Is Climate Policy Effectiveness Important for Country's Competitiveness Among EU Member States?

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Abstract

This study examines the level of relationships between the competitiveness position of the EU countries and the climate and sustainable finance policy effectiveness. In this research we utilized panel data analysis, where the level and direction of connectedness between World Competitiveness Index (WCI) and climate policy effectiveness and green finance regulatory frameworks were empirically analyzed. It was found that the level of relationships between a country's competitiveness index and level of climate policy regulations is positive and significant among the EU member states. Moreover, we are among the first who analyze the relationship between the level of a country's competitiveness and green finance regulatory framework which represents the cornerstone for the implementation of the EU sustainability strategy. The paper and the empirical results provide solid grounds for the policymakers to continue developing the climate and sustainable finance regulatory ecosystem needed to achieve the Eurozone climate targets by 2030 and become fully climate neutral by 2050.

Key words: sustainability, competitiveness, climate policies, green finance regulatory frameworks
J.E.L. classification: G38, Q43, Q56, P28

1. Introduction

The Paris agreement was a trigger point for humanity to change its direction for development in the next century. Each signatory party defined its time calendar to achieve the climate targets and sustainable development objectives. In the context of the Paris agreement, it was decided to set-up the global timescale to achieve the climate targets, and it was evident that some countries achieved them in advance (e.g., EU member states) while some other nations set-up these targets with a certain delay (e.g., China).

The main objective of the research is to reveal the contribution of climate policies to an increase in a country's competitive position and the role of green finance in achieving the climate targets at the EU level.

In the context of the UN Climate Change Conference (COP21) in Paris, which took place on December 12th, 2015, the climate targets were set and agreed by 196 nations and include *"the decreasing in the global average temperature to well below 2°C above pre-industrial levels"* (United Nation, Paris Agreement, 2015) and to maintain the temperature increase to *"1.5°C above pre-industrial levels"* (United Nation, Paris Agreement, 2015). The member states agreed that to achieve the target of 1.5°C the greenhouse gas emissions should reach the maximum level by latest 2025 and afterword's the emissions should be reduced by about 43% by 2030. The timeline targets were adapted by different countries and regions. For example, the EU strategy for climate change regulates that by 2030 the greenhouse gas emissions should be reduced by at least 55% and by 2050 EU should

become fully climate neutral (European Commission, 2023) . Comparing with EU targets China established to reach its maximum level of emissions by 2030 and become climate neutral by 2060 (Chen and Lin, 2021; Jia and Lin, 2021).

Considering the climate targets set by different nations at the EU level, the development of the regulatory streams evolved differently at each country level. Zheng et al. (2023) in their research found that CO2 emissions reductions can be achieved only with an outstanding and solid climate regulatory system. A detailed analysis of relationships between competitiveness and sustainability policies was undertaken by Cohen and Tubb, (2018) from the perspective of academic contribution. In most of the research, outstanding climate legislation positively impacts the positive dynamics of country's competitiveness at macro level and organizational productivity at micro level. Essentially, the identified results validate the main research hypothesis which Porter and van der Linde raised since 1995; they stated that one important source of organizational competitiveness is achieved through sustainability.

In the research we employed multivariate data analysis and found positive and significant relationships between a country's World competitiveness index (WCI) and level of effectiveness of climate policies. Moreover, we are among the first to identify the extent to which the level of development of sustainable finance regulatory framework impacts the country's competitiveness position among EU member states. The paper and the empirical results provide solid grounds for the policymakers to continue developing the climate and sustainable finance regulatory ecosystem needed to achieve the Eurozone climate targets by 2030 and become fully climate neutral by 2050. The rest of the paper is organized as follows: Section 2 provides evidence about current literature perspective and the research gaps; Section 3 reveals the methodology and hypothesis development; fundings of the empirical research will be presented in Section 4 and conclusions are presented in Section 5.

2. Literature review

The academic analysis of the level of connectedness and the impact of corporate sustainable development "attitude" is not new. The academic interest in corporate sustainable development started in the early 1980's when in 1983 at the level of United Nations it was decided to undertake initiatives and actions to recalibrate the economic model existing at that time. Thus, they created the World Commission on Environment and Development to reveal and understand the liaison between ecological health, economic development, and social capital. Throughout time both academic and professional community understood that in a world with scares resources, it is only possible to achieve competitiveness through sustainable development which was the main consideration for our research direction (Balkyte et al, 2010; Bucher, 2018; Hoang et al, 2020).

