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PUBLIC DEBT VS. GOVERNMENTAL ENVIRONMENTAL EXPENDITURE: EVIDENCE FROM EU ECONOMIES

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ABSTRACT: The main purpose of this study is to evaluate the impact of public debt levels on public environmental protection expenditures. The underlying hypothesis suggests that the level of public debt influences the amount of public spending allocated to environmental protection. The methodology is based on a panel data regression analysis for the yearly observations from 1995 to 2022 on all EU economies. Data were collected from the Eurostat database. The results are contextualised within the broader framework of sustainable development and legal regulations, which promote higher environmental protection expenditures. The findings contribute to the ongoing discourse on the efficiency of environmental protection expenditure, exploring the tension between fiscal responsibility and the need for greater investment in environmental sustainability.

KEYWORDS: public debt, public expenditure, sustainable development, environmental protection

Introduction

Climate change and environmental protection have emerged as pressing global issues, requiring a comprehensive response across various sectors. In the financial domain, the concept of sustainable development extends beyond the framework of green finance, encompassing the necessity to secure public funding for sustainability-related expenditures. Ensuring adequate (and often significant) resources within central budgets, as well as in the budgets of regional and local governments, is crucial to addressing the growing demands for sustainability initiatives.

Most countries worldwide, including nearly all European Union (EU) member states, are characterised by high levels of public debt, not only in nominal terms but also relative to their GDP. To ensure clarity of our research, we narrowed the scope of public expenditures relevant to sustainable development goals to those related specifically to environmental protection. Therefore, the primary objective of our research is to evaluate the impact of public debt levels on public environmental protection expenditures. To conduct our research, we employed panel data regression analysis. The dataset spans the years 1995 to 2022, incorporating annual data for all the EU economies (taken from the Eurostat database).

The article is structured as follows: after the introduction, we provide a literature review, where we emphasise sustainable development and the relationship between increased environmental expenditures and fiscal policies. This is followed by a discussion of the statistical data and research methods used in the study. Next, we present the empirical findings. The final section, “Conclusion and Policy Implications,” highlights the key conclusions of the research.

Research gap and motivations for the study

The issue of public environmental protection expenditure has been widely addressed in academic literature, with numerous studies exploring its level, structure, and effectiveness – particularly within the framework of sustainable development goals. However, one critical dimension remains underexplored: the degree to which such expenditures are influenced by fiscal conditions, notably the level of public debt and the broader sustainability of public finances.

Although the relationship between fiscal policy and environmental protection has been acknowledged, existing research often focuses on individual countries or on isolated fiscal instruments. There is a clear lack of various cross-country comparative analyses that systematically assess how fiscal variables impact environmental spending. This gap is especially pronounced in the context of EU economies, where fiscal constraints such as those imposed by the Stability and Growth Pact may limit the scope of discretionary spending on sustainability objectives (Bacchiocchi et al., 2011; Koehler & König, 2015).

This study seeks to address these deficiencies by providing a comprehensive, EU-wide analysis of the relationship between selected fiscal indicators – public debt, general government balance, and interest payments – and general government expenditure on environmental protection. Particular attention is given to the distinction between “EU-15” countries (members prior to the 2004 enlargement) and “new” member states (joined in 2004 or later), in order to reflect the varying fiscal legacies and institutional capacities across the Union.

A contribution of this article lies in the use of a newly constructed dataset and a panel data regression model that has not previously appeared in the literature. The model draws on annual data for all 27 EU countries spanning the years 1995 to 2022, allowing for the identification of long-term trends and structural differences. The empirical findings demonstrate that fiscal conditions can have both enabling and constraining effects on environmental spending, depending on the level of debt, the cost of its servicing, and the macroeconomic and institutional context.

By integrating fiscal analysis with environmental policy, this study contributes to the growing body of research at the intersection of debt sustainability and green investment. It offers new, data-driven insights into how European governments may pursue environmental goals within the boundaries of fiscal discipline – and where flexibility may be required to reconcile both imperatives.

Theoretical framework, literature review and research hypothesis

The theoretical foundation of this study is rooted in the interplay between fiscal policy and environmental sustainability within the paradigm of sustainable development economics. According to this perspective, governments face a dual responsibility: maintaining fiscal discipline and ensuring sufficient public investment in areas that promote long-term socio-economic and environmental well-being. Environmental protection, though often considered a discretionary spending category, constitutes one of the three fundamental pillars of sustainable development. From a fiscal standpoint, expenditures on environmental protection may be influenced by the availability of public resources, the structure of fiscal priorities, and the broader macroeconomic context. In this light, the concept of “fiscal space” becomes particularly relevant – referring to a government’s capacity to provide resources for a specific purpose without undermining fiscal sustainability (Heller, 2005). This concept underpins our assumption that the size and structure of public debt, alongside related fiscal indicators, can have a significant effect on the ability of states to fund environmental objectives.

Moreover, this study is situated within the theoretical framework that views public finance not only as a stabilising tool but also as a mechanism for structural transformation. In economies facing increasing climate and environmental challenges, fiscal policy can serve as a channel for green transition. However, the ability to leverage this potential is often constrained by high levels of debt, rigid fiscal rules, or competing budgetary demands. The “environmental fiscal policy” literature suggests that both tax-based instruments and targeted spending can facilitate greener economies – provided that governments retain sufficient autonomy in allocating their budgets. This context informs the research direction adopted in this paper, namely: assessing whether fiscal variables such as public debt, deficits, and interest payments are conducive to – or restrictive of – environmental spending in EU economies.

