“What determines energy tax rates in European Union countries?”

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WHAT DETERMINES ENERGY TAX RATES IN EUROPEAN UNION COUNTRIES?

Abstract

The modern tax system must support the transition to a carbon-neutral economy. Increasing the environmental tax burden is the most effective measure to achieve this goal. In this context, it is essential to assess the determinants of energy tax rates in European Union countries and understand the crucial conditions for making informed policy decisions. This study contributes to the existing literature by examining the determinants of energy tax rates. It incorporates not only macroeconomic, energy efficiency, and environmental factors, but also indicators of companies' financial performance. The study analyzes a sample of European Union countries from 2010 to 2020, using fixed effects panel regression analysis. The results indicate a negative relationship between energy tax rates and energy intensity (β = –0.347), the return on equity of non-financial companies (β = –0.058), and investments (β = –0.202). The results indicate that energy tax policies in European Union countries are primarily influenced by incentives related to economic growth, specifically energy consumption (β = 0.389), renewable energy (β = 0.076), trade openness (β = 0.544), and the level of public debt (β = 0.234). The results show that environmental motives are not yet a significant factor in the decision-making to increase energy tax rates. The findings indicate that when determining energy tax rates, national governments must carefully consider the balance between environmental motives and the potential consequences for the financial performance of non-financial corporations and their investments, especially in countries with energy-intensive industries.

Keywords energy taxes, environmental taxes, government policy, European Union countries

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INTRODUCTION

The COVID-19 pandemic, the war in Ukraine, and the worsening climate crisis threaten to undermine the progress made in recent years since the Paris Agreement on achieving sustainability goals. This situation underscores the importance of environmental taxes, particularly carbon taxation. The question of whether the appropriate level of taxes is being collected is relevant and urgent, especially now, when European countries have to decide how to finance the increased demand for defense expenditure.

Depending on the circumstances of a particular country, tax policy must play a key role in supporting a just and affordable transition to a low-carbon and climate-resilient economy. It is hoped that through taxation, fuel-intensive products can be replaced in a way that the structure of production and energy consumption changes toward greener products (Wolde & Mulat, 2019). Therefore, the main goal of energy taxes is to encourage companies to change their behavior and use greener technologies and green energy to reduce negative environmental impacts. However, current energy tax levels do not reflect the extent of pollution from different energy sources (European Court of Auditors, 2022). According to the European Court of Auditors (2022), countries should rationalize energy taxes by maximizing the tax base to cover all fossil fuel use and fully capture the environmental costs of these fuels.

The taxation burden affects both consumption and production; therefore, the smooth operation of the tax mechanism requires continuous evaluation and improvement. Based on Wolde and Mulat (2019), Bashir et al. (2021b), Dogan et al. (2022), Ali and Kirikkaleli (2023), and Zhao et al. (2024), it can be stated that the scientific literature emphasizes the positive effects of environmental taxes, including energy taxes, in achieving countries transition to climate–neutral economic development, improving the state of the country's economy and environment, promoting innovation in sustainable technologies, reducing energy dependence on fossil fuels and foreign energy suppliers, and increasing the prestige and value of companies. However, Miceikienė et al. (2022), Shen and Wang (2024), and Feng et al. (2024) also identify negative aspects, raising concerns about the possible negative impact of taxes on a financial performance of companies, competitiveness of the country, and the relocation of businesses to countries with lower environmental tax rates, justifying the delay of policymakers in implementing initiatives to increase environmental taxes.

The relevance of the topic and the research problem is based on the lack of comprehensive and unambiguous studies and the need to assess the determinants of the energy tax rate to achieve environmentally sustainable economic growth.

1. LITERATURE REVIEW

Empirical evidence on factors of energy taxes can be divided into several streams. Scientists examine the relationship between energy taxes and energy efficiency, economic growth, CO_2 emissions, and renewable energy. Some studies emphasize the state of the country's economy and public finances, while others focus on the financial performance of companies. Therefore, a review of the literature will be conducted by analyzing studies in each of these areas.

