

Article

Does Economic Globalisation Harm Climate? New Evidence from European Union

Nela Vlahinić Lenz and Barbara Fajdetić * 

Faculty of Economics and Business, University of Rijeka, Ivana Filipovića 4, 51000 Rijeka, Croatia

* Correspondence: barbara.fajdetic@efri.hr

Abstract: The issue of globalisation-induced greenhouse gas emissions is an ongoing topic and a major challenge to the EU climate goals of achieving non-zero emissions by 2050. In the light of this ongoing debate on the globalisation–environment nexus, the paper examines the impact of economic globalisation on climate in EU countries over the period 2000–2019 and provide some new empirical evidence. After applying the panel cointegration analysis and the Granger causality test, the dynamic panel analysis is performed for 26 EU countries using the Arellano–Bond estimator. For the policy perspective, the analysed sample of countries is grouped into two subpanels according to their level of development—EU countries with above-average and below-average GDP per capita. After testing the effects of different dimensions of economic globalisation and environmental taxes on GHG emissions, the results revealed the following: (1) Trade globalisation is detrimental to the climate, as trade openness significantly increases emissions in both country groups. Financial globalisation has a weaker impact and increases emissions only in below-average countries, suggesting that FDI inflows could be important for the transfer of green technologies when a country reaches higher development level. (2) Passenger transport reduces GHG emissions in both groups of countries, while FDI are beneficiary for the climate in above-average countries. (3) Environmental taxes as a proxy for environmental policy show statistically significant results, but with different outcomes in the two groups; they have a negative impact on emissions in countries that are below the GDP p/c average, indicating the shortcomings of the tax system in addressing climate change. (4) The total energy consumption increases emissions in both country groups and, thus, harms the climate. Therefore, despite the current unfavourable circumstances, EU countries should continue to expand the green economy, increase energy consumption from renewables, and develop low-carbon technologies that do not depend on imported fossil fuels.



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1. Introduction

The motivation for our research is underlined by the current energy crisis on the eve of the probable economic recession in the European Union. Energy supply problems and high dependence on oil and gas imports make the European Union extremely sensitive to changes in energy markets and push it towards domestic energy sources. These deglobalisation trends are gaining momentum, while, at the same time, increased energy consumption from coal has pushed the issue of climate change and greenhouse gas emissions somewhat into the background. The current energy crisis risks pushing the European and global economies into another carbon-rich decade and preventing the Paris Agreement's 1.5 °C limit from being met. Most governments have introduced energy subsidies to compensate households and the industry for high energy prices by providing tax cuts on gasoline and diesel. While it is important to address energy poverty in the short term, it is even more important in the long term to incentivise energy-efficient behaviour. However, the long-term goal of all countries is surely to reduce emissions and ensure sustainable growth for current and future generations. Therefore, the issue of the impact of economic activity

and globalisation on the climate remains extremely important and should be discussed both in academia and in the general public.

Globalisation is a multidimensional process that integrates different markets and nations, while trade, investment, mobility, and technological development have become faster and easier. Although globalisation has various aspects, this paper focuses on economic globalisation, which is measured by several indicators to capture different dimensions. The theoretical framework, which is important for our research, has two sides. On the one hand, according to ecological modernisation theory and world polity theory, homogenisation processes through globalisation lead to the institutionalisation of environmental culture and practices, thus reducing carbon emissions on a global scale [1]. Ecological modernisation theory assumes that environmental degradation is not a necessary result of industrialisation and economic growth, and that technological progress and structural changes can reduce the impact of carbon emissions and climate change [2]. World polity theory is based on the perspective of new institutionalism. It states that global models influence all aspects of social life and that economic actors (individuals, firms, and states) behave according to global rules and expectations (Meyer et al. [3] and Boli and Thomas [4]). On the other hand, ecological unequal exchange theory argues that globalisation has strengthened the historical economic and overall position of developed and less-developed countries and increased inequalities between countries (Rice [5] and Roberts et al. [6]). As a result of economic differences, their economic and technological systems differ greatly, so their contribution to carbon emissions varies. For example, developed economies may externalise environmental costs through outward FDI and networks of global exchange. Therefore, the results obtained will vary greatly depending on the level of development of the countries, and this is the basis for our research approach.

The impact of globalisation on the environment has often been evaluated as negative, and many empirical studies such as Gaies et al. [7], Huo et al. [8], Pata [9], Xiaoman [10], Sun et al. [11], and Acheampong [12] show that globalisation, liberalisation, and international trade lead to an increase in greenhouse gas emissions and, thus, environmental degradation. However, there are other studies (Khan et al. [13], Zafar et al. [14], Aluko et al. [15], He et al. [16], Muhammad and Khan [17], Baloch et al. [18], Islam et al. [19], and Xue et al. [20]) that have reached different conclusions. The inconclusive results on the impact of globalisation on carbon emissions as a cause of climate degradation stimulate new research, while climate change and decarbonisation are gaining new momentum. High emission reduction targets are only possible with major structural changes, increasing the use of renewable energy and other low-carbon technologies, while energy-intensive economic activities should be restructured. The issue of deglobalisation takes on renewed importance in light of recent events in Europe—the dramatic rise in energy prices, problems in supply chains, the war in Ukraine, and uncertainty. The aforementioned circumstances have led European countries to look to their own resources and bring the industry back to Europe to reduce the risks, costs, and time required to obtain the necessary resources, intermediates, and final products. Given these new circumstances, we also want to test the development hypothesis, i.e., that more developed countries have adopted low-carbon technologies and changed their economic structure toward “green” activities. Therefore, we divide EU countries into two subpanels in terms of their level of development: countries with above-average GDP per capita and countries with below-average GDP per capita.

The purpose of this paper is to examine the relationship between various aspects of economic globalisation and GHG emissions in the EU, to evaluate the impact of environmental taxes as a policy measure, and to test the development hypothesis and the globalisation-induced carbon emissions hypothesis. The impact of economic globalisation can be analysed in several dimensions: (1) It connects different markets and increases the opportunities to trade goods, raw materials, and components. This increases the transportation of goods and people and impacts the environment and climate by increasing greenhouse gas emissions. (2) It leads to a narrower specialisation, which is generally a positive development, because it increases productivity and efficiency, but it can also

lead to overspecialisation and overdependence on imported goods, overuse of natural resources, etc. However, greater interdependence between countries and regions makes the negative impacts on climate change, deforestation, and other negative consequences of globalisation more transparent, which may contribute to a greater awareness and new regulations regarding climate change.