From a fiscal perspective, two opposing hypotheses can be proposed regarding the relationship between public spending on sustainable development and public debt. On the one hand, public expenditures for sustainability initiatives may increase budget deficits and, consequently, raise public debt levels. On the other hand, precautionary fiscal mechanisms in highly indebted countries could potentially limit the public spending directed toward sustainability-related goals. In this study, we chose to explore the latter path. In this study, we chose to explore the hypothesis that considers limitations of the public spending directed toward sustainability-related goals caused by a high level of public debt. We put forth the following research hypothesis: public debt levels influence the amount of public spending on environmental protection. We decided to concentrate on the hypothesis because the issue of the relationship between expenditure on sustainable development and the state of public finances is broad and multi-threaded.

The implementation of sustainable development is a process based on international cooperation, which is essential for the effective realisation of its objectives. The countries involved in this process coordinate their actions by organising multilateral conferences and drafting documents setting new goals and proposing methods for achieving them. One of the most recent documents is the “2030 Agenda for Sustainable Development”, which aims to promote development in a balanced way in all countries of the world, leaving no one behind and paying special attention to the poorest and most marginalised people. The agenda emphasises that sustainable development should be economically, socially and environmentally balanced (Dugarova & Gülasan, 2017).

The environmental aspect of sustainable development is multifaceted and touches on many issues relevant to sustainability. These issues include, for example, the circular economy, which is aimed at decoupling economic growth from resource consumption through reduction, reuse, and recycling, and has gained momentum in Europe with initiatives like the Circular Economy Package (Sanguino et al., 2020). Similarly, advancements in sustainable energy, such as hybrid bioenergy and waste-to-wealth systems, enhance energy efficiency and support sustainable economic growth (Chu et al., 2022). Also, renewable energy is linked to economic growth, though reliance on fossil fuels still poses challenges like CO₂ emissions (Madaleno & Nogueira, 2023). In the EU, exports of renewable energy and ICT contribute positively to GDP growth (Žarković et al., 2022). Among these issues, environmental protection remains an important area of influence in the environmental sphere of sustainable development. The depletion of natural resources, the degradation and pollution of soil, air and

water, and the destruction of ecosystems are changing the climate, causing global temperatures to rise (Tirtayasa, 2021).

The particular growth of interest in the concept of sustainable development in the 21st century has contributed to the appearance of a succession of publications considering the relationship of public spending on sustainable development goals, including environmental protection, with the central budget situation, the fiscal policy pursued, and the size of the debt. These publications consider the relationship from both the point of view of the impact of the size of public debt on the size of environmental expenditures and the impact of these expenditures on the size of public debt. Indeed, solving environmental problems can face a major barrier in the form of unsustainable public finances. For example, high levels of budget deficits and public debt can restrict investments in renewable energy infrastructure by redirecting resources toward servicing debt obligations instead of financing sustainable projects. This effect is especially pronounced in countries emphasising fiscal discipline to allocate resources for renewable energy (Auteri et al., 2024). In the European Union, fiscal limitations imposed by frameworks like the Stability and Growth Pact (SGP) often result in underinvestment in public infrastructure, including projects related to sustainability, as nations focus on meeting debt and deficit requirements (Bacchiocchi et al., 2011). Debt and deficit ceilings exert pressure on economies, necessitating substantial adjustments in tax and spending, which can restrict the fiscal space for sustainability investments, especially in high-debt nations (Uctum & Wickens, 2000). The European Stability and Growth Pact has successfully reduced government debt but has simultaneously limited public spending on sustainability initiatives in countries such as Greece, Portugal, and Italy (Koehler & König, 2015). Though fiscal constraints may limit sustainability spending, they also promote fiscal discipline and long-term financial stability, essential for sustainable development. Certain fiscal policies, like environmental taxes and green budgeting, directly support sustainability by internalising environmental costs and enhancing resource efficiency (Meng, 2024; Afshan et al., 2024). However, the success of these policies largely depends on their design, implementation, and the wider economic and political context. Therefore, fiscal policies, encompassing tax incentives, subsidies, and environmental levies, are pivotal in enhancing natural resource efficiency and fostering green economic growth. These instruments can redirect economic activities toward sustainability, even amid fiscal constraints (Sun et al., 2024; Meng, 2024).

The question of the relationship between fiscal policy design and the state of the environment has been analysed in the literature from various points of view. Boly et al. (2023) point out that the condition of the environment is strongly influenced by political decisions and the structure of budgetary spending. In the years leading up to elections, politicians favour a spending structure that worsens the state of the environment. They also reduce environmental taxes and increase subsidies for fossil fuels. In agricultural countries, the conversion of forests into farmland causes other forms of pollution. Russel and Benson (2014) argue that the level of environmental spending and the use of environmental stimulus programmes depend on the party whose government decides on fiscal policy. These authors suggest that green budgeting is an important tool for evaluating environmental spending and promoting greener economic growth. This is because it allows politicians to draw attention to the environmental consequences of investment programmes. Another issue that is often addressed is the impact of environmental taxes on the condition of the environment and the level of CO₂ emissions. Orazio (2025), who analyses the impact of climate risk on fiscal policy in developing countries, notes that the effects are multidirectional. Climate change poses a number of challenges but also opportunities for the economy. Given the tight fiscal situation in most countries, it is important to channel limited resources into investments that adapt the economy to climate change. Tapping additional sources, such as funds from international aid agencies, will also help. Such policies will help build sustainable public finances in an economy that is increasingly resilient to climate change. According to a study by Mehta and Prajapati (2024), increasing the level of taxes on CO₂ emitters increases investment in environmental protection and contributes to emission reductions. The authors also point out that public spending on environmental protection increases this effect. The fact that an increase in public spending leads to an increase in fiscal imbalances raises the question of the relationship between the level of public debt and the level of environmental spending. This question has been prominent in the literature for many years. Young and Roncisvalle (2002) indicate in their study that as public debt and the cost of servicing it increased, environmental spending in Brazil decreased. These results, although based on studies for a single country, nevertheless point to

an important problem: a deterioration in the financial situation of the government budget results in a reduction in expenditure that is not considered a priority. Unfortunately, environmental spending is often not the most relevant category for governments, especially in developing countries.

