

DOI: 10.47743/ejpar.2026-7-1

EFFECTS OF FISCAL POLICY AND RENEWABLE ENERGY USE ON CARBON EMISSIONS IN EU

BOGDAN FLORIN FILIP

Alexandru Ioan Cuza University of Iași

Iași, Romania

bogdan.filip@feaa.uaic.ro

Abstract

The latest years of the current century have brought to attention increasingly acute issues regarding the climate change caused by the economic activities and its disastrous impacts all over the world and raised therefore motivated concerns regarding the measures to be taken in order to mitigate them. Since one of the most important determinants of the climate change is represented by the carbon emissions this paper proposes an analysis on the way in which there can be reduced such emissions, focusing on the case of the European Union case. The paper analyses the effects of the fiscal policy, regarding both environmental taxes and government expenditures, but also of the use of the renewable energy on the level of the carbon emissions per capita, during 2010-2020 in EU. The results prove that the extensive use of the renewable energy, especially, but also fiscal policy instruments can mitigate the problem of the carbon emissions and help reducing the climate change.

Keywords: carbon emissions; renewable energy; environmental taxes; taxes on pollution; government environmental expenses; GDP growth.

JEL Classification: C33; E62; F64; O13; Q58.

1. INTRODUCTION

The reality of the last two decades, and especially of the latest years have increasingly brought into the attention of the mankind and of governments from all over the world the major issue of the climate change that, year after year, had determined destructive phenomena which have increased both in number, but also in their amplitude. The global warming seems to rise more rapidly than expected and has already led to much higher temperatures, fires, floods and other disasters, resulting not only in economic loses, but also in human casualties.

While the cause of the climate change has been identified to reside in the excessive growth of the carbon emissions and of the greenhouse gases emissions, it obviously becomes imperative to search and apply solutions in order to protect the environment and to limit the greenhouse and carbon emissions, that are majorly determined by the economic activities.

The increase of the carbon emissions was and still is determined basically by the expansion of industrial activities producing goods or services demanded in higher quantities by the population. These enhanced industrial activities, either produce directly carbon emissions and/or, by consuming higher quantities of energy (which is still mainly generated by burning fossil fuels), lead indirectly to significant carbon emissions. At the same time, also the population determines carbon emissions, less directly, but similarly indirectly, by consuming energy.

Because the negative effects of the climate change, determined partly but importantly by carbon emissions, are affecting peoples' lives, there are needed solutions in order to match the needs for goods and services with the environment protection, including diminished carbon emissions.

Since one of the major causes of the carbon emissions is the consumption of oil, coal and other resources used to generate energy, which have as side effect large quantities of carbon emissions, a natural solution can be finding and using other green and renewable sources of energy, such as solar or wind. On the other hand, people and especially manufacturers need to be convinced to develop responsibly their activities, avoiding as possible generating carbon emissions.

Even some of manufacturers and even some citizens can employ willingly such solutions, there is needed that the entire society to adopt such solutions in order to generate a notable impact on the reduction of the carbon emissions. Therefore, it is reasonable that governments should intervene to convince or to determine the society to act for the reduction of the carbon emissions maintaining, at the same time, also the goal of economic development. Through their fiscal policy, governments can apply taxes to the polluters, in order to discourage the activities that generate high carbon emissions. On the other hand, governments may use the gathered money and other financial resources for expenditures to invest directly in own green projects or to sustain financially the private users of green and renewable energy and the manufacturers that invest in solutions that limit pollution and carbon emissions.

This paper aims to explore the influence that fiscal measures and the use of the renewable energy are exerting on the level of the carbon emissions, on the background of the economic development and develops such an analysis on the 27 member states of the European Union, during the period 2000-2020.

The remainder of the paper includes a short literature review in the second part, followed by a description of the data and methodology that were used, the results and discussion on the analysis performed and, in the end, by the conclusions and the suggestions regarding the ways in which the issue of carbon emissions can be approached.