1.1. Relationship between energy efficiency, economic growth, CO_2 emissions, renewable energy, and energy taxes

Implementing effective policies is crucial, and it is essential to analyze the impact of environmental taxes on energy consumption and energy intensity (Bashir et al., 2021a). To this end, it should be ensured that these taxes are cost–effective (Bashir et al., 2021a). Mahmood and Ahmad (2018) conducted a study on a sample of 19 EU countries from 1995 to 2015 and found a significant negative relationship between GDP growth rate and energy intensity. The research results of Bashir et al. (2021b), Țibulcă (2021), and Ahmed et al. (2022) showed that economic growth is still strongly linked to energy consumption and intensity but also confirmed that the introduction of environmental taxes helps limit energy demand and promote energy efficiency, while at the same time reducing the use of energy resources to lower CO_2 emissions. Dogan et al. (2022) found a strong negative relationship between environmental taxes and CO_2 emissions. Some researchers emphasize that the environmental effect is felt only when the tax rate exceeds a certain threshold. Mardones and Baeza (2018) noted that only the highest rates of environmental taxes can help reduce CO_2 emissions in most South American countries. However, it was found that high pollution taxes and higher taxes on CO_2 emissions establish certain efficient patterns of use of available resources, create a sustainable environment, and stimulate economic growth. The external effect of CO_2 arises mainly from the economic activities of energy-intensive industries (Bashir et al., 2021a). However, Rybak et al. (2022) argue that environmental taxes can be used to reduce greenhouse gas emissions, but this is not a necessary condition. They are often spent on reducing budget deficits or paying off debts. This leads to the consideration that insufficiently high taxes do not change the behavior of producers and consumers and that environmental taxes collected in countries with budget deficits primarily play a fiscal role. However, Ali and Kirikkaleli (2023) concluded that the impact of a carbon tax on environmental pollution is negative, while energy use and economic growth have a positive influence on environmental pollution in the case of France.

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Scientists investigate whether the link between environmental taxes, economic growth, and renewable energy consumption is significant. Bashir et al. (2021a), based on 29 OECD economies using data from 1996–2018, found a negative and significant relationship between environmental taxes and consumption of renewable energy. Meanwhile, the GDP growth rate had a positive and strong relationship with renewable energy consumption, showing that renewable energy is promoted by economic growth. Al-Mulali et al. (2013) examined the relationship between renewable energy and GDP in high-, middle-, and low-income countries and confirmed that for all countries, GDP growth and renewable energy had a bidirectional relationship. Lapinskienė et al. (2017), using a sample of European countries, found no significant relationship between environmental taxes and the increase in renewable energy consumption and identified that the GDP rate is positively associated with renewable energy, confirming the conclusions of other researchers that renewable energy is promoted within the framework of economic growth. A study by Fang et al. (2022) analyzing the relationship between environmental taxes and renewable energy consumption using data from 15 Belt and Road developing and transition economies confirmed that while there is an overall negative relationship between environmental taxes and renewable energy consumption in the short run when examining the long–run relationship, there is a positive relationship between environmental taxes and renewable energy consumption and the share of renewable energy consumed in total energy consumption. These results were confirmed by Shahzad et al. (2021) based on data from 29 developed countries from 1994 to 2018.

In summary, empirical studies identify a strong relationship between economic growth and energy consumption and energy intensity, which confirms theoretical considerations about energy demand as a key factor for economic development. Scientific studies also confirm a negative relationship between energy consumption and intensity and environmental taxes. However, it is revealed that energy efficiency indicators, including CO_2 emissions, do not always change depending on the change in environmental taxes (including energy taxes), since the effectiveness of taxes is manifested only when a certain threshold value is exceeded. The role of environmental taxes in the promotion of renewable energy development is proven in the long term.

1.2. Theoretical aspects of the relationship between the state of the country's economy, public finance, and energy taxes

The scientific literature reveals the significance of differences in countries' economies with respect to environmental taxes and argues that the introduction and adjustment of energy taxes should consider each country's unique economic circumstances.

