar results can be achieved in other countries, although the tax system and economic structure of each country is different). The first is that this tax will help increase Italy's contribution to the EU budget due to the weight of its plastic waste. Second, it would shift the tax burden from labor to the environment, thus triggering an increase in employment. Finally, such a tax would reduce plastic production and consumption of single-use plastics (Scuderi, 2021: 6-7).

Another tax instrument introduced to reduce greenhouse gas emissions is the Energy Tax Directive. The Energy Tax Directive brings with it the taxation of many energy-related products. Traditional energy goods/services such as motor fuels, heating and electricity, as well as agriculture, fisheries, and maritime transportation will be subject to this tax (Carvalho & Guillen, 2021, p.2).

The Energy Tax Directive, which was updated under the EGD, was introduced in 2003. The reason for updating the Energy Tax Directive is that it does not provide sufficient benefits in reducing greenhouse gas emissions and does not sufficiently promote the use of renewable energy (Ortega-Gil et al., 2021: 2).

With the revised Energy Tax Directive, new minimum tax rates will be set for fossil fuels, while many products/services will be re-taxed according to their energy content and environmental impact. In addition, the exemptions provided for fossil fuels will also be re-evaluated with the directive. Thus, exempted products, especially heating, will not be taxed below the minimum rates. Air transport, maritime transport, and fishing will no longer be exempt from energy tax, taking into account the pollution they create (European Commission, 2021).

Finally, the Carbon Border Adjustment means that carbon-intensive companies operating in non-EU countries will face a tax on their exports to the EU. This tax is applied at the rate of environmental taxes applied in the EU in order to prevent the EU's local companies from losing their competitiveness due to environmental taxes (Falcao, 2020: 1048).

There are basically three main reasons for the introduction of Carbon Border Adjustment. The first one is to protect the competitiveness of local industries as mentioned in the previous paragraph. The EU imposes many taxes and tariffs on carbon-intensive production within its borders. It is also known that new environmental taxes may be on the agenda to achieve the goal of becoming a carbon-neutral continent by 2050. This will weaken the competitiveness of European companies against non-

[9] In this study, it would be beyond the scope of the study to address all countries one by one for the plastic tax. For this reason, only the case of Italy has been focused on as an example (Author note).

[10] In Italy, the implementation of this tax has been shifted to 2023 under COVID-19 measures (Author note).

European companies, especially Chinese companies. A border carbon mechanism would remedy this situation. The second important potential impact of this regulation is the impact on non-European countries importing into the EU. These countries will adopt environmentally friendly policies to ensure that their companies do not fall behind in the competition and lose export revenues. As can be seen in the case of Turkey, many countries have started to work to adapt to this regulation (European Commission, 2021). The third reason is related to the risk of emission leakage. Emission leakage is when European companies move their production from the EU, which has strict policies against emissions, to countries outside the EU with less stringent emission standards. Carbon Border Adjustment would reduce the risk of emissions leakage (Keen et al, 2022: 210).

Although Carbon Border Adjustment initially covers sectors such as iron and steel and cement, it is expected to expand to other sectors in the coming years (Droege & Fischer, 2020: 31).

4. Literature Review

There have been many important contributions to the literature focusing on the relationship between environmental tax and employment since the mid 1990s. These studies have mainly used a computable general equilibrium model and analyzed the possible effects of the ETR. Some of the studies and findings in this context are presented below.

Carraro et al. (1996), using a general equilibrium model, showed that carbon tax revenues generate double dividends only in the short run.

Bovenberg & Mooij (1997), in their endogenous growth model analysis, conclude that ETR yields a double dividend effect. That means that environmental tax reform not only improves environmental quality but also increases welfare through growth.

Bayar (1998) argues that environmental tax reform will have a positive effect on employment, but this effect will diminish over time due to wage suppression.

Holmlund & Kolm (2000) analyzed environmental tax reform in a small economy with unemployment in general equilibrium. Using the general equilibrium model, this study estimated that reforming the environmental tax would lead to a limited increase in employment. An increase in environmental tax rates will also lead to a reduction in real GDP.

André et al. (2005) included the Andalusian region and economy of Spain and used a computable general equilibrium model. This study analyzed a situation in which a tax on greenhouse gases is accompanied by a reduction in the tax paid by employers for social security. Therefore, according to the model, there is no change in public revenues and expenditures. According to the results obtained, it is observed that the implementation of environmental tax has a positive effect on employment.