Public debt can supply essential resources for environmental protection, financing initiatives like pollution abatement, especially in the short term, where budget deficits support environmental spending (Boly et al., 2022). In ASEAN-5 countries, where economic development often raises public debt, balancing growth with environmental sustainability is crucial. Managing public debt effectively can facilitate environmental protection if investments are strategically allocated to sustainable projects (Shaari et al., 2023).

In emerging economies, external debt has been observed to impede green growth, indicating inefficiencies in leveraging debt for sustainable development. This underscores the necessity for effective fiscal policies to channel external debt toward sustainability objectives (Afshan et al., 2024). In China, credit allocation and government environmental expenditures play a crucial role in determining environmental quality. The interplay between these factors can either strengthen or limit the effectiveness of environmental protection efforts, underscoring the need for strategic financial management in environmental policy (Yang et al., 2021).

Adelaja et al. (2008), on the other hand, in examining the impact of various factors on the amount of environmental spending in the various US states, indicated that it is strongly influenced by the amount of tax revenue collected. The greater the tax collection capacity of states, the greater their ability to finance environmental spending. In contrast, a 1% increase in public debt, which provides an alternative source of funding for public spending, contributes to a 0.35% decrease in environmental spending. Hence, the authors conclude that central governments are not willing to finance environmental spending with debt instruments, but rather with taxes. Thus, the deterioration of the tax base and the increase in public debt are factors that limit the amount of environmental spending.

Petkova (2009), on the other hand, notes that the effective preparation and implementation of environmental programmes requires a longer than annual budget planning horizon. This is because these programmes mostly have a medium to long-term planning, implementation, and payback perspective. The author proves that the implementation of medium-term budget planning has a positive impact on the amount of environmental spending. This has been especially true in developing countries.

Zenius (2024) addresses the complexity of the relationship between debt and climate change. He points to the fact that climate change has an impact on the public debt-to-GDP ratio. He analyses both the impact of climate change on the denominator of the relationship (i.e., the level of GDP) and on the numerator (i.e., the size of the debt). He includes mitigation and adaptation costs among the direct costs. In contrast, he includes in indirect costs the fiscal costs of climate change-induced instability, climate-induced forced migration and conflict. This author points to the link between the debt financing of climate action and the fiscal costs of climate change. He points out that climate change negatively affects the amount of natural capital. Conversely, natural disasters and climate change adaptation expenditures result in additional expenditures, thereby reducing budget revenues. He also points to the example of corporate bankruptcy caused by climate change, which he notes is the first directly related but undoubtedly not the last. This will contribute to the volatility of capital flows and political instability. The author illustrates these correlations through the 'doom loop', whose elements are presented in Figure 1. He emphasises, however, that it does not imply an inevitability of disaster, but rather a series of challenges. Adequately planned and taken measures can contribute to limiting the consequences of unsustainable debt. One instrument that will help in this is public debt. This author emphasises that future generations will be forced to repay these debts, but at the same time will benefit if these actions prevent climate change. He also points out that debt-financed spending on climate change adaptation can have the effects of economic recovery and reduced climate change risk. The article also provides evidence that an increase in climate risk contributes to a non-negligible proportional increase in debt servicing costs, and that a decrease in climate risk causes a less than proportional (but still) decrease in debt servicing costs. Hence, it can be concluded that it is in the interest of the state to reduce the impact of climate change on the economy, even if financed by public debt. The author also points out that financing investments with green bonds provides too little benefit to be an effective tool for climate change impacts.



Figure 1. Influence of climate change on public finance stability

Source: authors' work based on Zenios (2024).

As Hurnik and Sirimaneetham (2023) note, public spending on the Sustainable Development Goals adds to debt levels in the short term. However, in the long run, they will generate savings that are significant enough to better balance debt levels. Hence, the assessment of fiscal policy in terms of debt sustainability should consider the amount of spending on sustainable development goals (especially environmental). In particular, the authors highlight the social benefits of environmental investments. Their analysis indicates that these will be clearly higher than the benefits associated with a restrictive fiscal policy based on tax increases and debt reduction. Similar conclusions are reached by Carnazza et al. (2023), who show a conflict between the requirements of the European Union's fiscal constraints and the need to reduce CO₂ emissions. Their results show, among other things, that increasing the stringency of the European fiscal framework, including the debt-to-GDP ratio, increases carbon intensity. They therefore call for fiscal rules to be made more supportive of environmental sustainability.

Davin et al. (2024) analyse the question of the relationship between public debt dynamics, pollution levels, and economic growth. They base their analysis on an endogenous growth model. The authors consider the interplay between the above factors. High levels of pollution can negatively affect the productivity of the economy and, through this, make it difficult to maintain debt sustainability. On the other hand, investment in pollution reduction financed by public debt allows capital productivity to increase and, based on that, facilitates the maintenance of debt sustainability. The authors refer to a study by Heijdra et al. (2006), which showed that financing environmental spending with public debt helps to balance the amount of capital (environmental and physical) available to current and future generations. They also refer to research by Fodha and Seegmuller (2014), which

showed that high debt levels limit the scope for increasing environmental spending. This is because limits on debt levels block the possibility of further debt increases. In contrast, the research presented in this article shows the importance of the initial level of debt and pollution and the type of fiscal policy pursued. The authors identify two sustainable development paths, which are characterised by different levels of pollution and public debt. In contrast, the unsustainable path occurs primarily when pollution levels are high enough to result in a decline in capital productivity. Then both pollution and debt levels rise. Hence, the authors suggest that it is particularly important to invest in efficient environmental technologies to maintain a sustainable growth path. They also point out that these investments can be financed by both public debt and tax revenues. Appropriate fiscal policies that consider environmental damage (and by extension productivity) maintain a sustainable path that reduces pollution and keeps public debt at a sustainable level (Davin et al., 2024).