Environmental taxes can negatively affect the economy of a less developed country, because the sensitivity of energy–intensive enterprises to the impact of taxes depends on how much carbon–emitting fuel is used in production processes (Andersen et al., 2007). Zhixin and Ya (2011) studied the relationship between carbon taxes and economic growth in 29 provinces in China from 1999 to 2008. The researchers found a positive relationship between taxes and economic growth in the eastern provinces of the country and a negative relationship in some central and western regions. Researchers have noted the negative impact of taxes on less economically developed regions that rely heavily on fossil fuels. These conclusions can be supported by Feng et al. (2024). Tchapchet-Tchouto et al. (2022) studied the impact of environmental taxes on economic growth using data from 2009–2019 for 29 European Union countries, the UK, Norway, Iceland, and Switzerland. The research showed a negative and significant relationship between environmental taxes and economic growth. Low- and middle-income countries were found to be more negatively affected than higher- and middle-income countries. This negative mechanism was explained by the fact that after the introduction of carbon taxes, reducing the use of one of the main factors of production, fossil fuels, can lead to a corresponding decrease in production volumes in enterprises. Therefore, given the uneven impact in different countries, this should be considered when forming the EU strategy for the transition to a climate–neutral economy.

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Similar results were obtained by Castiglione et al. (2014) and Castiglione et al. (2018). Castiglione et al. (2014) used data from 24 European countries from 1996–2012 and, considering the uneven economic and environmental performance of European countries, divided the sample into three groups to highlight the heterogeneity of European economies, depending on the degree of economic development, environmental awareness, and the quality of institutions. The results confirmed the relationship between the level of economic development and environmental progress, as countries in an advanced stage of economic development invest more in environmental protection. Castiglione et al. (2018) analyzed the significant factors determining the collection of environmental tax revenues by analyzing a group of 27 European countries based on data from 1996–2011, complementing the study with institutional factors. The results showed that the factors vary between countries due to different institutional models and economic development. The researchers emphasized that the determining factor of environmental taxes is the quality of their management and, therefore, the ability of the government to manage the tax system. From a tax perspective, the rule of law is very important, as it reflects the supremacy of law and the quality of the institutional context itself. In addition, Hassan et al. (2020) studied the relationship between environmental taxes and economic growth rates, analyzing data from 31 OECD countries for the period 1994–2013. The study found that the impact of environmental taxes on GDP depends on the initial level of gross domestic product per capita. The higher the initial GDP per capita, the greater the potential for economic growth to increase environmental tax revenues. This assumption is justified by the fact that environmental taxes raise prices. However, with a higher GDP per capita, people have more disposable income after purchasing basic goods, allowing them to pay higher prices.

Openness to international trade is often considered one of the most important aspects of any economic model, since unrestricted trade flows contribute to increased economic development and energy consumption (Ahmed et al., 2022). Studies have supported a positive relationship between energy consumption, trade openness, and economic growth (Nasreen & Anwar, 2014; Ahmed et al., 2022). In a country with greater trade openness, competition between local manufacturing companies for continuous innovation increases, as evidenced by market changes and research and development (Ahmed et al., 2022). One of the effects of globalization on energy taxes is the increasing competition between countries seeking to attract foreign investment and ensure the competitiveness of their industrial sectors. This often manifests itself in delays in increasing energy taxes and consequently affects the decisions of other countries when adjusting their energy tax rates.

According to the scientific literature, the level of public debt is also an essential indicator for making fiscal policy decisions. As noted by Hassan et al. (2021), many studies showed that when the level of debt is high, the stimulus policies implemented can increase the public budget deficit, increase the level of debt, and cause difficulties for the economy. However, when researchers examine the effect of energy taxes on economic growth, they usually do not consider the negative aspects of high public debt. According to Zhang (2020), due to increased public debt, local governments weaken the strictness of environmental regulations to attract private investment, reduce debt pressure, and raise funding for debt service. Researchers argue that studies that examine the impact of energy taxes on investment must include the public debt indicator in their analysis because the impact of energy taxes on investment is sensitive to the level of public debt. In other words, if a country has a high level of public debt, the negative impact of energy taxes on investment is greater than in a country with a low level of public debt. Hassan et al. (2021) provided macroeconomic evidence on the sensitivity of energy taxes to capital investment and economic growth, depending on the level of public debt, based on data from 31 OECD countries for 1994–2013. The results showed a negative and significant relationship between energy taxes and public debt. The higher the level of public debt in a country, the more harmful an increase in energy taxes is to capital investment in the short run. However, Florea et al. (2021) argue that part of public debt could be oriented toward sustainable investments. Furthermore, Pászto et al. (2020) studied the fiscal impact of environmental taxation in EU member states based on data from 2008 to 2017. The authors found that the environmental tax revenues collected in countries do not

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correspond to the level of emissions, i.e., countries with high emissions can collect as much low, medium, and high environmental tax revenues as countries with low emissions. The researchers emphasized that policymakers rarely consider environmental considerations and are mostly guided by fiscal tax objectives and socio–economic arguments to balance external pressures arising from environmental policy acts of the European Union and hostility to tax increases arising from companies operating in the countries.