Daitoh & Omote (2011) investigated how employment would be affected by an urban pollution tax for an economy with limited capital mobility across sectors. Using

the Harris-Todaro (HT) model, the study finds that the implementation of an urban pollution tax will result in an increase in urban unemployment.

Ciaschini et al (2012) investigated the double dividend situation at the regional level in the Italian economy. The results show that double dividends occur in at least one region.

Hafstead & Williams (2018) used a 2-sector general equilibrium analysis to analyze the impact of pollution tax, a type of environmental tax, on employment. According to the analysis, the pollution tax imposed on the polluting industry caused a decline in employment in this industry, while there was an increase in employment in the non-polluting industry. In general, there was no change in the level of employment in the short run.

Yip (2018) investigated the impact of an income-neutral carbon tax on employment in British Columbia, which led to a 1.4% decline in middle-income male individuals and a 2.4% decline in low-income male individuals.

Aubert & Chiroleu-Assouline (2019) investigate the distributional and efficiency implications of environmental tax reform with an analytical general equilibrium model based on imperfect, heterogeneous labor markets and non-homothetic preferences. According to the analysis, if environmental taxes have a more regressive impact on low-income labor, the trade-off between equity and efficiency can be smoothed through a non-linear income tax.

Böhringer et al. (2019) analyzed alternative policy proposals implementing additional environmental taxes in a general equilibrium model. Additional environmental taxes were applied to fossil fuels, local air pollutants, and carbon emissions. This study suggests that the regressive effect of additional environmental taxes to be implemented in Spain will be eliminated through the transfer of environmental tax revenues.

Maxim & Zander (2019) compare European and non-European countries in their study on green tax reform and employment. In this study, which uses the simulation method, green tax reform provided more employment in European countries than in non-European countries. Therefore, a universal environmental tax reform policy will not lead to an optimal outcome in terms of environment and employment. Therefore, each country should adopt an environmental tax reform according to its own conditions.

Kuralbayeva (2019) analyzed the impact of environmental tax reforms on employment and welfare in a model with three different scenarios. According to the scenarios prepared under a taxation scheme under double dividend conditions, lower public expenditures have less impact on after-tax household incomes and may mean a higher increase in employment.

Metcalf & James (2020) found that carbon taxes do not have any negative impact on employment with their dynamic effects panel for 31 European countries.

Domguia et al. (2022) included 94 countries (OECD countries and others) in the study covering the period between 1994-2018. The data used in the study were compiled from OECD Data and the World Bank. In this study, there are three different

dependent variables: total employment, male employment, and female employment. The main independent variable of the study is environmental taxes. Apart from this variable, GDP, inflation, political stability, and schooling are also included in the analysis as control variables. More than one method was used in the study. These methods are the fixed effects model, Driscoll Kraay and Lewbel's augmented GMM model, and the augmented 2SLS method that accounts for endogeneity. The authors find that the effect of environmental taxes on total employment is positive and significant. However, women benefited less from the employment created than men. Therefore, authors suggest that environmental policy should be updated to ensure women's employment.

5. Empirical analysis

As can be seen from the literature review, general equilibrium models have been predominantly used for environmental taxes and employment and the possible effects of the ETR have been analyzed with prepared scenarios. In this study, unlike these studies, the panel data method is used. Thus, a contribution to the literature has been made.

5.1. The data

This study includes 26 EU countries[11] as well as Türkiye, the United Kingdom, and Norway. These countries were included in the model because they are geographically located on the European continent, their efforts to align with the European Green Deal and their data availability. The number of observations in the analysis covering the period between 1994-2020 is 27. The dependent variable is unemployment in order to see the impact of the green transition on employment. The main independent variable in the study is environmental taxes (envtax). The other independent variables are GDP, renewable energy (renewable), and energy efficiency (efficiency) variables. The reason for including renewable energy and energy efficiency in this model is that these two variables are at the core of the European Green Deal.

Table 1: Variables in the Model

Dependent/Independent	Variable	Dataset	Measure
Dependent variable	Unemployment	World Bank Data	% of total labor force
Independent variable (1)	Environmental Tax	OECD Data	% of GDP
Independent variable (2)	GDP	OECD Data	Million US dollars
Independent variable (3)	Energy Efficiency	Eurostat Data	Million tons of oil equivalent
Independent variable (4)	Renewable Energy	OECD Data	Thousand toes

Note: This and following tables are prepared by the author

[11] The EU countries covered by the model are: Austria, Belgium, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Malta, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Croatia, Romania.