Earlier research by Fodha and Seegmuller (2012) examines the question of the relationship between debt levels and the amount of environmental spending. These authors argue that with the increase in the level of public debt, and especially its explosion, there is a problem with the financing of environmental expenditures. This is because they are one of the categories that are curtailed in the first place. However, these authors note that the development of taxes that burden polluters leads to a more stable system of financing environmental spending. At the same time, it leads to a more balanced central budget, shifting the financing of some expenditure from debt instruments to tax instruments. These authors also cite the issue of the environmental poverty trap. This occurs when high levels of public debt require corrective action. At that point, the household savings rate falls, and, through this, the investment rate falls. They also consider the issue of the crowding-out effect of private environmental spending by rising public spending and suggest prudent increases in such spending, especially debt-financed spending.

The variety of studies on the relationship between fiscal policy and the size of debt and the level of spending on sustainable development goals, including environmental protection, has resulted in mixed results. Therefore, we have attempted to reassess the relationship between the level of selected fiscal variables and the level of environmental spending. The analysis was carried out on the example of the European Union countries and covers the period 1995-2022.

In light of the reviewed literature and theoretical considerations, this study formulates and empirically tests the following hypothesis: the level of public debt has a statistically significant impact on the amount of public expenditure allocated to environmental protection. Specifically, we assume that higher levels of public debt may both enable and constrain such expenditure, depending on whether the debt leads to expanded fiscal capacity or increased servicing costs that crowd out discretionary spending. Furthermore, we explore how this relationship may differ across EU member states, distinguishing between “old” and “new” EU countries, which differ in their fiscal histories, institutional development, and environmental policy integration. The study aims to quantify these relationships and provide empirical insight into how fiscal sustainability relates to environmental priorities in varying European contexts.

Data and methodology

The aim of our research was to evaluate the relationship between the sustainability of public finance and the level of environmental protection expenditures. To achieve this, we developed a panel model in which the dependent variable represents the environmental protection expenditures of the general government sector. The explanatory variables include fiscal variables, whose relationship with the dependent variable is the focus of our analysis, as well as control variables. Based on this approach, the following model was constructed:

$$EXP_{ENV_t} = \alpha_0 + \alpha_1 EXP_{GPS_{it}} + \alpha_2 DEF_{it} + \alpha_3 INTR_{it} + \alpha_4 DEBT_{it} + \alpha_5 GHAS_{it} + \alpha_6 GDP_{it} + \varepsilon, \quad (1)$$

where:

$EXP_{ENV_{it}}$ – Total general government expenditure on environmental protection (Percentage of GDP),

$EXP_{GPS_{it}}$ – General government expenditure on general public services (Percentage of GDP),

DEF_{it} – Net lending (+)/net borrowing (-) of the General government sector (Percentage of GDP),

$INTR_{it}$ – expenditure of general government – Interest (Percentage of GDP),

$DEBT_{it}$ – Government consolidated gross debt of the General government sector (Percentage of GDP),

$GHAS_{it}$ – Greenhouse gases (CO₂, N₂O in CO₂ equivalent, CH₄ in CO₂ equivalent, HFC in CO₂ equivalent, PFC in CO₂ equivalent, SF₆ in CO₂ equivalent, NF₃ in CO₂ equivalent) total emission (tonnes per capita),

GDP_{it} – Gross domestic product at market prices, Current prices (million euros).

The selection of variables was based on their potential impact on the level of total general government expenditure on environmental protection (environmental protection expenditures). Therefore, the analysis assessed the influence of government consolidated gross debt (public debt), the net lending/net borrowing (budget surplus/deficit) of the general government sector, expenditure of general government on interest on public debt (public debt servicing cost) and general government expenditure on general public services. The relationship between government spending on public services and environmental protection is multidimensional, with economic, social, and governance components. Government spending on public services frequently attempts to improve citizens' well-being and economic progress, whereas environmental protection spending focuses on sustainability and reducing ecological deterioration. These two areas of expenditure can be interconnected, since effective environmental protection can boost public service outcomes by enhancing health and quality of life, while public service investments can support environmental goals through infrastructure and policy development (Stojanović et al., 2022; Noja et al., 2021).

Additionally, the relationship between the level of public expenditures on public services was examined. As control variables, gross domestic product at market prices (GDP) and greenhouse gas emissions were included in the analysis. Table 1 presents the correlation coefficients of the explanatory variables. Their analysis indicates a low level of correlation between the explanatory variables.

Table 1. Correlation coefficients of explanatory variables

	GDP_{it}	$GHAS_{it}$	$DEBT_{it}$	$INTR_{it}$	DEF_{it}	$EXP_{ENV_{it}}$
$EXP_{GPS_{it}}$	0.0989	0.028	0.6224	0.8575	-0.2805	1
DEF_{it}	-0.0332	0.2147	-0.3373	-0.3284	1	
$INTR_{it}$	0.081	-0.0144	0.6321	1		
$DEBT_{it}$	0.3352	-0.0774	1			
$GHAS_{it}$	0.004	1				
GDP_{it}	1					

The research sample consisted of 27 European Union countries. The data covered the years 1995–2022 and were sourced from the Eurostat database. The conducted data analysis, the size of the panel and the characteristics of the analysed objects suggest that a fixed-effects model should be appropriate (Dańska-Borsiak, 2011; Muszyńska, 2006). Nevertheless, the obtained Hausman test results suggest that the random effects model should be chosen. In consequence, it presents Tables 2-4, which present the results of the estimation of both models. Due to the ambiguity of the results obtained, lagged variables were not included in the model.

In the empirical section, we estimated the model for all EU countries, as well as separately for the so-called “new EU” countries (those that joined the European Union in 2004 or later) and the “old EU” countries (those that were members of the Union before 2004).