1.3. Relationship between corporate financial performance and energy taxes

Environmental taxes partly lead to the compensation of negative environmental impacts with the funds of the participant who caused this phenomenon, thereby increasing the operating costs of companies and reducing the profitability of the initial production strategy (Zhao et al., 2023). According to Miceikienė et al. (2022), environmental taxes create a strong incentive to innovate, but the innovations developed reduce business costs only in the long run. Therefore, a strict fiscal policy can become a heavy tax burden for energy–intensive companies. In this way, the costs incurred would reduce capital investments that could be used for innovation (Albrizio et al., 2017). However, properly set environmental taxes play an important role in encouraging companies to change polluting technologies to more environmentally friendly ones, improve energy efficiency, and achieve mutual benefits (Zhao et al., 2023). The ideal expected effect is that environmental taxes would encourage investments in technological innovations, which would improve the financial performance of companies in the long run and at the same time limit the CO_2 emissions that cause environmental change (Zhao et al., 2023; Zhao et al., 2024). However, the research results of Shen and Wang (2024) show that environmental taxes can negatively impact the financial performance of companies due to corporate technology inputs. Therefore, one of the main goals of environmental taxes is to create competitive, efficient, and environmentally friendly markets (Steinbrunner, 2022).

A negative relationship between taxes and corporate return on assets was found by Long et al. (2022). Based on Franco and Marin (2017), the results support the positive relationship between environmental taxes and the efficiency of companies' operations. Lei et al. (2022) found a positive effect of environmental taxes on the company's financial performance: return on assets, return on capital, and return on sales. However, Zhao et al. (2022) and Zhao et al. (2023) emphasize that when the intensity of environmental taxes is too high, companies simultaneously face both a decrease in profits in the short run and a lack of capital. Leiter et al. (2011) found a positive relationship between environmental taxes and all types of investment, but also identified that, above a certain threshold, the positive effect decreases as taxes continue to increase. Commins et al. (2011) indicated that energy taxes have a positive relationship with the total factor productivity index, investment, and the rate of return on capital employed in many sectors. Meanwhile, a negative relationship between energy taxes and employment (number of employees) was identified in almost all sectors.

Following the literature review, energy tax policy is complex and involves numerous factors that must be considered to ensure its effectiveness. According to previous studies, the country's energy efficiency, economic development, and state of public finances collectively form the conditions for setting energy taxes. However, as the scientific literature reveals, when determining the energy tax rate, it is essential to assess its impact on corporate financial performance.

To better understand the characteristics of energy taxation, the study aims to assess the determinants of the energy tax rates in European Union countries.

2. METHODOLOGY

This section defines dependent and independent variables, the research sample, and the methods that will be used to assess the determinants of energy tax rates.

The variables included in the study can be divided into five groups: 1) energy taxes – dependent variable. Other groups are studied as factors of energy taxes – independent variables: 2) indicators related to energy efficiency, 3) economic

growth indicators, 4) public finance indicators, and 5) macro-level financial indicators of companies. Table 1 presents the variables used in the study and the hypothetical relationship between the independent and dependent variables. In assessing the significance of energy taxes, the scientific literature uses the ratio of energy taxes to total tax revenue (Abdullah & Morley, 2014; Castiglione et al., 2018; Dogan et al., 2022) or the ratio of energy tax revenue to GDP (Abdullah & Morley, 2014; Aydin & Esen, 2018). Since the study only analyzes the EU countries, the implicit tax rate on energy provided by the European Union (Eurostat) is chosen to assess energy taxes, which more accurately reflects the energy tax rate than the indicators used in the literature.