The equation for the panel data method is expressed as follows. In the equation, y is the dependent variable, x is the independent variable, α is the constant term, β is the slope parameter and μ is the error term. Unlike time series, the panel data method also includes the number of cross-sections. Therefore, both the time dimension and cross-sectional dimension are added to the equation below. In this study, the lower index i denotes time and the lower index t denotes the number of cross-sections.

$$y_{it} = \alpha_i + \beta_i . x_{it} + \mu_{it} \quad i=1,.....,N \; ; \; t=1,..... \qquad (1)$$

The adaptation of the above equation to the model is as follows:

$$unemployment_{it} = \alpha_i + \beta_1 * envtax_{it} + \beta_2 * renewable_{it} + \beta_3 * GDP_{it} + \beta_3 * efficiency_{it} + \mu_{it} \qquad (2)$$

Table 2 shows the mean, standard deviation, and minimum/maximum values of the variables in this model. The fact that the minimum/maximum values of the variables are in a wide band is not a favorable situation for the model. Therefore, logarithmic transformations of the variables were made to provide a more flexible model.

Table 2: Summary of the Model

Variable	Obs	Mean	Std. Dev.	Min	Max
envtax	779	2.695648	0.7026	0.07	5.36
renewable	754	6022.097	7106.576	0	44019.09
unemployment	783	8.112688	4.3990	1.33	24.47
GDP	777	31.249.88	17263.56	5430.22	119871.4
efficiency	783	58.85595	76.92559	0.71	332.75

After the logarithmic transformation, the equation of the model can be expressed as follows:

$$lunemployment_{it} = \alpha_i + \beta_1 * lenvtax_{it} + \beta_2 * lrenewable_{it} + \beta_3 * lGDP_{it} + \beta_3 * lefficiency_{it} + \mu_{it} \qquad (3)$$

The logarithmic transformation will also make it easier to interpret the results obtained in the model.

5.2. Methodology

In this study, the number of observations (i) is more than the number of cross-sections (t). In addition, t>10 is the case in this study. Therefore, the study will start by conducting the cross-section dependence test. Then, homogeneity test is applied as the second test. Neglecting homogeneity in an econometric model will lead to wrong results. Therefore, a test that considers cross-sectional dependence should be applied.

According to the results obtained, the study will continue by performing appropriate unit root test. Unit root tests are divided into two category according to whether they consider cross-sectional dependence or not. Since economic relations

between countries have intensified in recent years, second generation unit root tests are generally applied more frequently. In this study, since cross-sectional dependence was detected, second generation unit root test was applied.

Afterwards, since the variables contain unit root, there is cross-sectional dependence in the model and the model is heterogeneous, the analysis should be continued with one of the second generation cointegration tests. However, since no cointegration relationship was found in the model, the variables were differenced and estimated with the fixed effects model and the analysis was completed.

5.3. Panel data analysis

The number of cross-sections in the model is 29. For T>10, the study should continue with the cross-sectional dependence test. The CD test of Pesaran (2004) is used in the cross-sectional dependence test. This test gives more appropriate results when the number of cross-sections in the model is larger than the number of observations (N>T). The table below presents the test statistics for cross-section dependence. As can be seen from Table 3 the probability values for all variables in the study are less than 5%. This leads to the conclusion that there is a cross-section dependence in the model.

Table 3: Cross-Sectional Dependence Test

Variable	CD-test	p-value	average joint T	mean ρ	mean abs(ρ)
lenvtax	11.858	0.000*	26.74	0.11	0.41
lrenewable	86.359	0.000*	25.45	0.85	0.85
lunemployment	22.388	0.000*	27.00	0.21	0.38
lGDP	101.317	0.000*	26.62	0.97	0.97
lefficiency	27.647	0.000*	27.00	0.26	0.41

Note: * shows the cross sectional dependency

Once the existence of cross-sectional dependence relationship is established, homogeneity test should be performed. Ignoring heterogeneity/homogeneity in the model leads to incorrect results in the model. Therefore, estimation is performed using the slope homogeneity test developed by Pesaran & Yamagata (2008). In this test, H_0 is set as "the null hypothesis is that the slope coefficients are homogeneous". As a result of the values obtained, H_0 is rejected, and it is concluded that the model is heterogeneous.

