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IMPACT OF CARBON REVENUE ON EU GROSS DOMESTIC PRODUCT

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Annotation. Carbon taxes motivate consumers to choose carbon-neutral or green options, such as energy-efficient technologies or renewable energy sources, which are considered environmentally safer compared to carbon-intensive alternatives. Carbon taxes encourage manufacturers to invest in cleaner production methods and technologies and to innovate. Today, more than 70 carbon dioxide pricing schemes are in place worldwide, but their contribution to emissions reduction remains a subject of intense debate in politics and science. Carbon dioxide pricing reduces greenhouse gas emissions, but its effectiveness depends on the context of implementation and policy. Not all schemes are equally efficient. The purpose of the study is to investigate the relation of carbon tax revenue and gross domestic product. The research problem and the gap in the literature arise because existing scientific work typically examines carbon dioxide pricing only as a means of reducing emissions or analyses the use of revenues for social or environmental programmes, but does not examine its influence on GDP, investment, or economic growth. Research objective: to investigate the impact of carbon taxation revenue on gross domestic product based on the consequences of carbon taxation analysis.

Keywords: sustainability, carbon dioxide pricing, carbon taxes, EU gross domestic product.

JEL classification: O44, O52, P45.

Introduction

Taxes, as instruments for reducing environmental pollution and conserving environmental resources, are among the most important fiscal policy measures, helping to promote a green economy and protect the environment from excessive resource consumption and pollution (Miceikienė, Čiulevičienė, 2014). Although the initial concept of taxes that reduce environmental pollution and conserve resources was formulated at the beginning of the 20th century, massively these taxes have been applied in countries around the world recently, contrary to other taxes (Miceikienė, Čiulevičienė, 2014). In the scientific literature, increased attention is paid to the analysis of taxes that reduce environmental pollution and conserve environmental resources, emphasising their significance for the country's economy and the environment. The essence of these taxes is that they are an economic stimulus for ecological development. However, as economic instruments aimed at reducing harmful environmental impacts, they also perform a fiscal function. Scientists name taxes that reduce environmental pollution and conserve environmental resources based on different concepts Parry (2012), Barde and Braathen (2007), De Miguel and Manzano

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(2011), Patuelli *et al*. (2005), Gago and Labandeira (2000), Bosello *et al*. (2001), refer to them as "green taxes", Ekins (1999), Ekins *et al*. (2012), Schöb (2003) as environmental taxes, Conrad and Loschel (2005) as eco (logical) taxes.

Thirty-seven carbon tax mechanisms are currently in use and implemented worldwide, covering a variety of sectors, including transport, industry, and energy. Since 1990, European countries such as Germany, Finland, the Netherlands, and Denmark have implemented carbon dioxide (CO2) taxes to reduce carbon emissions (Ji *et al*., 2025). Governments, through emissions trading schemes or taxation, increase carbon prices to reduce greenhouse gas emissions. The various impacts of carbon taxes, such as on transport (Zhou *et al*., 2020), employment (Li *et al*., 2020), and the economy (Cao *et al*., 2021; Ojha *et al*., 2020), are currently being examined in several studies. Carbon taxes are increasingly recognised as a crucial climate change mitigation tool for reducing carbon emissions. Many countries are making significant efforts to reduce CO2 emissions as the negative impacts of climate change intensify (Rahma *et al*., 2025). The growing threat to the climate has prompted policymakers worldwide to implement stringent measures to transition to a green economy and reduce carbon emissions (Roy, 2024). Among these measures, carbon taxes have become a key incentive to reduce emissions, encouraging the adoption of green technologies by internalising the social costs of carbon (Elkins and Baker, 2001; Boyce, 2018).