A panel data analysis was conducted for 26 EU countries—Cyprus was excluded from the study due to missing data. We assess economic globalisation using several indicators: trade as a share of GDP, foreign direct investment as a share of GDP, and the modal split of passenger cars as an indicator of economic mobility. We also include environmental taxes to capture the impact of climate-friendly policies, energy consumption, and GDP per capita as control variables. The dependent variable is greenhouse gas emissions as an indicator of environmental and climate impacts. Our goal is to provide new empirical evidence on economic globalisation in the European Union and its role in the process of decarbonisation to provide some new insights into the EU's transition to a low-carbon economy. Our paper adds to the current literature and policy discussions on the link between economic globalisation and climate in two ways. First, according to our knowledge, all existing studies have used CO₂ emissions as a proxy variable for climate impacts. Although CO₂ is an important factor responsible for climate degradation, climate change is caused by greenhouse gas (GHG) emissions, while CO₂ is only one part of it. Second, the novelty of our study is that we divide EU countries into two subpanels groups according to their GDP per capita in order to capture the heterogeneity of the level of development. In this way, we aim to examine the importance of the level of development, since the same policy can have very different effects for economies with different levels of development. Therefore, all countries are divided into two groups: one with above-average GDP per capita and one with below-average GDP per capita.

This article is organised as follows. Section 2 provides a literature review on economic globalisation and its impact on the environment and climate. Section 3 explains the data and methodology. Section 4 provides the research findings and discusses some policy implications. Section 5 provides concluding remarks.

2. Literature Review

There is a growing body of research on the impact of economic activity and globalisation on environmental degradation and climate, but the empirical evidence is still inconclusive. Many studies confirm the intuitive hypothesis that economic globalisation leads to greenhouse gas emissions and damages the environment. In the case of Japan, Ahmed et al. [21] found that the long-term empirical results from the symmetric ARDL suggest that economic globalisation and financial development increase the footprint in Japan. On the other hand, their results from the asymmetric ARDL suggest that positive and negative changes in economic globalisation decrease the footprint. The same authors [22] argue that economic globalisation can increase technology transfer through foreign trade and foreign direct investment, thereby promoting the environmental quality. However, in the absence of adequate environmental regulations, trade openness reduces environmental sustainability through a scale effect. Shahbaz et al. [23] studied the role of foreign investment in environmental pollution, and their results confirmed that the impact of foreign direct investment on the climate can be negative when developed countries invest in developing countries with lax environmental regulations. Destek [24] found that economic globalisation increases carbon emissions in the cases of Central and Eastern European countries. However, he also noted that these conclusions are valid up to a certain level of development; after which, higher economic activity and globalisation reduce carbon emissions. A study by Xiaoman et al. [10] on MENA (Middle East and North Africa) countries, which are rich in mineral resources and energy resources, found that, during the period 1980–2018, trade openness, urbanisation, and economic growth significantly worsened the environmental quality. The role of urbanisation as a consequence of globalisation has also been an interesting topic for researchers. Abbasi et al. [25] investigated

the impact of urbanisation and energy consumption on CO₂ emissions in eight Asian countries (Bangladesh, China, India, Indonesia, Malaysia, Nepal, Pakistan, and Sri Lanka) over the period 1982–2017 by using panel cointegration and Granger causality techniques. They concluded that there was a long-term relationship between urbanisation, energy consumption, and CO₂ emissions and a positive and significant impact of urbanisation and energy consumption on CO₂ emissions. Similar results were found by Sun et al. [11]. They examined the impact of trade, energy consumption, urbanisation, and economic growth on carbon emissions over the period 1992–2015 in two groups of countries: Belt and Road (B&R) and OECD countries. According to their findings, trade openness, urbanisation, and energy consumption are responsible for the increase in CO₂ emissions globally. However, the impact is greater within the OECD region than the B&R region. A new study from Huo et al. [8] examined the effects of economic globalisation on CO₂ emissions in developed countries during the period 1970–2019. They applied the Wavelet Coherence (WC) and Quantile on Quantile Regression (QQR) approach and again concluded that economic globalisation harms the climate. According to their study, CO₂ emissions have positive associations and co-movements with globalisation, economic growth, and coal consumption. According to Shahbaz et al. [26], governments in developing countries often tend to promote economic development by relaxing environmental regulations. This phenomenon, also known as “pollution havens”, has a negative impact on the environment and climate through foreign direct investment. On the contrary, FDI can have a positive impact and increase climate sustainability if foreign investment is focused on energy-efficient technologies [27]. Yasmeen et al. [28] reached a similar result regarding the role of foreign direct investment inflow and technological innovations on ecological footprint in 52 Belt & Road countries during the 1992–2017 period. Their findings supported the “pollution havens” hypothesis for these countries and concluded that the ecological footprint can be lowered in the economies by technological advancement. Maiwada and Jamoh [29] concluded that there is a bidirectional relationship as well, because sustainable development could indeed drive innovation and generally enhance the overall transfer of the technology process via all networks. In light of the ongoing desire to increase energy efficiency, the study from Sun et al. [30] showed that the global energy issue can only be addressed with long-term policies that increase technological progress.

