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Research article

Green finance and its role in sustainability in the EU

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ABSTRACT

The aim of this paper is to investigate the role of green finance on sustainability in Germany and the European Union (EU). This aim will be achieved by examining recent data in this field via a panel fixed effect regression model. When comparing Germany and the EU in terms of the value of issued green bonds, the results show that Germany is leading in reducing emissions with several initiatives. One plausible reason could be the higher per-capita income of residents, which enables them to use more energy-efficient technologies than other EU countries. The fixed effect regression results reveal that in Europe, the value of issued green bonds has a negative impact on emissions. Meanwhile, expenditure on environmental protection, fossil fuel subsidies, and environmental tax revenue are counterproductive and do not impact lowering emissions.

1. Introduction

Measuring the sustainable development goals (SDGs) of the United Nations has always been a major focus of research work by scholars across the world. Among the SDGs is SDG13, which is related to climate change and reducing greenhouse gas emissions (GGE). The reduction of greenhouse gas emissions has been a critical global challenge for a long time. This issue has been reflected in various legal regulations and actions taken by international organisations aiming to reduce emissions in individual countries (Wojtowicz et al., 2021; UN SDG13, 2022).

The concept of green finance has been defined in the literature; however, there is no single commonly agreed-upon definition. This article defines green finance as green growth and transition to a green economy while reducing the negative environmental impacts. To elaborate further, green finance refers to investments in green bonds, reduction in CO_2 emission, and efficiency of the environmental tax by individual countries. Moreover, organic agriculture, water management, and waste management by private and public actors have also defined green finance. The European Commission classified sustainable finance as a process of considering environmental, social, and governance (ESG) considerations when making investment decisions. This leads to increased longer-term investments in sustainable activities. Sustainable finance is a powerful movement led by governments and institutional investors globally.

With the emphasis on green finance and sustainable development in the past two decades, it can be seen that the role of finance is changing. Previously, it encompassed neoclassical economic theory emphasising the maximization of profit and shareholders' wealth. However, in the past decade, it has moved towards a system that supports green economy, sustainable development, low carbon economy, and mitigation of climate change (Afzal, Rasoulinezhad, Malik, 2022; Sepahvand et al., 2023).

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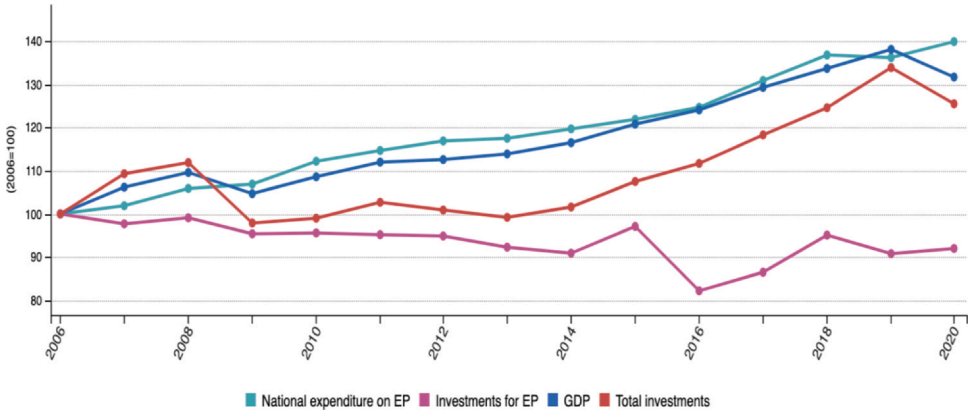


Fig. 1. Environmental Protection Expenditure in the EU.
Source: Eurostat 2022

Weber (2015) claimed that between US$363 billion and US$2.4 trillion would be needed to mitigate climate change (based on the estimation from the Stockholm Environment Institute). This value shows that the financial sector is crucial in fostering sustainable development and protecting the environment due to its capital provision function. As an intermediary sector, the financial sector can channel capital into business projects with a potentially positive impact on sustainable development. Therefore, the funded businesses must be green to achieve this objective.