Carbon taxes promote emission reductions through several channels. First, they motivate consumers to choose carbon-neutral or green options, such as energy-efficient technologies or renewable energy sources, because these options are cheaper than carbon-intensive alternatives (Narassimhan *et al*., 2018). Second, carbon taxes encourage manufacturers to invest in cleaner production methods and technologies and to innovate (Erdoğan, 2023). Carbon taxes can stimulate the growth of green trade and influence trade patterns (Messerlin, 2012). Carbon taxes encourage companies to switch to green production and implement cleaner technologies (Känzig and Konradt, 2023). Some scholars argue that carbon taxes can encourage a shift toward cleaner production technologies, thereby stimulating the growth of green trade and industry (Meltzer, 2014). The increase in imports of energy-consuming goods and the decrease in their exports are attributed to the carbon tax, which worsens the trade balance (Timilsina, 2022). An important element in the development of unilateral climate policy is carbon taxes, which tax the carbon content of imported products, regardless of whether they are subject to carbon pricing (Böhringer *et al*., 2025). The purpose of the study is to investigate the impact of carbon revenue collection on the gross domestic product. Research problem: there is virtually no research on this topic, and existing scientific work typically examines carbon pricing only as a means of reducing emissions or analyses the use of revenue for social or environmental programmes, but not its direct impact on GDP, investment, or economic growth. Research objectives: to investigate the impact of carbon revenue collection on the gross domestic product. Review carbon pricing schemes. In summary, a carbon tax is a complex economic instrument with several important aspects: it promotes emission reductions, generates government revenue, influences macroeconomic indicators, stimulates technological innovation, and helps regulate international competition. Its success depends on appropriate design, revenue use strategy, and international coordination. The scientific literature emphasises that a well-designed carbon tax can be among the most effective and economically sustainable instruments for mitigating climate change while promoting long-term economic growth, innovation, and social equality.

1. Literature Review

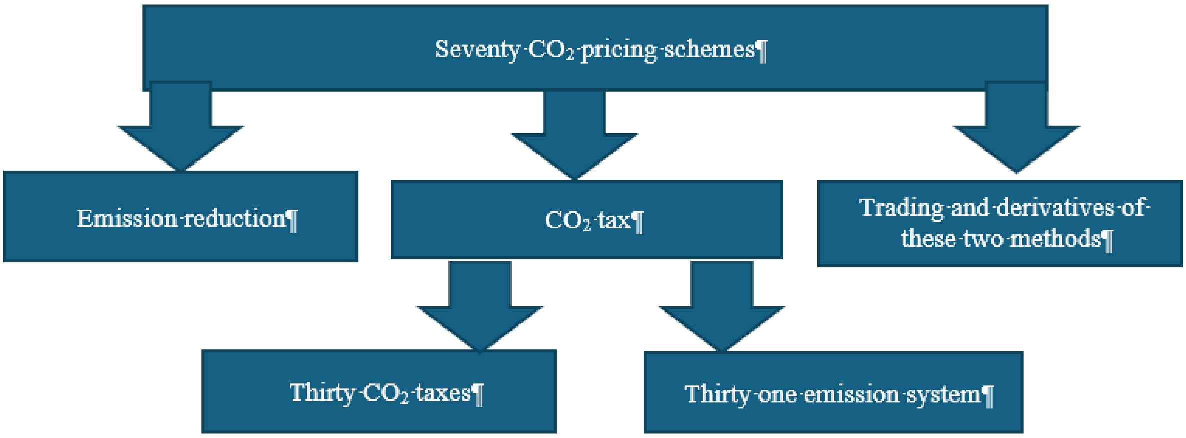
A carbon tax has long been a favourite policy tool among economists for reducing greenhouse gas emissions and thereby mitigating climate change (Metcalf, 2021). A carbon tax imposes a price on CO_2 emissions, allowing the market to determine the level of pollution. All developed and some developing countries have robust tax collection systems, including the capacity to tax most fossil fuels. A carbon tax is the most cost-effective, reliable and simple way to reduce greenhouse gas emissions. Today, more than 70 carbon pricing schemes are in place worldwide, but their contribution to emissions reduction remains a subject of intense debate in policy and academia (Döbbeling-Hildebrandt *et al.,* 2024). The most cost-effective way to reduce greenhouse gas emissions is through the use of carbon pricing policy instruments (Aldy, 2015; Metcalf and Weisbach, 2009; Edenhofer *et al.,* 2015). For policymakers, carbon pricing is a climate policy instrument, such as a carbon cap-and-trade system or a carbon tax (Aldy, 2015).