The second group of studies came to different conclusions, concluding that economic globalisation actually reduces emissions and negative climate impacts, especially when combined with more developed environmental regulation. For example, Zafar et al. [14] analysed developed OECD countries, and their empirical analysis showed that globalisation and financial development actually reduce carbon emissions. They concluded that trade in green products can be environmentally beneficial, while environmental policies should encourage local industries to produce and export energy-efficient products. Baloch et al. [18] also found a positive and statistically significant impact of globalisation on energy innovation and the reduction of carbon emissions in OECD countries. Moreover, they suggest that globalisation supports green investments, FDI, and the transfer of technology, which could help in promoting environmentally friendly technologies and mitigate carbon emissions. Sabir and Gorus [31] found that globalisation increases environmental pressures in the cases of South Asian countries, but they also noted that globalisation may not have a negative impact on the environment if environmental laws have been implemented and are in place. Aluko et al. [15] examined the environmental impact of economic globalisation in the case of developed countries based on two aspects—*de facto* and *de jure*. They concluded that the overall economic globalisation and economic globalisation reduce environmental degradation, but in terms of the *de facto* and *de jure* aspects, they concluded that only economic globalisation *de facto* reduces environmental degradation. He et al. [16] studied the effects of economic complexity, economic growth, renewable energy, and globalisation on CO₂ emissions in the top 10 energy transition economies (Iceland, France, New Zealand, the United Kingdom, Finland, Austria, Switzerland, Denmark, Norway, and Sweden) where renewable energy and globalisation have increased signifi-

cantly over the past three decades. They also analysed the joint effects of globalisation and economic complexity on CO₂ emissions. Their long-term results confirm that globalisation, renewable energy, and economic complexity reduce carbon emissions, while economic growth increases carbon emissions. In addition, the joint effect of economic complexity and globalisation promotes environmental sustainability. Although most of the studies that found similar results focused on developed economies, some papers confirmed the same for less developed countries as well. For example, Khan et al. [13] investigated the relationship between globalisation, economic growth, energy consumption, and CO₂ emissions in South Asian countries. They found that globalisation, economic growth, and energy consumption have a positive impact on environmental degradation. Similarly, Xue et al. [20] concluded that increased globalisation improves the environmental quality in South Asian countries in both the short run and long run. Islam et al. [13] examined the effects of globalisation, economic dynamics, and energy consumption on CO₂ emissions in Bangladesh. The results indicated that globalisation, FDI, and innovation have a reducing effect on carbon emissions, while energy consumption, economic growth, trade, and urbanisation increase carbon emissions in Bangladesh. Adebajo and Shakiru [32] researched Jordan, and their results supported the Environmental Kuznets Curve (EKC). The results indicated that Jordan has achieved a sufficient growth level to keep environmental pollution at low levels and provide a healthy environment. Muhammad and Khan [17] examined the impact of globalisation on the environment in 170 world countries and concluded that economic globalisation decreases CO₂ emissions.

Although one might expect different effects in different countries, even the same countries arrive at different results using different methods and time periods. Dinda [33] studied the impact of globalisation on the pollution levels in OECD, non-OECD countries, and at the global level during the period 1965–1990. The research results show that globalisation plays a different role in developed and developing countries; globalisation contributes to the reduction of CO₂ emissions in developed countries, while it increases CO₂ emissions in developing countries. Kalayci and Hayaloglu [34] examined the effects of economic globalisation and trade openness on GHG emissions in NAFTA countries during 1990–2015 and found that higher levels of economic globalisation led to higher CO₂ emissions. Nevertheless, they found a negative correlation in linear and quadratic forms between economic growth and CO₂ emissions and concluded that developed countries above a certain income level invested more in energy efficiency and low-carbon technologies, thereby reducing pollution. Shahbaz et al. [35] studied the causality between economic globalisation and GHG emissions in 25 developed countries and found the same relationship for most countries. Vlahinić Lenz and Fajdetić [36] studied the impact of a broader globalisation process on GHG emissions in EU countries, and their results showed that a significant and positive relationship was found between economic globalisation and GHG emissions, while environmental taxes can correct the negative climate effect. On the other hand, social and political dimensions of globalisation reduce the negative climate impact. To achieve net-zero emissions, the EU needs to continue its global leadership on climate change; expand the use of environmental taxes; and boost economic growth based on low-carbon technologies such as hydrogen, energy storage, and CCUS. Table 1 chronologically summarises the above-mentioned papers and gives a short overview.

Table 1. Literature review. Source: authors.

Authors	Countries	Sample Period	Methodology	Dependent Variable	Findings
Dinda [33]	OECD, non-OECD countries	1965–1990	Fixed and random effects	CO ₂ emissions	Globalisation reduces CO ₂ emissions in developed countries and increases CO ₂ emissions in developing countries
Shahbaz et al. [26]	99 high-, middle-, and low-income countries	1975–2012	FMOLS	CO ₂ emissions	FDI reduces CO ₂ emissions in high-income countries; in middle- and low-income countries FDI increase CO ₂ emissions
Zhu et al. [27]	ASEAN-5	1981–2011	Panel quantile regression	CO ₂ emissions	FDI in energy efficient technologies decrease CO ₂ emissions
Shahbaz et al. [35]	25 developed economies in Asia, North America, Western Europe, and Oceania	1970–2014	CCEMG, AMG	CO ₂ emissions	Economic globalisation increases CO ₂ emissions.
Shahbaz et al. [23]	France	1955–2016	ARDL	CO ₂ emissions	FDI increases CO ₂ emissions
Ahmed et al. [22]	Malaysia	1971–2014	ARDL	Ecological footprint	Globalisation increases the ecological carbon footprint
Kalayci and Hayaloglu [34]	NAFTA countries	1990–2015	Fixed and random effects	CO ₂ emissions	Higher levels of economic globalisation increase CO ₂ emissions
Sabir and Gorus [31]	South Asian countries	1975–2017	ARDL	Ecological footprint	Globalisation increases ecological footprint in short and long run
Zafar et al. [14]	OECD	1990–2014	Cup-FM and Cup-BC	CO ₂ emissions	Globalisation and financial development reduce CO ₂ emissions
Abbasi et al. [25]	Bangladesh, China, India, Indonesia, Malaysia, Nepal, Pakistan, and Sri Lanka	1982–2017	FMOLS, VECM, Granger	CO ₂ emissions	Urbanisation and energy consumption increase CO ₂ emissions
Baloch et al. [18]	OECD	1990–2017	PMG/ARDL	GHG emissions	Globalisation affects energy innovations and reduces GHG emissions
Destek [24]	CEE countries	1995–2015	AMG	CO ₂ emissions	Economic globalisation increases CO ₂ emissions
Sun et al. [11]	OECD and B&R countries	1992–2015	CCEMG, AMG	CO ₂ emissions	Trade openness, urbanisation and energy consumption increase CO ₂ emissions
Ahmed et al. [21]	Japan	1971–2016	ARDL	Ecological footprint	Economic globalisation and financial development increase ecological footprint
Aluko et al. [15]	27 industrialised countries	1991–2016	STRIPAT	CO ₂ emissions	Overall economic globalisation reduces environmental degradation
He et al. [16]	Iceland, France, New Zealand, the United Kingdom, Finland, Austria, Switzerland, Denmark, Norway, and Sweden	1990–2018	CS-ARDL, CCEMG	CO ₂ emissions	Globalisation and renewable energy reduce CO ₂ emissions, while economic growth increases CO ₂ emissions
Islam et al. [19]	Bangladesh	1972–2016	ARDL	CO ₂ emissions	Globalisation, FDI and innovation have reducing effect on CO ₂ emissions, while energy consumption, economic growth, trade, and urbanisation increase CO ₂ emissions
Khan et al. [13]	South Asian countries	1972–2017	FMOLS	CO ₂ emissions	Globalisation, economic growth, energy consumption increases environmental degradation
Muhammad and Khan [17]	170 countries	1990–2018	GMM and fixed effects	CO ₂ emissions	Economic globalisation decreases CO ₂ emissions.
Vlahinić Lenz and Fajdetić [36]	EU countries	2001–2018	Arellano-Bond estimator	GHG emissions	Positive relationship was found between economic globalisation and GHG emissions
Xiaoman et al. [10]	MENA countries	1980–2018	Cup-FM and Cup-BC; Granger causality	CO ₂ emissions	Urbanisation, trade openness and economic growth increases CO ₂ emissions
Xue et al. [20]	South Asian countries	1991–2018	Dynamic Common Correlated Effects	Ecological footprint	Increased globalisation improves the environmental quality
Yasmeen et al. [28]	52 Belt & Road countries	1997–2017	ARDL, Driscoll and Kraay methods	Ecological footprint	Technological innovations and FDI reduce carbon footprint
Huo et al. [8]	Developed countries	1970–2019	The Wavelet Coherence (WC) and Quantile on Quantile Regression (QQR) approach	CO ₂ emissions	Globalisation increases CO ₂ emissions