Sachs et al. (2019) argue that global investment in renewable energy declined by 3 % in 2017 and that fossil fuels are still the main target for energy investment. These will threaten the development of green energy and alter climate change goals. Finance is the engine for development and should be responsibly used to support green projects. However, financial institutions show more interest in fossil projects than green projects due to (i) several risks associated with new technologies and (ii) the low return on green projects. However, achieving sustainable development goals requires serious attention to green finance, which provides environmental benefits. In a similar study, Andrade et al. (2021) show that the returns in the European green energy stock portfolio were better than the non-green counterparts (data from 2008 to 2020). However, this difference has narrowed in recent years. The study concludes that from 2008 to 2020, the performance of green energy firms could not significantly outperform that of non-green energy firms.

This paper discusses several initiatives that could curb emissions and foster sustainable development in Europe. Those initiatives are the value of green bonds issued by several authorities within the country, general expenditure on environmental protection, environmental tax revenue, and fossil fuel subsidies. Therefore, this paper's main objective is to investigate these variables' impact on sustainable development in the context of Germany and the EU-27 countries. Greenhouse gas emissions are used as the proxy for sustainability and sustainable development.

2. Literature Review

In 2019, Germany recorded the largest tax revenue (EUR 2.8 billion) from emission permits in the EU, followed by Italy (EUR 1.3 billion), Poland (EUR 1.2 billion) and Spain (EUR 1.0 billion), according to European Commission. (2021).

The European Union's expenditure on environmental protection has significantly increased during recent years (40 % increase from 2006 to 2020). However, when this increase is compared to the GDP (measured as a percentage of GDP), this expenditure remained relatively unchanged over the past 15 years. This means that the expenditure has just followed the GDP trends, which indicates that this amount is not sufficient to curb emissions enough to promote sustainable development. Fig. 1 illustrates this fact.

The value of green bonds issued in Germany is 20 % of that of total green bonds issued in the EU in 2019. However, the greenhouse gas emission per capita in Germany is larger than that of the EU, i.e., 10.1 metric tons (MT) in 2019 in Germany and 8.40MT in the EU in the same year. This has happened even though Germany has reduced fossil fuel support and increased the national environmental protection expenditure. One of the plausible reasons could be the extent to which German industries depend on natural resources.

Wojtowicz, Szolno-Koguc & Braun (2021) examined the role of public expenditure on CO_2 emissions in several Polish regions. They concluded that public spending contributes to lowering CO_2 emissions, but environmental spending is counterproductive. This was observed in the regions with high levels of socioeconomic development, high energy consumption, and higher carbon emissions. They claimed that the failure of environmental expenditure in these regions can be explained by the green paradox, which indicates that a green environmental policy that becomes greener over time acts like an announced expropriation for the owners of fossil fuel resources, inducing them to accelerate resource extraction and hence to accelerate global warming (Sinn, 2012).

On a separate note, Afshar Jahanshahi et al. (2020) claimed that embracing green innovation is one of the key elements for improving environmental performance. In another study by Gharleghi and Jahanshahi. (2020) and Nawaser et al. (2023), it was found that financial development positively impacts income inequality and will eventually lead to sustainable development.

Table 1
variables' definition.

Abbreviation	Variable definition	Source
gbond-FC	Volume of green bonds issued by Financial Corporations -Euro Billion	DeutscheBank
gbond -NFC	Volume of green bonds issued by Non- Financial Corporations -Euro Billion	DeutscheBank
gbond -PFC	Volume of green bonds issued by Public Financial Corporations -Euro Billion	DeutscheBank
gbond -G	Volume of green bonds issued by Government -Euro Billion	DeutscheBank
epro	Environmental protection expenditure in % of GDP	IMF Climate Change Dashboard
etr	Environmental tax revenues in % of GDP	European Environment Agency (EEA), Eurostat
ffs	Fossil fuel Subsidy in % GDP	IMF Climate Change Dashboard
ghg	Net Greenhouse gas emissions- Tonnes per capita	European Environment Agency (EEA), Eurostat