Carbon pricing mechanisms are effective in reducing greenhouse gas emissions. Carbon pricing requires ongoing effort to better understand the harms of climate change (Aldy, 2015). A growing body of scientific literature provides quantitative assessments of the impact of different carbon pricing mechanisms on emissions. (Hu *et al.,* 2020; Rafaty *et al.,* 2020; Leroutier, 2022). Some carbon pricing schemes target large emitters in the industrial and energy sectors, while others target households. Döbbeling-Hildebrandt (2024) analyses 21 pricing schemes. Dobbeling-Hildebrandt *et al.* (2024) conducted a systematic review to assess the different carbon pricing schemes. The authors reviewed 17,000 studies and described 21 pricing schemes. The analysis of the evaluations focuses on the long-term and immediate emission reductions that carbon pricing brings. Another important result of the study is that differences in context and policy formulation affect the effectiveness of carbon pricing. The extent of emission reductions is influenced by the contributions of economic sectors and the tax system (Sterner, 2024).

Carbon pricing comprises three types: emission reduction, carbon tax, and trading and derivatives of these two methods, which are based on carbon reduction policies (Calvia, 2024). The carbon tax is derived from the Pigouvian tax, which sets a price for carbon emissions (Calvia, 2024). Pigouvius (1920) argued that taxing pollution according to its social marginal harm would equalise the social and private marginal costs and ensure an efficient market outcome (Metcalf, 2021). The adoption and implementation of carbon taxes are complex processes (Criqui *et al.,* 2019), which is why carbon reduction schemes are preferred. Despite their effectiveness in reducing carbon emissions, both policies do not encourage a real transition to zero-carbon technologies (Lilliestam *et al.,* 2021).

The latest Carbon Pricing and Competitiveness Report states that carbon pricing is an effective and cost-effective means of reducing greenhouse gas emissions (CPLC 2017). The growing and widespread use of carbon pricing reflects this belief. There are currently 30 carbon taxes and 31 emissions trading systems (ETSs) around the world, covering 22% of global emissions (Metcalf, 2021) (*Figure 1*).

Carbon taxes impose a surcharge on the use of energy or fuel (Green, 2021). Haites (2018) reviews the effectiveness of carbon pricing in terms of cost efficiency and emission reduction. According to Döbbeling-Hildebrandt (2024), carbon pricing reduces greenhouse gas emissions, but its effectiveness depends on the context and policy. Not all schemes work equally. Many authors write about carbon capture schemes (Hu *et al.,* 2020; Rafaty *et al.,* 2020; Leroutier, 2022; Döbbeling-Hildebrandt *et al.,* 2024). However, there are no studies on collected taxes and their impact on the economy and gross domestic product. This is the novelty of this study. There is little research on this topic, and existing studies typically examine carbon pricing only as a means of reducing emissions or analyse the use of revenues for social or environmental programmes, but not its direct impact on GDP, investment, or economic growth. Additionally, most studies are limited to theoretical models or macroeconomic scenarios, without empirical data on revenue-collection mechanisms and their integrated impact on the economy. Therefore, this work aims to fill this gap by examining how carbon taxes are translated into revenue and their impact on gross domestic product. The study provides an opportunity to systematically assess the efficiency of revenue generation and its macroeconomic implications, which have not been examined in the literature to date.



Source: compiled by the author.

Figure 1. **Carbon Pricing**

In the short term, carbon prices encourage households and businesses to reduce emissions cost-effectively. In the long term, the prospect of constant and rising carbon prices also encourages innovation to reduce the costs of reducing emissions (Boyce, 2018).

Table 1. Carbon dioxide tax rate (per tonne of CO_{2e}), Euros, in the EU and implementation year

Country	Carbon dioxide Tax Rate	Year of implementation
Austria (AT)	€ 32.50	2022
Denmark (DK)	€ 24.37	1992
Estonia (EE)	€ 2.00	2000
Finland (FI)	€ 76.92	1990
France (FR)	€ 44.55	2014
Germany (DE)	€ 30.00	2021
Iceland (IS)	€ 35.40	2010
Ireland (IE)	€ 48.45	2010
Latvia (LV)	€ 14.98	2004
Liechtenstein (LI)	€ 120.16	2008
Luxembourg (LU)	€ 44.19	2021
Netherlands (NL)	€ 51.07	2021
Norway (NO)	€ 83.47	1991
Poland (PL)	€ 13.27	1990
Portugal (PT)(a)	€ 23.90	2015
Slovenia (SI)	€ 17.30	1996
Spain (ES)	€ 14.98	2014
Sweden (SE)	€ 115.34	1991
Switzerland (CH)	€ 120.16	2008
Ukraine (UA)	€ 0.75	2011
United Kingdom (GB)	€ 20.46	2013
EU ETS(b) (For Reference)	€ 88.46	2005

Note: data from https://taxfoundation.org/data/all/eu/carbon-taxes-in-europe-2023.