3. Data and Methodology

This study examines the impact of economic globalisation on climate as measured by greenhouse gas emissions. A panel data analysis was conducted for 26 EU member states over the period 2000–2019, with Cyprus excluded from the analysis due to a lack of data. The EU member states are divided into two groups in terms of GDP per capita—above-average and below-average countries. The first group includes countries with a GDP per capita above the EU-27 average in 2019, while the second group includes countries with a GDP per capita below the EU-27 average in 2019. Countries with a GDP per capita above the EU-27 average include Luxembourg, Ireland, Denmark, the Netherlands, Austria, Sweden, Finland, Germany, Belgium, and France. The ones below average are Italy, Malta, Spain, Slovenia, the Czech Republic, Estonia, Portugal, Lithuania, Slovakia, Greece, Latvia, Hungary, Poland, Croatia, Romania, and Bulgaria. The dependent variable is greenhouse gas emissions, expressed in thousand tons. According to our knowledge, all studies investigated the nexus between globalisation and climate by using carbon dioxide (CO₂) emissions as a proxy variable for the climate impact. The novelty of our approach is to use GHG emissions, since CO₂ is only one of the factors responsible for climate and environmental degradation. GHG include CO₂, N₂O in CO₂ equivalents, CH₄ in CO₂ equivalents, HFCs in CO₂ equivalents, PFC in CO₂ equivalents, SF₆ in CO₂ equivalents, and NF₃ in CO₂ equivalents. The research data are available on the Eurostat database.

Economic globalisation is measured by trades in goods, foreign direct investments, and passenger transport. Since economic globalisation is strongly related to energy consumption, we added new variable total energy consumption to capture this consequence of economic globalisation. Many studies used energy consumption as an independent variable to capture the impact of economic activity and energy intensity on carbon emissions (Jamil [37], Muhammad and Khan [17], Berrill et al. [38], and Imran and Ozcatlbas [39]). Furthermore, environmental taxes are also included to capture the impact of climate-friendly policies and their implementation in the taxation system in the European Union. The latter have been investigated by Bashir et al. [40], Ganda and Garidzirai [41], Ghazouani et al. [42], Tibulca [43], and Meireles et al. [44]. The GDP per capita is included as the control variable. The list of independent variables used in our study is shown and explained in Table 2.

Table 2. List of independent variables. Source: authors.

Symbol	Variable	Explanation	Unit	Source
ENERGY	Final energy consumption	Energy consumed by end users, like households, industry, transport, services, and agriculture	million tons of oil equivalent	Eurostat database
ENVI	Environmental taxes	Environmental tax revenues	millions of Euros	Eurostat database
FDI	Foreign direct investments	Net inflows of investments	percentage of GDP	World Bank database
GDPPC	Gross domestic product per capita	Measures economic activity per capita, expressed in current prices	euro per capita	Eurostat database
PASS	Modal split of passenger transport	Percentage of transport by passenger cars in total inland passenger transport performance	passenger kilometre *	Eurostat database
TRADE	Merchandise trade	Sum of merchandise imports and exports as a percentage of GDP	percentage of GDP	World Bank database

* Passenger kilometre is a unit that shows one passenger travelling the distance of one kilometre.

Table 3 summarises the descriptive statistics of the research variables for both groups of the EU member states. The mean, standard deviation, and minimum and maximum values are calculated for each variable. The first group includes 200 observations, while the second group includes 320 observations.

Table 3. Descriptive statistics. Source: authors.