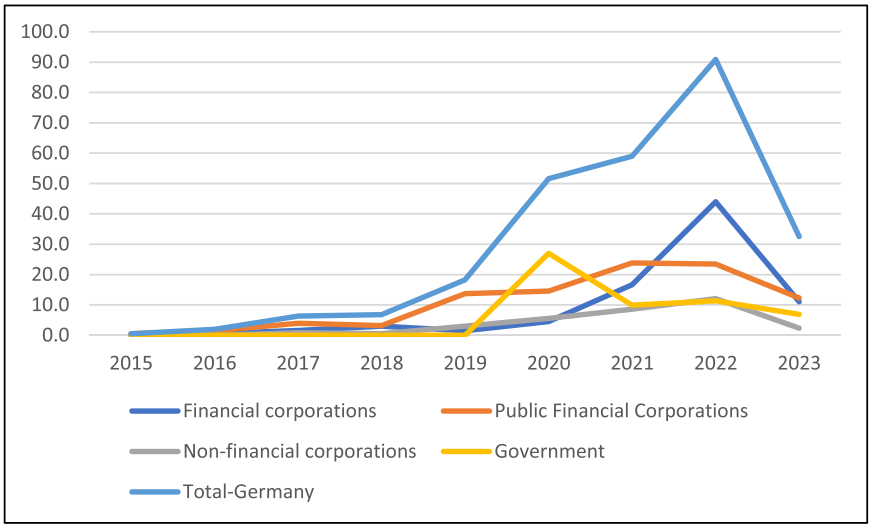


Fig. 2. The volume of green bonds issued in Germany – Euro Billion.

Kwilinski, Lyulyov and Pimonenko (2023) investigated the spatial spillover effect of green finance on sustainable development in the EU between 2008 and 2021. Using the spatial Durbin model, the findings confirm that green finance promotes sustainable development goals but is regionally specific. The EU should intensify the green finance policy by reducing greenhouse gas emissions, promoting renewable energy, and improving energy efficiency. They further suggest that alternative financial sources, such as green bonds, should be considered to promote green construction, etc.

3. Methodology and data

Since the concept of green finance is relatively new, there is not much data available worldwide for a perfect statistical estimation. However, since the EU has been the pioneer in green business and green development, there is a relatively good range of data for the European countries. We are trying to utilize the most recent available data in this article so that it sheds some new light on the field of green finance and sustainable development. The available data spans from 2000 to 2022. Table 1 describes the variables in this paper.

In this paper, we would like to examine whether the recent initiatives impacted sustainable development. More specifically, the impact of newly developed tools with regard to sustainable finance on greenhouse emissions will also be investigated. We assume that the initiatives will have an impact on emissions with a one-year lag. In brief, the following equation will be estimated via the panel fixed effect model:

$$ghg_t = gbond_{t-1} + epro_{t-1} + ffs_{t-1} + etr_{t-1}$$

4. Results and discussion

Fig. 2 depicts the value of the green bonds issued in Germany by various institutions. The diagram reveals an almost consistent increase in issuing green bonds only in financial corporations. It is also clear that the total value consistently increased until 2022 and dropped in 2023.

Fig. 3 depicts the value of the green bonds issued by different authorities in the EU-27 countries (Germany not included). All issuers' overall pattern had an almost steady increase until 2022, except for the government share of issued green bonds.

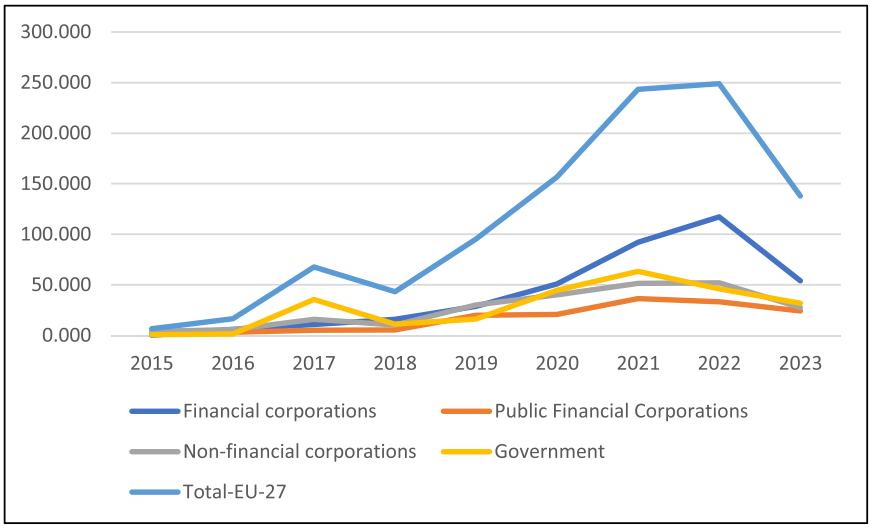


Fig. 3. The volume of green bonds issued in EU-27 – Euro Billion.