Source: own research.

With the growth of international trade, carbon dioxide emissions into the environment have increased. Carbon dioxide is released into the environment through the use of energy to produce products and the transportation of imported products by plane, road, rail, and sea into the European Union from third countries. Therefore, the European Union has introduced a carbon tax, which would be applied to certain third countries whose environmental standards are less stringent. This tax would also ensure that imported products are not priced below the equivalent goods produced in the European Union. For the study, we used the carbon tax established by the European Union member states (*Table 1*).

Carbon dioxide pricing is an economic climate policy instrument that aims to internalise the external costs of greenhouse gas emissions by assigning a monetary value to carbon dioxide emissions. The most common forms are carbon taxes and emissions trading schemes (ETSs), which provide incentives for polluters to reduce emissions by making pollution financially unprofitable. Empirical research shows that carbon dioxide pricing is effective in reducing carbon dioxide emissions, especially when the price level is sufficiently high and the policy framework is stable. Furthermore, an appropriate distribution of revenue from carbon dioxide pricing can mitigate the social and economic costs of carbon taxation and increase public support for climate policy. There is a broad agreement among economists that carbon dioxide pricing is a key element of an effective climate policy mix (Nesje *et al.,* 2025). Carbon dioxide pricing has spread significantly to neighbouring countries in recent decades (Linsenmeier *et al.,* 2023). The question of whether a carbon dioxide price should be implemented as a carbon tax, through an emissions-reduction scheme, or as a combination of measures has long interested scholars (Weitzman 1974; Karp, Traeger 2019; Stavins 2022). Similarly, the use of carbon dioxide pricing revenues is subject to intense debate, particularly regarding the potential impact on public acceptance of carbon dioxide pricing and its political feasibility (Carratini *et al.,* 2019; Klenert *et al.,* 2018; Douenne, Fabre, 2022), as well as its relationship to the choice of instrument.

Revenue from a carbon tax on carbon dioxide emissions affects GDP growth. In the short term, higher production costs and energy prices can reduce investment and consumption, thereby slowing GDP growth. The long-term impact depends on how these revenues are used. The impact of carbon dioxide revenues on GDP growth is not straightforward; it depends on fiscal policy decisions, the economy's structure, and the capacity to channel these revenues into activities that promote GDP growth. Consequently, the presence of a carbon dioxide pricing mechanism has been shown to accelerate national transitions to green economies, and investments in solar and wind power are more popular in countries with carbon dioxide pricing schemes (Best, Burke, 2018). In terms of carbon dioxide price developments, prices in the EU carbon dioxide market are relatively stable compared with those in other global carbon dioxide markets (Gao *et al.,* 2023). However, increased uncertainty in economic policy, capital, and energy markets can affect carbon dioxide markets in the EU, leading to declines (Gao *et al.,* 2023). Carbon dioxide prices typically rise with economic growth, as greater economic activity increases energy demand and emissions, thereby intensifying the pressure to limit pollution through stricter climate policies. Economic growth also increases society's and governments' capacity to finance emission reductions, which may lead to higher carbon dioxide pricing. Furthermore, economic growth increases investment in low-carbon technologies, which often become competitive only at higher carbon dioxide prices. For these reasons, economic development is often associated with higher long-term carbon dioxide prices. Theoretically, carbon dioxide prices are predicted to increase with economic growth (Adamolekun, 2024). However, temperature-related risks and other anthropogenic environmental crises will accelerate the rise in carbon dioxide prices (Olijslagers *et al.,* 2023). Carbon dioxide pricing is a key element of climate policy, but carbon taxes and emissions trading currently cover less than a quarter of global emissions. In contrast, general energy taxes that cover the entire economy (e.g., motor fuel taxes), although not originally intended for climate change purposes, can also contribute to reducing emissions (Stepanov, Albrecht, 2025). Carbon dioxide pricing is often considered the most cost-effective policy approach to reducing carbon dioxide emissions. In both academic and public policy debates, various explicit or so-called direct carbon dioxide pricing instruments are often highlighted and analysed as key components of a comprehensive climate strategy (Stepanov, Albrecht, 2025). Experts recommend carbon dioxide pricing as the most cost-effective means of reducing greenhouse gas (GHG) emissions. This is almost certainly true for marginal reductions, but more than gradual emission reductions are needed to avoid dangerous climate change (Tvinnereim, Mehling, 2018).