	Mean	Standard Deviation	Minimum	Maximum
Above-Average Countries				
GHG	220,184.5	287,344.2	10,633.91	1,071,950
ENERGY	57.5945	67.0974	3.5	225.4
ENVI	16,436.86	17,555.38	611.35	61,103
FDI	9.090399	16.80333	−57.53231	86.47915
GDPPC	41,076.35	15,549.34	24,280	100,890
PASS	17.0495	2.67777	12.2	23
TRADE	82.70021	37.0175	38.7152	181.3447
Below-Average Countries				
GHG	128,688.1	157,605.1	2231.33	599,463.5
ENERGY	26.36062	34.2268	0.4	137.2
ENVI	6280.989	11,993.63	104.39	59,480.99
FDI	9.98488	39.95855	−40.08106	449.0828
GDPPC	13,266.88	6549.302	1770	30,080
PASS	20.32156	6.458627	7.7	39.2
TRADE	89.85251	38.0914	27.16282	176.4247

The first group of EU member states includes countries that are above the average value of GDP per capita. In this group, the average value of the greenhouse gas emissions was 220,184.5 thousand tons. The highest value was recorded in Germany in 2001 and the lowest in Luxembourg in 2000. In 2019, Germany still had the highest greenhouse gas emissions among the countries studied—829,639 thousand tons. The average final energy consumption is 57.6 million tons of oil equivalent, with the highest value also recorded in Germany in 2006 and the lowest in Luxembourg in 2000. In addition, environmental taxes in the above-average member states have significantly higher average values, indicating that the above-average countries have a well-developed system of energy and environmental taxation. On average, environmental tax revenues amount to 16,436 million EUR, 162% more than in the below-average countries. The highest level was recorded in Germany in 2019. Similar average levels of FDI were recorded in the above-average and below-average EU member states. In the above-average countries, FDI averaged 9.09% of GDP. The highest value of FDI inflows was recorded in the Netherlands in 2007, while the lowest value was negative in Luxembourg in the same year. However, Luxembourg is the country with the highest GDP per capita in this group of member states, which amounted to 100,890 EUR in 2019. The average value of GDP per capita in the observed period was 41,076 EUR. The transport sector has a significant impact on the economy and the environment. The average passenger transport was 17.04 passenger kilometres, with the highest value in Austria in 2019 and the lowest in the Netherlands in 2003. Finally, trade in goods represented, on average, 82% of the GDP. Belgium had the highest share of merchandise trade during the observation period while France had the lowest. In 2019, the Netherlands had the largest share of trade in goods among the observed countries.

In addition, the second group includes EU member states whose GDP per capita is below the EU average. In this group, greenhouse gas emissions averaged 128,688.1 thousand tons during the observation period. This means that the EU member states with an above-average GDP per capita emit, on average, 71% more emissions. The highest value of GHG emissions in countries with a below-average GDP was reached in Italy in 2005, while Malta recorded the lowest value in 2016. Countries with a below-average GDP also have lower final energy consumption, averaging 26.4 million tons of oil equivalent. Italy marked the highest value in 2005, while Malta had the lowest value in the final energy consumption. The level of

environmental taxes in below-average countries is significantly lower than in the first group. Italy had the highest environmental taxes in 2016. Foreign direct investment accounts for 9.98% of the GDP on average, slightly higher than the first group. Malta had the highest value in 2007, while the negative inflow in Hungary was in 2018. In 2019, Malta has the highest value of FDI inflows at 26.5% of the GDP. The average value of GDP p/c in the observed period was 13,266 EUR, with the highest value in Italy in 2019. In this group, the average value of foreign direct investment is slightly higher than in the first group of above-average countries. The highest value was recorded in Bulgaria in 2000 and the lowest in Lithuania in 2007. In 2019, Hungary had the highest value for passenger transport with 27.1 passenger kilometres and Slovakia with 26.2 passenger kilometres. This group also recorded higher levels of trade than the first group, with an average of 89.9% of the GDP. Slovakia had the highest level of trade in goods in 2018, while Greece recorded the lowest level in 2002. In 2019, Slovakia and Slovenia had the highest levels of trade in goods, over 160% of their GDP.

To determine the relationship between the selected variables and their influence on the GHG emissions, we used a unit root analysis, cointegration analysis, the Granger causality test, and dynamic panel analysis.

3.1. Panel Unit Root Test

The Im–Pesaran–Shin [45] and Phillips–Perron [46] unit root tests were employed to analyse the stationarity of the employed variables. The following equation is the starting point for the unit root tests:

$$\Delta y_{it} = \phi y_{i,t-1} + z'_{it} \gamma_i + \epsilon_{it} \quad (1)$$

where y_{it} is the variable that is being tested, $z'_{it} \gamma_i$ represents the panel-specific means, and ϕ is the panel-specific AR parameter. The null hypothesis is that all the panels contain unit roots. The results are shown in Table 4.

Table 4. Unit root test results. Source: authors.

Variables	Im–Pesaran–Shin		Phillips–Perron	
	Level	First Differences	Level	First Differences
Above-Average Countries				
GHG	4.5966 (1.0000)	−7.9920 (0.0000)	−2.6153 (0.9955)	42.7287 (0.0000)
ENERGY	−3.3672 (0.0004)	−9.0488 (0.0000)	8.5399 (0.0000)	78.6006 (0.0000)
ENVI	5.8184 (1.0000)	−6.3599 (0.0000)	0.3481 (0.3639)	21.5025 (0.0000)
FDI	−3.7678 (0.0001)	−7.7415 (0.0000)	8.3384 (0.0000)	42.6965 (0.0000)
GDPPC	3.4167 (0.9997)	−5.8995 (0.0000)	−2.2320 (0.9872)	17.0017 (0.0000)
PASS	0.6725 (0.7494)	−7.3034 (0.0000)	−0.1544 (0.5613)	28.4222 (0.0000)
TRADE	−1.5884 (0.0561)	−6.4513 (0.0000)	2.7737 (0.0028)	20.1302 (0.0000)
Below-Average Countries				
GHG	4.5910 (1.0000)	−6.5044 (0.0000)	−2.6625 (0.9961)	15.2185 (0.0000)
ENERGY	0.8230 (0.7947)	−7.4027 (0.0000)	−1.2993 (0.9031)	21.8478 (0.0000)
ENVI	2.7649 (0.9972)	−7.5268 (0.0000)	−1.5797 (0.9429)	23.4759 (0.0000)
FDI	−2.2819 (0.0112)	−7.0751 (0.0000)	2.9614 (0.0015)	17.2787 (0.0000)
GDPPC	4.1968 (1.0000)	−5.2455 (0.0000)	1.5914 (0.0558)	9.3828 (0.0000)
PASS	−2.2363 (0.0127)	−8.2031 (0.0000)	2.3393 (0.0097)	30.9505 (0.0000)
TRADE	−0.3434 (0.3656)	−6.9018 (0.0000)	−0.4340 (0.6679)	19.1117 (0.0000)

The acquired results show that, in the first dataset, the final energy consumption, the FDI level, and merchandise trade are stationary. In the second dataset, the FDI level and passenger transport are stationary. Other variables are affirmed to be nonstationary. Moreover, in the first differences, all the variables have become stationary, and the null hypothesis can be rejected. We can conclude that all the variables are integrated at order I.