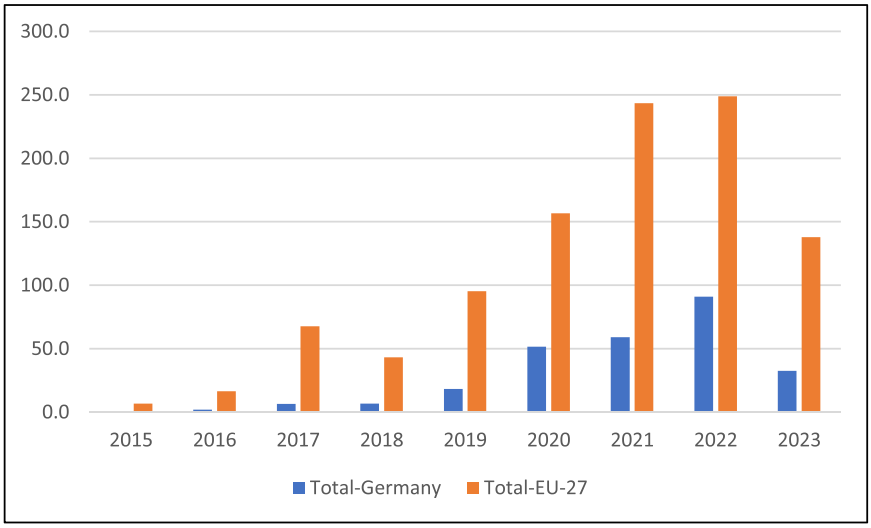


Fig. 4. The total value of green bonds issued in Germany and EU-27 - Euro Billion.

Fig. 4 compares the total value of the green bonds issued in Germany and the EU-27, indicating that Germany and the EU have increased their efforts towards green finance and green economy until 2022. A reduction can be seen overall for both groups in 2023, requiring further investigation in future research.

Fig. 5 shows the national expenditure on environmental protection as a percentage of GDP in Germany and the EU-27. We can observe that Germany has spent more on environmental protection than the average of other EU-27 countries.

Figs. 6 and 7 show that both environmental tax revenues and fossil fuel subsidies have decreased in Germany and the EU.

Fig. 8 shows the relationship (interaction) between the total green bonds issued in Germany and the EU with greenhouse gas emissions. It shows that green bonds issued in Germany substantially impacted emissions reduction as the trend line slope is steeper (-0.023). As mentioned earlier, Germany issued a comparable 20 % of green bonds compared to the EU. These diagrams further show that Germany is leading in the EU in reducing greenhouse gas emissions with the help of green bonds. The steeper slope in Germany depicts the attempts and investments in Germany to combat climate change and foster sustainable development to reduce emissions successfully. This could be due to high per capita income. Higher-income encourages the residents to utilise more energy-efficient technologies.

4.1. Panel regression results

This section presents the fixed effect panel regression results for the period of 2015–2022. The descriptive statistics of the variables are depicted in Table 2.

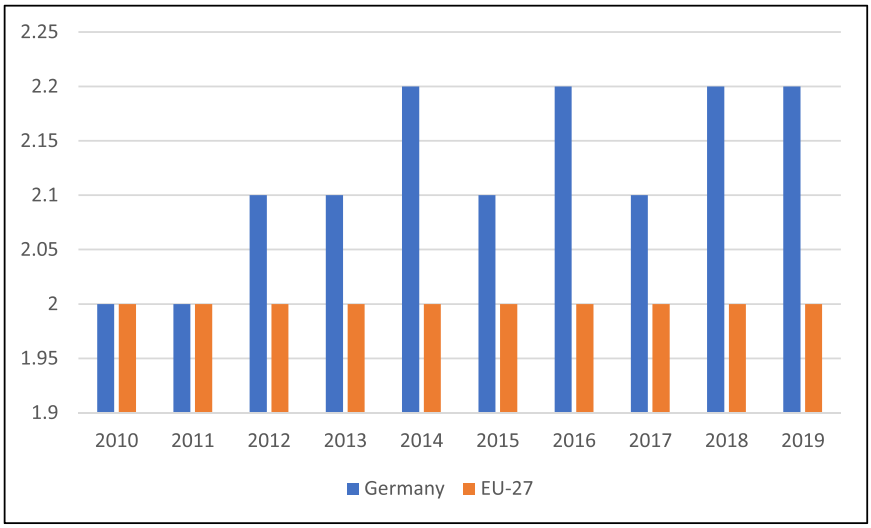


Fig. 5. General expenditure on environmental protection in Germany and the EU-27- %GDP.