2. Research Methods and Data

The study aimed to determine the impact of carbon tax revenues on the gross domestic product. The study sample is 2010-2024. The study used two variables: gross domestic product and carbon revenue (*Table 2*).

Table 2. Variables

Variable name	Variable description	Data source
Gross domestic product	Gross domestic product of European Union countries	World Bank, https://data.worldbank.org/
Carbon revenue	Gross domestic product of European Union countries	World Bank, https://data.worldbank.org/

Source: own research.

Before conducting an econometric analysis, the stationarity of the data was first checked. This step is necessary to continue the further calculations. Stationarity check allows to select the econometric model which can solve including potential endogeneity issues. After assessing the stationarity of gross domestic product and carbon dioxide emissions for all EU countries that apply carbon taxes, the suitability of the data for further analysis was determined. If the stationarity assumptions were not met, nominal and time-series transformations were performed. If ADF ($p<0.05$), the data are stationary. If ADF ($p > 0.05$), the data are non-stationary (*Table 3*).

Table 3. ADF test results

Differenced	Indicator	ADF t-statistic.	p-value
I (0)	GDP (EU)	-4.34	0.0004
I (0)	Carbon revenue (EU)	-1.86	0.6162
I (1)	Carbon revenue (EU)	-2.46	0.0181
I (0)	GDP (Denmark)	-0.49	0.8655
I (0)	Carbon revenue (Denmark)	-1.27	0.6099
I (1)	GDP (Denmark)	-4.04	0.0102
I (1)	Carbon revenue (Denmark)	-5.01	0.0020
I (0)	GDP (Estonia)	-1.70	0.6943
I (0)	Carbon revenue (Estonia)	-1.92	0.3125
I (1)	GDP (Estonia)	-4.01	0.0107
I (1)	Carbon revenue (Estonia)	-5.14	0.0017
I (0)	GDP (Latvia)	-4.79	0.0185
I (0)	Carbon revenue (Latvia)	-2.73	0.1059
I (1)	Carbon revenue (Latvia)	-2.75	0.0119
I (0)	GDP (Liechtenstein)	-1.79	0.6894
I (0)	Carbon revenue (Liechtenstein)	-2.79	0.0857

Table 3 (*continuation*). ADF test results

Differenced	Indicator	ADF t-statistic.	p-value
I (1)	GDP (Liechtenstein)	-5.53	0.0011
I (1)	Carbon revenue (Liechtenstein)	-4.74	0.0037
I (0)	GDP (Portugal)	0.22	0.9566
I (0)	Carbon revenue (Portugal)	0.52	0.9759
I (1)	GDP (Portugal)	-3.32	0.0681
I (1)	Carbon revenue (Portugal)	-4.36	0.0130
I (2)	GDP (Portugal)	-4.75	0.0105
I (0)	GDP (France)	-5.07	0.0132
I (0)	Carbon revenue (France)	-3.11	0.0540
I (0)	GDP (Slovenia)	1.57	0.9609
I (0)	Carbon revenue (Slovenia)	-2.22	0.2079
I (1)	GDP (Slovenia)	-4.08	0.0095
I (1)	Carbon revenue (Slovenia)	-2.58	0.0142
I (0)	GDP (Finland)	-1.62	0.4459
I (0)	Carbon revenue (Finland)	-3.31	0.0341
I (1)	GDP (Finland)	-4.79	0.0029
I (0)	GDP (Sweden)	-2.73	0.0929
I (0)	Carbon revenue (Sweden)	-0.91	0.7538
I (1)	GDP (Sweden)	-5.00	0.0021
I (1)	Carbon revenue (Sweden)	-5.78	0.0006
I (0)	GDP (Norway)	-2.09	0.2499
I (0)	Carbon revenue (Norway)	-2.81	0.0814
I (1)	GDP (Norway)	-3.31	0.0361
I (1)	Carbon revenue (Norway)	-5.59	0.0008
I (0)	GDP (Ireland)	0.48	0.9789
I (0)	Carbon revenue (Ireland)	0.97	0.9932
I (1)	GDP (Ireland)	-3.36	0.0333
I (1)	Carbon revenue (Ireland)	-1.82	0.0657
I (2)	Carbon revenue (Ireland)	-3.52	0.0270

Note: *p<0.05.