3.2. Panel Cointegration Analysis

To examine the existence of a long-run relationship among the variables, a cointegration analysis was employed using the Pedroni test [47]. The cointegration test was based on the following model:

$$y_{it} = x'_{it}\beta_i + z'_{it}\gamma_i + e_{it} \quad (2)$$

where y_{it} is the dependent variable, and x_{it} is the independent variable. β_i denotes the cointegration vector that may vary across panels, and γ_i represents the vector of coefficients on z_{it} , which is the deterministic term that controls for panel-specific effects and linear time trends. e_{it} is the error term. The within dimension test allowed for panel-specific cointegrating vectors and AR parameters. The in between dimension AR parameter was the same across all panels. The null hypothesis states there is no cointegration between variables. The rejection of the H_0 implies that e_{it} is stationary and that x_{it} and y_{it} are cointegrated. The results presented in Table 5 reject the null hypothesis, indicating there is a cointegration between the variables.

Table 5. Pedroni cointegration test results. Source: authors.

Between-Dimensions			Within-Dimension		
	Test Statistics	Probability		Test Statistics	Probability
Above-Average Countries					
			Modified variance ratio	−3.2164	0.0006
Modified Phillips–Perron t	3.3370	0.0004	Modified Phillips–Perron t	1.6990	0.0447
Phillips–Perron t	−1.8436	0.0326	Phillips–Perron t	−1.8755	0.0304
Augmented Dickey–Fuller t	−2.1557	0.0156	Augmented Dickey–Fuller t	−2.1442	0.0160
Below-Average Countries					
			Modified variance ratio	−4.9020	0.0000
Modified Phillips–Perron t	4.9550	0.0000	Modified Phillips–Perron t	3.4060	0.0003
Phillips–Perron t	−3.3976	0.0003	Phillips–Perron t	−2.5343	0.0056
Augmented Dickey–Fuller t	−3.8371	0.0001	Augmented Dickey–Fuller t	−3.7356	0.0001

3.3. Granger Causality Test

To identify the direction of the causal relationship, the Granger causality test for the panel data was employed, which implemented the procedure proposed by Dumitrescu and Hurlin [48]:

$$y_t = \alpha + \sum_{k=1}^K \gamma_{ik} y_{i,t-k} + \sum_{k=1}^K \beta_{ik} X_{i,t-k} + \varepsilon_{i,t} \quad (3)$$

where α is the slope of intercept, $X_{i,t}$ and $y_{i,t}$ are the observations of the two variables for individual i in period t , k is the number of the lag order, which is assumed to be identical for all individuals, and γ_{ik} and β_{ik} are the slopes of the coefficients. The null hypothesis states that the independent variable does not Granger cause the dependent variable. If the null hypothesis is rejected, we can conclude that the causality between x and y exists. Table 6 summarises the causality test results.

Table 6. Granger causality test results. Source: authors.

Above-Average Countries							
Indep./Dep.	GHG	ENERGY	ENVI	FDI	GDPPC	PASS	TRADE
GHG	/	6.8689 (0.0000)	1.3741 (0.1694)	3.0123 (0.0026)	0.1531 (0.8783)	2.7030 (0.0069)	−0.1033 (0.9178)
ENERGY	9.6962 (0.0000)	/	0.7473 (0.4549)	−1.0179 (0.3087)	0.7942 (0.4271)	−0.7385 (0.4602)	0.0447 (0.9643)
ENVI	10.3742 (0.0000)	7.2109 (0.0000)	/	−0.0819 (0.9347)	0.9250 (0.3550)	3.0902 (0.0020)	0.7148 (0.4747)
FDI	−0.9085 (0.3636)	−1.1338 (0.2569)	2.3783 (0.0174)	/	2.0414 (0.0412)	−1.0608 (0.2888)	−1.3656 (0.1721)
GDPPC	18.9039 (0.0000)	11.4853 (0.0000)	0.1552 (0.8767)	0.3804 (0.7037)	/	7.3276 (0.0000)	1.6302 (0.1031)
PASS	3.5208 (0.0004)	6.7219 (0.0000)	−0.6045 (0.5455)	0.2315 (0.8169)	0.8498 (0.3954)	/	1.4139 (0.1574)
TRADE	13.2225 (0.0000)	9.9292 (0.0000)	2.6181 (0.0088)	−1.6797 (0.0930)	1.2055 (0.2280)	1.1790 (0.2384)	/
Below-Average Countries							
indep/dep	GHG	ENERGY	ENVI	FDI	GDPPC	PASS	TRADE
GHG	/	4.4352 (0.0000)	−0.7489 (0.4539)	1.7522 (0.0797)	−0.4593 (0.6460)	0.8198 (0.4123)	4.8680 (0.0000)
ENERGY	3.6209 (0.0003)	/	1.5667 (0.1172)	0.3458 (0.7295)	1.8756 (0.0607)	1.9451 (0.0518)	2.2398 (0.0251)
ENVI	5.0935 (0.0000)	1.9253 (0.0542)	/	2.1896 (0.0286)	6.6637 (0.0000)	1.0069 (0.3140)	3.3273 (0.0009)
FDI	−0.1558 (0.8762)	−0.6190 (0.5359)	−0.5556 (0.5785)	/	1.1935 (0.2327)	0.9083 (0.3637)	4.5551 (0.0000)
GDPPC	9.1246 (0.0000)	3.3722 (0.0007)	1.2811 (0.2002)	1.9847 (0.0472)	/	2.3575 (0.0184)	1.3694 (0.1709)
PASS	4.3970 (0.0000)	3.1682 (0.0015)	1.0463 (0.2954)	2.0197 (0.0434)	1.9037 (0.0570)	/	3.6230 (0.0003)
TRADE	6.2706 (0.0000)	3.5184 (0.0004)	1.1908 (0.2337)	0.4442 (0.6569)	2.2249 (0.0261)	−1.2369 (0.2161)	/

The results show that all the independent variables, apart from FDI, exhibit Granger causality for GHG emissions for at least one panel unit in both groups of the EU member states. In the group of above-average countries, bidirectional causality was found between the GHG emissions and final energy consumption. Causality was found between environmental taxes and GDP p/c. In the group of below-average countries, a bidirectional causality was found between GHG emissions and final energy consumption and merchandise trade and final energy consumption.