Empirical results

The results of the panel model estimation for the 27 countries of the European Union are presented in Table 2. The model has a coefficient of $R^2 = 0.713$. The results of the tests were also presented in Table 2. The distribution of residuals is presented in Figure 1.

The above data indicate that the level of environmental expenditure in the analysed countries of the European Union depends on several factors. Firstly, the analysed fiscal variables have a statistically significant impact on this variable. The first one is public debt, which, according to the results of the model, has a significant impact on the level of environmental expenditure. The positive value of the coefficient indicates that as public expenditure financed by public debt increases, so does the volume of environmental expenditure. This relationship can be explained by the greater financial capacity of public finance sector entities. This outcome may appear debatable. However, it is important to note that most EU countries are significantly indebted – some of them excessively so. Highly indebted countries continue to invest in development and infrastructure. In complying with EU directives on environmental protection and safeguarding the well-being of their citizens, these countries are unlikely to reduce environmental expenditures. They have, in a sense, become “accustomed to debt.” According to Kantorowicz et al. (2024), public debt can facilitate increased voter support for green investments, as it shifts the financial burden into the future.

It is also worth noting that the level of public debt is not the sole factor considered by credit rating agencies when evaluating national economies. Consequently, many countries with public debt levels that significantly exceed fiscal benchmarks still receive top ratings (e.g., AAA) and are thus able to allocate public funds toward citizen well-being, including spending related to environmental protection.

A similar relationship is indicated by the relationship of the analysed variable with the budget surplus/deficit. The relationship shows that as the budget surplus/deficit increases, the volume of environmental protection expenditure increases. Again, an increase in the value of public expenditure creates an opportunity to increase environmental expenditure. In contrast, the relationship with the public debt servicing cost, which is also statistically significant, shows a slightly different relationship. A negative coefficient on this variable indicates that an increase in the burden of public debt servicing costs on public finances leads to a decrease in environmental protection expenditure. The rationale for such results may be that an increase in the burden of public debt servicing costs on the government budget leads to the consequent abandonment of expenditures that are not considered rigid. Unfortunately, environmental protection expenditure is one of them.

Table 2. Panel data estimation results for the environmental protection expenditure variable for the European Union countries, 1995-2022

Variable	Coefficient	Standard error	t-Student	P-value	Coefficient	Standard error	z	P-value
	Fixed effects model (FEM)				Radnom effects model (REM)			
<i>const</i>	0.627848	0.0704018	8.918	3.97e-018***	0.599714	0.0838016	7.156	8.28e-013 ***
<i>EXP_{GPS_{it}}</i>	0.00529359	0.00933389	0.5671	0.5708	0.00235722	0.00920496	0.2561	0.7979
<i>DEF_{it}</i>	-0.00663112	0.00245479	-2.701	0.0071***	-0.00704314	0.00244741	-2.878	0.0040 ***
<i>INTR_{it}</i>	-0.0600877	0.0113783	-5.281	1.71e-07***	-0.0547320	0.0110994	-4.931	8.18e-07 ***
<i>DEBT_{it}</i>	0.00352252	0.000434236	8.112	2.18e-015***	0.00350096	0.000425085	8.236	1.78e-016 ***
<i>GHGAS_{it}</i>	0.00543738	0.00470276	1.156	0.2480	0.00718753	0.00436510	1.647	0.0996 *
<i>GDP_{it}</i>	-1.35806e-07	5.07922e-08	-2.674	0.0077***	-9.41303e-08	4.34596e-08	-2.166	0.0077***

Test Statistics: $F(6, 711) = 20.153$
 with p-value = $P(F(6, 711) > 20.153) = 7.84249e-22$
 Test Statistics: $F(26, 711) = 53.1475$
 with p-value = $P(F(26, 711) > 53.1475) = 1.5362e-147$
 Coefficient of determination $R^2 = 0.712595$

Breusch-Pagan Test
 Chi-square (1) = 3754.27.
 with p-value = 0
 Hausman Test
 Chi-square (6) = 7.89081
 with p-value = 0.246212