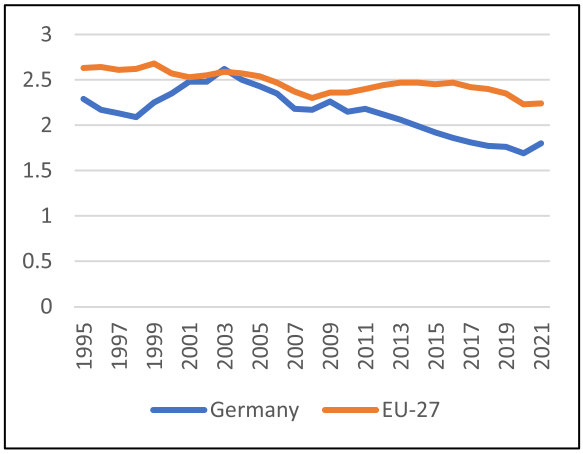


Fig. 6. Environmental tax revenues in Germany and the EU-27 (% GDP).

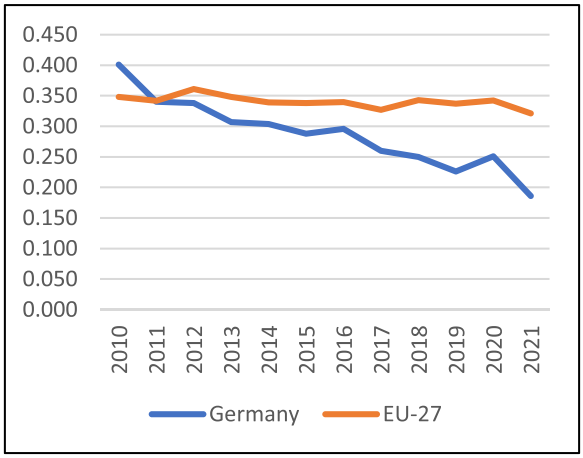


Fig. 7. Fossil fuel subsidy in Germany and the EU-27 (% GDP).

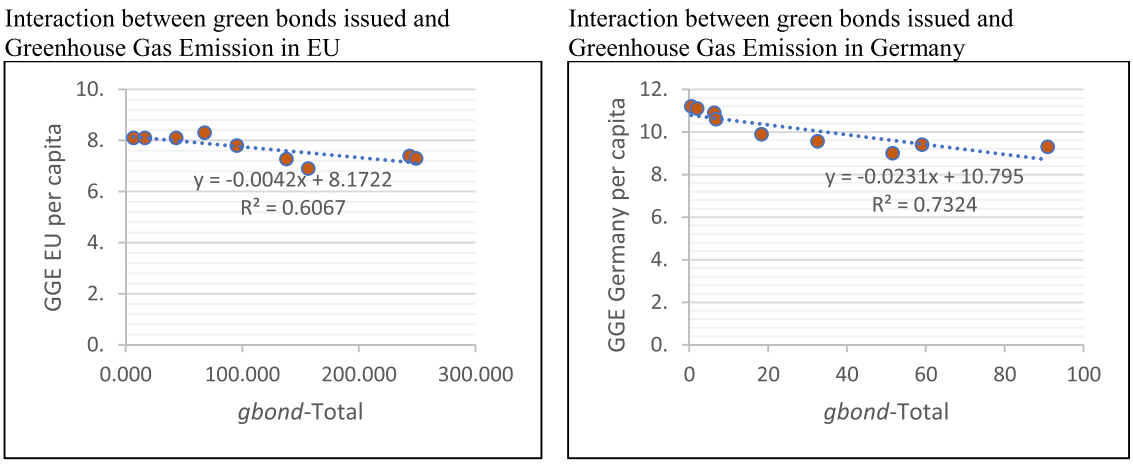


Fig. 8. Interaction between green bonds issued and Greenhouse Gas Emission in the EU & Germany.

Table 2
descriptive statistics (2015–2022).