2. LITERATURE REVIEW

While during the last decades there were registered rapid and more and more worrying changes of the climate, that determined the appearance of many disastrous phenomena impacting both the economy, but also human life, the subjects regarding climate change have become more present in literature. On this background, were developed studies, either regarding the consequences of climate change, or the determinants of it and the possible solutions to counteract this change.

Literature has identified, generally, as the major cause of the climate change the greenhouse gas emissions (Firtescu et al., 2025), residing in methane, nitrous oxide, sulfur dioxide (Halkos and Paizanos, 2013; López and Palacios, 2014), carbon dioxide and several other gas emissions. Moreover, literature has recognized as the major determinant of the climate change, the increasing carbon emissions.

In the past two decades, studies have either analyzed the effects of the carbon emissions on the society, or the causes of such emissions and the possible ways to limit them. In this regard, different authors have developed analyses regarding the carbon emissions that studied either the specific of a single country (Yang et al., 2019; Ramlogan and Nelson, 2024), or the situation of groups of countries (Zaman and Moemen, 2017; Baloch, Mahmood and Zhang, 2019; Li et al., 2023). Out of the later kind of studies, some of them were developed on data regarding European countries (Acaravci and Ozturk, 2010; Dogan and Seker, 2016; Neves, Marques and Patrício, 2020).

A number of previous papers have approached the relationship between carbon emissions and GDP (Dogan and Seker, 2016), some of which considering carbon emissions as determinant of GDP growth, and other the reverse relationship, considering GDP as determinant of carbon emissions. Most of the studies determined a positive relationship between GDP and carbon emissions (Baloch, Mahmood and Zhang, 2019; Ike, Usman and Sarkodie, 2020; Li et al., 2023). However, Acaravci and Ozturk (2010) found that beyond a threshold level of real GDP per capita, any increase in real GDP per capita likely reduce the carbon emissions per capita in Denmark and Italy.

Other studies have examined different potential determinants of carbon emissions, consisting in foreign direct investments (FDI), trade or trade openness, population (Zaman and Moemen, 2017), monetary policy (Ramlogan and Nelson, 2024) etc. Some studies on the impact of FDI on carbon emissions showed that FDI reduce the carbon emissions (Neves, Marques and Patrício, 2020). On the other hand, trade appears to reduce carbon emissions as demonstrated by Dogan and Seker (2016), but may act reversely in low-income countries (Zaman and Moemen, 2017; Balsalobre-Lorente et al., 2018). At the same time, population growth determines higher CO₂ emissions.

Several studies have evaluated the effects of renewable energy consumption on carbon emissions and found all that as the renewable energy consumption increases it results a decrease of the level of carbon emissions (Dogan and Seker,

2016; Balsalobre-Lorente et al., 2018; Baloch, Mahmood and Zhang, 2019; Neves, Marques and Patrício, 2020; Li et al., 2023). However, the impact of the renewable energy consumption was found to be more or less significantly statistic depending on the specific study and the analyzed countries.

Fiscal policy has also been considered as potential influence factor of carbon emissions in some studies (Katircioglu and Katircioglu, 2018; Ike, Usman and Sarkodie, 2020; Li et al., 2023; Ramlogan and Nelson, 2024). For instance, Chishti et al. (2021), as well as Ramlogan and Nelson (2024) found that expansionary fiscal policy raises carbon emissions, while contractionary fiscal policy reduces carbon emissions.

On the other hand, other papers have analyzed the impact on carbon emissions of only some fiscal instruments, such as taxes on pollution or government expenditures.

Some of the papers (Neves, Marques and Patrício, 2020; Li et al., 2023; Ma et al., 2023) showed that the taxing of polluting activities and the promotion of have proved to be significant barriers to an increase in CO₂ emissions. However, Leitão (2025) showed that in OECD countries environmental taxes stimulated carbon and greenhouse gas emissions.