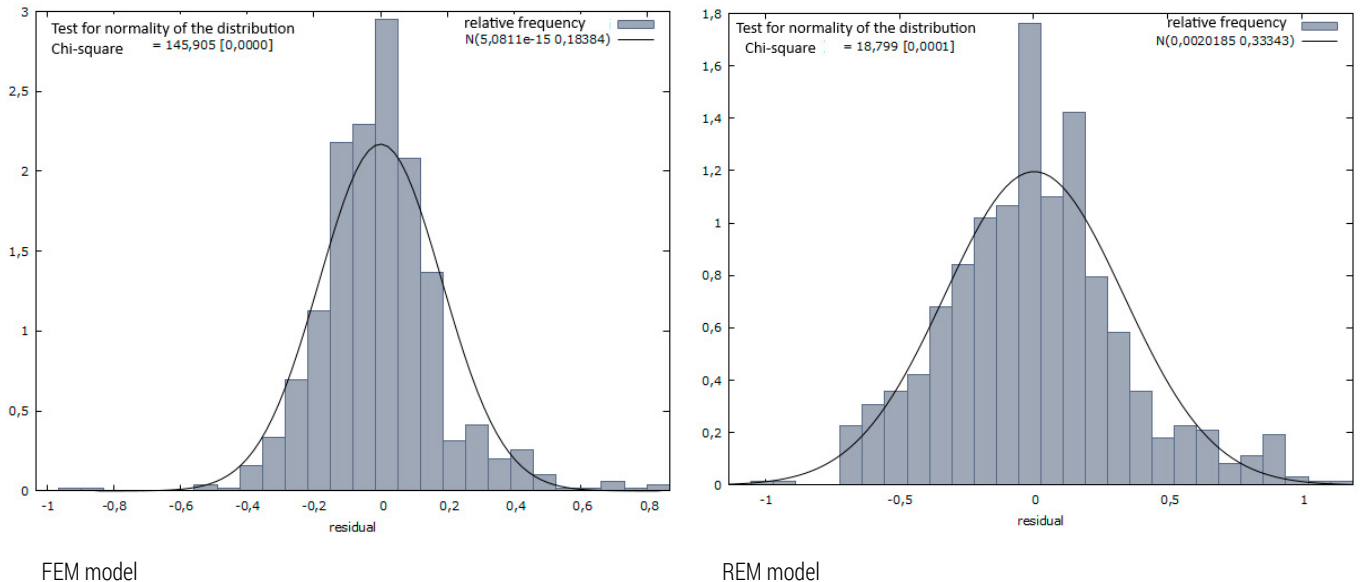


Figure 1. Residuals for the model for the European Union countries

The variable that does not have a statistically significant influence on the level of environmental protection expenditure is the level of general government expenditure on general public services. Among the control variables, the relationship between the level of GDP and the level of environmental protection expenditure is statistically significant. As the level of GDP increases, the amount of resources allocated to environmental protection expenditure decreases. This relationship may be related to better environmental conditions in countries with higher GDP levels, which in turn reduces environmental challenges. In contrast, no statistically significant relationship was found between the level of greenhouse gas emissions and the level of environmental protection expenditure.

The next step in the analysis was to check whether the results obtained would be the same in the groups of so-called 'old' and 'new' EU countries. First, a panel model was estimated for the countries that were members of the European Union before its enlargement in 2004. The results for the "old" European Union countries were presented in Table 3. The model has a coefficient of $R^2 = 0,814$. The results of the tests were also presented in Table 3. The distribution of residuals was presented in Figure 2. The data show a very similar relationship between environmental expenditure and the explanatory variables considered. In the case of the variables budget surplus/deficit, public debt servicing cost, public debt, and gross domestic product, a statistically significant relationship was obtained in the same direction as for all the countries of the European Union. The coefficients for these variables also indicate a similar strength of the relationship. The situation was different for greenhouse gas emissions. In the case of the variable, a significant relationship was obtained, but at a significance level of 0.1. The coefficient obtained indicates that environmental protection expenditure increases as greenhouse gas emissions increase. In the case of the volume of general government expenditure on general public services, no statistically significant relationship was obtained with the volume of environmental protection expenditure.

Table 3. Results of panel data estimation for the environmental protection expenditure variable for the “old” European Union countries in the years 1995-2022

Variable	Coefficient	Standard error	t-Student	P-value	Coefficient	Standard error	Z	P-value
	Fixed effects				Radnom effects			
<i>const</i>	0.774198	0.112516	6.881	<0.0001***	0.750448	0.142268	5.275	1.33e-07***
<i>EXP_{GPS}_{it}</i>	-0.00435708	0.0180720	-0.2411	0.8096	-0.00932294	0.0176690	-0.5276	0.5977
<i>DEF_{it}</i>	-0.00818757	0.00280455	-2.919	0.0037***	-0.00861064	0.00278582	-3.091	0.0020***
<i>INTR_{it}</i>	-0.0758532	0.0179081	-4.236	<0.0001***	-0.0687846	0.0174951	-3.932	8.44e-05 ***
<i>DEBT_{it}</i>	0.00341653	0.000466591	7.322	<0.0001***	0.00342415	0.000461620	7.418	1.19e-013***
<i>GHGAS_{it}</i>	0.00875231	0.00522271	1.676	0.0946*	0.00997700	0.00503536	1.981	0.0475**
<i>GDP_{it}</i>	-1.91566e-07	4.44234e-08	-4.312	<0.0001***	-1.60428e-07	4.15937e-08	-3.857	0.0001***

Test Statistics F(6. 367) = 28.9947
with p-value = P(F(6. 367) > 28.9947) = 2.17291e-28
Test Statistics: F(13. 367) = 82.4984
with p-value = P(F(13. 367) > 82.4984) = 2.62788e-100
Coefficient of determination R² = 0.814003

Breuscha-Pagan Test
Chi-square (1) = 2530.14
with p-value p = 0
Hausmana Test
Chi-square (6) = 6.27176
with p-value = 0.393446