Variables	Mean	Standard Deviation	Min.	Max.	Count
etr	2.53	0.76	0.87	5.60	208
epro	0.73	0.31	0.20	1.60	208
ghg	8.30	3.71	0.30	20.00	208
ffs	0.68	0.90	0	4.54	208
gbond	15.35	18.57	0.16	83.84	48

Note: *epro* is Environmental protection expenditure in % of GDP, *etr* is Environmental tax revenues in % of GDP, *ffs* is Fossil fuel Subsidy in % GDP, *ghg* is Net Greenhouse gas emissions- Tonnes per capita, *gbond* is green bonds issued by respective sample.

Table 3
Fixed effect regression (2015–2022).

Variable	Western EU	Eastern EU	Scandinavian	Full sample
etr(−1)	3.434***	0.340	1.919***	1.468***
epro(−1)	−3.011*	0.315	0.902	−0.979
ffs(−1)	−0.765	1.782***	−0.019	0.425**
Constant	3.882	4.499**	0.988	4.936***
R-square (overall)	0.185	0.274	0.468	0.013

Note: The dependent variable is Greenhouse Gas Emissions. *, **, *** denote significant at 10 %, 5 %, and 1 % respectively. *epro* is Environmental protection expenditure in % of GDP, *etr* is Environmental tax revenues in % of GDP, *ffs* is Fossil fuel Subsidy in % GDP.

In this paper, explicit subsidies are used to reflect underpricing due to supply costs being greater than prices paid by users. Whenever a higher explicit subsidy is observed, a higher amount of fossil fuel is consumed. Amongst the European countries, only Switzerland had the lowest possible fossil fuel subsidy (0 %), while the highest subsidy was given in Estonia (4.54 %). The highest greenhouse gas emission is observed in Luxemburg (20 tonnes), and the lowest is from Sweden (0.30 tonnes). The highest environmental tax revenue was received by Greek authorities (5.6 %), and the lowest was for Ireland (0.87 %). The highest value for the issued green bonds is Germany (83.84 billion euro); the lowest value was issued by Switzerland (0.16 billion euro). These statistics show a significant difference between the environmental policies adopted across European countries; therefore, these economies have been divided into three sub-sample countries, i.e., Western EU, Eastern EU, and Scandinavian, to better estimate the impact of these variables on reducing greenhouse gas emissions.

The outcome of the fixed effect panel regression is reported in Table 3. The full sample estimation and the sub-sample results are given, and several notable results can be observed. In the case of Western European countries, environmental tax revenue does not exert any impact on lowering emissions as its impact is positive. This is perhaps because the taxes are not high enough to help curb emissions. Another plausible reason for these insignificant impacts is the green paradox, which states that intensive use of climate policy instruments (such as national expenditure on environmental protection, environmental tax revenue, etc) encourages fossil fuel owners to extract raw materials faster and, therefore, accelerating global warming (Wojtowicz, Szołno-Koguc and Braun, 2021; Grafton et al., 2012).

However, the impact of general expenditure on environmental protection is negative and significant (-3.011), meaning that more protection leads to lower emissions. Fossil fuel subsidy in this paper is referred to as explicit subsidies, which reflect underpricing due

Table 4
Fixed Effect Regression (2000–2022).

Variable	Western EU	Eastern EU	Scandinavian
etr(−1)	2.410***	1.853***	2.888***
epro(−1)	−5.915***	−0.114	6.459***
Constant	10.363***	2.761***	−4.573***
R-square (overall)	0.0002	0.0001	0.448

Note: The dependent variable is Greenhouse Gas Emissions. *, **, *** denote significant at 10 %, 5 %, and 1 % respectively. *epro* is Environmental protection expenditure in % of GDP, *etr* is Environmental tax revenues in % of GDP.

Table 5
Fixed Effect regression- green bonds (2015–2022).