To assess factors related to energy efficiency, the study includes the energy intensity indicator (based on Castiglione et al., 2018; Mahmood & Ahmad, 2018; Bashir et al., 2021b; Ahmed et al., 2022), the indicator of energy consumption (based on Fang et al., 2022; Bashir et al., 2021; Ahmed et al., 2022), the share of renewable energy in total energy consumption (based on Bashir et al., 2021a; Fang et al., 2022) and CO2 emissions (based on Aydin & Esen, 2018; Rybak et al., 2022). The indicator of gross domestic product per capita is selected for the group of economic growth indicators (based on Aydin & Esen, 2018; Mahmood & Ahmad, 2018; Fang et al., 2022; Bashir et al., 2021a) and the indicator that describes the level of trade openness is used for international comparisons of countries (based on Bashir et al., 2021b; Shahzad

Table 1. Research variables

Indicator	Abbr.	Description	Expected relationship with the tax rate on energy and authors
Implicit tax rate on energy	ITRE	Ratio between energy tax revenues (in euros (deflated)) and final energy consumption (as a toe (tons of oil equivalent)) calculated for a calendar year.	
Energy intensity	EI	Energy intensity of GDP in chain-linked volumes (2010), kilograms of oil equivalent (KGOE) per thousand euros. The indicator shows the energy needs of the country's economy, i.e., the amount of energy needed to produce one unit of GDP.	Negative (Mahmood & Ahmad, 2018; Bashir et al., 2021b; Ahmed et al., 2022)
Energy consumption per capita	EC	The indicator measures the total energy needs of a country, excluding all non-energy use of energy carriers (tons of oil equivalent (TOE) per capita).	Negative (Bashir et al., 2021b; Ahmed et al., 2022)
Share of renewable energy in gross final energy consumption	RE	The indicator measures the share of renewable energy consumption in gross final energy consumption according to the Renewable Energy Directive (percentage).	Positive (Shahzad et al., 2021; Fang et al., 2022)
CO_2 emissions	CO_2	Air pollutants and greenhouse gases: Greenhouse gases (CO_2, N2O, CH4, HFC, PFC, SF6, NF3) in CO_2 equivalent, (kilograms per capita).	Insignificant (Castiglione et al., 2018; Mardones & Baeza, 2018; Pászto et al., 2020; Rybak et al., 2022)
GDP per capita	GDP	Real GDP per capita, Chain-linked volumes (2010), euro per capita.	Positive (Castiglione et al., 2018)
Trade openness	Trade	The indicator is the sum of exports and imports of goods and services measured as a share of gross domestic product (percentage).	Positive (Nasreen & Anwar, 2014; Ahmed et al., 2022)
Government debt	Gdebt	General government gross debt as a percentage of gross domestic product (GDP).	Positive (Zhang, 2020; Hassan et al., 2021; Rybak et al., 2022)
Investment	Inv	The gross investment rate of non–financial corporations (percentage) is defined as gross fixed capital formation divided by gross value added.	Negative (Albrizio et al., 2017; Hassan et al., 2021; Zhao et al., 2022; and Zhao et al., 2023)
ROE	ROE	Net return on equity, after taxes, of non–financial corporations (percentage).	Negative (Albrizio et al., 2017; Long et al., 2022; Zhao et al., 2022; Zhao et al., 2023; Shen & Wang, 2024)
Gross profit share	GP	Gross profit share of non–financial corporations. The profit share of non–financial corporations is defined as gross operating surplus divided by gross value added (percentage).	Negative (Albrizio et al., 2017; Zhao et al., 2022; Zhao et al., 2023; Shen & Wang, 2024)

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et al., 2021; Ahmed et al., 2022). According to Hassan et al. (2021), the indicator of the public debt to GDP ratio is selected to assess the situation of public finances. The group of companies' financial performance indicators includes the national accounts indicators published in the Eurostat database. Due to the insufficiency of the data for these indicators, Bulgaria and Luxembourg were excluded from the study sample.

The empirical study sample is the European Union countries (except Belgium and Luxembourg). To ensure the largest possible sample while minimizing data distortions from the cumulative effects of the COVID-19 pandemic and the subsequent outbreak of the war in Ukraine, the research period is 2010–2020, based on data availability. The study variables are collected from the Eurostat database of the European Commission, except for the trade openness indicator, which is obtained from the World Bank database.

To assess the relationships between the dependent variable and the independent variables, standard panel data correlation and regression analysis are used. This method selection is based on Aydin and Esen (2018), Mahmood and Ahmad (2018), Hassan et al. (2020), Bashir et al. (2021b), Țibulcă (2021), Ahmed et al. (2022), and Dogan et al. (2022). The study utilizes balanced panel data. The panel data regression model selection and the results of associated tests are presented in the Results section. EViews' statistical analysis software is used.