Taušová et al. (2022) found that the key regulatory frames that should prevail at the EU level should refer to the resource utilization and efficiency (water, soil, energy etc.) to achieve competitiveness and a prominent level of productivity. They concluded that such regulatory streams would enable the EU to achieve its target level for a circular economy. Also, they showed that the Visegrad's countries are less efficient in managing the efficiency of the resource utilization compared to the EU average. In fact, the idea was first launched by Porter in 1995; countries' competitiveness (higher productivity indexes of resource utilization) can be achieved through sustainability (especially achieved through innovations) (Porter and van der Linde, 1995). In their research, Zheng et al. (2023) analyze an indirect approach of Porter's perspective; they show the effectiveness of the climate policy on CO2 emissions as an indirect factor representing the efficiency of resource utilization. They found a significant and negative relationship between CO2 emissions and the global climate policy effectiveness evaluation and compared the results with the leading countries for CO2 emissions. It was revealed that China shows the best results in terms of effectiveness of climate policies and reduction of CO2 emissions. Still, at the global level the best regulatory mechanisms did not achieve to manage efficiently the tradeoff between level of CO2 emissions and effectiveness of the climate policies. For example, Bak et al. (2017) through their research propose a policy package which balances the trade-off between the CO2 emissions reduction and increasing the sustainable infrastructure, by mobilizing sustainable finance through adoption of carbon pricing mechanisms thus, creating the prerequisite to increase the competitiveness. Another important aspect of the

relationship analysis between climate policies and competitiveness is driven by the negative effects of inefficiency in implementing the climate policies at country level. Sokołowski and Heffron, (2022) in their research analyze the circumstances for failure of policy creation and implementation by central authority as follows: unfeasible policy instrument selected, country's economy specifics were neglected, low public awareness about the environmental protection, low political support etc. The specifics and challenges mentioned above create academic dispute in revealing the level of connectedness between climate policy regulation and country's level of competitiveness.

Cohen and Tubb, (2018) did a meta-analysis of the literature analyzing the impact of sustainability (through the lenses of environmental regulation) on the competitiveness and productivity at both micro and macroeconomic levels. They found that among the researchers the consensus about the level of connectedness between competitiveness and sustainability is still not achieved, neither at country levels nor at company levels. From the analyzed papers about 54% of the studies reveal negative relationship between environment policies and company's productivity or profitability while 46% show negative relationship between climate policies and regional or country's competitiveness. Cohen and Tubb, (2018) identified about 37% of the analyzed sample considered solely US market and only 25 articles (24%) referred to the EU countries. Due to this reason our research will enrich the current literature on the impact of climate policy and sustainable finance regulatory efficiency on the competitiveness of the EU member states.

There are few research mechanisms used to determine the relationships between level competitiveness and efficiency of the climate policies because of the complexity of the researched topic. In the literature, there were many attempts to analyze climate policies' effectiveness by using quantitative and qualitative methods. For example, it is worth to mention in qualitative methods the description analysis of the evolution of the solar photovoltaic (PV) feed-in tariff in Spain, and implication of the energy policies (Mir-Artigues and Rı'o, 2014), or the analysis of the efficacy of energy regulation in Indonesia in the context of green and renewable energy transitions (Santika et al, 2020). Some other authors used statistical and econometric analysis to reveal the effectiveness of the climate policies on different micro and macroeconomic vectors more precisely. Thus, Kersey et al. (2021) and Liu et al. (2019) used the panel data analysis to show the effectiveness and the effect of the renewable energy policies on the country level development.

Cohen and Tubb, (2018) identified different approaches to represent the level of development of climate policy as proxies for empirical analysis, important to mention the number or types of regulatory policies which are not the only ones used by the research (Brunel and Levinson, 2016). It is also worth mentioning the pollution control expenditures or measures of regulatory stringency (e.g., Environmental policy stringency index developed by the World Bank).

From the existent literature we can depict the importance of current research considering the multiple perspective aspects. Firstly, a solid climate policy set-up for a country represents the baseline to achieve the climate targets and increase the competitiveness of the country through sustainability. Secondly, it is important to harmonize the design and implementation of the climate regulatory framework in a way that encompasses all the country's realities (e.g., economic, politic, financial etc.). Thirdly, the EU climate policy design should consider and if possible, internalize legal provisions that mitigate the adverse effects on country's competitiveness that arise from leakage of unilateral climate policy adoption.