Table 4: Slope Homogeneity Test

	Delta	p-value
Delta	19.615	0.000*
$Delta_{Adj.}$	22.428	0.000*

Note: * shows the heterogeneity

After these a priori tests, it is concluded that it is more appropriate to continue with the second-generation unit root tests. Therefore, analysis proceed with the CIPS test developed by Pesaran (2007), an improved version of the Augmented Dickey-Fuller test that considers cross-section dependence. In this test, when the critical values are smaller than the CIPS values, it is concluded that there is no unit root in the model. The results of the estimation are presented in the Table 5 below. The model estimation shows that all variables contain unit root.

Table 5: CIPS Unit Root Test

Variables	Results	
	Critical Values	**CIPS**
lenvtax	-0.2523	-2.67*
lrenewable	0.0000	-2.69*
lunemployment	-0.4132	-2.67*
lGDP	-0.57361	-2.67*
lefficiency	0.000	-2.67*

Note: * shows the variables which contain unit root.

The cointegration test developed by Westerlund (2007) is used as a panel cointegration test. In this test, bootstrap values are also calculated to take into account cross-sectional dependence and heterogeneity, thus obtaining more robust results. In the Westerlund cointegration test, the h_0 hypothesis is that there is no cointegration relationship. As a result of the test, the bootstrap probability values are greater than 0.05, which leads to the acceptance of hypothesis h_0. According to this result, a cointegration relationship could not be established between the variables.

Table 6: Westerlund Cointegration Test

Statistic	Value	Z-value	P-value	Bootstrap
Gt	-1.244	3.846	1.000	0.713
Ga	-2.458	5.619	1.000	0.975
Pt	-7.277	1.128	0.870	0.090*
Pa	-2.103	2.955	0.998	0.339

Note: Table shows that there is no cointegration relationship except *

Since a cointegration relationship could not be established in the model, the difference of the series in the model was taken and the estimation was made in this way. Summary of this model is shown in the Table 7 below. As a result of the estimation, the probability value of renewable energy supply was calculated as 0.324. Since this value is greater than 0.05, this variable cannot be interpreted within the scope of this study. On the other hand, among the other variables included in the study, GDP was found valid at 1% significance level, while environmental taxes and energy efficiency were found valid at 10% significance level. When the coefficients of these variables are analyzed, it

is seen that 1% increase in environmental taxes increases unemployment by 1.2%. Unlike environmental taxes, the increase in energy efficiency and GDP has a positive effect on reducing unemployment. 1% increase in energy efficiency reduces unemployment by 2%, while a 1% increase in GDP reduces unemployment by 16.6%.

Table 7: Fixed Effects Panel

	Coefficents	**Std. Err.**	**t**	**P>|t|**
dlrenewable	0.0136406	0.0138143	0.99	0.324
dlenvtax	0.1244554	0.0661969	1.88	0.061**
dlGDP	-1.669724	0.1405254	-11.88	0.000*
dlefficiency	-0.2040793	0.1095907	-1.86	0.063**
C	0.062072	0.0085466	7.26	0.000
F	46.60			
Prob>chi2	0.000			
Within R^2	0.2157			

Note: * indicates variables accepted at 1% significance level and ** indicates variables accepted at 10% significance level.

As a result of fixed effects panel data analysis for European countries covering the period between 1994 and 2020, it is observed that environmental taxes have an increasing effect on unemployment. Therefore as Bovenberg (1995) points out, governments should not rely solely on environmental taxes to reduce unemployment. On the other hand the EU has also introduced some new environmental taxes since 2019, when it designated EGD as its new climate strategy (COVID-19 caused some delays in implementation). This means that European countries could see larger increases in unemployment rates due to the green taxation. Therefore, the introduction of an ETR program that mitigates the socio-economic impacts of environmental taxes would provide an important opportunity for the EU to fulfill its commitment to leave no one behind in the green transition. The socio-economic and environmental success of the ETR has been demonstrated by many studies in the past years.