4. Results and Discussion

A dynamic panel analysis was conducted using the Arellano–Bond estimation [49], where the lagged levels of GHG emissions were considered. Arellano–Bond uses the robust standard error estimator. The AR (2) test presents no serial correlation in the first-differenced errors at order 2 and presents no evidence of model misspecification. The model is presented with the following equation:

$$GHG_{it} = \beta_0 GHG_{i(t-1)} + \beta_1 ENERGY_{it} + \beta_2 ENVI_{it} + \beta_3 FDI_{it} + \beta_4 GDPPC_{it} + \beta_5 PASS_{it} + \beta_6 TRADE_{it} \varepsilon_{it} \quad (4)$$

where GHG_{it} is the dependent variable; $\beta_0, \beta_1, \beta_2, \beta_3$, and β_4 represent the parameters to be estimated; μ are country-specific effects; and ε is the error term. The results are given in Table 7.

Table 7. Arellano and Bond dynamic panel analysis. Source: authors.

Above-Average Countries		
Dependent Variable: Greenhouse Gas Emissions (GHG)	Coefficients	p-Value
GHG _{t-1}	0.8038387	0.000
ENERGY	3470.154	0.000
ENVI	0.5420934	0.000
FDI	−2.55721	0.905
GDPPC	−0.2745401	0.037
PASS	−106.2369	0.795
TRADE	7.435416	0.904
Constant	−155,159.6	0.022
AR(1) test (p-value)	−1.9002	0.0497
AR(2) test (p-value)	0.02308	0.9816
Below-Average Countries		
Dependent Variable: Greenhouse Gas Emissions (GHG)	Coefficients	p-Value
GHG _{t-1}	0.4526657	0.000
ENERGY	2551.149	0.000
ENVI	−2.340656	0.000
FDI	1.788677	0.552
GDPPC	−0.827855	0.089
PASS	−187.115	0.484
TRADE	14.62691	0.694
Constant	30,948.81	0.061
AR (1) test (p-value)	−1.9427	0.0489
AR (2) test (p-value)	−1.9563	0.0504

Note: The robustness of the Arellano–Bond specification is tested using the Arellano–Bond AR (1) and AR (2) tests. The AR (2) test presents no serial correlation in the first-differenced errors at order 2.

As explained earlier, the new approach in dealing with EU countries is that we divide EU countries into two subpanels according to their GDP per capita in order to capture the heterogeneity at the development level. In this way, we aim to examine the importance of the development level, because the same policies can have considerably different effects for differently developed economies. Therefore, all countries are divided into two groups: one group with above-average and one with below-average GDP per capita. According to this criterion, Luxembourg, Ireland, Denmark, the Netherlands, Austria, Sweden, Finland, Germany, Belgium, and France are above-average performers. Below-average members include Italy, Malta, Spain, Slovenia, the Czech Republic, Estonia, Portugal, Lithuania, Slovakia, Greece, Latvia, Hungary, Poland, Croatia, Romania, and Bulgaria.

The results show that greenhouse gas emissions are corrected by 803 tons of CO₂ equivalent per year in the group of above-average countries and by 452 tons of CO₂ equivalent per year in the group of below-average countries. In addition, the final energy consumption was found to have a positive and statistically significant impact on GHG emissions in both

groups of countries. The results revealed similar conclusions as Muhammad and Khan [17] and Sterpu et al. [50] that energy consumption is a significant contributor to the GHG emission level. However, this impact is higher in the above-average countries, with an increase in emissions of 3470 thousand tons of CO₂ equivalent. In the below-average countries, the increase in emissions from the final energy consumption is 2551 thousand tons of CO₂ equivalent. Environmental taxes show statistically significant results but with different results in the two groups. Although the level of environmental taxes is significantly higher in the above-average countries, the results show positive effects on the level of GHG emissions, indicating the inadequacies of the tax system and the inability to reduce GHG emissions. In contrast, environmental taxes in countries below the average have a negative impact on GHG emissions, which are reduced by 2.3 thousand tons of CO₂ equivalent. The GDP per capita as a control variable reduces GHG emissions by 274 tons of CO₂ equivalent in more developed countries than average. This result is statistically significant at a 5% significance level. In below-average countries, the GDP per capita reduces GHG emissions by as much as 827 tons of CO₂ equivalent. This result is statistically significant at a 10% significance level. Economic globalisation was examined with the FDI inflow, passenger transport, and trade in goods. The inflow of foreign direct investment showed statistically insignificant results in both groups. In the first group, the results indicate that higher FDI inflows reduce the level of GHG emissions, while, in the second group, FDI inflows increase the level of GHG emissions. These results could be related to the technological level of new foreign investments, as FDI inflows in more developed EU countries are more sophisticated and less harmful to the environment and climate. Passenger transport was found to have a reducing effect on GHG emissions in both groups but was statistically insignificant. Furthermore, merchandise trade increased GHG emissions in both groups of countries, which is aligned with Islam et al. [19] and Sun et al. [51]. The results point out that a trade in goods still significantly contributes to the environmental degradation. Nevertheless, globalisation has to promote the exchange of technology and know-how in order to reduce the negative impacts of transportation and trade.