3. Research methodology

To achieve our research objective, the research hypothesis must be defined. Referring to the ideas discussed by Porter in his paper, the level of competitiveness to be achieved through sustainability is a complex process and embeds corporate strategies which should be addressed in the medium and long term. The main structural component of Porter's hypothesis is that competitiveness can be achieved through sustainability only if it is implemented through innovations. Jaffe and Palmer (1997) identified several facets of the Porter Hypothesis: the weak version where climate policies will stimulate only several types of innovations which means the implementation costs will exceed the benefits; the strong version where the innovations undertakings will determine higher value from benefits rather than cost of compliance; narrow version which should be well designed, flexible and create good incentives for companies to innovate through sustainability and increase the

competitiveness of the company. Considering the baseline of the Porter's Hypothesis we presume the following research hypothesis:

- *H1. The level of climate regulatory development positively impacts the country's competitiveness in the EU region.*
- *H2. The level of sustainable finance regulatory development positively impacts the country's competitiveness in the EU region.*

Zheng et al., (2023) found that climate policy effectiveness represented through the number of regulatory frameworks positively influences the level of CO2 emissions, which is an indirect component and performance indicator of corporate productivity and country competitiveness achieved through sustainability.

Empirical specifications

Consistent with the approach used by other research (Cohen and Tubb, 2018; Du and Li, 2020; Ma et al., 2019) regarding the analysis of the relationship between competitiveness and sustainability, and the extent to which the latter impacts the level of competitiveness through innovation we employed panel data analysis. To deal with endogeneity issues in the model we included regulatory effectiveness variables as lagged measures one year, to capture the full realization of the climate and sustainable finance policy implementation. Furthermore, to capture the yearly regulatory specific trends and impact, also including some of the specific economic trends in the results (e.g., COVID 19 effects) we consider in the model the year dummies. Thus, to assess the relationships between country competitiveness and climate and sustainable finance policy effectiveness set-up at country level we employ the following multivariate regression model:

$$\boldsymbol{WC_{it} = \beta_0 + \beta_1 * CPE_{it-1} + \beta_2 * GFPE_{it-1} + \beta_3 * X_{it} + TimeEffect_t + \varepsilon_{it}} \quad \textbf{(1)}$$

where the subscripts ***it*** indicates the ***i*** country-level characteristics, in the period ***t***. WCI stands for world competitiveness index issued by International Institute for Management Development (IMD), CPE denotes the climate policy effectiveness lagged one year, GFPE represents the green finance policy effectiveness, also lagged one year and *X* ***it*** stands for control variables. The year fixed effects and the ***εit*** which represent the error terms were included in the model. To assess hypothesis 1 and 2 we employed separate analysis for climate policies and green finance policies. Moreover, we test which panel data analysis model is more suitable for the empirics, either fixed-effects panel data analysis (FE) or random-effects analysis (RE). Additionally, we intend to include the ordinary least square (OLS) regression in the research, for robustness check purposes.

Data and Variables

The sample data for this research was built from various sources. First, the information about climate policies was extracted from the Climate Policy Database, which manages the issued climate policies from around the world. The selected climate policies were referring to the EU member states that were "in force" since 2009 and onwards. In the sample data we did not consider those climate policies that were regulated at the eurozone level, especially representing the EU directives regulated by EU Commission. It is worth mentioning that we have chosen 2009, one year after the first commitment period defined through Kyoto protocol (e.g. 2008-2012) to ensure that it was enough time for regulatory bodies to internalize the new regulatory framework undertakings. In the analysis the sustainable finance regulatory frameworks were also included considering they represent a vital component in the implementation of the sustainability strategy both at country level and among the players from the financial markets. For this purpose, the sustainable finance regulatory policies issued by countries from 2009, which were in force as of 30th of April 2023 were considered in the analysis. Data about sustainable finance policies was extracted from the specialized platform whose mission is to monitor the global green finance regulatory dynamics called Green Finance Platform. To quantify the level of competitiveness at the country level, the IMD competitiveness index was chosen, and extracted from the database of International Institute for Management Development. To obtain more relevant results we have considered data from 10 years (the period 2012-2021) for all the EU member states as of 30th of April 2023 (which does not include the UK) and excludes Malta for lack of data. There are many approaches and methodologies to quantify the country competitiveness index issued by organizations such as: the World Economic forum, EU Commission etc. The IMD competitiveness index is one of the oldest representations for country's

competitiveness position calculated by Institute for Management Development since 1989. Because this is the oldest representation which has the most complex view about competitiveness position calculated at country level, it will be considered in our empirical analysis as a *dependent variable*. The IMD world competitiveness index encompasses the following structural components to be quantified: Economic Performance, Governance Efficiency, Business Efficiency, and Infrastructure – the latest includes the sustainability components in it.