In turn, Yang et al. (2019) showed that subsidies have a positive threshold effect on renewable energy investment of China and on this basis on low-carbon emissions. Moreover, Adewuyi (2016) found a positive effect of government investment expenditures on reducing carbon emissions, but also a negative effect of the total government expenditures. We note also that Li et al. (2023) showed that government expenditure intensify CO₂ emissions, while Halkos and Paizanos (2013) observed no evident impact.

Based on the previous observations regarding the existing literature, we observe that the issue of the carbon emissions gained more attention especially in the last years. In this regard, several studies have investigated the effects of potential determinants of the level of carbon emissions, some of them resulting to be relevant, but also some of them having ambiguous effects. Therefore, on the background of these concerns regarding the problem of carbon emissions, we develop an analysis on how, specific fiscal policy instruments, such as environmental and pollution taxes or environmental government expenditures and also the renewable energy consumption and economic growth can impact on the level of carbon emissions.

3. DATA AND METHODOLOGY

Our analysis uses annual data for all the current 27 countries, members of European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden. We developed our analysis using

data from the period between 2000 and 2020, in accordance with the availability of the data, and we created a strongly balanced data panel of data from Eurostat and World Bank databases.

In our analysis we use as proxy for the carbon emissions, the Carbon dioxide (CO₂) emissions excluding LULUCF per capita (t CO₂e/capita), symbol CO₂cp, gathered both from the World Bank database.

At the same time, we take into consideration as independent variables and as determinants of the carbon emissions, several variables presented in Table 1, based on the expected normal influence of these determinants on the dependent variable.

Table 1. The independent variables/ determinants

Independent variable/ factor	Indicator name	Indicator symbol	Expected impact (+/-)	Source
Environmental taxes	Total environmental taxes (%GDP)	TEp	-	EUROSTAT Database
Pollution taxes	Taxes on pollution(%GDP)	TPg	-	EUROSTAT Database
Government expenditures on environmental protection	Total general government expenditure on environmental protection (%GDP)	GEEp	-	EUROSTAT Database
Renewable energy consumption percentage	Renewable energy consumption (% of total final energy consumption)	RECpt	-	World Bank Database
Economic growth	GDP per capita growth (annual %)	GDPcg	+	World Bank Database

Source: Author

Table 1 contains details for the independent variables which include the original indicator and the databases from which the data were gathered. Moreover, based on the identified logical connections and previous results from the existing literature, we included also the expected impact of the independent variables on the level of the carbon emissions.

Our research is based on the use of statistical methods consisting in Pearson correlations, respectively in building and testing econometric models, using Panel Ordinary Least Squares method.

4. RESULTS AND COMMENTS

The analysis we perform begins with verifying the existence of the connections between the dependent variable, consisting in the Carbon dioxide (CO₂) emissions excluding LULUCF per capita on the one hand, and the

anticipated determinants of its evolution. Therefore, we use Pearson correlations to observe the intensity and the significance of these connections and the results are shown in Table 2.

Table 2. The correlation matrix of the variables

	CO2cp	TEp	TPg	GEEp	RECpt	GDPcg
CO2cp	1.0000					
TEp	-0.0244	1.0000				
	0.5617					
TPg	-0.0643	0.2558***	1.0000			
	0.1328	0.0000				
GEEp	0.0546	0.1281***	0.2025***	1.0000		
	0.1945	0.0023	0.0000			
RECpt	-0.3200***	0.0705*	0.1389***	-0.4998***	1.0000	
	0.0000	0.0936	0.0011	0.0000		
GDPcg	-0.0189	-0.0911***	0.0029	-0.1785***	-0.0630	1.0000
	0.6526	0.0300	0.9458	0.0000	0.1339	

***, **, * - denotes significance at 1%, 5%, respectively 10% level

Source: Author calculation using STATA 12

As Table 2 reveals, the level of the carbon emissions can be influenced both by fiscal measures, by the use of renewable energy and also by the rhythm of economic development, but also the relationship can operate vice versa. We observe the negative and statistically significant relationships between the carbon emissions and the renewable energy consumption, that suggest that using renewable energy lowers the carbon emissions. Moreover, the fiscal instruments consisting in the environmental taxes and the taxes on pollution can lead to lower carbon emissions. At the same time, we note a negative relationship between carbon emissions and GDP growth, that may suggest that problems generated by the economic activities generating carbon emissions outcome their benefits and lead not to an increase in GDP, but to a reverse effect.