The results show that some aspects of economic globalisation in EU countries reduce GHG emissions, especially passenger transport, which has a reducing effect on GHG emissions in both groups of countries. The inflow of foreign direct investment could also be important for the technology transfer of green technologies and have a positive impact on emissions and the climate. Our results reconfirm the Environmental Kuznets Curve, as the economic growth, measured by GDP per capita, reduces GHG emissions and provides environmental improvement. As expected, there are differences between the two groups of countries that confirm our hypothesis that the development level is an important predictor of sustainability. Although we did not examine the underlying mechanisms, these asymmetric effects are likely attributable to a combination of factors. Therefore, economic growth remains a top priority for all EU countries, especially economies with below-average GDP per capita. Our results showed that international trade in goods and energy consumption increase emissions and harm the climate in both groups of countries, but the effects of financial globalisation and environmental taxes on GHG emissions differed between the above and below-average countries. Given the common outcomes for both groups, it seems important to continue the transition towards a green economy, change the energy mix, increase the use of renewable energy sources, and increase the trade openness. This is especially important for EU economies, which are mostly small- and medium-sized economies, and deglobalisation will not be the right policy response to the unfavourable current circumstances. During this crisis, new deteriorations have occurred, and some EU countries have increased their coal consumption and CO₂ emissions despite Green Deal climate targets and decarbonisation commitments. The European Union is particularly vulnerable to an energy crisis due to its high energy dependence on imported fossil fuels from Russia, while the inflation is increasing due to the rise in energy and all other prices. At the same time, the next few years are crucial for climate action and an opportunity to keep the 1.5 °C limit within the set climate targets. So far, governments have largely missed

their opportunity to shift energy supplies away from fossil fuels. Instead, we are seeing a global “gold rush” for new fossil gas production, pipelines, and liquefied natural gas (LNG) facilities. Fossil gas production and infrastructure expansion are being planned around the globe with the argument of replacing Russian gas. All these projects are strongly opposed to the energy transition and decarbonisation targets for 2030 and 2050. The current energy crisis risks locking the European and global economy into another carbon-rich decade and preventing the Paris Agreement’s 1.5 °C limit from being met.

However, we hope that this was only a short-term trend, and that the energy transition will accelerate in the future. Governments should promote the transfer of low-carbon technologies and improve their energy efficiency and conservation, as well as create appropriate policy incentives to reduce greenhouse gas emissions. Financial globalisation can help, and a higher level of development could be beneficial for CO₂ mitigation and climate change. Technology transfer through foreign direct investment and more developed and electrified passenger transport, supported by higher levels of environmental regulation and protection, could reduce GHG emissions and mitigate climate change.

5. Conclusions

On the eve of the likely economic recession and deglobalisation trends in the European Union due to the energy crisis, energy supply problems, and inflation, the issue of climate change and greenhouse gas emissions took a backseat, to some extent. However, the long-term goal of all countries is certainly to reduce emissions and ensure sustainable growth for current and future generations. Therefore, the issue of the impact of economic activity and globalisation on the climate remains extremely important and should be discussed both in academia and in the general public. The aim of our paper is to test the hypothesis of globalisation-induced greenhouse gas emissions and provide some new empirical evidence for the European Union. Although there is a growing body of research and some of it is mentioned in the literature review, the apparently ambiguous results suggest that we still do not have a conclusive answer to the question of whether globalisation is harming the climate and what policies and measures policymakers should adopt to save the climate without reducing the economic activity. Our study focused only on economic globalisation, and we chose several variables to capture different aspects of this globalisation: trade globalisation, measured as the share of goods trade in GDP; financial globalisation, measured as the share of foreign direct investment in GDP; and mobility, measured as passenger transport. We introduced two control variables: GDP per capita, to capture heterogeneity during development, and energy consumption, as a proxy for the energy intensity. Since we want to investigate whether the policy framework can reduce emissions and improve sustainability, we also included environmental taxes as an independent variable. After applying the panel cointegration analysis and the Granger causality test, a dynamic panel analysis was performed for 26 EU countries using the Arellano–Bond estimator. From a policy perspective, the analysed countries are divided into two subpanels depending on their level of development—EU countries with above-average and below-average GDP per capita.

After examining the impact of different dimensions of economic globalisation and environmental taxes on GHG emissions, the results show that: (1) trade globalisation has a detrimental effect on climate, as trade openness significantly increases the emissions in both groups of countries. Financial globalisation has a weaker effect, increasing emissions only in below-average countries, suggesting that FDI inflows may be important for transferring green technologies when a country reaches a higher level of development. (2) Passenger transport reduces GHG emissions in both country groups, while FDI benefits the climate in above-average countries. (3) Environmental taxes show statistically significant results but with different results in the two groups. Although the level of environmental taxes is significantly higher in above-average countries, the results show positive effects on the level of GHG emissions, indicating the shortcomings of the tax system in addressing climate change. On the other hand, environmental taxes in countries below the average

have a negative impact on GHG emissions, which are reduced by 2.3 thousand tons of CO₂ equivalent. (4) The total energy consumption significantly increases emissions in both groups of countries, thus harming the climate. However, this impact is higher in above-average countries, with an increase in emissions of 3470 thousand tons of CO₂ equivalent. In below-average countries, the increase in emissions from the final energy consumption is 2551 thousand tons of CO₂ equivalent. Since energy consumption is strongly related to economic activity and economic growth, EU countries should focus on a green economy and transition to low-carbon energy sources, as this would be the way to reduce greenhouse gas emissions and, at the same time, reduce the dependence on imported fossil fuels. Our results confirm the heterogeneity among the EU countries related to their level of development. Some of the variables (foreign direct investment and environmental taxes) have different effects and significance for the different groups of countries, while only trade openness and energy consumption have the same impact for both groups. These results suggest that there is a disparity between EU countries, not only in the level of development but also in the economic and energy structures. Having in mind these differences, governments should promote the transfer of low-carbon technologies and improve their energy efficiency and conservation, as well as create appropriate policy incentives to reduce greenhouse gas emissions. Financial globalisation can help, and a higher level of development could be beneficial for CO₂ mitigation and climate change. Technology transfer through foreign direct investment, and more developed and electrified passenger transport, supported by higher levels of environmental regulation, could reduce GHG emissions and mitigate climate change.

This study is limited to a few variables that are considered when evaluating the impact of economic globalisation on GHG emissions. Future research could expand the model by introducing new variables, such as urbanisation and energy consumption from renewable and fossil fuels. It would also be interesting to include financial development and green finance to assess the impact of sustainable policies other than environmental taxes. The study can be further extended by using advanced econometric techniques that can better show the links between different aspects of economic globalisation and carbon emissions, providing a clearer picture for policy implications.

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