To empirically test the research hypothesis, in the panel analysis the independent variables are represented by the climate policy effectiveness measure and sustainable finance regulatory frameworks. The climate policy effectiveness variable follows the approach of (Zheng et al., 2023) which include the following characteristics: the national distribution of the policies, temporal dynamics over time and regulatory areas. To embed it in the model, the variable was calculated as the active number of policies issued each year in every country (EU region) in a cumulative manner. This approach was considered because there are cumulative and complementary effects of active climate policies on the economy. For this reason, we expect to see the improvement of the competitiveness position at country level over time through the strengthening of the country's environment regulatory framework. Analyzing the database of the climate policies at EU level we have obtained the following policy distribution themes: energy efficiency; renewables; energy service demand reduction and resource efficiency; other low-carbon technologies and fuel switch; other related climate policies; non-energy use having the distribution as indicated in the Table 1.

Table no. 1 Distribution of climate policies in force at the level of EU member states.

Climate policy's themes	**Number of policies issued**
Energy efficiency	168
Renewables	94
Energy service demand reduction and resource efficiency	90
Other low-carbon technologies and fuel switch	74
Other related climate policies	18
Non-energy use	14
Total climate policies for EU countries	**458**

Source: (Climate policy database)

It is worth mentioning that the dominant areas of the climate regulatory policies at the level of EU refers to the: energy efficiency and renewable which should significantly impact the level of competitiveness across the EU countries considering that it refers to the energy sector.

Sustainable finance regulatory policies set at EU level is structured considering the following regulatory themes: Environmental, Social and Governance (ESG); Climate Change; Sustainable, Green, and Social Bonds; Standards and Regulations etc. (details are provided in the Table 2). As these types of regulatory policies are prerequisites for stimulating the flow of green finance investments in a country, which is an important accelerator for sustainable investment projects, a positive relationship between competitiveness index and the development of sustainable finance regulatory process was expected.

Table no. 2 Distribution of sustainable finance regulatory themes in force among EU member states.

Sustainable finance regulatory themes	**Number of policies issued**
Environmental, Social and Governance (ESG)	37
Climate Change	30
Sustainable, Green, and Social Bonds	20
Standards and Regulations	14
Other sustainable finance	7
Stock Markets and Regulators	5
Stewardship	4
Risk and Resilience	2
Impact Investment	1
Indicators and Measurement	1

Infrastructure	1
Natural Capital	1
Total sustainable finance policies for EU countries	123

Source: (Green finance platform)

Consistent with (Hurduzeu et al., 2022; Zhang and Zhao, 2019) the following control variables were included in the model as an important explanatory factor that can impact the competitiveness of the country: total country expenditure on research and development; scientific research legislation; equal employment opportunity; GDP (PPP) per capita; government budget surplus-deficit; image abroad or branding. The selected control variables refer directly to the competitiveness index as these factors are considered in the realization of the indicator as well. In Table 3 we describe in a detailed manner the structure of the variables which will be considered in the model.

Table no. 3 Research variable included in the empirical model.

Variable name	Description	Source
Overall World Competitiveness Index (O_WCI)	Competitiveness index calculated based on the IMD methodology	IMD Website: https://www.imd.org/
Climate policies Effectiveness (CPE)	Distribution of climate policies calculated cumulatively every year	Climate Policies Database: https://climatepolicydatabase.org/
Green finance policies Effectiveness (GFPE)	Distribution of green finance policies calculated cumulatively every year	Green finance platform: https://www.greenfinanceplatform.org/
Total expenditure on Research and Development (TE_R&D)	Percentage of GDP	The World Bank data: https://data.worldbank.org/
Scientific research legislation (SRL)	Laws relating to scientific research do encourage innovation	IMD Website: https://www.imd.org/
Equal opportunity for employment (EOE)	Equal opportunity legislation in the economy encourages economic development	IMD Website: https://www.imd.org/
GDP PPP per capita	US$ GDP per capita at purchasing power parity	The World Bank data: https://data.worldbank.org/
Government budget surplus deficit (GB_SD)	Percentage of GDP	European central bank database: https://sdw.ecb.europa.eu/browse.do?node=9693760
Country Image abroad or branding (C_IAB)	The image abroad of your country encourages business development	IMD Website: https://www.imd.org/

Source: (author's own contribution)