3. RESULTS

First, the descriptive statistics of the implicit tax rate data are evaluated (see Table 2).

Table 2. Descriptive statistics of implicit tax rate data

Country	Mean	Min	Max	Std. Dev.
Denmark	408.60	353.97	454.55	32.98
Italy	369.83	287.58	417.50	35.22
Greece	336.41	242.41	376.40	49.64
The Netherlands	278.76	236.54	320.71	26.28
Cyprus	271.11	213.88	303.70	31.80
France	259.58	203.95	314.30	41.23
Malta	258.25	229.42	275.04	16.62
Ireland	243.70	213.41	264.96	17.13
Slovenia	240.16	210.54	257.62	16.42
Sweden	228.78	215.06	250.11	9.37
Germany	222.76	206.94	244.59	10.64
Belgium	206.74	160.35	238.35	24.92
Spain	202.73	167.45	227.64	22.78
Portugal	198.60	182.89	214.69	13.58
Austria	181.99	153.52	195.94	11.08
Slovakia	174.99	118.49	193.69	22.75
Croatia	164.74	117.35	203.02	31.38
Finland	157.32	128.66	169.09	10.27
Estonia	154.99	129.78	212.58	24.19
Latvia	150.14	114.09	179.45	21.80
Poland	146.37	126.87	156.28	11.29
Czech Republic	142.79	133.36	155.00	5.70
Romania	126.93	96.30	151.39	21.08
Hungary	120.65	115.60	125.78	3.19
Lithuania	113.31	98.51	128.32	10.51

Summarizing the results of the implicit tax rate on the descriptive statistics of energy in the data of the EU countries, it can be stated that the values of the mean implicit tax rate on energy vary significantly between the sample of countries. It is observed that the lowest tax rates are applied by countries with a lower GDP per capita and a higher intensity of energy. However, one tendency cannot be attributed to the entire group of countries since economically stronger countries may also apply a relatively low tax rate on energy, and the practices of applying energy taxes in countries may also depend on other important factors.

The results of the correlation between the dependent variable and the independent variables are presented in Table 3. Before that, all variables are logarithmized and their stationarity is checked.

The correlation matrix reveals a significant relationship between energy taxes, their factors, and the factors themselves. The strongest positive linear correlation (compared to other relationships) is found between the implicit tax rate on energy and GDP per capita (0.636), while a similar negative correlation is observed with the energy intensity indicator (-0.660). Consequently, there is a strong negative correlation between GDP per capita and energy intensity indicators (-0.770). A strong positive relationship is observed between energy consumption and GDP per capita (0.723). This relationship also reflects the tendencies identified in the scientific literature that economic develop-

Table 3. Correlation matrix for the variables used in the regression analysis

	ITRE	EC	EI	CO_2	GDP	RE	Inv	ROE	GP	Trade	Gdebt
ITRE	1										
EC	0.132*	1									
EI	−0.660***	−0.343***	1								
CO_2	0.214***	0.474***	−0.238***	1							
GDP	0.636***	0.722***	−0.770***	0.408***	1						
RE	−0.193**	0.189**	−0.096	−0.235***	−0.651	1					
Inv	−0.263***	0.102	−0.048	−0.045	0.047	0.153*	1				
ROE	−0.187**	−0.043	0.029	0.030	0.032	−0.160**	−0.003	1			
GP	−0.281***	−0.353***	0.184***	0.106	−0.270***	−0.250***	0.238***	0.455***	1		
Trade	−0.147*	−0.036	0.322***	0.174**	−0.647	−0.450***	0.214***	0.130*	0.480***	1	
Gdebt	0.432***	−0.057	−0.480***	−0.211***	0.261***	−0.259***	−0.236***	−0.098	−0.219***	−0.339***	1

Note: *** p < 0.001, ** p < 0.01, * p < 0.05.

ment is highly dependent on energy consumption, and vice versa, as the economy develops, energy consumption increases.