6. Conclusion

The EGD adopted by the European Commission in 2019 is an important strategy that demonstrates the EU's vision and commitment to tackling the climate crisis. With this strategy, the EU aims to become the world's first carbon-neutral continent by completely halting carbon emissions by 2050. For this target to be successful, the transition to renewable energy and energy efficiency have the most important place in the EGD. Apart from this, new regulations are planned in the transportation, heating, agriculture, and industry sectors. The EU also utilizes taxes, which are public fiscal policy instruments, to increase the effectiveness of these sectoral regulations. Plastic tax, Energy Taxation Directive, and Carbon Border Adjustment are tax regulations that can be considered in this context. In addition, the EU continues to develop subsidy

mechanisms to increase renewable energy supply while continuing its initiatives to end subsidies to the fossil fuel industry.

The social dimension of these regulations for the green transition is another important issue. The imposition of new environmental taxes on carbon-intensive firms and the fossil fuel industry, and the cessation of incentive mechanisms and tax exemptions will lead to a downsizing of these sectors and thus a loss of employment. This is why the EU has implemented the Just Transition Mechanism. In the panel data analysis conducted within the scope of this study, it was observed that environmental taxes implemented in Europe caused a decrease in employment in the period between 1994-2020. It can be predicted that the taxes introduced within the scope of the EGD will further increase this decline in employment. The renewable energy variable may also have negative employment implications. Therefore, it can be said that there is a need for an ETR within the EGD where environmental taxes are considered together with public subsidies. This would provide a more integrated view of environmental taxes and the revenues generated by these taxes and thus support the Just Transition Mechanism. The revenues generated by environmental taxes could be used to boost employment, either directly into the EU budget or through a fund. Reducing taxes on labor and capital incomes in the proportion of revenues collected from environmental taxes is also a possible policy. These policies would eliminate the regressive effect of environmental taxes and create a double dividend situation.

A review of the literature on the ETR reveals that the majority of studies suggest that the implementation of environmental taxes alone has negative consequences on employment. On the other hand, as discussed by Bovenberg & Mooij (1997), Bayar (1998), André et al. (2005), Böhringer et al. (2019) and Maxim & Zander (2019), an ETR under double dividend conditions leads to an increase in employment. In this study, the findings that environmental taxes lead to a decrease in employment support the literature. Moreover, this study is expected to make important contributions to the literature. Although the ETR has been discussed since the 1990s, it is seen that it has not been sufficiently addressed in the literature within the scope of EGD. Therefore, this study will contribute to filling this gap. On the other hand, the Covid-19 pandemic, the Ukraine-Russia War and other developments have created new problems and needs in the labor market. These issues cannot be addressed in this study, which constitutes a limitation of this study. There is evidence in the literature that especially carbon-intensive sectors will be more affected by green transition policies. For this reason, more studies are needed to examine employment in these sectors. In addition, regional implications of environmental tax policies, their effects on women's labor, their effects on youth employment, etc. can also be the subject of new studies. Thus, these studies can provide a smoother and fairer transition for countries in the European region, including Türkiye.

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References

André, F.J., Cardenete, M.A. & Velazquez, E. (2005). "Performing an Environmental Tax Reform In A Regional Economy. A Computable General Equilibrium Approach". *Ann Reg Sci.* 39, 375–392 (2005). https://doi.org/10.1007/s00168-005-0231-3

Aubert, D. & Chiroleu-Assouline, M. (2019). "Environmental Tax Reform and Income Distribution With Imperfect Heterogeneous Labour Markets". *European Economic Review*. 116, 60-82. https://doi.org/10.1016/jeuroecorev.2019.03.006

Bayar, A. H. (1998). "Can Europe Reduce Unemployment Through Envıronmental Taxes? A General Equilibrium Analysis". *Twelfth International Conference on Input-Output Techniques International Input-Output Association*. New York.

Bosquet, B. (2000). "Environmental Tax Reform: Does It Work? A Survey Of The Empirical Evidence". *Ecological Economics*. 34(1), 19-32. https://doi.org/10.1016/S0921-8009(00)00173-7.

Bovenberg, A.L. (1995). "Environmental Taxation and Employment". *De Economist.* 143, 111–140. https://doi.org/10.1007/BF01384532

Bovenberg, A. & Mooij, R. A. (1997). "Environmental Tax Reform and Endogenous Growth". *Journal of Public Economics.* 63(2), 207–237. doi:10.1016/s0047-2727(96)01596-4

Böhringer, C., Garcia-Muros, X. & Gonzalez-Eguino, M. (2019). *Greener and Fairer: A Progressive Environmental Tax Reform For Spain.* Oldenburg Discussion Papers in Economics, No. V-418-19, University of Oldenburg, Department of Economics, Oldenburg.