4. Findings

Table 4 provides summary statistics of the variables used in the model calculations. Using Stata software, we found that the empirical analysis panel data is strongly balanced, including data of yearly time variables for 2012-2022. The data sample consists of 280 yearly observations analyzed at country level, members of the EU area as of 30th of April 2023 (e.g., excluding the UK) and excluding Malta, for which data was not identified in the analysis. The variable used in the model has different quantitative representations (e.g., index, percentage, gross USD value etc.) which is the most complex structure represented by the IMD country competitiveness index. TE_R&D and GDP PPP per capita present a lower number of observations used in the model because of the missing data from 2022 and 2012, therefore the model calculation will limit the empirical analysis to this number of observations. Having strongly balanced panel data will allow us to test different models considering the structure of sample variables (e.g., OLS, panel regression with fixed effects, with random effects etc.).

Table no. 4 Summary statistics

VARIABLES	(1) N	(2) mean	(3) sd.	(4) min	(5) max
O_WCI	280	71.52	14.13	38.97	100
CPE	286	12.43	16.54	0	78
GFPF	286	1.752	3.382	0	29
TE_R&D	234	1.663	0.877	0.382	3.525
SRL	280	5.532	1.449	2.080	8.100
EOE	280	6.057	1.113	2.785	8.476
GDP PPP per capita	260	41,867	20,294	7,432	131,875
GB_SD	260	-2.376	3.004	-14.58	4.064
C_IAB	280	5.973	1.708	1.067	9.083

Source: (author's own contribution)

The results obtained from equation (1) partially validate our research hypothesis and are indicated in Table 5. In the empirical analysis we test the hypothesis by using two approaches, first, the time fixed effects for multivariate regression were considered in the model, and the hypothesis was tested without time fixed effects. In both cases the results differ and are presented in Table 5 and Table 6. Climate policy effectiveness is a strong instrument to measure the country's competitiveness index and position. Moreover, this relationship was first introduced by Porter and van der Linde in 1995 with focus on innovation as a liaison mechanism of the relationships between sustainability and competitiveness. Considering that in the model we do not control time fixed effects, we found a positive relationship between country competitiveness and climate policy effectiveness set at country level for all EU member states. These results are consistent in both OLS regression and panel data analysis with fixed and random effects. Both hypotheses are validated for climate policies and green finance regulatory framework adopted and implemented across the EU. The results show a positive relationship between regulatory frameworks and competitiveness index which indicates that highly regulated areas, that refer to the sustainable development will impact positively the level of country competitiveness and productivity, thus the Porter's hypothesis also has been validated. Moreover, we found the results to be positive and significant at 5% across OLS and panel data regressions which shows that countries' strategy directions for each EU member state should be oriented towards sustainability through the lenses of a solid climate and sustainable finance regulatory frameworks. The results found by using this methodological approach is consisted to the research conclusions achieved by (Cohen and Tubb, 2018) and (Zheng et al., 2023), the latter analyzed the effectiveness of the climate regulatory effectiveness from the perspective of the CO2 emission as an indirect proxy for competitiveness and productivity.

To strengthen the concept developed by Porter and van der Linde the following was indicated in the model as control variables: the level of R&D expenditures as % of GDP and number of scientific research legislation. The identified results show the following: negative relationships between level of R&D expenditures and competitiveness index indicates that higher expenditure will not necessarily ensure the expected results, meaning that higher sustainability will trigger innovation and will impact the higher competitiveness. Moreover, it might be possible that R&D expenditures are not undertaken exclusively to achieve the sustainability scope of the country therefore, higher cost for R&D is a negative sign for uncertainty of the expected results. The level of relationships is negative but not significant. On the other hand, we have the number of scientific research legislation as proxy for measuring innovation – again regulatory proxy to analyze the behavior of the competitiveness index through sustainability. In fact, as indicated by Porter, the scientific vector of the national economy is a crucial factor for its competitiveness and a proxy for sustainable development. In the research we found that the relationships between the number of scientific research legislation and competitiveness index is positive and significant at 1 % across all the models controlled and not for time fixed effects.