On the other hand, the positive relationship between the government expenditure on environmental protection and the carbon emissions may suggest that the governments are forced to spend more money on counteracting the impacts of the carbon emissions.

While the correlations can operate both ways, it is important to find out more precisely how the considered independent variables are impacting the level of the

carbon emissions. In this regard, we deepen our analysis by using POLS (pooled ordinary least squares) method.

The test regarding the possible multicollinearity led to results that show a low-moderate multicollinearity. Moreover, the Breusch-Pagan test revealed a probability of 0.0000, below the 0.05 threshold, showing that a random effects model is more appropriate, instead of a simple one. However, beside using a normal random effects model, we will use also the robust random effect model in order to avoid the heteroscedasticity.

The results obtained applying both the normal random effects model and the robust random effects model on the specified panel of data, are shown in the following Table 3:

Table 3. Results of the random effects models

RE	Normal		Robust	
	Coef.	P>t	Coef.	P>t
TEp	.5972474***	0.000	.5972474	0.173
TPg	-1.542233***	0.004	-1.542233	0.164
GEEp	-.1216468	0.588	-.1216468	0.812
RECpt	-.1761563***	0.000	-.1761563***	0.000
GDPcg	.0108302	0.362	.0108302	0.214
cons	9.714413***	0.000	9.714413***	0.000
R-squared	0.5163		0.5163	
Wald test	548.81		50.95	
Prob.	0.0000		0.0000	

***, **, * - denotes significance at 1%, 5%, respectively 10% level

Source: Author calculation using STATA 12

According to Table 3, both the normal random effects model and the robust random effects model show similar values of all the coefficients, but the statistical significance appears to be different in some cases. We can observe that taxes on pollution impact negatively and statistically significant the level of CO₂ emissions in both models, their high impact being confirmed by the coefficient value, which suggests that the fiscal policy of punishing the polluters leads to the expected results of diminishing the CO₂ emissions. Moreover, the general government expenditures on environmental protection prove to have also an important negative impact on carbon emissions in terms of the coefficient, but less statistically significant, showing so that the government expenditures on environmental protection lead to a decrease of carbon emissions. However, the lack of statistical significance may imply that this fiscal instrument is not used at its entire capacity and can suggest that either this kind of expenditures are not enough, or their destinations are not chosen properly by the governments. On the other hand, the environmental taxes, even with a less important impact in terms of the coefficient, seem not to diminish the CO₂ emissions, but to increase them,

which leads to the conclusion that this fiscal instrument is not used properly by the authorities and needs to be adjusted to serve its purpose.

As expected, the economic growth, still based mainly on using fossil fuels, proves to lead to a slightly increase in the level of the carbon emissions, judging upon its coefficient, but not statistically significant. On the other hand, the general tendency, of promoting the use of the green or renewable energy leads to a very important negative effect, in terms of the coefficient and statistical significance impact, on the CO₂ emissions, which is also in line with the previous expectations and with the results from the previous literature.

The Hausman test for the described variables revealed a probability of 0.3610, above 0.05 threshold, which suggests that random effects model is preferable to the fixed effects one. However, in order to deepen our analysis, we will test also the POLS fixed effects models, both normal and robust, for evaluating the impact the independent variables on the CO₂ emissions level. The results of these tests are presented in Table 4, below.