Canpolat Bıcakcı S. (2017). "Çevre Vergilerinin Araçsallığı Üzerine Bir Değerlendirme". *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi.* Gazi Akademi Genç Sosyal Bilimciler Sempozyumu 2017 Özel Sayısı, 348-369.

Ciaschini, M., Pretaroli, R., Severini, F. & Socci, C. (2012). "Regional Double Dividend from Environmental Tax Reform: An Application for The Italian Economy". *Research in Economics*. 66(3), 273–283.

Carraro, C., Galeotti, M., & Gallo, M. (1996). "Environmental Taxation and Unemployment: Some Evidence on The Double Dividend Hypothesis in Europe". *Journal of Public Economics.* 62(1-2), 141–181.

Carvalho, N. & Guillen J. (2021). "Economic Impact of Eliminating the Fuel Tax Exemption in the EU Fishing Fleet", *Sustainability*. 13(2719), 1-15. https://doi.org/10.3390/su13052719

Chiroleu-Assouline, M. & Fodha, M. (2014). "From Regressive Pollution Taxes to Progressive Environmental Tax Reforms". *European Economic Review*. 69, 126-142. https://doi.org/10.1016/j.euroecorev.2013.12.006.

Daitoh, I. & Omote, M. (2011). "The Optimal Environmental Tax and Urban Unemployment in an Open Economy". *Review of Development Economics*. 15, 168-179. https://doi.org/10.1111/j.1467-9361.2010.00600.x

Delgado, F., Freire-Gonzalez, J. & Presno, M.J. (2022), "Environmental Taxation in The European Union: Are There Common Trends?". *Economic Analysis and Policy*. 73, 670-682, https://doi.org/10.1016/j.eap.2021.12.019.

Droege, S. & Fischer, C. (2020). *Pricing Carbon at the Border: Key Questions for the EU. ifo Institut - Leibniz-Institut für Wirtschaftsforschung an der Universität München*. 18(01), 30-34.

Domguia, E. N., Pondie, T.M., Ngounou, B.A. & Nkengfack, H. (2022). "Does Environmental Tax Kill Employment? Evidence From OECD And Non-OECD Countries", *Journal of Cleaner Production.* 380(1), 134873, https://doi.org/10.1016/j.jclepro.2022.134873.

Douenne, T. & Fabre, A. (2022), "Yellow Vests, Pessimistic Beliefs, and Carbon Tax Aversion." *American Economic Journal: Economic Policy.* 14(1), 81-110.

Ekins, P., Summerton, P., Thoung, C. & Lee, D. (2011), "A Major Environmental Tax Reform for the UK: Results for the Economy, Employment and the Environment". *Environ Resource Econ.* 50, 447-474. doi 10.1007/s10640-011-9484-8.

European Commission (2019). *The European Green Deal*. Brüksel, https://ec.Europa.eu/info/sites/info/files/European-green-deal communication_en.pdf., Accessed on: 21.05.2023

European Commission (2021). *Making Energy Taxation Greener.* https://ec.europa.eu/ commission/presscorner/detail/en/fs_21_3667, Accessed on: 24.05.2023

Eurostat Data (2023). *Energy Efficiency*. https://ec.europa.eu/eurostat/cache/ metadata/en/nrg_ind_eff_esmsip2.htm, Accessed on 04 August 2023

Falcao, T. (2020), "Toward Carbon Tax Internationalism: The EU Border Carbon Adjustment Proposal". *Tax Notes International*. 98(9), https://ssrn.com/abstract=3827522

Hafstead, M.A.C. & Williams, R. C. (2018). "Unemployment and Environmental Regulation In General Equilibrium". *Journal of Public Economics*. 160, 50-65. https://doi.org/10.1016/j.jpubeco.2018.01.013.

Heine, D. & Black, S. (2018). "Benefits beyond Climate: Environmental Tax Reform". In Pigato, M. A. (ed.), *Fiscal Policies for Development and Climate Action*. https://doi.org/10.1596/978-1-4648-1358-0_ch1

Holmlund, B. & Kolm, A.-S. (2000). "AS. Environmental Tax Reform in a Small Open Economy With Structural Unemployment". *International Tax and Public Finance.* 7, 315–33. https://doi.org/10.1023/A:1008757830467

Keen, M., Parry, I. & Roaf, J. (2022). "Border Carbon Adjustments: Rationale, Design And Impact". *Fiscal Studies*. 43, 209– 234. https://doi.org/10.1111/1475-5890.12307.