To determine the factors of energy taxes, based on the research methodology, an econometric model of panel data is constructed. First, an econometric model of the least squares method (LSM) is constructed, and its homogeneity is checked. Homogeneity is checked after constructing a fixed effects model, and an F-test is performed. Since the p-value of the F test is 0.000, the null hypothesis is rejected; therefore, it can be stated that the data are not homogeneous and the LSM model is not appropriate. In this case, another model, random effects, is constructed, and it is checked whether the random effects correlate with the independent variables. For this purpose, a Hausman test is performed. The test value obtained after performing the Hausman test is 0.0010, which is less than the theoretical probability value. The random effects model is rejected because the random effects correlate with the independent variables, which is why it is most appropriate to choose the fixed effects regression model.

The panel fixed effects regression model is constructed after removing multicollinearity and insignificant variables (see Table 4). To ensure that the fixed effects model is still appropriate after eliminating variables from the sample, the F-test and Hausman test values are checked, which confirms that the fixed effects model is still the most relevant (VIF values of the model are presented in Appendix A, Table A1; Hausman test results are presented in Appendix A, Table A2).

Table 4. Fixed effects regression model

Variable	Coefficient	Std. Error	t-statistics	Prob.
C	3.824	0.689	5.548	0.000
RE	0.076	0.033	2.339	0.020
EI	−0.347	0.075	−4.597	0.000
EC	0.389	0.112	3.481	0.001
Inv	−0.202	0.048	−4.163	0.000
ROE	−0.058	0.018	−3.122	0.002
Trade	0.544	0.088	6.147	0.000
Gdebt	0.234	0.042	5.471	0.000
R-squared		0.950		
Adjusted R-squared		0.944		
S.E. of regression		0.084		
F-statistics		150.022		
Prob (F-statistics)		0.000		

The results of the regression model show the importance of energy variables in determining energy tax rates. According to the results, if the amount of renewable energy consumed in the final energy consumption increases by 1 percent, the implicit energy tax rate increases by 0.076 percent (β = 0.076). The overall change in the share of renewable energy sources in total energy consumption in the analyzed countries is positive, but the average in 2020 was only 20%; therefore, the energy tax rate is also increased to further develop renewable energy. The results indicate a negative relationship between energy intensity and energy tax rate (β = −0.347), and a positive relationship between energy consumption and the implicit tax rate on energy (β = 0.389). The positive relationship between trade openness and the implicit tax rate on energy (β = 0.544) can be interpreted as an indication that countries that are more open to international trade are also oriented towards achieving sustainability goals and applying stricter en-

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ergy tax policies. The relationship between public debt and the implicit tax rate on energy is positive (β = 0.234). Other indicators that have a significant relationship with energy taxes are indicators that describe the financial performance of companies. A negative relationship exists between energy taxes and investment (β = –0.202) and return on equity (β = –0.058).

In the initial stage of the model, to eliminate the problem of multicollinearity between energy intensity and GDP per capita, the GDP per capita indicator was removed from the model, and a significant relationship was assigned to the energy intensity indicator that remained in the model. Based on the correlation analysis, the GDP per capita indicator should show a similar strength and negative relationship with the implicit tax rate on energy as the energy intensity indicator.

The study covers a broad literature analysis, which ensures that it includes the main factors affecting the energy tax rate and can reduce the chances of omitted variable bias. The regression model has high explanatory power (R-squared = 0.95) (see Table 4), meaning that a significant portion of the variance in the energy tax rate is explained by the variables included in the regression model.

4. DISCUSSION

The results of the study are consistent with some previous studies. Previous studies have identified a negative relationship between energy consumption and energy taxes (Bashir et al., 2021b; Ahmed et al., 2022), but this study finds a positive relationship. The results may differ due to the different research samples used and the measurement of the tax indicator. Energy demand is still growing rapidly, and this is one of the necessary conditions for economic growth in EU countries. However, tax rates are being increased to make energy consumption more sustainable by encouraging an increase in the share of renewable energy in total energy consumption. Renewable energy is a positive and significant determinant of energy taxes. This confirms the results of the studies by Shahzad et al. (2021) and Fang et al. (2022). Several EU countries stand out significantly from the overall sample of countries due to their high level of renewable energy consumption (Sweden, Finland, Latvia). However, the overall average share of renewable energy in total energy consumption in EU countries is still low.