Source: own research.

Table 4. Granger causality test results

Country	*H:	l=1	l=2	l=3	l=4
EU	GDP→dICO dICO→GDP	0.4572 0.5028	0.8663 0.8530	0.6568 0.7433	0.4220 0.1784
Estonia	dGDP→dICO dICO→dGDP	0.1089 0.7518	0.1099 0.3548	0.3431 0.7083	0.6785 0.2735
Latvia	GDP→dICO dICO→GDP	0.3702 0.3765	0.7969 0.8338	-	-
Liechtenstein	dGDP→dICO dICO→dGDP	0.6647 0.6138	0.8140 0.3468	0.9782 0.1598	-
Portugal	dGDP→dICO dICO→dGDP	0.2801 0.1489	0.1797 0.6220	-	-
France	GDP→ICO ICO→GDP	0.0681 0.1327	0.7880 0.4325	0.5688 0.6977	-
Slovenia	dGDP→dICO dICO→dGDP	0.5540 0.9707	0.1730 0.7329	0.5484 0.7888	0.5885 0.9533
Finland	dGDP→ICO ICO→dGDP	0.6494 0.6407	0.9975 0.8010	0.2700 0.0638	0.7003 0.0156
Sweden	dGDP→dICO dICO→dGDP	0.0909 0.0796	0.2623 0.1967	0.7510 0.5886	0.9230 0.9387
Ireland	dGDP→dICO dICO→dGDP	0.2329 0.0738	0.5144 0.2807	0.2752 0.0609	0.6900 0.4599

Note: *p<0.05.

Source: own research.

After assessing the stationarity of the data, a Granger causality test was performed to determine the reciprocal relationship between gross domestic product and carbon dioxide revenue. The purpose of the Granger causality test is to determine which indicator is the cause of which indicator. The results (*Table 4*) indicate that gross domestic product for the European Union, Estonia, Latvia, Liechtenstein, Portugal, France, Slovenia, Finland, Sweden, and Ireland does not affect carbon dioxide revenue, and vice versa: carbon dioxide revenue does not affect gross domestic product. The indicators obtained for all countries did not meet the required threshold ($p < 0.05$). Therefore, we will perform a correlation matrix in the following.

Table 5. Correlation matrix

Countries	Indicator	Correlation coefficient/ probability
EU	**Revenue generated from carbon dioxide**	**0.870**
	Probability	**0,0000**
Estonia	**Revenue generated from carbon dioxide**	**0.595**
	Probability	**0.0192**
Latvia	Revenue generated from carbon dioxide	0.438
	Probability	0.1771
Liechtenstein	**Revenue generated from carbon dioxide**	**0.618**
	Probability	**0.0184**
Portugal	**Revenue generated from carbon dioxide**	**0.817**
	Probability	**0.0039**
France	Revenue generated from carbon dioxide	0.370
	Probability	0.2627
Slovenia	Revenue generated from carbon dioxide	0.316
	Probability	0.2506
Finland	**Revenue generated from carbon dioxide**	**0.558**
	Probability	**0.0305**
Sweden	Revenue generated from carbon dioxide	-0.208
	Probability	0.4562
Ireland	**Revenue generated from carbon dioxide**	**0.819**
	Probability	**0.0002**

Note: *Bold text – countries with p<0.05.

Source: own research.

After performing the correlation matrix for the European Union, Estonia, Liechtenstein, Portugal, Finland, and Ireland, we obtained probabilities below the required threshold ($p < 0.05$) (*Table 5*). This means that we can continue to build linear models for these countries.