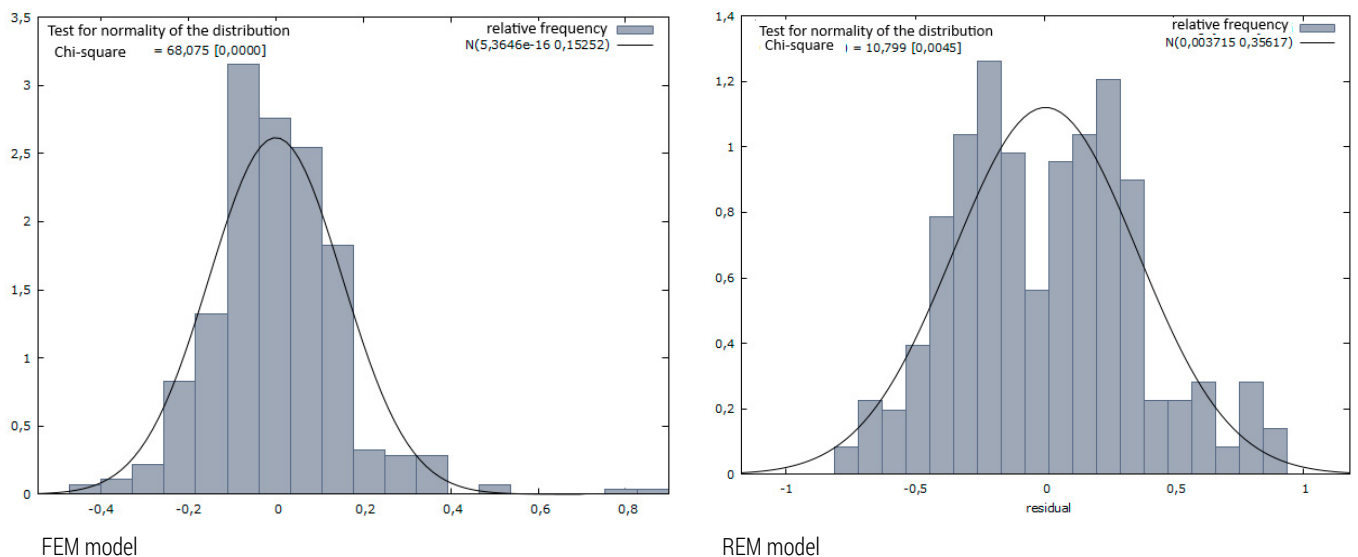


Figure 2. Residuals for the model for the “old” European Union countries

The analysis was also carried out for the so-called ‘new’ EU countries (countries that joined the European Union in 2004 or later). The results for the “new” European Union countries were presented in Table 4. The model has a coefficient of R² = 0,606. The results of the tests were also presented in Table 4. The distribution of residuals is presented in Figure 3. The data show a very different picture for this group of countries. First of all, only one variable – public debt – was found to have a statistically significant relationship with the level of environmental protection expenditure. The positive sign of the coefficient indicates that environmental protection expenditure increases as debt increases. This relationship can be explained, as in the case of the European Union as a whole, by the fact that an increase in the total volume of public expenditure can also lead to an increase in environmental protection expenditure. However, for the new European Union countries, no statistically significant relationship was found between the level of environmental protection expenditure and the level of general government expenditure on general public services, the budget surplus/deficit, and the public debt servicing cost.

Table 4. Results of the panel model estimation for the variable of environmental protection expenditure for the “new” European Union countries in the years 1995-2022

Variable	Coefficient	Standard error	t-Student	P-value	Coefficient	Standard error	z	P-value
	Fixed effects				Radnom effects			
<i>const</i>	0.529049	0.0885465	5.975	<0.0001***	0.539801	0.113838	4.742	2.12e-06***
<i>EXP_{GPS_{it}}</i>	0.00392210	0.0118212	0.3318	0.7403	0.00237591	0.0117150	0.2028	0.8393
<i>DEF_{it}</i>	-0.00627060	0.00435906	-1.439	0.1512	-0.00645706	0.00433642	-1.489	0.1365
<i>INTR_{it}</i>	-0.00907789	0.0195229	-0.4650	0.6422	-0.00908517	0.0190680	-0.4765	0.6337
<i>DEBT_{it}</i>	0.00294932	0.000877908	3.359	0.0009***	0.00294961	0.000859047	3.434	0.0006***
<i>GHGAS_{it}</i>	0.00401031	0.00837263	0.4790	0.6323	0.00392852	0.00790677	0.4969	0.6193
<i>GDP_{it}</i>	1.15850e-07	3.02289e-07	0.3832	0.7018	6.95140e-08	2.80986e-07	0.2474	0.8046
Test Statistics: F(6. 338) = 3.13261 with p-value $p = P(F(6. 338) > 3.13261) = 0.00530831$ Test Statistics: F(12. 338) = 38.9037 with p-value $= P(F(12. 338) > 38.9037) = 1.7644e-56$ Coefficient of determination R ² = 0.606159					Breuscha-Pagan Test Chi-square (1) = 1342.54 with p-value = 6.44853e-294 Hausmana Test Chi-square (6) = 4.99029 with p-value = 0.545059			