Table 4. Results of the fixed effects models

FE	Normal		Robust	
	Coef.	P>t	Coef.	P>t
TEp	.593476***	0.000	.593476	0.198
TPg	-1.52264***	0.005	-1.52264	0.194
GEEp	-.0924673	0.682	-.0924673	0.858
RECpt	-.1780103***	0.000	-.1780103***	0.000
GDPcg	.0108304	0.363	.0108304	0.220
cons	9.838392***	0.000	9.838392***	0.000
R-squared	0.5163		0.5163	
Wald test	109.96		9.98	
Prob.	0.0000		0.0000	

***, **, * - denotes significance at 1%, 5%, respectively 10% level

Source: Author calculation using STATA 12

We note that the fixed effects models show the same degree of high confidence as the random effects models, reflected by the R-squared level of 0.5163. Moreover, there can be observed similar positive or negative impacts of the independent variables on the CO₂ emissions, as in the previous random effects models. We also observe that the coefficients obtained by using the fixed effects models are very little different from the ones obtained in the case of using the random effects models. These observations lead to the conclusion that the models used are catching very realistic the impacts of the considered independent variables on the level of the CO₂ emissions and sustain the conclusions drawn previously.

5. CONCLUSIONS

On the background of the increasing concerns regarding the climate change and its destructive effects reflected both in economic but also in human lives losses, the need to address the generator factors of climate change, consisting in excessive emissions of greenhouse gases and carbon has become a pressing issue for all countries and governments.

During the past years there have been proposed solutions for diminishing the carbon emissions, such as using green and renewable energy or implementing green technologies for environmental protection etc. However, such solutions cannot provide significant results in the absence of the combined efforts of all members of the society, which are not all aware of this necessity or do not all consider such an issue an important one. Therefore, beside the voluntary involvement of some members of the society in actions concurring to environmental protection, governments have to develop instruments, such fiscal policies, in order to determine the entire society to act toward such a goal.

Based on the previous assumptions, our paper has employed an analysis of the effects of fiscal policy and of the use of renewable energies on the level of the carbon emissions, in EU27 countries, during the 2000-2020 period, using statistical methods consisting in Pearson correlations, respectively in building and testing Panel Ordinary Least Squares econometric models.

Our results are showing that the use of the renewable energy represents an important and significantly statistic determinant for diminishing the level of carbon emissions and therefore the solution of replacing the use of energy generated by fossil fuels with the renewable one has to be a central goal. While the natural need of development of the society proves to contribute to the increase of the carbon emissions and implies the use of more energy, the need to switch on using renewable energy becomes more pressing.

On the other hand, considering the need of the governments to intervene for driving the society towards assessing the importance of preventing environmental degradation and acting to reduce the carbon emissions, our analysis has focused on the effects of the taxes and government expenditures regarding pollution, as instruments of fiscal policy. In this regard, our results show that governmental expenditures and the taxes on pollution have important contributions on diminishing the level of the carbon emissions. Such results show that the governments can act both for discouraging the polluters, but also for investing directly or financially sustaining private initiatives for limiting the carbon emissions.

Generally, our results show that the way towards preventing the climate change, and especially the excessive carbon emissions, depends both on developing targeted fiscal policies by the governments, but also by the understanding and the capacity of the society to shift towards using renewable energy.