In the models where we control for time fixed effects in both OLS and panel data analysis, different results were found in the sense that the nature of relationships between climate and green finance regulatory effectiveness and the level of competitiveness are both positive and negative depending on the employed model. In the OLS regression the level of relationships between climate policies and competitiveness is positively and significantly correlated at 1% while the green finance

regulatory efficiency the relationship is positive and non-significant. Furthermore, if we run the model considering only the green finance regulatory proxy, we see the level of relationships becomes slightly negatively and non-significantly correlated which does not support the research hypothesis. The panel data analysis controlled for time fixed effects shows negative relationships between climate regulatory effectiveness and country competitiveness which is inconsistent with the defined hypothesis in our research. Further analysis is needed to identify the sources of discrepancies with other models and papers. Moreover, it is required to employ a detailed analysis of the structural components of world competitiveness index (e.g., economic performance, government efficiency, business efficiency and infrastructure) and the level of relationships with the climate policy effectiveness.

The identified results are important for policymakers as they provide insights into the impact of regulatory frameworks and their efficiency on a country's competitiveness performance. Moreover, climate policies and green finance regulatory frameworks set at country level are two complementary regulatory instruments that will support the implementation of the country's sustainability development initiatives with visible results on medium and long term. This also will help countries to set-up climate targets through efficient climate policies and will help to achieve these targets by investing sustainable financial resources obtained through a robust regulatory platform for green finance.

5. Conclusions

Although Porter and van der Linde authored their paper in 1995 the problematics of sustainability impact on the organizational and country competitiveness is much more popular today than before. The level of complexity and the magnitude of the research topic reached the global level with the Paris Agreement. This research area, including our paper, has a multidisciplinary character as it combines elements from climate-technical, legal, economics, finance. Considering its novelty character, the current literature shows discrepancies in the achieved results as it was indicated through the meta-analysis undertaken by Cohen and Tubb, (2018). Zheng et al. 2023 found consistent and indirect implications of the climate policies effectiveness on the level of CO2 emissions which ultimately impacts the level of country competitiveness.

We employed the panel analysis to reveal the level of relationship between country's competitiveness index and climate policy and sustainable finance effectiveness and found that the relationship is positive and significant for both types of regulatory framework. Our findings validate the idea the competitiveness can also be achieved through sustainability. For this reason, policymakers should invest more effort in development and consolidation of the sustainable development regulatory ecosystem in a harmonized manner. This is because a strong climate policy ecosystem cannot survive in a country where there is no, or there is a weak sustainable finance regulatory ecosystem. This is the main reason the European Union is acting in a multidisciplinary manner to achieve its climate targets and redesign its macroeconomic development model towards sustainability. In addition to the regulatory drivers which impact on the level of a country's competitiveness should not be neglected, also the other economic drivers for competitiveness that we considered in the model as control variables. For example, it was found that the level of GDP, government surplus or deficit significantly and positively determines the level of country's level of competitiveness. The social facet of the economy represented in our model through the equal opportunity for employment together with the indicator for country image abroad or branding are qualitative characteristics of the economy which was found in our research to play an important role for the country's competitiveness level.

Our research has limitations from the perspective of endogeneity, and this limitation has partially solved by lagging the independent variables, still further investigation is needed with instrumental variable analysis. Moreover, we must consider a further dimensional analysis of the IMD world competitiveness index as it is built, considering over 330 criteria measuring different facets of competitiveness. We expect that further structural detailed analysis will bring more accurate results in revealing the influence of climate policy on the country's competitiveness.