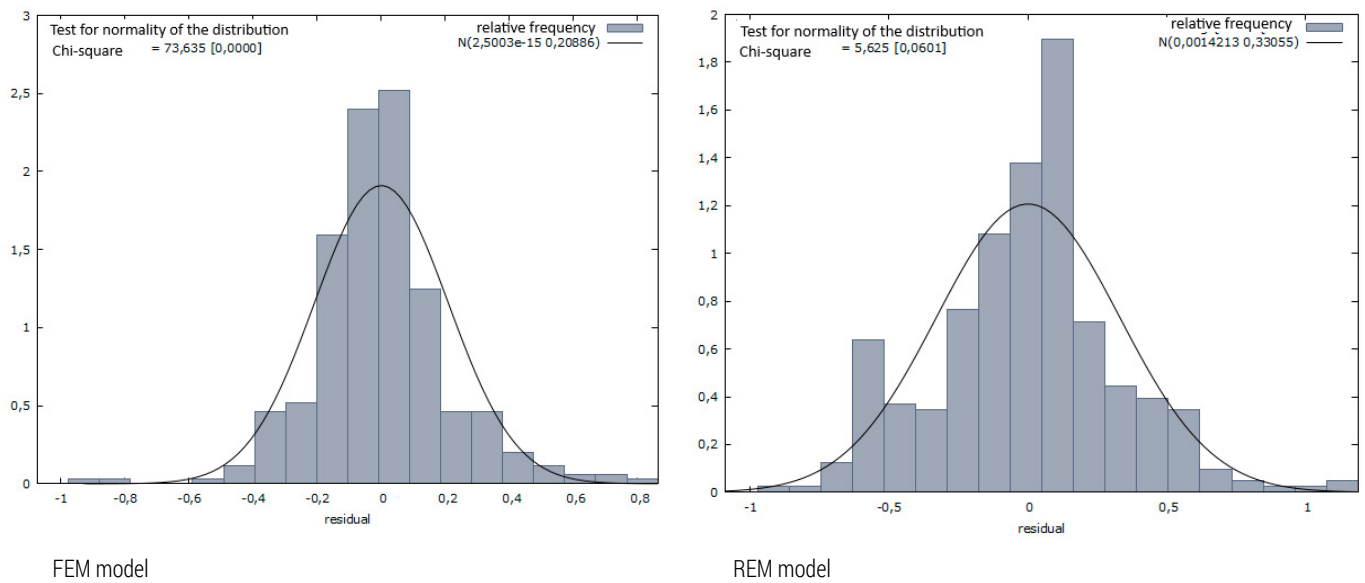


Figure 3. Residuals for the model for the “new” European Union countries

The results of the panel data analysis indicate a relationship between fiscal sustainability and the level of environmental protection expenditure. This variable is negatively affected by the public debt servicing cost. It can be concluded that the deterioration of the fiscal position forces greater fiscal discipline and environmental protection expenditures among those that are reduced. However, there is a positive relationship between the level of public debt, the budget surplus/deficit, and the level of environmental protection expenditure. These results are largely consistent for the European Union countries as a whole and for the so-called ‘old’ European Union countries. However, similar relationships were not found for the so-called ‘new’ EU countries. In this case, only the relationship with the level of government debt has a statistically significant relationship with the explanatory variable.

Summary and policy implications

A policy based on the concept of sustainable development requires special attention to the balance between economic, social, and environmental issues. Environmental issues are therefore one of its pillars. The issue of the impact of the sustainability of public finance on the level of general government environmental protection expenditure, which is considered in this article, has important implications for both fiscal and environmental policies and, through them, for sustainable development policy.

The obtained results show that, over the analysed period, there is a statistically significant relationship in all countries of the European Union between the level of public debt, the general government fiscal balance, and the cost of public debt, and the level of environmental protection expenditure. The data show that as debt and deficit increase, so do the expenditures. This suggests that as fiscal space increases, it becomes easier to allocate larger amounts to environmental protection. On the other hand, an increase in interest on public debt reduces this space and has a negative impact on the amount of expenditure analysed. These results were confirmed for the old European Union countries. However, an important finding of the research is the lack of confirmation of the above correlations (except for the public debt link) for the new EU countries. This may be due to the lower level of economic development and its differentiation in this group.

Our results confirm the results obtained by (Boly et al., 2022) and (Shaari et al., 2023). In addition, they correspond positively with the results obtained by Hurnik and Sirimaneetham (2023), Hejdra et al. (2006) and Zenios (2024), who also analysed the relationship between the volume of environmental expenditure and public debt. According to the above-mentioned studies, an increase in the share of environmental spending and the achievement of sustainable development goals in the public debt-financed expenditure structure has a positive impact on the long-term sustainability of public finances. An increase in environmental spending results in an increase in public debt, but at the same time, these studies point to the savings and capital efficiency gains achieved through this spending. In a similar direction were the conclusions of Fodha and Seegmuller (2012), who recommended cautious financing of their growth with public debt when its level is safe. In contrast, partially different results from ours were obtained by Young and Roncisvalle (2002). This fact is probably due to the example analysed. After all, Brazil is a country where an increase in public debt is perceived by investors as a major risk factor, whereas in the European Union countries we analysed, it does not cause such a sharp reaction. This is demonstrated by the relationship obtained in both articles between environmental spending and the cost of servicing public debt. As these costs increase, the expenditure analysed falls.

In conclusion, the research shows that there is a statistically significant relationship between the sustainability of public finances and the level of environmental protection expenditures. As the imbalance of public finances increases, so does environmental protection expenditure. It can be concluded that when it is necessary to reduce the deficit or public debt, expenditure that is not a priority is reduced. Unfortunately, environmental spending is one of them. This is a factor that can have a negative impact on the sustainability of development when there is a need for greater sustainability of public finance.

Prioritising environmental protection over short-term fiscal stability can be justified by the long-term opportunity costs associated with inaction. Environmental degradation imposes substantial economic burdens in the form of health costs, productivity losses, and climate-related damages, which may far exceed the short-term savings from fiscal restraint. Public investment in environmental protection not only mitigates these future costs but also stimulates green innovation, employment, and resilience. Therefore, treating environmental spending as a strategic investment rather than a discretionary cost aligns with both economic prudence and sustainable development imperatives. It therefore seems reasonable to recommend a change in the approach to environmental protection expenditure, making it more independent of the situation of public finance and treating it as a priority in the face of clearly visible climate change.

Acknowledgements

Financially supported by the Minister of Science under the 'Regional Initiative of Excellence' (RID) programme.



Ministry of Science and Higher Education
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Doskonałości

The contribution of the authors

Conceptualisation, T.U. and P.P.; literature review, T.U. and P.P.; methodology, P.P.; formal analysis, T.U. and P.P.; writing, T.U. and P.P.; conclusions and discussion, T.U. and P.P.

The authors have read and agreed to the published version of the manuscript.

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DŁUG PUBLICZNY A RZĄDOWE WYDATKI NA OCHRONĘ ŚRODOWISKA: DOWODY Z GOSPODAREK UNII EUROPEJSKIEJ

STRESZCZENIE: Głównym celem artykułu jest ocena wpływu poziomu długu publicznego na publiczne wydatki na ochronę środowiska. Podstawowa hipoteza zakłada, że poziom długu publicznego wpływa na wysokość wydatków publicznych przeznaczonych na ochronę środowiska. Metodologia opiera się na analizie regresji danych panelowych dla rocznych obserwacji z lat 1995-2022 dla 27 państw Unii Europejskiej. Dane zostały zebrane z bazy danych Eurostatu. Wyniki zostały osadzone w szerszych ramach zrównoważonego rozwoju i regulacji prawnych, które promują wyższe wydatki na ochronę środowiska. Wyniki badań stanowią wkład w toczący się dyskurs na temat efektywności wydatków na ochronę środowiska, badając napięcie między odpowiedzialnością fiskalną a potrzebą większych inwestycji w zrównoważony rozwój środowiska.

SŁOWA KLUCZOWE: dług publiczny, wydatki publiczne, zrównoważony rozwój, ochrona środowiska