The reduction in energy intensity (that is, the increase in efficiency) is one of the most important national objectives of the EU. The negative relationship between energy intensity and energy taxes is consistent with the findings of previous studies (Mahmood & Ahmad, 2018; Bashir et al., 2021b; Ahmed et al., 2022). The negative relationship between these variables is a desirable result, suggesting that increasing energy taxes is an effective measure to reduce energy intensity. Countries that use energy more efficiently are more economically developed and tend to apply higher energy tax rates than countries with lower economic development and energy efficiency.

The statistically insignificant relationship between CO_2 emissions and energy taxes (consistent with Rybak et al. (2022) and Castiglione et al. (2018)) indicates that CO_2 emissions are not a sufficiently significant factor in making decisions on adjusting energy tax rates.

The positive relationship between GDP per capita and energy taxes (consistent with Castiglione et al., 2018), and trade openness and energy taxes shows that increasing economic development as well as trade openness, despite the increase of public debt, does not hinder tax increase initiatives, but, if implemented correctly, stimulates economic growth and has a positive effect on energy taxes. Based on the results, it can be stated that factors related to economic growth have a significant impact and create favorable conditions for the country's fiscal policymakers when making decisions on the increase of taxes. However, revenues collected from environmental taxes are often spent on reducing the budget deficit (Rybak et al., 2022); therefore, as the budget deficit and debt level increase, fiscal motives may also encourage an increase in the energy tax rate. In addition, after analyzing the statistical data of the countries, it can be concluded that countries with higher economic development have a higher average level of public debt than less developed countries and are also characterized by higher energy tax rates. Therefore, an increase in the energy tax rate can be seen as an incentive for the need for a fiscal function.

The negative relationship between the return on equity of companies and energy taxes obtained in this study partially coincides with the results of other studies (Long et al., 2022; Steinbrunner, 2022; Zhao et al., 2023; Shen & Wang, 2024) that also found a negative relationship between corporate financial performance and environmental taxes. The results show that countries where non-financial companies have higher financial performance tend to apply lower energy taxes. The negative relationship between investment in fixed assets and energy taxes obtained in this study coincides with the results of Hassan et al. (2021), which can be attributed to a general explanation of the tax burden: energy taxes create additional costs for businesses, reducing their free cash flow that could be used for investment.

CONCLUSIONS

The study examines the determinants of energy tax rates in the sample of European Union countries from 2010 to 2020 using fixed effects panel regression analysis. The research results showed that the increase in energy tax rates is determined by the increase in GDP per capita, final energy consumption, share of renewable energy in final energy consumption, trade openness, and public debt. The increase in energy intensity, investments of non-financial companies, and the return on equity of non-financial companies had a negative relationship with the energy tax rates.

This study offers a new perspective by linking energy taxes to the financial performance of non-financial companies, as well as to macroeconomic and environmental factors. Investigating the relationship between macroeconomic conditions and the performance of non-financial companies provides a unique contribution that differentiates it from other scientific studies.

The findings indicate some policy implications. To achieve sustainability goals and fiscal needs, governments of EU countries may consider increasing energy taxes, as environmental motives are not yet pivotal in their decision-making regarding energy tax rates. However, when determining energy tax rates, national governments must carefully consider the balance between environmental motives and the potential consequences for the financial performance of non–financial corporations and their investments, especially in countries with energy–intensive industries. Nevertheless, this issue is particularly complex given the increasing public debt of European Union countries, along with rising financing needs due to trade tariff threats and escalating defense expenditures.

Although providing valuable insights, some limitations of the study were identified. The study focuses on European Union countries due to data availability, and the findings may be relevant to other countries; however, with caution. The European Union has a general energy policy and the energy taxation directive; therefore, results may vary in samples from different countries. Future studies could also employ different empirical methodologies based on the findings of this study to enhance the accuracy and applicability of the empirical model.

AUTHOR CONTRIBUTIONS

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APPENDIX A

Table A1. VIF results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.475142	18473.08	NA
RE	0.001067	340.1983	1.846848
EI	0.005698	5700.622	1.897468
EC	0.012502	278.6350	1.364251
Inv	0.002349	898.9426	1.341217
ROE	0.000342	111.3826	1.079721
Trade	0.007821	6749.611	1.369181
Gdebt	0.001822	1211.889	1.332923

Note: VIF values assess multicollinearity, with values > 4 indicating high multicollinearity.

Table A2. Hausman test results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	24.833178	7	0.0008

Note: P-value less than 0.05 indicates that the fixed effects model is appropriate.