3. Results and Discussion

In all models (*Table 6*), there is a strong positive statistical relationship, and the indicators obtained are below the required threshold ($p<0.05$). In the European Union models for Portugal and Ireland, R-squared and adjusted R-squared are high. When the values of R-squared and adjusted R-squared are close to one, the model is statistically significant, reliable, and stable. The Breusch-Pagan-Godfrey tests indicate that the errors are homoscedastic ($p < 0.05$). In Estonia, Liechtenstein, and Finland, the R-squared and adjusted R-squared are slightly lower. All models are reliable and stable. As countries' economies strengthen, carbon dioxide revenues increase because higher consumption and production lead to higher tax collections on pollution permits and to higher emissions. As the gross domestic product grows, production, energy consumption, transport intensity, and total resource use increase. This increases carbon dioxide emissions and, at the same time, carbon dioxide revenues. The more efficient a country's economy is, the more pollution is taxed and, as a result, carbon dioxide revenues grow along with the country's gross domestic product.

Table 6. GDP model parameter estimates and their statistical significance

Country, criteria	Beta	t	p
European Union			
Intercept: c	1.46E+13	48.04084	0.0000
Revenue for carbon dioxide	82930560	6.365426	0.0000
R-squared	0.757094		
Adjusted R-squared	0.738409		
Mean	0.000977		
Schwarz criterion	57.93850		
Breusch-Pagan-Godfrey	0.010207		
Estonia			
Intercept: c	5.15E+11	6.260581	0.0000
Revenue for carbon dioxide	-8.98E+10	-2.671538	0.0192
R-squared	0.354426		
Adjusted R-squared	0.304766		
Mean	6.92e-05		
Schwarz criterion	52.60507		
Breusch-Pagan-Godfrey	0.362682		
Liechtenstein			
Intercept: c	4.35E+09	5.308290	0.0002
Revenue for carbon dioxide	4.70E+08	2.725506	0.0184
R-squared	0.382347		
Adjusted R-squared	0.330876		
Mean	0.000000		
Schwarz criterion	43.82672		
Breusch-Pagan-Godfrey	0.250492		
Portugal			
Intercept: c	2.16E+09	21.74080	0.0000
Revenue for carbon dioxide	82611497	4.011183	0.0039
R-squared	0.667906		
Adjusted R-squared	0.626395		
Mean	2.96e-05		
Schwarz criterion	50.62530		
Breusch-Pagan-Godfrey	0.055277		
Finland			
Intercept: c	2,22E+11	11,14693	0.0000
Revenue for carbon dioxide	33830638	2,426686	0.0305
R-squared	0.311762		
Adjusted R-squared	0.258820		
Mean	-3.81e-06		
Schwarz criterion	50.16068		
Breusch-Pagan-Godfrey	0.488016		
Ireland			
Intercept: c	1.03E+11	1.825749	0.0909
Revenue for carbon dioxide	468E+08	5.152471	0.0002
R-squared	0.671285		
Adjusted R-squared	0.645999		
Mean	-8.04e-05		
Schwarz criterion	53.19126		
Breusch-Pagan-Godfrey	0.049575		

Note: *Countries with p<0,05.

Source: own research.

When comparing the study's results with existing scientific research, it is important to consider several aspects. The scientific literature often emphasises that carbon dioxide emissions can negatively affect GDP growth through higher production costs or increased energy consumption. The impact on gross domestic product depends on how the revenues are used. For example, investments in innovation positively affect gross domestic product. The contribution is the demonstration of the relation between gross domestic product and carbon dioxide revenue.

Summarising the models, we conclude that carbon dioxide revenues are increasing because higher consumption and production lead to higher taxes collected from emission permits and to higher emissions.

Through the scale of economic activity and climate policy, the gross domestic product and carbon dioxide revenues are closely linked. As countries' gross domestic product grows, consumption, production, and energy demand increase, and therefore, carbon dioxide pricing increases the revenue collected from carbon dioxide. Economically stronger countries apply higher carbon dioxide pricing per tonne and adopt broader carbon dioxide pricing systems because they have greater fiscal capacity; however, in the long term, with successful decarbonisation of the economy, this link may weaken, and revenues may decline or stabilise even with continued gross domestic product growth. Therefore, carbon dioxide revenues grow differently along with the growth of the gross domestic product.