6. References

- Bak, C., Bhattacharya, A., Edenhofer, O., & Knopf, B., 2017. Towards a comprehensive approach to climate policy, sustainable infrastructure, and finance. *Economics*, *11*(1). https://doi.org/10.5018/economics-ejournal.ja.2017-33
- Balkyte, A., & Tvaronavičiene, M., 2010. Perception of competitiveness in the context of sustainable development: facets of "sustainable competitiveness". *Journal of business economics and management*, *11*(2), 341-365. https://doi.org/10.3846/jbem.2010.17
- Brunel, C., & Levinson, A., 2016. Measuring the stringency of environmental regulations. *Review of Environmental Economics and Policy*. https://doi.org/10.1093/reep/rev019
- Bucher, S., 2018. The Global Competitiveness Index as an indicator of sustainable development. *Herald of the Russian Academy of Sciences*, *88*, 44-57. https://doi.org/10.1134/S1019331618010082
- Chen, X., & Lin, B., 2021. Towards carbon neutrality by implementing carbon emissions trading scheme: Policy evaluation in China. *Energy Policy*, *157*, 112510. https://doi.org/10.1016/j.enpol.2021.112510
- Cohen, M. A., & Tubb, A., 2018. The impact of environmental regulation on firm and country competitiveness: a meta-analysis of the porter hypothesis. *Journal of the Association of Environmental and Resource Economists*, *5*(2), 371-399. https://doi.org/10.1086/695613
- Du, W., & Li, M., 2020. Assessing the impact of environmental regulation on pollution abatement and collaborative emissions reduction: Micro-evidence from Chinese industrial enterprises. *Environmental Impact Assessment Review*, *82*, 106382. https://doi.org/10.1016/j.eiar.2020.106382
- Hoang, T. H. V., Przychodzen, W., Przychodzen, J., & Segbotangni, E. A., 2020. Does it pay to be green? A disaggregated analysis of US firms with green patents. *Business Strategy and the Environment*, *29*(3), 1331-1361. https://doi.org/10.1002/bse.2437
- Hurduzeu, G., Lupu, I., Lupu, R., & Filip, R. I., 2022. The Interplay between Digitalization and Competitiveness: Evidence from European Countries. *Societies*, *12*(6), 157. https://doi.org/10.3390/soc12060157
- Jaffe, A. B., & Palmer, K., 1997. Environmental regulation and innovation: a panel data study. *Review of economics and statistics*, *79*(4), 610-619. https://doi.org/10.1162/003465397557196
- Jia, Z., & Lin, B., 2021. How to achieve the first step of the carbon-neutrality 2060 target in China: The coal substitution perspective. *Energy*, *233*, 121179. https://doi.org/10.1016/j.energy.2021.121179
- Kersey, J., Blechinger, P., & Shirley, R., 2021. A panel data analysis of policy effectiveness for renewable energy expansion on Caribbean islands. *Energy Policy*, *155*, 112340. https://doi.org/10.1016/j.enpol.2021.112340
- Liu, W., Zhang, X., & Feng, S., 2019. Does renewable energy policy work? Evidence from a panel data analysis. *Renewable Energy*, *135*, 635-642. https://doi.org/10.1016/j.renene.2018.12.037
- Ma, X., Wang, C., Dong, B., Gu, G., Chen, R., Li, Y. & Li, Q., 2019. Carbon emissions from energy consumption in China: its measurement and driving factors. *Science of the total environment*, *648*, 1411-1420. https://doi.org/10.1016/j.scitotenv.2018.08.183
- Mir-Artigues, P., & Del Río, P., 2014. Combining tariffs, investment subsidies and soft loans in a renewable electricity deployment policy. *Energy policy*, *69*, 430-442. https://doi.org/10.1016/j.enpol.2014.01.040
- Porter, M. E., & Linde, C. V. D., 1995. Toward a new conception of the environment-competitiveness relationship. *Journal of economic perspectives*, *9*(4), 97-118. https://doi.org/10.1257/jep.9.4.97
- Santika, T., Budiharta, S., Law, E. A., Dennis, R. A., Dohong, A., Struebig, M. J., & Wilson, K. A., 2020. Interannual climate variation, land type and village livelihood effects on fires in Kalimantan, Indonesia. *Global Environmental Change*, *64*, 102129. https://doi.org/10.1016/j.gloenvcha.2020.102129
- Sokołowski, M. M., & Heffron, R. J., 2022. Defining and conceptualizing energy policy failure: the when, where, why, and how. *Energy Policy*, *161*, 112745. https://doi.org/10.1016/j.enpol.2021.112745
- Taušová, M., Tauš, P., & Domaracká, L., 2022. Sustainable development according to resource productivity in the EU environmental policy context. *Energies*, *15*(12), 4291. https://doi.org/10.3390/en15124291
- Zhang, S., & Zhao, T., 2019. Identifying major influencing factors of CO2 emissions in China: regional disparities analysis based on STIRPAT model from 1996 to 2015. *Atmospheric Environment*, *207*, 136-147. https://doi.org/10.1016/j.atmosenv.2018.12.040
- Zheng, S., Pu, Y., Lu, H., Zhang, J. J., Wang, D., & Ma, X., 2023. Global climate policy effectiveness: A panel data analysis. *Journal of Cleaner Production*, 137321. https://doi.org/10.1016/j.jclepro.2023.137321