Variable	Fixed effect	Random effect	Mixed model
etr(−1)	0.770	0.995	0.532
epro(−1)	0.063	0.894	4.523*
ffs(−1)	−0.199	−0.194	−1.371**
gbond(log) (−1)	−0.555	−0.551***	−0.587*
constant	6.272***	5.164*	4.011*
R-square (overall)	0.044	0.205	-

Note: The dependent variable is Greenhouse Gas Emissions. *, **, *** denote significant at 10 %, 5 %, and 1 % respectively. *epro* is Environmental protection expenditure in % of GDP, *etr* is Environmental tax revenues in % of GDP, *ffs* is Fossil fuel Subsidy in % GDP, *ghg* is Net Greenhouse gas emissions- Tonnes per capita.

to supply costs greater than users' prices. The impact of fossil fuel subsidies is surprisingly negative but insignificant. This could be partially due to the subsidies given to residents during COVID-19 to curb inflation rather than emissions (Kuehl et al., 2021).

In the case of Eastern European countries, environmental tax revenue and environmental protection expenditure do not help lower emissions. The impact of fossil fuel subsidies is positive and significant, reflecting that more subsidy leads to more emissions (Antimiani, Costantini and Paglialunga, 2023).

In the case of Scandinavian countries, environmental tax revenue and environmental protection expenditure are counter-productive and do not help in lowering emissions. The impact of fossil fuel support is almost negligible. And finally, for the full sample estimation, only environmental protection expenditure contributes to lowering emissions. Even though the impact is not significant, the magnitude of impact is higher in Scandinavian countries and lower in Western European countries.

The constant term for all estimations is positive, indicating that the average level of greenhouse gas emissions is positive when all explanatory variables are zero after controlling for the fixed effects.

The impacts of the *etr* and *epro* on emissions are further examined for a longer period of time to see if the impact remained consistent across time (Table 4). *ffs* is not included in the estimation as the data is not available. A comparison between Table 3 and Table 4 findings shows that the impact remains the same for Western European and Scandinavian countries. However, for Eastern European countries, environmental protection expenditure seems to have a negative impact in the long term (-0.114 as compared to 0.315).

Table 5 shows the results when green finance is added to the model. It should be noted that this estimation is limited to six countries due to the availability of green finance data (the six countries are France, Germany, Netherlands, Norway, Sweden, and Switzerland). The results reveal that the impact of environmental tax revenue, environmental protection expenditure, and fossil fuel subsidy are similar to that of Western and Scandinavian countries in previous estimations. It is interesting to observe that the impact of green finance is negative, i.e., the higher the green finance, the lower the level of emissions. Such impact has been supported in the literature by Kuhn (2022).

The impact of green finance becomes even more prevalent when the random effect model and mixed model are estimated as the coefficient of this variable becomes significant in both models. This clarifies the importance of green finance in sustainable development in Europe.

5. Conclusion and policy implications

This paper examined the role of green finance (via different instruments) on sustainable development in the context of European countries, especially in Germany and the EU-27. The results reveal that initiatives in Germany have a stronger impact on reducing greenhouse emissions than those in the EU-27. One plausible reason is that Germany aims to become greenhouse gas neutral by 2045. This is after it has set the targets for such a goal. The reduction in emissions is set to be at least 65 % by 2030 and 88 % by 2040 (compared to 1990 levels). We also observed that among the several initiatives, only green finance seems to impact reducing emissions. This has also been claimed in other contexts (Wang et al., 2022). The results further show that other initiatives are somewhat counterproductive, requiring attention from policymakers, especially for *etr* and *ffs*.

Practical implications: this study can be used to guide the development of financial policies in terms of environmental degradation. This information can be useful to authorities in implementing changes with regard to environmental taxes, expenditures, and fossil fuel subsidies to make them more effective. Another implication of this study is linked to the role of green finance in directing capital towards projects that improve SDGs, such as energy efficiency and renewable energy projects. In addition, green finance helps promote eco-friendly products and biodiversity, fostering economic resilience and eventually moving towards a low-carbon economy.

Regarding environmental tax revenues, governments of the EU countries should focus on the efficiency of the taxes to make them more effective in curbing emissions. However, the current level of environmental protection expenditure in the Scandinavian countries is insufficient to reduce emissions. This could be partially due to the high-income level enabling these economies to continue high consumption and slow adoption of green technologies (Juszczyk et al., 2022).

Although this research has useful implications, it has certain limitations. The model can expand to include more variables, such as other types of financial instruments. Different samples could also be examined to see if the results hold for other countries, including emerging and developing nations. In addition, the data for all variables are not available for 2023 to see the impacts simultaneously. Therefore, these should be viewed as opportunities for future research.

Declaration of Competing Interest

The authors declare that there are no competing interests, financial or non-financial.

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