Revenues generated from carbon emissions have positive implications for business decision-making, EU climate policy, and overall domestic product growth. In the context of the European Union's climate policy, carbon revenues constitute an important financial source, enabling, for example, the financing of renewable energy development. This has a positive impact on GDP. At the business level, carbon revenues affect investment decisions and firms' cost structures, encouraging the adoption of innovative, less polluting technologies.

The relation between gross domestic product and carbon dioxide revenue found in our research allows one to evaluate which countries are more successful in implementing carbon taxation policies.

The positive effect of carbon dioxide revenues on gross domestic product depends on the strength of the economy and on the level of carbon taxes. The positive effect of carbon dioxide revenues is evidenced by lower pollution intensity and the adoption of more efficient technologies that reduce emissions.

Conclusions

Summarising the analysis of European Union countries, it can be concluded that revenues from carbon dioxide taxes and carbon dioxide pricing do not negatively affect gross domestic product, and that an appropriate carbon dioxide pricing policy can be aligned with countries' economic growth. There is a tendency in European Union countries that, as gross domestic product grows, climate policy also strengthens. Including increased carbon dioxide prices and higher revenues from carbon taxes and pollution trading permits. This indicates that economic development increases countries' capacity to implement stricter environmental regulations. The experience of European Union countries indicates the potential compatibility between reducing carbon dioxide emissions and economic growth. Carbon dioxide pricing can be considered an important tool for achieving sustainable economic growth at the European Union level.

Carbon taxes motivate consumers to choose carbon-neutral or green options, such as energy-efficient technologies or renewable energy sources, because they are cheaper than carbon-intensive alternatives. Carbon taxes encourage manufacturers to invest in cleaner production methods and technologies and to innovate. Carbon taxes have long been a favourite policy tool among economists for reducing greenhouse gas emissions and thereby mitigating climate impacts. Today, more than 70 carbon dioxide pricing schemes are implemented worldwide, but their contribution to emissions reduction remains a subject of intense debate in politics and science. Carbon dioxide pricing mechanisms are effective in reducing greenhouse gas emissions. Carbon dioxide pricing reduces greenhouse gas emissions, but its effectiveness depends on the implementation context and policy. Not all schemes work the same.

Carbon revenue and its impact on GDP are an important direction for future econometric research. Most studies analyse the short-term impact on GDP. However, future research should pay greater attention to technological progress across different markets. The limitations of this research stem from the lack of accessible data on the specifics of different countries' implementation of EU climate policy. Such an analysis would be valuable for examining how different uses of carbon revenue affect gross domestic product.

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ANGLIES DIOKSIDO MOKESČIŲ POVEIKIS ES BENDRAJAM VIDAUS PRODUKTUI

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Santrauka. Anglies dioksido mokesčiai skatina vartotojus rinktis anglies dioksido požiūriu neutralias arba ekologiškas alternatyvas, pavyzdžiui, energiją taupančias technologijas ar atsinaujinančius energijos šaltinius, kurie laikomi aplinkai saugesniais, palyginti su daug anglies dioksido išskiriančiomis alternatyvomis. Anglies dioksido mokesčiai skatina gamintojus investuoti į švaresnius gamybos metodus ir technologijas bei diegti naujoves. Šiuolaikiniame pasaulyje veikia daugiau nei 70 anglies dioksido kainodaros schemų. Tačiau jų indėlis mažinant išmetamųjų teršalų kiekį aktyviai diskutuojamas politikoje ir moksle. Anglies dioksido kainodara mažina šiltnamio efektą sukeliančių dujų išmetimą, tačiau jos veiksmingumas priklauso nuo įgyvendinimo konteksto ir politikos. Ne visos schemos yra vienodai veiksmingos. Tyrimo tikslas – ištirti anglies dioksido mokesčio pajamų poveikį bendrajam vidaus produktui, remiantis anglies dioksido mokesčio pasekmių analize. Tyrimo problema ir literatūros spraga ta, kad esami moksliniai darbai daugiausia nagrinėja anglies dioksido kainodarą kaip priemonę mažinti išmetamųjų teršalų kiekį arba analizuoja pajamų panaudojimą socialinėms bei aplinkosaugos programoms, tačiau neįvertina šios kainodaros įtakos BVP, investicijoms ar ekonomikos augimui.

Reikšminiai žodžiai: tvarumas; anglies dioksido kainodara; anglies dioksido mokesčiai; ES bendrasis vidaus produktas.