References

- 1) Acaravci, A. and Ozturk, I. (2010). On the relationship between energy consumption, CO2 emissions and economic growth in Europe. *Energy* 35 (12), 5412–5420, <https://doi.org/10.1016/j.energy.2010.07.009>
- 2) Adewuyi, A. O. (2016). Effects of Public and Private Expenditures on Environmental Pollution: A Dynamic Heterogeneous Panel Data Analysis. *Renewable and Sustainable Energy Reviews* 65: 489–506. doi: <https://doi.org/10.1016/j.rser.2016.06.090>
- 3) Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D. and Farhani, S. (2018). How Economic Growth, Renewable Electricity and Natural Resources Contribute to CO2 Emissions? *Energy Policy* 113: 356–367. doi: <https://doi.org/10.1016/j.enpol.2017.10.050>
- 4) Baloch, M.A., Mahmood, N. and Zhang, J.W. (2019). Effect of natural resources, renewable energy and economic development on CO2 emissions in BRICS countries. *Science of The Total Environment* 678, 632–638, <https://doi.org/10.1016/j.scitotenv.2019.05.028>
- 5) Chishti, M. Z., Ahmad, M., Rehman, A., and Khan, M. K. (2021). Mitigations pathways towards sustainable development: Assessing the influence of fiscal and monetary policies on carbon emissions in BRICS economies. *Journal of Cleaner Production*, 292, 126035. <https://doi.org/10.1016/j.jclepro.2021.126035>
- 6) Dogan, E. and Seker, F. (2016). Determinants of CO2 emissions in the European Union: The role of renewable and non-renewable energy. *Renewable Energy* 94:429–39. doi: <https://doi.org/10.1016/j.renene.2016.03.078>
- 7) Firtescu, B., Droj, L., Florea, A., and Filip, B.-F. (2025). Policy Implications and Risk Mitigation of Greenhouse Gas Management in the Renewable Energy Sector. *Risks*, 13(12), 250. <https://doi.org/10.3390/risks13120250>
- 8) Halkos, G.E. and Paizanos, E.A. (2013). The Effect of Government Expenditure on the Environment: An Empirical Investigation. *Ecological Economics* 91: 48–56. doi: <https://doi.org/10.1016/j.ecolecon.2013.04.002>
- 9) Ike, G. N., Usman, O., and Sarkodie, S. A. (2020). Fiscal policy and CO2 emissions from heterogeneous fuel sources in Thailand: Evidence from multiple structural breaks cointegration test. *Science of the Total Environment*. 702, 134711. <https://doi.org/10.1016/j.scitotenv.2019.134711>
- 10) Katircioglu, S. and Katircioglu, S. (2018). Testing the Role of Fiscal Policy in the Environmental Degradation: The Case of Turkey. *Environmental Science and Pollution Research* 25 (6): 5616–5630. doi: <https://doi.org/10.1007/s11356-017-0906-1>
- 11) Leitão, N. C. (2025). The Impact of Environmental Taxes and Renewable Energy on Carbon Dioxide Emissions in OECD Countries. *Energies*, 18(10), 2543. <https://doi.org/10.3390/en18102543>
- 12) Li, S., Samour, A., Irfan, M. and Ali, M. (2023). Role of renewable energy and fiscal policy on trade adjusted carbon emissions: evaluating the role of environmental policy stringency, *Renewable Energy* 205: 156–165, <https://doi.org/10.1016/j.renene.2023.01.047>

- 13) López, R. and Palacios, A. (2014). Why has Europe Become Environmentally Cleaner? Decomposing the Roles of Fiscal, Trade and Environmental Policies. *Environmental and Resource Economics* 58, 91–108. <https://doi.org/10.1007/s10640-013-9692-5>
- 14) Ma, B., Sharif, A., Bashir, M., and Bashir, M. F. (2023). The dynamic influence of energy consumption, fiscal policy and green innovation on environmental degradation in BRICST economies. *Energy Policy*. 183, 113823 Elsevier Ltd. <https://doi.org/10.1016/j.enpol.2023.113823>
- 15) Neves, S.A., Marques, A.C. and Patrício, M. (2020). Determinants of CO2 emissions in European Union countries: Does environmental regulation reduce environmental pollution? *Economic Analysis and Policy* 68: 114–125, <https://doi.org/10.1016/j.eap.2020.09.005>
- 16) Ramlogan, A., and Nelson, A. (2024). Assessing the influence of fiscal and monetary policies on carbon dioxide emissions. *Latin American Journal of Central Banking*. 5, 100114. <https://doi.org/10.1016/j.lacsb.2023.100114>
- 17) Yang, X., He, L., Xia, Y. and Chen, Y. (2019). Effect of government subsidies on renewable energy investments: the threshold effect, *Energy Policy* 132 156–166, <https://doi.org/10.1016/j.enpol.2019.05.039>
- 18) Zaman, K. and Moemen, M.A.-E. (2017). Energy consumption, carbon dioxide emissions and economic development: evaluating alternative and plausible environmental hypothesis for sustainable growth. *Renewable and Sustainable Energy Reviews* 74:1119–30, <https://doi.org/10.1016/j.rser.2017.02.072>