Kuralbayeva, K. (2019), "Environmental Taxation, Employment and Public Spending in Developing Countries". *Environ Resource Econ.* 72, 877–912. https://doi.org/10.1007/s10640-018-0230-3

Maxim, M & Zander, K. (2019), "Can a Green Tax Reform Entail Employment Double Dividend in European and Non-European Countries? A Survey of the Empirical Evidence". *International Journal of Energy Economics and Policy*. 9(3), 218-228.

Metcalf, G, E. & James H. S. (2020). "Measuring the Macroeconomic Impact of Carbon Taxes". *AEA Papers and Proceedings*. 110, 101-106**.**

OECD (2022). *Global Plastic Waste Set To Almost Triple By 2060.* https://www.oecd.org/newsroom/global-plastic-waste-set-to-almost-triple-by-2060.htm

OECD (2023-a). *Environmental tax (indicator)*. doi: 10.1787/5a287eac-en (Accessed on 04 August 2023)

OECD (2023-b). *Gross domestic product (GDP) (indicator)*. doi: 10.1787/dc2f7aec-en (Accessed on 04 August 2023)

OECD (2023-c). *Renewable energy (indicator)*. doi: 10.1787/aac7c3f1-en (Accessed on 04 August 2023)

OECD (2023-d). *Unemployment rate (indicator)*. doi: 10.1787/52570002-en (Accessed on 08 December 2023)

Ortega-Gil, M., Cortes-Sierra, G. & Elhichou-Ahmed, C. (2021), "The Effect of Environmental Degradation". *Climate Change, and the European Green Deal Tools on Life Satisfaction.* 14(18), 1-14. https://doi.org/10.3390/en14185839

Patuelli, R., Nijkamp, P. & Pels, E. (2004). "Environmental Tax Reform and The Double Dividend: A Meta-Analytical Performance Assessment". *Ecological Economics.* 55(4), 564-583, https://doi.org/10.1016/j.ecolecon.2004.12.021

Pesaran, M.H. (2004). *General Diagnostic Tests for Cross-Section Dependence in Panels*. University of Cambridge Faculty of Economics, Cambridge Working Papers in Economics No. 0435, https://link.springer.com/article/10.1007%2Fs00181-020-01875-7,

Pesaran, H. M. (2007). "A Simple Panel Unit Root Test In The Presence Of Cross-Section Dependence". *Journal of Applied Econometrics.* 22, 265 312.

Pesaran, M. H., & Yamagatai T. (2008). "Testing Slope Homogeneity In Large Panels". *Journal of Econometrics.* 142(1), 50–93.

Scuderi, E. (2021). Towards A Plastic-Free Economy: The Italian Plastic Tax. Rivista Telematica di Diritto Tributario. SSRN: https://ssrn.com/abstract=3822296, Accesed on: 20.07.2023

Siddi, M. (2020). *The European Green Deal: Assessing Its Current State and Future Implementation*. FIIA Working Paper 114, https://www.fiia.fi/wp-content/uploads/2020/05/wp114_European-green-deal.pdf.

Walker, T., Gramlich, D. & Dumont-Bergeron, A. (2020). "The Case for a Plastic Tax: A Review of Its Benefits and Disadvantages Within a Circular Economy". *Sustainability, Business and Society.* 360(4), 185-211. https://doi.org/10.1108/S2514-175920200000004010

Westerlund, J. (2007). "Testing for Error Correction in Panel Data". *Oxford Bulletin of Economics and Statistics.* 69, 709-748.

World Bank Data (2023). Unemployment, total (% of total labor force) (modeled ILO estimate). https://data.worldbank.org/indicator/SL.UEM.TOTL.ZS, (Accessed on 04 August 2023)

Wolf, S., Teitge, J., Mielke, J., Schütze, F. & Jaeger, C. (2021). "The European Green Deal — More Than Climate Neutrality". *Intereconomics.* 56, 99–107. https://doi.org/10.1007/s10272-021-0963-z

Yip, C. M. (2018). "On The Labor Market Consequences of Environmental Taxes". *Journal of Environmental Economics and Management*. 89, 136-152. https://doi.org/10.1016/j.jeem.2018.03.004.