Appendix

Table no. 5 Multivariate Data analysis results (no time fixed effects)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
VARIAB.	**OLS**	**OLS**	**OLS**	**FE**	**FE**	**FE**	**RE**	**RE**	**RE**
CPE	0.116***	0.116***		0.033	0.036		0.075**	0.083***	
	(0.022)	(0.022)		(0.033)	(0.033)		(0.031)	(0.031)	
GFPF	0.112		0.122	0.334**		0.338**	0.273**		0.315**
	(0.123)		(0.130)	(0.148)		(0.144)	(0.134)		(0.136)
TE_R&D	-0.378	-0.418	0.741	-2.437	-1.948	-2.177	-0.015	-0.146	0.298
	(0.563)	(0.561)	(0.551)	(1.623)	(1.574)	(1.656)	(0.822)	(0.812)	(0.872)
SRL	3.840***	3.891***	3.500***	2.523***	2.704***	2.567***	2.947***	3.092***	2.865***
	(0.512)	(0.509)	(0.538)	(0.466)	(0.481)	(0.470)	(0.560)	(0.559)	(0.570)
EOE	1.550***	1.547***	1.429**	1.808**	1.975***	1.824**	1.881***	1.889***	1.797***
	(0.543)	(0.543)	(0.574)	(0.718)	(0.691)	(0.710)	(0.579)	(0.582)	(0.587)
GDP PPP per capita	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GB_SD	0.899***	0.904***	0.829***	0.764***	0.751***	0.768***	0.846***	0.838***	0.835***
	(0.108)	(0.108)	(0.113)	(0.099)	(0.094)	(0.099)	(0.100)	(0.100)	(0.100)
C_IAB	2.491***	2.497***	2.464***	2.138***	2.105***	2.187***	2.303***	2.333***	2.321***
	(0.307)	(0.306)	(0.324)	(0.508)	(0.483)	(0.532)	(0.427)	(0.425)	(0.448)
Constant	24.35***	24.35***	25.62***	29.53***	25.99***	28.54***	25.16***	24.56***	25.37***
	(1.870)	(1.869)	(1.961)	(5.851)	(5.332)	(5.804)	(2.678)	(2.644)	(2.894)
Obs.	228	228	228	228	228	228	228	228	228
R-squared	0.902	0.902	0.890	0.633	0.625	0.632			
Number of country ID				26	26	26	26	26	26
Year FE	NO	NO	NO	NO	NO	NO	NO	NO	NO

Source: (author's own contribution); *Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Table no. 6 Multivariate Data analysis results (fixed effects included)

	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9
VARIAB.	**OLS**	**OLS**	**OLS**	**FE**	**FE**	**FE**	**RE**	**RE**	**RE**
CPE	0.1***	0.1***		-0.049*	-0.053*		-0.008	-0.011	
	(0.019)	(0.019)		(0.029)	(0.029)		(0.026)	(0.026)	
GFPF	0.046		-0.006	0.108		0.131	0.133		0.139
	(0.110)		(0.116)	(0.102)		(0.102)	(0.101)		(0.100)
TE_R&D	-0.144	-0.136	0.936**	-1.590	-1.594	-1.757	0.865	0.933	0.633
	(0.475)	(0.473)	(0.451)	(1.078)	(1.079)	(1.079)	(0.695)	(0.690)	(0.710)
SRL	3.96***	3.96***	3.53***	2.31***	2.28***	2.37***	2.90***	2.89***	2.87***
	(0.431)	(0.430)	(0.448)	(0.432)	(0.431)	(0.433)	(0.396)	(0.397)	(0.394)
EOE	1.43***	1.45***	1.50***	1.65***	1.70***	1.63***	1.85***	1.92***	1.84***
	(0.451)	(0.449)	(0.478)	(0.396)	(0.393)	(0.397)	(0.389)	(0.387)	(0.385)
GDP PPP per capita	0.00***	0.00***	0.00***	0.000*	0.000*	0.000**	0.00***	0.00***	0.00***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GB_SD	0.70***	0.70***	0.58***	0.39***	0.39***	0.40***	0.45***	0.46***	0.45***
	(0.120)	(0.119)	(0.125)	(0.093)	(0.093)	(0.094)	(0.094)	(0.094)	(0.092)
C_IAB	2.51***	2.50***	2.46***	1.76***	1.73***	1.73***	1.94***	1.91***	1.89***
	(0.254)	(0.253)	(0.269)	(0.341)	(0.340)	(0.342)	(0.315)	(0.315)	(0.318)
Constant	24.6***	24.6***	24.5***	37.6***	37.8***	37.3***	26.6***	26.4***	27.3***
	(1.784)	(1.780)	(1.889)	(3.980)	(3.978)	(3.996)	(2.331)	(2.316)	(2.480)
Observations	228	228	228	228	228	228	228	228	228
R-squared	0.939	0.939	0.932	0.875	0.874	0.873			
Number of country ID				26	26	26	26	26	26
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES

Source: (author's own contribution); *Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*